A CROSS-COUNTRY REPLICATION STUDY OF THE IMPACT OF QUALITY MANAGEMENT ON PERFORMANCE

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ABSTRACT

Enormous research has been done on QM in western countries. Yet, there is limited QM research in eastern countries. This study replicates the TQM/Six Sigma model in Zu, Fredendall and Douglas (2008) with data collected from China. The findings reveal similarities and differences of QM implementation between China and US.

INTRODUCTION

With the increasing globalization of market and production, more and more companies in western developed countries expand their production and operations overseas or rely on international suppliers to provide materials and products. As the companies move their production and operations across countries, management methods are transferred as well, in order to ensure that effective control and management can be achieved in their international facilities or their foreign suppliers’ sites. Quality management (QM) is one area that managers particularly emphasize in the process of globalizing their operations and supply chains. However, when management methods are applied from one culture to another, it is a major concern about the universal applicability of QM across cultures (Rungtusanatham et al., 1998, 2005). While there have been extensive research and profound findings on QM in US and other western countries, little is known about the implementation of QM and its impact in eastern countries,
and even less research that compares and assesses the similarities and differences of QM implementation between western and eastern countries.

Over the past three decades, China has experienced remarkable economic growth and become increasingly important to the global economy, owing to its huge market potential, relative low cost of land and labor, increasing manufacturing capability and capacity, favorable policies toward foreign investments, and constant government investment in infrastructure development (Jiang, 2002; Jiang et al., 2007; Zhao et al. 2006). Being one of the largest manufacturing sites in the world, China has developed from a supplier of low-end products such as toys and textiles to a producer of almost all types of products, including those of higher value and technology (Jiang et al., 2007). As a dramatically growing number of products are supplied from manufacturers in China to consumers around the world, it becomes important and necessary to understand how those manufacturers manage their product quality. In addition, China is an exemplar country in Asia and has a tremendous influence over other Asian countries, especially those in East Asia, through its cultural and social heritage. In China, QM methods, particularly Total Quality Management (TQM), have been widely accepted and promoted in order to assure quality in light of increasing global competition during the time of its rapid economic growth (Tuan and Ng, 1998). Recently, there is an increasing trend of adopting Six Sigma in China (He 2009), but little is known about how it is implemented (Zhao et al., 2006). Essentially, there still lacks answers to the question of whether the QM practices that are initiated and developed in US work the same way in China. In order to answer the above question, this study attempts to perform a cross-country replication of the QM practices-performance relationships proposed in Zu et al. (2008) by using data collected from firms operating in China.

Understanding of QM implementation in China provides valuable knowledge about not only the country itself but also other Asian countries which are the critical manufacturers and suppliers to the global market. In the study by Zu et al. (2008), the QM-performance model, which includes a comprehensive set of QM practices – both total quality management (TQM) and Six Sigma, was empirically tested via a sample of manufacturers operating in US. Through a replication study, this study intends to evaluate the generalizability of QM implementation in China which has different sociocultural environments and to establish the external validity of existing QM-performance framework to accumulate scientific knowledge of QM. Replication research is crucial to theory development (Berthon et al., 2002; Easley et al. 2000; Hubbard et al., 1998; Lindsay and Ehrenberg, 1993; Singh et al. 2003; Tsang and Kwan 1999) because it helps us discover “whether methods that work in one environment will be as well applied in another” (Berthon et al., 2002, p. 423). The results of this study also provide insights that are especially important for companies which have to manage their operations or supply chains across countries in today’s global economy.

QUALITY MANAGEMENT IN CHINA

As early as the 1950s, statistical quality control (SQC) had been introduced to China, but it was used only in selected firms under the centralized, planned economic system (Lau et al., 2004; Liu, 1994; Tuan and Ng, 1998). After the Chinese government started the economic reform and open-door policy in 1978, Chinese companies became exposed to high-quality products of foreign companies, and more importantly, to their advanced QM methods and international quality
standards (Lau et al., 2004; Lee et al. 2001). In order to meet the new requirements of market-driven economy, Chinese companies were under pressure to change the way they had been operating, and they had to examine their existing quality control procedures and to adopt advanced QM methods in order to comply with international standards (e.g., Chin et al., 2001; Liu, 1994; Liu and Willborn, 1990). New ideas and techniques of QM, such as quality circles, total quality control, total preventive maintenance, ISO, TQM, and Six Sigma, have been extensively implemented in China (Hopkins et al., 2004; Lau et al., 2004; Xu et al., 2006). The adoption of advanced QM methods at companies in China is accompanied and driven by governmental legislation and administration as an institutional force (Tuan and Ng, 1998), though it is noticed that these laws are not always strictly enforced (Li et al., 2003). After China joined the WTO as a member in 2001, the QM methods are being increasingly applied by the Chinese production industry, which is faced with even more pressure to improve product and service quality so that they can compete not only in domestic market but also in global markets.

Corresponding to the growing implementation of QM in China, researchers have investigated various issues in this subject, including the status of QM development in China (e.g., Lau et al., 2004; Li et al., 2003; Yeung et al., 2003; Zhao et al., 2004), the impact of QM implementation on performance (e.g., Lee et al., 2001; Su et al. 2008), the comparison of QM in China versus other countries (e.g., Rao et al. 1997; Sun 2000), and the effect of national or Chinese culture on QM implementation (e.g., Noronha 2002, 2003; Pun 2001). However, few studies have thoroughly examined the interrelationships among QM practices at companies in China. Only one study by Yeung et al. (2005), based on a sample of 225 electronics companies in Hong Kong and the Pearl River Delta region of China, explored the linkages among various QM practices. Moreover, in recent years, Six Sigma is gaining popularity in the Chinese industry, but little research about Six Sigma implementation in China has been published in the English literature; one exception is the study by He (2009), in which a conceptual framework for assessing the maturity of Six Sigma deployment in China is proposed but not empirically tested. It is important to develop an up-to-date understanding of the degree to which Six Sigma is adopted and how it is applied at companies in China (Zhao et al., 2006).

When studying QM in China, it is important to recognize that China’s social and cultural environments have profound implications on QM implementation (Lau et al., 2004). Researchers suggest that in developing countries, their different sociocultural and socioeconomic environments may influence the transfer of advanced QM concepts, principles, and techniques (Goonatilake, 1988; Mersha, 1997). Management theory and practice are tightly bounded with the context where they are applied in, particularly in China (Shenkar and von Glinow 1994). Many suggest that Chinese society exhibits culture and ideology largely different from western countries (Hofstede 1991; Ogden and Cheng, 2005; Xing 1995). Chinese society is characterized by a number of salient sociocultural factors, such as prevalent reliance on guanxi for doing business, large power distance, high collectivism, and high Confucian dynamism (i.e., long-term orientation). These sociocultural characteristics affect Chinese people’s beliefs, attitudes and behavior, which can have a bearing on how QM principles and practices are applied at companies in China (Noronha 2002, 2003; Pun 2001; Zhao et al. 2006). Therefore, it is necessary and valuable to study whether the model developed in the western business context is applicable in the context of China. This study attempts to examine the applicability of the QM
practices-performance framework in China and to provide theory-driven guidelines to sustain effective QM implementation in a global scope.

LITERATURE REVIEW AND THEORETICAL FRAMEWORK

TQM has been extensively studied in terms of its key principles and practices, its implementation, and its impact on firm performance. As a result of significant efforts of previous research studies, the literature has generally agreed about what constitute TQM practices and their interrelationships and effects on firm performance. Distinctive TQM models can be found in studies such as Anderson et al. (1995), Flynn et al. (1995), and Kaynak (2003), among others. On the other hand, Six Sigma represents the most recent development of QM, which adds an organized structure of process improvement and product/service development by using improvement specialists, a structured method, and performance metrics to achieve strategic objectives (Linderman et al., 2003; Schroeder et al., 2008; Swink and Jacobs, 2012). In western business settings, research on Six Sigma has empirically examined its efficacy on firm performance (Foster, 2007), quality improvement effectiveness (Linderman et al., 2006), and knowledge creation (Choo et al., 2007). Based on previous research, Zu et al. (2008) proposed a QM model that integrates traditional TQM practices with Six Sigma practices.

In this model, TQM and Six Sigma practices are viewed from the perspective of infrastructure-core QM practices as suggested by Flynn et al. (1995). Prior research on QM concurs that key TQM practices can be categorized into two groups: infrastructure/soft practices and core/hard practices. The infrastructure or soft TQM practices include people- and culture-oriented practices focusing on organization change and development in the areas of management commitment and leadership, relationships with external customers and suppliers, and the management of human resources. The core or hard TQM practices are technique- and methodology-oriented practices including the use of quality data and information, product design, statistical process control (SPC), and other process improvement techniques (Evans and Lindsay, 1999; Flynn et al., 1995; Wilkinson, 1992). It is suggested that the infrastructure practices create an organizational environment supporting the application of the core practices, which in turn directly lead to quality performance. The validity of this type of QM practice-performance relationship has been supported by findings of empirical studies (e.g., Anderson et al., 1995; Kaynak, 2003; Kaynak and Hartley, 2008; Rahman and Bullock, 2005, Yeung et al., 2005). The study by Zu et al. (2008) extended the infrastructure-core model to include Six Sigma. In the model, Six Sigma role structure represents the infrastructure practice in Six Sigma, while Six Sigma structured improvement procedure and focus on metrics are the core practices. Using a sample of US manufacturers, Zu et al. (2008) studied the relationships among TQM and Six Sigma practices, suggesting that Six Sigma should be integrated with TQM to produce synergistic effects on quality improvement. Figure 1 presents the original relationships proposed in Zu et al. (2008).
**Figure 1. Proposed model of TQM/Six Sigma implementation in Zu et al. (2008)**

**H1a.** Top management support is positively related to the three TQM infrastructure practices.
**H1b.** Top management support is positively related to Six Sigma role structure.
**H1c.** Top management support is positively related to Six Sigma focus on metrics.

**H2a.** Customer relationship is positively related to quality information.
**H2b.** Supplier relationship is positively related to product/service design.
**H2c.** Supplier relationship is positively related to process management.
**H2d.** Workforce management is positively related to the three TQM core practices.

**H3a.** Six Sigma role structure is positively related to workforce management.
**H3b.** Six Sigma role structure is positively related to Six Sigma structured improvement procedure.

**H4a.** Quality information is positively related to supplier relationship.
**H4b.** Quality information is positively related to product/service design.
**H4c.** Quality information is positively related to process management.
**H4d.** Quality information is positively related to Six Sigma focus on metrics.
**H4e.** Product/service design is positively related to quality performance.
**H4f.** Process management is positively related to quality performance.
**H4g.** Product/service design is positively related to process management.

**H5a.** Six Sigma structured improvement procedure is positively related to product/service design.
**H5b.** Six Sigma structured improvement procedure is positively related to process management.
**H5c.** Six Sigma structured improvement procedure is positively related to Six Sigma focus on metrics.
**H5d.** Six Sigma focus on metrics is positively related to product/service design.
H5e. Six Sigma focus on metrics is positively related to process management.

RESEARCH METHODOLOGY

Survey instrument

The survey instrument used in Zu et al. (2008) was originally developed based on an extensive review of the QM literature. The measurement items for seven TQM practices were extracted from empirical studies on TQM, including Anderson et al. (1995), Douglas and Judge (2001), Flynn et al. (1994, 1995), and Kaynak (2003). The items designed to measure the implementation of three Six Sigma practices were developed by reviewing the academic and practitioner literatures on Six Sigma (e.g., Bhote, 2003; Breyfogle et al., 2001; Choo et al., 2004; George, 2003; Linderman et al., 2003; Pande et al., 2000, 2002; Schroeder, 2000). These items are to capture the degree to which companies apply different techniques and activities involved in those TQM/Six Sigma practices. Quality performance is measured by multiple items assessing a company’s performance in product quality, process variability, delivery, customer satisfaction, and other related aspects, whereas business performance is to evaluate the company’s financial and marketing performance. The items for quality and business performances were adapted from empirical research on QM and performance (e.g., Choi and Eboch, 1998; Douglas and Judge, 2001; Flynn et al., 1995; Kaynak, 2003; Powell, 1995; Samson and Terziovski, 1999; Reed et al., 1996). The polar points pertaining to the items for TQM, Six Sigma, and performance were “strongly disagree = 1” and “strongly agree = 7”.

Because Zu et al. (2008) targeted the US manufacturing companies, the initial survey questionnaire was developed in English. Yet, the current study seeks to evaluate the manufacturing companies in China. Accordingly, following the suggestion of Brislin (1970) regarding translation in cross-cultural studies, in this study we first translated the English version of survey questionnaire into Chinese by one author and then another author checked the translation for correctness and understandability. Next, the Chinese version of questionnaire was back-translated into English by another bilingual – in English and Chinese – professional who has an education background in operations management. The back-translated English version was verified against the original English version for consistency. In this process, several questions were reworded to more accurately reflect the original meaning of the questions in English. The Chinese version of the questionnaire was then pilot-tested on four operations managers from China. They were asked to assess whether every question is accurate, understandable, and easy to read. Their feedback was used to refine the questionnaire.

Sample and data collection

In the current study, a sample was collected from manufacturing companies operating in mainland China. The sampling frame consisted of 789 manufacturing companies selected from registered members of the China Association for Quality and several provincial associations of enterprises. We sought companies of different demographic and operating characteristics so as to fully explore the underlying pattern of QM implementation in China. The research team contacted senior managers, administrators, and/or department managers at the targeted
companies to request their participation in this research. We preferred target respondents who had sufficient knowledge of the organization’s strategy, operating environment, and the use of QM practices, such as executive managers, plant managers, quality managers, production managers, supervisors, or quality engineers. Two approaches were used to administer the survey: some respondents were contacted through emails with an attached questionnaire in Microsoft Word format, while the other responses were collected by one of the authors via field surveys. No significant differences were found between the responses collected from the two approaches in terms of demographic characteristics and the levels of TQM/Six Sigma practices and firm performance. Of those companies targeted, 220 returned usable responses, which yield a response rate of about 28%. A comparison of the responding companies against a sample of non-responding companies shows no significant difference between the two groups in terms of company size. The responding companies are mainly located in the regions of Beijing, Shanghai, Jiangsu, Guangdong, Shenzhen, and Dalian.

The final sample consists of Chinese manufacturing companies from a wide spectrum of manufacturing industries. In this sample, the electronics, machinery, and chemical industries are being well represented, which is generally comparable to the distribution of industries in the US sample of Zu et al. (2008). Yet, it should be noticed that in the US sample, a substantial number of companies were from the transportation equipment industry but in the China sample, about 50 companies came from the textile industry. This is not surprising as the low-technology and highly labor-intensive industries like textile are among the industries that mostly outsource their production overseas to developing countries like China. In addition, the China sample includes a variety of companies with respect to the ownership structure. Specifically, 77 companies are domestic-owned (owned by Chinese governments and/or businesses); 22 companies are joint ventures whose ownership is shared by Chinese investment and foreign investment; and 121 companies are foreign-owned companies with investment from developed countries such as the United States, Europe, or Japan. The companies represent various sizes, ranging from 35 small businesses of fewer than 100 employees, 85 medium-sized companies of 101 to 500 employees, and 97 large companies of over 500 employees. The companies that participated in the survey have implemented ISO, TQM and Six Sigma to varying extent.

**Assessment of measurement reliability and validity**

Before testing the hypothesized model, the instrument was evaluated for construct reliability and validity. Table 1 listed the results of assessment on the measurement scales based on the China sample as well as the US sample for comparison.

The content validity was assured by an extensive review of relevant literature on TQM and Six Sigma that was conducted when the original survey instrument was developed in Zu et al. (2008) and by using experts of quality managers and operations managers in China to evaluate measures for the current study (Churchill, 1979). The scales of TQM and Six Sigma practices were drawn from the existing literature, and each of them consist of 6 to 13 questions, which provide extensive coverage of the relevant concepts involved in the theoretical constructs.
<table>
<thead>
<tr>
<th>Factor</th>
<th>Mean</th>
<th>S.D.</th>
<th>Reliability</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
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<th>10</th>
<th>11</th>
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</tr>
</thead>
<tbody>
<tr>
<td>1 Top mgt. support</td>
<td>5.09</td>
<td>1.55</td>
<td>0.93,0.93,0.93^b</td>
<td>184.85^d</td>
<td>190.52</td>
<td>138.00</td>
<td>507.58</td>
<td>203.78</td>
<td>163.28</td>
<td>675.72</td>
<td>517.16</td>
<td>441.76</td>
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<tr>
<td>2 Customer relationship</td>
<td>5.71</td>
<td>1.17</td>
<td>0.80,0.80,0.82</td>
<td>0.56^c</td>
<td>226.71</td>
<td>156.43</td>
<td>195.05</td>
<td>241.55</td>
<td>229.90</td>
<td>286.55</td>
<td>260.64</td>
<td>246.69</td>
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<td>3 Supplier relationship</td>
<td>3.87</td>
<td>1.46</td>
<td>0.83,0.83,0.83</td>
<td>0.58</td>
<td>0.40</td>
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<td>158.91</td>
<td>236.68</td>
<td>135.66</td>
<td>139.95</td>
<td>253.76</td>
<td>193.80</td>
<td>207.19</td>
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<tr>
<td>4 Workforce management</td>
<td>4.98</td>
<td>1.38</td>
<td>0.88,0.88,0.88</td>
<td>0.77</td>
<td>0.62</td>
<td>0.64</td>
<td>249.11</td>
<td>170.65</td>
<td>103.92</td>
<td>398.01</td>
<td>290.54</td>
<td>268.87</td>
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<td>5 Quality information</td>
<td>5.46</td>
<td>1.47</td>
<td>0.94,0.94,0.94</td>
<td>0.62</td>
<td>0.55</td>
<td>0.48</td>
<td>0.71</td>
<td>279.76</td>
<td>184.47</td>
<td>1034.16</td>
<td>676.02</td>
<td>545.11</td>
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<tr>
<td>6 Product design</td>
<td>4.67</td>
<td>1.45</td>
<td>0.86,0.86,0.86</td>
<td>0.68</td>
<td>0.39</td>
<td>0.65</td>
<td>0.70</td>
<td>0.55</td>
<td>102.57</td>
<td>311.02</td>
<td>196.63</td>
<td>190.58</td>
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<tr>
<td>7 Process management</td>
<td>5.04</td>
<td>1.19</td>
<td>0.83,0.83,0.83</td>
<td>0.71</td>
<td>0.41</td>
<td>0.63</td>
<td>0.78</td>
<td>0.69</td>
<td>0.74</td>
<td>335.16</td>
<td>250.17</td>
<td>186.01</td>
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<td>8 SS role structure</td>
<td>3.40</td>
<td>1.98</td>
<td>0.95,0.95,0.95</td>
<td>0.40</td>
<td>0.18</td>
<td>0.42</td>
<td>0.45</td>
<td>0.30</td>
<td>0.49</td>
<td>0.39</td>
<td>659.85</td>
<td>641.42</td>
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<td>9 SS structured procedure</td>
<td>1.77</td>
<td>2.47</td>
<td>0.98,0.98,0.98</td>
<td>0.08</td>
<td>0.18</td>
<td>0.22</td>
<td>0.17</td>
<td>0.22</td>
<td>0.17</td>
<td>0.18</td>
<td>552.65</td>
<td>353.16</td>
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<tr>
<td>10 SS focus on metrics</td>
<td>4.66</td>
<td>1.80</td>
<td>0.93,0.93,0.93</td>
<td>0.61</td>
<td>0.35</td>
<td>0.60</td>
<td>0.64</td>
<td>0.51</td>
<td>0.70</td>
<td>0.58</td>
<td>0.71</td>
<td>871.00</td>
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<tr>
<td>11 Quality performance</td>
<td>4.93</td>
<td>1.56</td>
<td>0.96,0.96,0.96</td>
<td>0.69</td>
<td>0.40</td>
<td>0.57</td>
<td>0.67</td>
<td>0.64</td>
<td>0.71</td>
<td>0.68</td>
<td>0.73</td>
<td>0.53</td>
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<tr>
<td>12 Business performance</td>
<td>5.21</td>
<td>1.45</td>
<td>0.94,0.94,0.94</td>
<td>0.41</td>
<td>0.20</td>
<td>0.33</td>
<td>0.42</td>
<td>0.30</td>
<td>0.36</td>
<td>0.39</td>
<td>0.45</td>
<td>0.42</td>
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</table>

^a In the cells, values on the top line represent US sample and the values on the bottom line represent China sample.
^b Values represent reliability measures – Cronbach’s alpha, Guttman’s Lambda 2, and composite reliability.
^c Values represent bivariate correlation for the factors.
^d Values represent reliability measures – Cronbach’s alpha, Guttman’s Lambda 2, and composite reliability.
Reliability of the measurement items was assessed using Cronbach’s alpha, Guttman’s Lambda 2, and composite reliability (Kaynak and Hartley, 2006). Several items were dropped because they did not contribute to the alpha values of their respective scales. The reliability indices for all the scales range from 0.78 to 0.98, exceeding the threshold level of 0.70 (Nunnally and Bernstein, 1994). After reliability of the instrument was established, unidimensionality was examined by evaluating the confirmatory factor analysis (CFA) model of each factor (Jöreskog and Sörbom, 1993). The CFA models of TQM, Six Sigma, and performance factors show satisfactory model fit as indicated by the Comparative Fit Index (CFI), which is 0.90 or higher for all the scales and thus indicates acceptable unidimensionality (Byrne, 1998).

Convergent validity and discriminant validity of scales were assessed through the measurement models using CFA (Anderson and Gerbing 1988). We built two measurement models of the variable underlying the latent constructs consistent with the measurement models assessed in Kaynak (2003) and Kim et al. (2012): one measurement model for TQM and Six Sigma practices, and another one for performance scales. These models were assessed by multiple goodness-of-fit indices including the ratio of χ² to degree of freedom, CFI, non-normed fit index (NNFI), standardized root mean square residual (SRMR), and root mean square error of approximation (RMSEA) (Kline, 2004). A comparison of the fit indices for the measurement models to the recommended values revealed satisfactory fit to the data.

Based on the measurement models, convergent validity of scales were evaluated by examining the factor loadings of each item to the factor that it is intended to measure. A high factor loading of at least 0.50, ideally above 0.70, or a significant t-value is considered to have demonstrated convergent validity (Hair et al., 2005). In this study, all the items have significant standardized factor loadings (i.e., t-values are greater than 1.96 at p < 0.05), and the factor loadings are above 0.50 – most factor loadings are greater than 0.70 – suggesting adequate convergent validity of scales used in this study.

Discriminant validity was assessed by performing chi-square difference tests between the constrained and the unconstrained model (Anderson and Gerbing, 1988). In the constrained model, each pair of factor correlations is set to 1.0, whereas in the unconstrained model, the correlation between factors is freely estimated. Discriminant validity can be demonstrated if a significant chi-square difference exists between the two models, with lower chi-square for the unconstrained model. We adjusted the p-value of the chi-square difference tests by the number of tests performed (Kaynak and Hartley, 2006). In Table 1, the chi-square differences between each constrained model and unconstrained model were all statistically significant (with a significantly lower chi-square value for the unconstrained model), indicating satisfactory discriminant validity of the scales (Hair et al., 2005).

Criterion-related validity should be evaluated to examine the extent to which predictions from a theoretical framework are supported (Venkatraman and Grant, 1986). In the existing literature, QM practices are presumed to affect organizational performance positively (e.g., Kaynak, 2003; Kaynak and Hartley, 2008). As shown in Table 1, the correlations pertaining to the relationships among the TQM, Six Sigma practices, and two performance factors as proposed in this study are positive and significant at p-value < 0.001, which provides evidence that the criterion-related validity of scales is adequate.
Because all the data were self-reported by single respondents, this study is subject to the potential threat of common method variance (CMV). We thus conducted Harman’s single factor test to detect the presence of CMV (Podsakoff et al., 2003). According to this technique, when an unrotated factor analysis is performed on all the variables in a study, if a single factor emerges from the factor analysis or one general factor accounts for the majority of the covariance among the measures, it indicates that a significant CMV is present in the data (Podsakoff et al., 2003). Based on the unrotated factor analysis results of all the measures studied, multiple factors are extracted and the highest amount covariance explained by a single factor is only 25.86%. We also conducted CFA to compare the proposed model and a single factor model and found that the proposed model shows substantially better model fit. Thus, it is reasonable to conclude that there is no significant CMV present in the data.

Model analysis

In this replication, after the measurement models have been established, structural equation modeling (SEM) was used to build and analyze the relationship model of TQM/Six Sigma practices and performance factors. Multiple goodness-of-fit indices used to assess the model fit include the ratio of $\chi^2$ to degrees of freedom, comparative fit index (CFI), non-normed fit index (NNFI), standardized root mean square residual (SRMR) and root mean square error of approximation (RMSEA) (Kline, 2004). According to the recommended values of fit indices (Byrne, 1998; Hu and Bentler, 1999), the model based on the China sample has a good fit.

To test for the significance of the relationship between the constructs, the standardized path coefficient indicates the strength of the relationship between a dependent factor and an explanatory factor. The coefficient of determination, $R^2$ measures the proportion of the variance of the dependent factor explained by a set of the explanatory factor that lead to this dependent factor. Figure 3 presents the resulting structural model of the China sample with the standardized path coefficients and coefficients of determinations and Figure 2 shows the model of the US sample. As shown in Figure 3, most of the hypothesized relationships are supported at the significance level of 0.05 in the China model. Yet, this study failed to find significant links between top management and Six Sigma focus on metrics (H1c), between supplier relationship and product/service design (H2b), between quality information and Six Sigma focus on metrics (H4d), between Six Sigma structured improvement procedure and production/service design (H5a) or process management (H5b), between Six Sigma focus on metrics and production/service design (H5d) or process management (H5e), and between product/service design and process management (H4g; please refer to the table that summarizes the hypotheses). When compared to the US model in Figure 2 and Table 5, there are some significant relationships between TQM and Six Sigma practices that are found in the China sample but not in the US sample, and vice versa. In next section, the similarities and differences between the US and China models are discussed, as well as their implications for QM research and practice.
Figure 2. TQM/Six Sigma model based on the US sample in Zu et al. (2008)

* P < 0.10, ** P < 0.05; *** P < 0.01

Figure 3. TQM/Six Sigma model based on the China sample in this study

* P < 0.10, ** P < 0.05; *** P < 0.01
DISCUSSION OF RESULTS

The primary purpose of this study is to examine QM implementation in China to identify how QM practices are applied in this country and to assess whether a QM model that is developed mostly based on western businesses and research is applicable to China, a symbolic country in East Asia. In general, by comparing the results in this current study with the results of Zu et al. (2008), it can be observed that the overall pattern of QM practices-performance relationships between US and China is comparable, suggesting the progress that companies in China have made as the country is adopting more scientific and modern management philosophies and methods from outside. But, there are also some differences between the two countries that are noteworthy to better understand the limitations of QM implementation in China and offer suggestions for further improvements.

First, the results of this study show that top management support is as critical for companies in China as for companies in western countries, in order to drive and promote effective QM implementation in organizations. Establishing an effective QM system demands a top-down approach. Unless senior managers understand the necessity and importance of quality improvement for the company’s survival and success, there will be no consistent efforts throughout the organization to push QM activities. Our study confirms that top management commitment and leadership is stressed by Chinese managers as the most important factor for TQM success (Chin et al., 2002). This finding is not surprising in the Chinese context because the influence of top management support for QM implementation can be reinforced by Chinese employees’ value for authority. In the Chinese society characterized by high power distance, subordinates acknowledge the power of others based on their formal, hierarchical positions, and less powerful people accept power relations that are autocratic or paternalistic (Hofstede, 1980; Ng, 1998). The paternalistic authority is emphasized to maintain harmony and order in the society or organization (Pun, 2001). Accordingly, when a firm’s senior executives encourage and promote the adoption of new QM methods in the company, the lower-level managers and employees of the organization are more willing to accept the methods with fewer doubts and questions. Similar to what Zu et al. (2008) found in the US sample, the results of this study found that in the China sample, top management support significantly related to the TQM and Six Sigma infrastructure practices – customer relationship, supplier relationship, workforce management and Six Sigma role structure. However, this study did not find a significant link from top management support to Six Sigma focus on metrics as Zu et al. (2008) did in the US sample. In US, the history of Six Sigma is rooted in the tradition that top executives, working as a Champion, initiate and promote the Six Sigma movement in the organization by setting the goals for improvement in the organization. In China, while quality is highly regarded as important for competitiveness, executive-level managers are less involved in operational- and tactic-level quality-related decisions. Findings in this study suggest that the impact of top management support in Chinese companies is primarily directed towards providing directions and resources to create an organizational environment and infrastructure such as making general strategies and policies toward quality control and improvement.

Customer focus is essentially important for quality control and improvement (Dean and Bowen, 1994). Among QM research in US including Zu et al. (2008), a close contact with customers is typically found to facilitate the collection and analysis of quality information (e.g., Kaynak and
Hartley, 2008). In this study, it is found that customer relationship is, as expected, significantly related to quality information. Prior to the open policy in China, customer desires were not a major consideration due to limited supply compared to demand and lack of market competition. But after China opened its door, particularly after joining the WTO, customer focus became an important issue (Zhao et al., 2007). Lau et al. (2004) identified that customer and market focus grows to be an essential part of QM in the firms which have progressed toward more advanced stages of QM maturity such as the stages of quality assurance and/or strategic quality management. When top management accept and embrace quality as a means for competitive advantage, quality is defined from the perspective of market competition and customer expectation to provide critical information for quality improvement in the organization (Lau et al., 2004).

Different from the findings in Zu et al. (2008), this study found that at companies in China, supplier relationship is weakly related to process management (at the significance level of 0.10) and is not related to product/service design. Pyke et al. (2000) pointed out that as compared with western companies, Chinese companies lagged behind in supply chain management, and those companies tend to communicate more with downstream customers than the upstream suppliers. One concern about supply chain management in China is related to the issue of supplier selection. The strength of the tie of guanxi has a substantial impact on how buying firms use information about the supplier’s ability, integrity, and benevolence, and thus affect the choice of suppliers (Liu and Deng, 2009). In this study, two items related to supplier selection and evaluation had to be dropped due to very low factor loadings to the construct of supplier relationship. It can be speculated that the priority of guanxi against other qualifications such as quality, costs, and delivery affects how much effort a company is willing to make to establish a fair supplier selection system. When the supplier relationship may not be established on the grounds of good quality, it has little support for the organization’s QM activities. The literature emphasizes the importance of establishing strategic quality management in supply chains (Flynn and Flynn, 2005; Kaynak and Hartley 2008; Robinson and Malhotra 2005). For companies in China, this task is even more challenging. As shown in this study, there is still room for those companies to build or adjust their relationships with suppliers to have a better focus on quality.

Workforce management is found to be directly and positively related to quality information, product/service design, and process management. This finding corroborates previous studies of QM in China which suggested that employee-focused management practices including employee education and training, employee involvement and empowerment, and communication and cooperation are essential for effective QM implementation (Chin et al., 2002; Pun, 2001, Yeung et al., 2005). The survey conducted by Pun (2001) shows that 60% of Chinese companies in their sample considered employee involvement to be an important part of their quality program, and many Chinese companies believe that employee involvement and TQM are compatible with increased employee trust in management and improved management decision making. The research and practice of QM in western businesses have universally confirmed the significance of human-based practices for achieving and sustaining successful QM implementation (e.g., Anderson et al., 1995; Cardy and Dobbins, 1996; Flynn et al., 1994, 1995, Howard and Foster, 1999; Kaynak, 2003). Yeung et al. (2003) have also reported that in China, QM implementation can be hindered by resistance from employees and lack of a supportive quality culture and integration of management system, even though top management provides strategic directions.
for quality improvement. As compared to Zu et al. (2008), the current study confirms that effective workforce management, including employee involvement, teamwork, employee training, is essential for successfully implementing QM in China as well as in US. The challenge for Chinese managers is to break the bureaucracy to grant employees power and participation in quality-related decision making. On the other hand, the managers should also take advantage of their employees’ value for collectivism to encourage teamwork and motivate employees to make more contributions for the organization’s quality improvement achievement.

The results show that collection and use of quality information supports product/service design and process management at companies in China, yet in studying the US sample, Zu et al. (2008) did not find significant links between these practices. While there have been doubts about the effectiveness of using data and information for management control in China, e.g., the use of management information system (e.g., Martinsons and Hempel, 1998), this study shows that it is important to have formal procedures in place to ensure the timeliness, accuracy, and availability of quality information in order to support QM activities in product design and process improvement. On the other hand, the insignificant link from product/service design to process management is counter to our expectation, though studies on US companies such as Flynn et al. (1995) and Zu et al. (2008) failed to find a significant link as well. One explanation is that at companies in China, product design has little focus on production and manufacturability for achieving better product quality. Research on new product development in China (e.g., Calantone et al., 1996) found that successful Chinese product development project teams appear to concentrate on gathering good information about the competition and the market to develop products of higher quality than competing products. It seems that competitive and market intelligence, rather than proficiency of technical activities, is employed for achieving good product quality in new product development (Calantone et al., 1996).

Both product/service design and process management have significant direct relationships with quality performance, which in turn leads to improved business performance. As Lau et al. (2004) suggested, when Chinese companies have implemented TQM programs, they consider achieving better quality as an opportunity for gaining competitive advantage. The significant relationship of quality performance to business performance indicates that quality improvement is one key source of business success for companies in China.

In addition to TQM practices, this study examined the implementation of Six Sigma in China. The relationships among three Six Sigma practices are supported with significant path coefficients. Six Sigma role structure has a positive effect on Six Sigma structured improvement procedure, which then supports Six Sigma focus on metrics. In addition, Six Sigma role structure is significantly related to workforce management. However, the proposed relationships of two technique-based Six Sigma practices (i.e., Six Sigma structured improvement procedure and Six Sigma focus on metrics) and TQM’s product/service design and process management, as well as the link from quality information to Six Sigma focus on metrics, are not supported in this study. These findings are different from Zu et al. (2008) which find the significant relationships between quality information to Six Sigma focus on metrics and between Six Sigma focus on metrics and product/service design or process management. The findings of this study based on the China sample suggest that in China, when a company adopts Six Sigma, it is used rather independently from the extant QM system, particularly at the operational and tactical levels. This
may be attributed to the difference between TQM and Six Sigma in how improvement teams are organized and operated. Traditional TQM teams are usually formed at the shop-floor level, within work groups, or with cross-functional members if needed, and have an ongoing charter for improvement in their work; however, Six Sigma teams are formed at the strategic level along process lines to focus on a particular process and are disbanded after the process improvement is implemented (Schroeder et al., 2008). As compared to China’s long exposure to TQM, its implementation of Six Sigma is just beginning. When Six Sigma is only used at a limited level, the practices of Six Sigma focus on metrics and structured improvement procedure can be more restrained within individual projects and lack influence on continuing improvement activities at product/service design and process management. It is advocated that Six Sigma should be integrated with TQM to produce synergistic effects on quality improvement (Revere and Black, 2003; Schroeder et al., 2008; Yang, 2004). It seems that the integration of Six Sigma with existing TQM practices is not yet in place in China’s manufacturing industry. In order to take full advantage of Six Sigma, it is important for firms in China to establish the connection between Six Sigma and the existing QM system to use them in a complementary manner.

Overall, the empirical results here indicate that the theoretical relationships between TQM practices that are suggested by the western literature are largely supported by the China data collected in this study. After thirty years of development and efforts, TQM implementation in China is compatible with that of western, developed countries. This growth can be attributed to the laws and/or administrative regulations in China which mandated TQM for quality improvement and protections of the well-being of consumers (Yu et al., 1998), as well as to the desire of Chinese companies to improve their competitiveness in global market. With the increasing globalization of operations and supply chains, management philosophy and techniques are transferred from country to country. It is necessary to test whether similar or different pattern of operations can be found in different countries so that stronger and more generalizable theories can be developed. Studies by Rungtusanatham et al. (1998, 2005) on the universality of TQM found that based on the Deming-based theoretical framework, equivalent practices can be found in countries such as Germany, US, Japan, and Italy, though some differences are detected, mostly in Italy. The relationships of TQM practices and performance in China as found in this study are consistent with those found in western countries, which indicates the applicability of TQM concepts and techniques in the oriental culture center – China – and verifies the generalizability of the TQM frameworks in a broader context.

On the other hand, this study also reveals that the implementation of Six Sigma method in China is not as mature as the TQM implementation and lag behind the US companies. During our survey, some respondents commented that a company’s origin has an influence on the focus of its QM system; for example, the companies invested by or joint-ventured with US businesses tended to apply Six Sigma, whereas those associated with Japanese businesses are more likely to apply Just-in-Time or lean manufacturing. Therefore, research that investigates the contextual factors influencing the directions and patterns of QM implementation would be worthwhile.

The results of this study provide managers in China important guidelines about how to build an effective QM system in their organization. Understanding the roles and functions of different TQM and Six Sigma practices is useful for the managers who must make decisions on resource allocation and implementation plan. First and foremost, top management support must be
secured for the adoption and deployment of TQM and Six Sigma. Top management has to be involved in building a nurturing environment and infrastructure for continuous improvement. Due to high respect for authority, it is essential for managers in China to show personal commitment and leadership for quality improvement to their employees. Next, companies in China need to bring quality management into their supply chains by, for example, soliciting useful information from customers to integrate critical-to-quality characteristics (derived from the voice of the customer) into assessment, control, and improvement of product and service quality, or by involving suppliers in early-stage product/service design as well as process improvement. Moreover, the employee-based TQM and Six Sigma practices are central in QM systems for supporting continuous improvement activities in the organization. Considering the distinctive social and cultural traits in human relations, the human resource management practices may not be entirely transferable to companies in China, but managers need to integrate the principle of teamwork and participate with Chinese employees’ value for harmony, order, and interdependence, in order to encourage employee training, teamwork, and participation in quality improvement. Furthermore, the findings about Six Sigma suggest that an important task for the companies practicing Six Sigma is to integrate the use of Six Sigma tools and techniques with existing QM activities to enhance their quality improvement capability. Finally, the positive effects of product/service design and process management on quality performance and then business performance should augment the continuing efforts of quality control and improvement at companies in China. For them to survive and succeed in today’s fierce global competition, providing good quality products and services is necessary. At the same time, companies outside of China can also benefit from the results of this study. Obtaining supply chain integration is necessary for success in global competition today. With the knowledge of the QM practices of their suppliers or operations in China, they can develop strategic and operational plans to work with their partners in China to improve quality control or facility operation, which will help to achieve competitiveness with lower costs and higher quality.

This study is subject to several limitations. The data collected in this study are based on self-reported perceptions of QM implementation from single respondents. The results of the study are subject to the threat of potential common method bias. Although statistical tests were conducted to verify that common method bias is not a serious problem in the data, the possibility of the bias cannot be completely eliminated. In addition, the data were collected from several regions in China that are relatively more developed than other regions in the country. One should be cautious when generalizing the results of this study to the less developed, remote regions in China. Then, the cross-sectional data in this study cannot test the causal relationships between the constructs of QM implementation. Although Cook and Campbell (1979) note that structural and path analyses can be used to clarify theory and to estimate specific causal effects from cross-sectional data, a longitudinal study that tracks the progress of QM practices in organizations would be much desired. Also, considering the number of hypotheses tested, the sample size of this study is only moderate, though it is comparable to recent empirical studies on QM practices (Naor et al., 2008; Sila and Ebrahimpour, 2005; Yeung et al., 2005; Zu et al., 2008). This limitation on the sample size has prevented us from testing simultaneously for invariant causal structure for the replicability of structural paths across the US and China samples simultaneously. The approach we adopted in this paper, however, is often used in other replication studies such as Goldstein and Iossifova (2012); Kaynak and Hartley (2008), Rungtusanatham et al. (1998), and Schoenherr and Swink (2012).
CONCLUSION

Operations management today is no longer limited to one country or one culture, but needs to incorporate the diverse geographical, social and cultural elements as firms expand their organizations and supply chains across the globe. Whether the management principles, practices and methods used in western countries and businesses can be transferred to other countries becomes a critical question that the managers have to consider when designing and managing the operating system of their firm. This study examines the applicability of QM practices in China as quality is a major concern for products made in China. Internally, Chinese companies are motivated to improve their product quality for better competitiveness in the global market, and externally, foreign companies need to understand how quality can be management in China to ensure that their supply from China is safe and of satisfactory quality. While rich research has been done on QM implementation in western businesses, QM research in China is still at the early stage and, for the most part, it lacks a systematic theory-building effort. This study assessed a theory-based TQM/Six Sigma model in China and compared the similarities and differences in the pattern of QM practices-performance relationships across US and China, with the hope of providing guidelines to China’s practice of QM and stimulating theory development of QM in a global context.

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