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Quality management theory development via meta-analysis

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A R T I C L E I N F O

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A B S T R A C T

Quality management (QM) research has frequently focused on investigating the QM system, while a collective consideration of the effects of individual QM practices on organizational performance and performance dimensions remains an under-investigated area of research. The current research provides insights for expanding quality management theory using evidence from a meta-analysis that examines the correlations presented in prior empirical studies. Specifically, this study investigates whether QM practices influence aggregate organizational performance and how individual QM practices influence different performance dimensions. Furthermore, this study investigates whether moderators exist among the relationships between QM and performance. This meta-analysis examined a sample of 28 empirical studies spanning a twenty-year period from 1995 to 2015. The results show that most individual QM practices have a positive impact on aggregate organizational performance and performance dimensions including financial performance, operational performance, customer service, and product quality. The results also reveal that moderators exist among relationships between most pairs of QM practices and performance. In particular, the results suggest a high level of importance is associated with management leadership and supplier quality management compared to other QM practices, as evidenced by their positive relationships with both aggregate organizational performance and the four performance dimensions. In addition, no moderating effects changed the relationships. This research contributes to the QM literature by providing a systematic understanding that addresses more complexity than previous research about the relationships between QM practices and organizational performance. This research also contributes to quality management theory development given the current state of information technology (IT). These findings suggest implications for managers interested in the effect of QM practices on performance.

1. Introduction

A growing demand for superior quality products and services at competitive prices is partially related to an increasingly competitive global marketplace marked by agility, adaptability, flexibility, and innovativeness. Over the past decades businesses have adopted quality management (QM) approaches such as TQM, Six Sigma, lean production, and ISO 9001. Different QM awards were created to foster quality improvement by recognizing companies with quality excellence. These awards include the European Foundation for Quality Management (EFQM), the Malcolm Baldrige National Quality Award (MBNQA), and numerous other country and regional awards.

Researchers have been studying QM for over three decades, with the focus shifting from the definitions of QM practices, the measurement of QM practices, to the relationships between QM practices and performance, and the contingent effects from contextual factors. Previous research has provided insights into the impact of QM on performance. Some of these studies focused on the relationships among QM practices and the effect of these practices as an entire system on organizational performance (Kaynak, 2003; Flynn et al., 1995). Other research examined QM as a single factor (Barata and Cunha, 2017; Pereira-Moliner et al., 2016; Sadikoglu and Zehir, 2010; Santos-Vijande and Álvarez-González, 2007). Although those prior studies investigate the effect of QM on organizational performance, the relative importance of individual QM practices in a collective manner and their effects on organizational performance dimensions remains under explored. Furthermore, previous literature has revealed inconsistent results in the relationships between QM practices and organizational performance. It is possible that QM practices influence organizational performance differently under different contexts (Nair, 2006), and this possibility is

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supported in several empirical studies (Das et al., 2000; Akgün et al., 2014; Jayaram et al., 2010). For instance, Das et al. (2000) found that international competition moderates the relationship between QM practices and customer satisfaction, and also moderates the relationship between high involvement work and organizational performance. Akgün et al. (2014) suggested that a firm's business innovativeness and organizational learning capability mediate the relationship between TQM and financial performance.

Further research is needed to illuminate the relationships between QM practices and organizational performance within different contexts. Such future work should also provide insights for managers on quality management implementation according to different business settings. In addition, prior research is restricted in terms of setting and firm size (Ahmad et al., 2016; Kafetzopoulos et al., 2015; O'Neill et al., 2016), industries (Parast et al., 2011; Parvadavardini et al., 2016; Pereira-Moliner et al., 2016), and countries (Ahmad et al., 2016; Kafetzopoulos et al., 2015; O'Neill et al., 2016; Parvadavardini et al., 2016). A literature review reveals a lack of a systematic examination of the general relationships between QM practices and organizational performance, and of explicit guidelines for managers on implementing QM. Nair (2006) systematically studied the relationship between QM practices and firm performance via meta-analysis based on 23 empirical articles published from 1995 to 2004. However, during the recent decades, there have been rapid shifts in market dynamics impacted by new IT infrastructure, increasing pressure to innovate across the supply chain, and increasing sophistication of the workforce. This changing environment provides compelling reasons to conduct an updated meta-analysis to investigate the landscape of QM research that focuses on business practices grounded in quality management theory. The exponential pace of technological progress and the increased expectations of modern consumers place a high priority on improving operational excellence (Trott, 2019) through a holistic understanding of the integration of QM practices and information technology (IT) to provide sustainable competitive advantages (Pérez-Aróstegui et al., 2015). To address this research gap, a meta-analysis that examines QM practices was conducted. This approach also provided an opportunity to examine the evolution of quality management theory given the current state of IT.

This study fills several research gaps by employing meta-analysis on the correlations between QM practices and performance. The objective of this study is to examine the relationships between QM practices and aggregate organizational performance, and organizational performance dimensions, as well as to investigate the existence of moderation effects among these relationships. Specifically, the meta-analysis of correlations in this study will address the following research questions:

- How QM practices affect aggregate organizational performance?
- How individual QM practices affect aggregate organizational performance?
- How individual QM practices affect organizational performance dimensions?
- What is the relative importance of individual QM practices?

This paper contributes to the QM theory development. First, it generalizes the relationships between QM practices and organizational performance based on extant empirical studies published from 1995 to 2015. Second, the theory updates and extends Nair (2006) findings. In particular, more pairs of positive QM-performance relationships are determined (P-value < 0.001), with 32 out of 35 pairs in our study while 20 out of 35 pairs in Nair (2006) study. In addition, we conducted a separate meta-analysis for articles published post 2005 as a comparison to Nair (2006) analysis for articles published prior 2005. The findings reveal an increased importance of QM and provide several new insights for managers on implementing QM. Third, this research develops QM theory by highlighting the relative importance of management leadership and supplier quality management compared to other QM practices when no moderators exist between their relationships with aggregate organizational performance.

2. Literature review on empirical studies linking QM and performance

The large amount of literature on QM provides sufficient resources to examine the relationship between QM practices and performance. Researchers have empirically investigated the effects of various QM practices on performance. For example, Zu (2009) focused on infrastructure and core quality management practices, and their relationships with quality performance. Sadikoglu and Olcay (2014) investigated the associations between TQM practices and firm performances. Recent studies examined the linkage of QM and performance in various contexts such as different industries, firm sizes, and countries (O'Neill et al., 2016; Ahmed and Badar, 2017; Tarí and Abdullah, 2017; Iqbal et al., 2018; Sila, 2018; Kumar et al., 2018; Parast and Golmohammadi, 2019). These studies and others (e.g., Sabella et al., 2014; Bhatia and Awasthi, 2018) generated mixed results on the relationships between QM practices and performance.

Some studies measured QM with a single construct (Santos-Vijande and Álvarez-González, 2007; Martínez-Costa and Martínez-Lorente, 2008; Sadikoglu and Zehir, 2010; Valmohammadi and Roshanzamir, 2015; Chen et al., 2018; Iqbal et al., 2018), while others operationalized QM as multiple constructs (Fotopoulos and Psomas, 2010; Jayaram et al., 2010; Escrig-Tena et al., 2018; Parast and Golmohammadi, 2019). The QM factors we consider in this study include management leadership, people management, process management, product design and management, quality data analysis, supplier quality management, and customer focus. We focused on these factors for three reasons. First, these factors have been frequently cited as critical QM factors in QM research area (e.g., Fotopoulos and Psomas, 2010; Sadikoglu and Zehir, 2010; Sila, 2018; Parast and Golmohammadi, 2019). Second, these factors are reflected in the Baldrige framework (NIST, 2019) that has served as the foundation for many QM studies (Flynn and Saladin, 2001, 2006; Peng and Prybutok, 2015; Mellat-Parast, 2015; Peng et al., 2020). Third, this is also consistent with the literature review did by Kumar et al. (2018) on 263 QM studies published in reputable journals during 2000–2017. Some QM practices are not presented as individual factor but actually embedded into other factors in our study. For example, tools and techniques are included in the process management factor. This is consistent with Zeng et al. (2013) definition of process management. Process management refers to monitoring the manufacturing process with the use of techniques and tools to reduce process variation (Zeng et al., 2013). Therefore, though tools and techniques were considered as one factor in some studies (Valmohammadi and Roshanzamir, 2015; Yusof and Aspinwall, 2000), many more studies included them in process management (Anderson et al., 1995; Kaynak, 2003; Martinez-Lorente et al., 2000; Kaynak and Hartley, 2008; Jung and Hong, 2008; Zeng et al., 2013, 2015; Iqbal et al., 2018). In the same manner, we include strategic planning in the management leadership factor as top management participates in making strategies and goals for quality improvement (Zu et al., 2008). Continuous improvement is stressed and permeated in all the relevant QM factors (Baird et al., 2011), as it involves the engagement of all organizational systems, process, and people in the organizations (Jurburg et al., 2017). The section on construct operationalization shows more details on how practices are classified in these seven factors.

Organizational performance was operationalized differently in terms of what constitutes this construct. Some studies have focused on financial aspects (O'Neill et al., 2016; Lo and Yeung, 2018; Sila, 2018), while others have concentrated on quality performance (Zu, 2009; Talib et al., 2013; Jayaram and Xu, 2016), operational performance (Baird et al., 2011; Ahmed and Badar, 2017), and customer satisfaction (Anderson et al., 1995). More studies operationalized performance covering multiple outcome aspects (Sadikoglu and Zehir, 2010; Parast et al., 2011;

Parast and Adams, 2012; Sadikoglu and Olcay, 2014; Valmohammadi and Roshanzamir, 2015; Iqbal et al., 2018; Kumar et al., 2018; Parast and Golmohammadi, 2019; Peng et al., 2020).

The research methodology used to analyze the relationship between quality management practices and organizational performance varies across studies. Research methodologies include structural equation modeling (Naor et al., 2008; Bou-Llusar et al., 2009; Jayaram et al., 2010; Sadikoglu and Zehir, 2010; Akgün et al., 2014; Peng and Prybutok, 2015), multiple regression (Arumugam et al., 2008; Jaafreh and Al-abedallat, 2012; Talib et al., 2013; Sadikoglu and Olcay, 2014), hierarchical regression (Ho et al., 2001), path analysis (Anderson et al., 1995; Flynn et al., 1995), Kendall's tau coefficient (Martinez-Lorente et al., 2000), and bivariate correlation analysis (Sánchez-Rodríguez and Martínez-Lorente, 2004).

Prior researches have investigated the inter-relationships among QM practices, implying the mediating effects of some QM practices (Kaynak, 2003; Naor et al., 2008; Azar et al., 2010; Sadikoglu and Zehir, 2010; Duh et al., 2012; Kim et al., 2012; Calvo-Mora et al., 2014; Peng and Prybutok, 2015). More recently, researchers found that TQM contributed to performance through external variables such as agile manufacturing (Iqbal et al., 2018) and corporate social performance (Sila, 2018). However, the mediation effect has not been generalized in terms of the specific mediators for any specific pair of relationship. Moreover, researchers suggested the moderating effect of contextual factors (Ahire and Dreyfus, 2000; Das et al., 2000; Jayaram et al., 2010; Zhang et al., 2012; Akgün et al., 2014; Sila, 2018), such as firm size, QM program duration, unionization, industry type, learning capability, business innovativeness, and competition.

This meta-analysis is designed to test relationships using data obtained from empirical studies by focusing on the accepted relationships between QM practices and performance. The meta-analysis also tests the existence of moderators between QM practices and performance. According to the prior studies, we present the hypotheses below:

H1. QM practices are positively correlated with aggregate organizational performance.

H2. The correlation between QM practices and aggregate organizational performance is influenced by moderating factors.

H3. Individual QM practice is positively correlated with aggregate organizational performance.

H4. The correlation between individual QM practice and aggregate organizational performance is influenced by moderating factors.

H5. Individual QM practice is positively correlated with individual performance dimension.

H6. The correlation between individual QM practice and individual performance dimension is influenced by moderating factors.

The next section explains how meta-analysis is employed and designed to investigate the correlations and moderating effects between QM practices and organizational performance.

3. Meta-analysis of correlations

3.1. Significant and non-significant correlations

We include both significant and non-significant correlations in the analysis, because a meta-analysis computes precise estimates of average correlations without the need of significance tests in the sample studies (Schmidt and Hunter, 2014, p. 7–12). Statistical tests for correlations are prone to Type I and Type II errors. However, because of the framework that meta-analysis uses, concern for these errors is minimized when point estimates of correlations are used to generalize and synthesize findings across studies (Schmidt and Hunter, 2014, p. 12). Therefore, non-significant correlations also provide valuable information when combined with other studies into a meta-analysis. Non-significant correlations may be caused by sampling error, which may be due to unrepresentative samples used in the individual studies. Meta-analysis incorporates these correlations using a framework to reduce the effect of errors due to sampling.

3.2. Validity of construct operationalization

The QM practices recorded in this paper are identical to those in Nair (2006). These factors are consistent with the extant literature in terms of frequent citations on QM practices (e.g., Fotopoulos and Psomas, 2010; Sadikoglu and Zehir, 2010; Sila, 2018; Parast and Golmohammadi, 2019), Baldrige framework (NIST, 2019), and literature review conducted by Kumar et al. (2018) recently. This section validates the construct operationalization in terms of definitions and the aspects of classifications of QM practices.

Management leadership demonstrates acceptance of quality responsibility by top management, which captures practices like leadership, top management support, top management commitment, and strategic planning;
People management refers to the extent to which employee involve in quality management, including practices like training, employee relation, empowerment, workforce management, teamwork, and people involvement;
Process management involves designing and monitoring processes to reduce process variation by the use of statistical and QM tools and techniques such as control charts, histograms, and scatter diagrams.
Product design and management focuses on designing manufactural products/workable services and improving quality;
Quality data analysis covers quality information availability and information analysis; *Supplier quality management* relates to quality management practices in supplier relationship management like partnership and resources, supplier cooperation, and supplier involvement;
Customer focus represents the extent to which an organization meet customer needs and expectations and manage customer relationships (Sabella et al., 2014).

Organizational performance is operationalized as a multi-dimensional construct including financial performance, operations performance, customer service, and product quality. *Financial performance* captures ROA, ROS, and marketing share. *Operational performance* covers inventory management performance like total inventory turnover and purchased material turnover. *Customer service* covers aspects associated with customer satisfaction. *Product quality* represents reliability, design quality, cost of scrap and rework, and productivity.

Measures of the QM practices and organizational performance dimensions vary across studies. We include these various measures to stay in line with a meta-analysis. This process is supported by multiple operationism, which involves the use of various measures that are supposed to measure the same theoretical concept but have different patterns of error variance (Webb et al., 1981). With multiple operationism in a meta-analysis, findings can be generalized by reducing one specific pattern of error variance.

3.3. Sample

To sample articles, we searched quality management and performance in the ABI/INFORMS database. Substantial articles were detected. After a thorough review for each article, we only included articles that investigate relationship between quality management and organizational performance. We collected the necessary data only based on the published information in the articles. Eventually, 28 studies were retained for the meta-analysis. See Appendix for the summary of the articles. Nair (2006) performed a meta-analysis using papers available from 1995 to 2004. This research extends the period for QM articles by eleven years, that is, the current research covers the period from 1995 to 2015. Some of the articles included in Nair (2006) study were not collected into our sample because we did not attempt to request additional information from authors, which was conducted in Nair (2006) study.

Within each study, we recorded the reliabilities and the pair-wise correlations at the individual level of the constructs, and then averaged the reliabilities and correlations to obtain the ones at the aggregated level. For instance, for Jayaram et al. (2010), we collected the reliability for management leadership, customer focus, product design and management, people management, supplier quality management, quality data analysis, product quality, and customer service. We also collected the correlations between each quality management construct and each organizational performance dimension. The reliability of the overall quality management construct is the averaged value of the reliabilities for all the quality management practices, and the reliability of the organizational performance is the average of the reliabilities of all the organizational performance dimensions. Similarly, the correlation between the overall quality management and organizational performance is the averaged value of all these pair-wise correlations.

3.4. Meta-analysis procedures

There are two stages of meta-analysis, following the approach developed by Schmidt and Hunter (2014) and adopted by Nair (2006) Mackelprang and Nair, 2010 and Gerwin and Barrowman (2002). Table 1 presents the meta-analysis procedure with all formulas and purpose for each step. In stage-I, we test H1 and H2, that is, the relationship and moderating effect between overall QM practices and aggregate organizational performance. The data for this portion of analysis is shown in Table 2. In stage-II, we test H3-H6, which is, the relationship and moderating effect between individual QM practice and organizational performance dimensions. The sample correlations, corrected correlations, and construct reliabilities are reported in Tables 3–6. If a single-item scale was used or reliability was not reported, we substitute the mean reliability (Crook et al., 2008). Furthermore, the sample correlations, corrected correlations, as well as sampling errors are summarized by weighted averaged in Table 7.

The procedure for the two stages of analysis is the same. For each study, we computed attenuation factor (A) that reflects measurement error; the study was weighted (W) by the sample size and attenuation factor; and the correlation was corrected ($r^{'}$)based on the attenuation factor. Then, we estimated the average correlation by the weighted-average corrected sample correlation ($\overline{r^{'}}$).Among all studies, the observed correlation variance consists of the sampling error variance and the population correlation variance. Therefore, the estimate of the population correlation variance $S_{\rho}^2$is the difference between the sampling error variance ($\overline{e}$) and the observed variance S_r^2. Finally, two ratios were calculated. RATIO1 is the ratio of the weighted-average corrected sample correlation to the estimated population correlation standard deviation. RATIO2 is the ratio of the sampling error variance to the observed variance.

Table 1
Meta-analysis procedure.

Steps	Formula	Purpose
Step 1: attenuation factor (A)	$A_i = \sqrt{\alpha_{xxi}\alpha_{yyi}}$	Evaluate measurement error for both the independent and dependent variables
Step 2: corrected correlation ($r^{'}$)	$r_i^{'} = r_i/A_i$	Adjust correlation for each study based on the attenuation factor
Step 3: sample size weighted-average sample correlation ($\overline{r}$)	$\overline{r} = \sum N_i r_i / \sum N_i$	Prepare for the estimate of the sampling error variance for each study
Step 4: weighted-average corrected sample correlation ($\overline{r^{'}}$)	$\overline{r^{'}} = \sum W_i r_i^{'} / \sum W_i$ $W = N_i A_i^2$	Estimate the weighted-average corrected correlation
Step 5: corrected sampling error variance (e) for each study	$e_i = (1-\overline{r}^2)^2/(N_i - 1)A_i^2$	Used to calculate the weighted-average sampling error variance
Step 6: weighted-average sampling error variance in the corrected correlations ($\overline{e}$)	$\overline{e} = \sum W_i e_i / \sum W_i$	Estimate the average of sampling error variance in the corrected correlations
Step 7: weighted-average variance of the corrected correlations S_r^2	$S_r^2 = \sum W_i r_i^{'} / \sum W_i$	Calculate the observed variance
Step 8: population correlation variance S_{ρ}^2	$S_{\rho}^2 = S_r^2 - \overline{e}$	Estimate the population correlation variance
Step 9: RATIO1	$RATIO1 = \overline{r^{'}}/S_{\rho}$	Evaluate the relationship between the independent variable and dependent variable
Step 10: RATIO2	$RATIO2 = \overline{e}/S_r^2$	Evaluate the moderating effect

Notes: $\alpha_{xx}$is the reliability of the independent variable, $\alpha_{yy}$is the reliability of the dependent variable, N is sample size, $r$is the correlation obtained from the individual study, and i is the subscript for each study.

3.5. Heuristics to guide hypotheses testing

Two heuristics developed by Huang and Liu (2014) and adopted by Nair (2006, 2010) were used to guide hypotheses testing. When RATIO1 is greater than 2, a positive relationship between QM practices and performance exists. When RATIO2 is greater than or equal to 0.75, it is reasonable to conclude that there is just one population correlation; when RATIO2 is less than 0.75, it implies that moderators exist between the relationships.

4. Results

The first objective of this meta-analysis is to examine if aggregate QM practices and aggregate organizational performance is positively correlated. Based on the data in Table 2, we computed the values of RATIO1 and RATIO2. RATIO1 is 2.41, which is greater than 2, indicating that at an aggregate level QM practices are positively correlated with organizational performance. RATIO2 is 0.12 less than the cut-off value of 0.75, we conclude there are moderators influencing the relationship between aggregate QM practices and aggregate organizational performance. Therefore, both H1 and H2 are supported.

The second objective of this study is to examine the relationships between individual QM practices and organizational performance/performance dimensions. These relationships were investigated for both aggregate level and individual level performance. See results in Table 7. The values of RATIO1 for all QM practices and aggregate organizational performance are larger than 2. We conclude that each QM practice is positively correlated with aggregate organizational performance and this finding supports H3. RATIO2 for management leadership's (1.70) and supplier quality management's (2.24) correlations with aggregate performance are larger than 0.75. Therefore, it supports that no moderators influence the relationships between these two QM practices and aggregate organizational performance. Meanwhile, RATIO2 for relationships between aggregate organizational performance and other QM practices - people management (0.70), process management (0.40), product design and management (0.36), quality data analysis (0.26), and customer focus (0.34) - are less than 0.75. The results support moderating effects between these relationships. Thus, H4 is partially supported. Furthermore, each organizational performance dimension - financial performance, operational performance, customer service, and product quality - are used in the meta-analysis. The relationship between customer service and product design and management was not studied

Table 2
Stage-I data.

Study	N	Qα	Pα	r	r'	W	e
Anderson et al. (1995)	41	0.782	0.821	0.368	0.459	26.323	0.030
Flynn et al. (1995)	42	0.841	0.745	0.405	0.512	26.315	0.030
Choi and Eboch (1998)	339	0.775	0.730	0.235	0.312	191.789	0.004
Dow et al. (1999)	698	0.778	0.623	0.076	0.110	338.316	0.002
Samson and Terziovski (1999)	1024	0.782	0.829	0.270	0.335	663.638	0.001
Ahire and Dreyfus (2000)	418	0.792	0.870	0.506	0.610	288.019	0.003
Martinez-Lorente et al. (2000)	223	0.784	0.829	0.100	0.124	144.985	0.005
Ho et al. (2001)	50	0.898	0.840	0.610	0.703	37.695	0.021
Kaynak (2003)	214	0.883	0.873	0.266	0.303	164.776	0.005
Sánchez-Rodríguez and Martínez-Lorente (2004)	306	0.777	0.829	0.201	0.250	197.045	0.004
Molina et al. (2007)	197	0.876	0.880	0.368	0.419	151.863	0.005
Bou-Llusar et al. (2009)	446	0.792	0.888	0.462	0.551	313.670	0.002
Benner and Veloso (2008)	75	0.826	0.829	0.115	0.139	51.358	0.015
Zu et al. (2008)	226	0.889	0.925	0.477	0.526	185.845	0.004
Arumugam et al. (2008)	122	0.750	0.800	0.337	0.435	73.200	0.011
Naor et al. (2008)	189	0.809	0.650	0.081	0.112	99.386	0.008
Jung and Hong (2008)	230	0.922	0.829	0.538	0.615	175.858	0.004
Kaynak and Hartley (2008)	263	0.820	0.823	0.381	0.464	177.488	0.004
Zu (2009)	226	0.889	0.930	0.600	0.660	186.850	0.004
Jayaram et al. (2010)	394	0.826	0.850	0.580	0.692	276.627	0.003
Sadikoglu and Zehir (2010)	373	0.863	0.840	0.501	0.588	270.395	0.003
Parast et al. (2011)	31	0.713	0.790	0.290	0.386	17.461	0.046
Parast and Adams (2012)	31	0.820	0.755	0.228	0.290	19.192	0.041
Talib et al. (2013)	172	0.889	0.879	0.530	0.600	134.406	0.006
Jaafreh and Al-abedallat (2012)	384	0.749	0.874	0.584	0.722	251.376	0.003
Sadikoglu and Olcay (2014)	242	0.842	0.868	0.408	0.477	176.867	0.004
Akgün et al. (2014)	193	0.809	0.860	0.289	0.346	134.278	0.006
Peng and Prybutok (2015)	161	0.947	0.960	0.280	0.294	146.368	0.005

because only the article by Shafer and Moeller (2012) provided the related information for this meta-analysis. Most values of RATIO1 are greater than 2, indicating the positive correlations between most individual QM practices and each organizational performance dimension. However, the values of RATIO1 are less than 2, for the relationship between people management and product quality (1.71) as well as the relationship between customer focus and customer service (0.99). It implies that positive relationships do not exist for these pairs. These findings partially support H5. All values of RATIO2 for individual QM practices' correlations with each performance dimensions are less than 0.75, except the one for the relationship between customer focus and operational performance (1.01). Therefore, moderators influence most pairs of relationships between individual QM practices and each organizational performance dimension and H6 is partially supported.

In addition, we performed a meta-analysis for articles published post 2005 and compared the results with Nair (2006) study in which articles were published prior 2005 (see Table 8). A total of 18 articles from our sample articles were included in the post 2005 period while 23 articles from Nair (2006) study were included in the prior 2005 period. In Table 8, only the pairs without moderator existence are presented because they indicate stronger relationships than the pairs with moderator existence. Remarkably, twelve such pairs are supported by our study, while only two pairs are evidenced by Nair (2006) study. In our study, the twelve pairs cover all seven QM practices, indicating that QM practices play a significant role on organizational performance in the post 2005 period. In contrast, only process management with two pairs of relationships to financial performance and customer service is presented without moderator existence from Nair (2006) study. The comparison between separate meta-analysis on post 2005 publications and prior 2005 publications demonstrates the increased importance of QM practices. With more paired relationships supported by post 2005 meta-analysis, practitioners could achieve higher performance improvements from implementing QM initiatives. Moreover, our study found that financial performance and operational performance were more likely to be positively influenced by QM practices than other performance dimensions.

5. Discussion

In this study, we integrate the results of empirical studies on the relationship between QM practices and organizational performance to generalize evidence for development of theory and practice on QM.

The results show that management leadership is positively associated with aggregate organizational performance and each organizational performance dimension. Management leadership has a much stronger significant effect on aggregate organizational performance compared to most of other QM practices, given the much higher value of Ratio 1. The results from Nair (2006) also support the significant relationship between management leadership and aggregate organizational performance along with three performance dimensions (financial performance, customer service, and product quality). Management leadership supported QM implantation through multiple areas, such as top management commitment, increased cross-functional cooperation, and improved reward and recognition system. Such supports from management leadership foster continuous improvement and open communication (Nair, 2006), and therefore, potentially improve financial performance, operational performance, customer service, and product quality. The role of management leadership in facilitating QM implementation has been improved, which is reflected by the existence of non-moderating effect between management leadership and aggregate organizational performance, as demonstrated by the high value of Ratio 2 (1.70). Such improvement in QM is also observed by the increased Ratio 1 value from prior 2005 (3.862) to post 2005 (5.95). With the interdisciplinary nature of QM, its implementation is affected by advances in other disciplines, such as management, technology, and engineering. The increasing leadership management skills, data-driven decision making processes, and more project oriented organizational structures possibly support increasing effectiveness of management leadership's role in QM implementation (Parast and Golmohammadi, 2019). Moreover, management leadership becomes stronger in a dynamic environment to drive the whole quality system through other QM practices (Mellat Parast and Adams, 2012). On one hand, leaders improve their management behaviors to increase employees' awareness of quality improvement (Sadikoglu and Olcay, 2014). On the other

Table 3
Relationship between QM practices and financial performance.

Study	N	Qα	FPα	r	r'	W
Management leadership						
Kaynak (2003)	214	0.92	0.89	0.264	0.292	175.223
Sánchez-Rodríguez and Martínez-Lorente (2004)	306	0.741	0.844	0.125	0.158	191.442
Bou-Llusar et al. (2009)	446	0.839	0.903	0.411	0.472	337.897
Kaynak and Hartley (2008)	263	0.8	0.74	0.305	0.396	155.696
Zu et al. (2008)	226	0.95	0.92	0.42	0.449	197.524
Parast et al. (2011)	31	0.73	0.77	0.3995	0.533	17.425
Parast and Adams (2012)	31	0.77	0.75	0.507	0.667	17.903
Akgün et al. (2014)	193	0.78	0.86	0.287	0.350	129.464
Sadikoglu and Olcay (2014)	242	0.835	0.9	0.34	0.392	181.863
People management						
Martinez-Lorente et al. (2000)	223	0.67	0.83	0.112	0.150	124.010
Kaynak (2003)	214	0.905	0.89	0.174	0.194	172.366
Sánchez-Rodríguez and Martínez-Lorente (2004)	306	0.747	0.844	0.168	0.212	192.992
Molina et al. (2007)	197	0.876	0.88	0.39	0.444	151.863
Bou-Llusar et al. (2009)	446	0.882	0.903	0.344	0.385	355.215
Kaynak and Hartley (2008)	263	0.835	0.74	0.280	0.356	162.508
Zu et al. (2008)	226	0.91	0.92	0.43	0.470	189.207
Parast et al. (2011)	31	0.71	0.77	0.234	0.316	16.948
Akgün et al. (2014)	193	0.83	0.86	0.29	0.343	137.763
Sadikoglu and Olcay (2014)	242	0.81	0.9	0.37	0.433	176.418
Process management						
Martinez-Lorente et al. (2000)	223	0.82	0.83	0.088	0.107	151.774
Kaynak (2003)	214	0.86	0.89	0.256	0.293	163.796
Molina et al. (2007)	197	0.86	0.88	0.34	0.391	149.090
Bou-Llusar et al. (2009)	446	0.733	0.903	0.477	0.586	295.207
Kaynak and Hartley (2008)	263	0.84	0.74	0.382	0.485	163.481
Zu et al. (2008)	226	0.86	0.92	0.38	0.427	178.811
Akgün et al. (2014)	193	0.84	0.86	0.19	0.224	139.423
Sadikoglu and Olcay (2014)	242	0.87	0.9	0.51	0.576	189.486
Product design and management						
Martinez-Lorente et al. (2000)	223	0.85	0.83	0.126	0.150	157.327
Kaynak (2003)	214	0.9	0.89	0.206	0.230	171.414
Kaynak and Hartley (2008)	263	0.8	0.74	0.395	0.513	155.696
Zu et al. (2008)	226	0.87	0.92	0.35	0.391	180.890
Parast et al. (2011)	31	0.5	0.77	0.286	0.461	11.935
Quality data analysis						
Martinez-Lorente et al. (2000)	223	0.76	0.83	0.084	0.106	140.668
Kaynak (2003)	214	0.78	0.89	0.287	0.344	148.559
Sánchez-Rodríguez and Martínez-Lorente (2004)	306	0.814	0.844	0.054	0.065	210.302
Kaynak and Hartley (2008)	263	0.78	0.74	0.339	0.446	151.804
Zu et al. (2008)	226	0.96	0.92	0.31	0.330	199.603
Parast et al. (2011)	31	0.87	0.77	0.218	0.266	20.767
Parast and Adams (2012)	31	0.87	0.75	0.004	0.005	20.228
Akgün et al. (2014)	193	0.83	0.86	0.36	0.426	137.763
Supplier quality management						
Kaynak (2003)	214	0.93	0.89	0.244	0.268	177.128
Sánchez-Rodríguez and Martínez-Lorente (2004)	306	0.804	0.844	0.089	0.108	207.718
Molina et al. (2007)	197	0.79	0.88	0.37	0.444	136.954
Bou-Llusar et al. (2009)	446	0.714	0.903	0.351	0.437	287.555
Kaynak and Hartley (2008)	263	0.81	0.74	0.391	0.505	157.642
Zu et al. (2008)	226	0.83	0.92	0.34	0.389	172.574
Parast et al. (2011)	31	0.8	0.77	0.125	0.159	19.096
Sadikoglu and Olcay (2014)	242	0.84	0.9	0.34	0.391	182.952
Customer focus						
Molina et al. (2007)	197	0.89	0.88	0.35	0.395	154.290
Benner and Veloso (2008)	75	0.806	0.844	−0.115	−0.139	51.038
Kaynak and Hartley (2008)	263	0.86	0.74	0.288	0.361	167.373
Zu et al. (2008)	226	0.84	0.92	0.24	0.273	174.653
Parast et al. (2011)	31	0.65	0.77	0.144	0.204	15.516
Akgün et al. (2014)	193	0.82	0.86	0.32	0.381	136.104
Sadikoglu and Olcay (2014)	242	0.86	0.9	0.51	0.580	187.308

Note: Qα is the reliability of QM practices; FPα is the reliability of financial performance.

hand, top managers use the advanced technology to establish communication and cooperation among employees, customers, and suppliers (Zu et al., 2008; Sadikoglu and Olcay, 2014).

People management has a positive influence on aggregate performance, financial performance, operational performance, and customer service. These results are consistent with other studies. Specifically, the results support prior findings that the components of people management impact performance. These include employee training (Samson and Terziovski, 1999; Sila and Ebrahimpour, 2005), teamwork (Flynn et al., 1995; Naor et al., 2008), employee involvement in decision-making processes (Ahire et al., 1996; Naor et al., 2008), and rewards and compensation policies (Jiang et al., 2012). However, people management has no positive influence on product quality because of the low Ratio 1 value ($1.71 < 2$). The missing positive influence on product quality from people management is not because of the non-importance of people management on product quality. Instead, people management influences product quality through other QM practices. Prior study also supported that people management is mediated by other core QM practices including quality data analysis, process management, and product design and management (Zu et al., 2008). People management has a strong focus on improving employees' skills and capabilities in performing their jobs through programs including training, employee relation, empowerment, workforce management, teamwork, and people involvement. Such programs will result in improving product quality potentially through quality data analysis, process management, and product design and management. Note that people management becomes more important in contributing to financial performance without moderator existence as evidenced by the large Ratio 1 value ($\gg 2$) and large Ratio 2 value (2.31) which are shown in Table 8 for the post 2005 publications meta-analysis.

Supplier quality management has positive impact on aggregate performance and all performance dimensions, which supports the importance of collaboration systems with suppliers. In particular, RATIO 1 has a value of infinity for the relationship between supplier quality management and aggregate performance, suggesting that supplier quality management is as important as management leadership in the QM system. In addition, the high value of Ratio 2 suggests that there is no moderating effect on the relationship between supplier quality management and aggregate performance. The results are in line with previous studies that "soft practices" including leadership and supplier

Table 4
Relationship between QM practices and operational performance.

Study	N	Qα	OPα	r	r'	W
Management leadership						
Flynn et al. (1995)	42	0.88	0.74	0.51	0.632	27.350
Choi and Eboch (1998)	339	0.92	0.73	0.09	0.110	227.672
Kaynak (2003)	214	0.92	0.855	0.311	0.351	168.332
Sánchez-Rodríguez and Martínez-Lorente (2004)	306	0.741	0.784	0.308	0.404	177.854
Kaynak and Hartley (2008)	263	0.8	0.75	0.298	0.385	157.800
Parast et al. (2011)	31	0.73	0.81	0.206	0.268	18.330
Parast and Adams (2012)	31	0.77	0.76	0.327	0.427	18.141
Sadikoglu and Olcay (2014)	242	0.835	0.9	0.255	0.294	181.863
People management						
Flynn et al. (1995)	42	0.955	0.74	0.425	0.506	29.681
Choi and Eboch (1998)	339	0.78	0.73	0.13	0.172	193.027
Kaynak (2003)	214	0.905	0.855	0.309	0.351	165.588
Sánchez-Rodríguez and Martínez-Lorente (2004)	306	0.747	0.784	0.318	0.415	179.294
Kaynak and Hartley (2008)	263	0.835	0.75	0.269	0.339	164.704
Parast et al. (2011)	31	0.71	0.81	0.582	0.767	17.828
Sadikoglu and Olcay (2014)	242	0.81	0.9	0.37	0.433	176.418
Process management						
Flynn et al. (1995)	42	0.89	0.74	0.38	0.468	27.661
Ahire and Dreyfus (2000)	339	0.69	0.73	0.13	0.183	170.754
Kaynak (2003)	214	0.86	0.855	0.292	0.341	157.354
Kaynak and Hartley (2008)	263	0.84	0.75	0.339	0.427	165.690
Sadikoglu and Olcay (2014)	242	0.87	0.9	0.5	0.565	189.486
Product design and management						
Flynn et al. (1995)	42	0.89	0.74	0.46	0.567	27.661
Kaynak (2003)	214	0.9	0.855	0.206	0.235	164.673
Kaynak and Hartley (2008)	263	0.8	0.75	0.307	0.396	157.800
Parast et al. (2011)	31	0.87	0.81	0.373	0.444	21.846
Quality data analysis						
Flynn et al. (1995)	42	0.76	0.74	0.52	0.693	23.621
Choi and Eboch (1998)	339	0.71	0.73	0.13	0.181	175.704
Kaynak (2003)	214	0.78	0.855	0.1825	0.223	142.717
Sánchez-Rodríguez and Martínez-Lorente (2004)	306	0.814	0.784	0.221	0.277	195.375
Kaynak and Hartley (2008)	263	0.78	0.75	0.318	0.416	153.855
Parast et al. (2011)	31	0.87	0.81	0.229	0.273	21.846
Parast and Adams (2012)	31	0.87	0.76	0.073	0.090	20.497
Supplier quality management						
Flynn et al. (1995)	42	0.74	0.74	0.25	0.338	22.999
Kaynak (2003)	214	0.93	0.855	0.339	0.380	170.162
Sánchez-Rodríguez and Martínez-Lorente (2004)	306	0.804	0.784	0.238	0.300	192.975
Kaynak and Hartley (2008)	263	0.81	0.75	0.447	0.574	159.773
Parast et al. (2011)	31	0.8	0.81	−0.133	−0.165	20.088
Sadikoglu and Olcay (2014)	242	0.84	0.9	0.4	0.460	182.952
Customer focus						
Flynn et al. (1995)	42	0.66	0.74	0.36	0.515	20.513
Kaynak and Hartley (2008)	263	0.86	0.75	0.274	0.341	169.635
Parast et al. (2011)	31	0.65	0.81	0.557	0.768	16.322
Sadikoglu and Olcay (2014)	242	0.86	0.9	0.3	0.341	187.308

Note: Qα is the reliability of QM practices; OPα is the reliability of operational performance.

management play more significant roles than other QM core practices in organizational performance (Naor et al., 2008; Samson and Terziovski, 1999). Successful development of supplier partnership and long-term relationships facilitates organizations to improve organizational performance such as product development, production process, and product removing (Calvo-Mora et al., 2013). These activities will lead to reduce product development time, production cost, and environmental sustainability. Although there are some turbulences in recent years about economic globalization, the business environment has been evolving into a more dynamic context with much higher level of globalization (Ghemawat and Altman, 2019). Supplier management is experiencing much higher importance in organizational performance. Supplier management serves as an effective way to improve financial performance and overall organizational performance through cost reduction and core competency focus without contextual moderators as evidenced by the results in Table 8.

Results of the study show that quality data analysis has a positive effect on aggregate performance and each dimension of performance. The successful quality data analysis requires quality data measure (Crosby, 1979), identification of appropriate data measure, collection of quality data (Mondon, 1982), and relevant analytical analyses, and regularly monitor of measurement performance (Saraph et al., 1989). Effective quality data analysis provides timely, effective, and reliable information for organizations, suppliers, and customers, and therefore influences financial and operational performance, product quality, and customer service (Sadikoglu and Zehir, 2010). For instance, Kaynak (2003) provided empirical support that the practice of quality data analysis helps new product design and process improvement through information sharing across supply chain. Kim et al. (2012) also suggested that quality data analysis improves organizational performance through both product and process innovation (Kim et al., 2012). Kim et al. (2012) found that analyzing quality data allows organizations to respond quickly to changing demand of customers. Samson and Terziovski (1999) demonstrated that data analysis helps organizations develop customer-focused products and prevent rework. Kim et al. (2012) discussed the areas of how quality data analysis will positively support quality management through improving supplier management, product and service design, and process management. In recent years, with new technology advances, complex algorithms, and super computing power in big data analytics, the role of quality data analysis in facilitating QM implementation has been strengthened. The current practices in industry, such as real time data collections from end consumers and industrial equipment, data mining on unstructured data, and prediction in supporting business decision making, has redefining the meaning of quality data analysis. In the near future, it can be expected to find additional significant paired relationships between quality data analysis and performances from quality research.

Process management positively influences aggregate performance and all dimensions of performance. The results are consistent with previous studies (Kaynak, 2003; Kim et al., 2012; Zu et al., 2008; Nair, 2006; Sadikoglu and Zehir, 2010). Process management involves management of two types of activities: repeating activities and enhancing activities (Kim et al., 2012). Repeating activities include process documentation, process outcome measuring, and value-added process identification (Klassen and Menor, 2007; ISO, 2008). With the focus of

Table 6
Relationship between QM practices and product quality.

Study	N	Qα	PPα	r	r'	W
Management leadership						
Flynn et al. (1995)	42	0.88	0.75	0.59	0.726	27.720
Dow et al. (1999)	698	0.795	0.623	0.188	0.267	345.709
Kaynak and Hartley (2008)	263	0.8	0.99	0.455	0.511	208.296
Naor et al. (2008)	189	0.86	0.65	0.27	0.361	105.651
Zu et al. (2008)	226	0.95	0.93	0.65	0.692	199.671
Zu (2009)	226	0.95	0.93	0.65	0.692	199.671
Jayaram et al. (2010)	394	0.85	0.85	0.520	0.612	284.665
Talib et al. (2013)	172	0.899	0.879	0.581	0.653	135.918
Sadikoglu and Olcay (2014)	242	0.835	0.86	0.415	0.490	173.780
People management						
Flynn et al. (1995)	42	0.955	0.75	0.42	0.496	30.083
Dow et al. (1999)	698	0.808	0.623	−0.058	−0.082	351.145
Ahire and Dreyfus (2000)	418	0.74	0.87	0.465	0.580	269.108
Ho et al. (2001)	50	0.898	0.84	0.61	0.703	37.695
Kaynak and Hartley (2008)	263	0.835	0.99	0.417	0.459	217.409
Naor et al. (2008)	189	0.67	0.65	0.12	0.182	82.310
Zu et al. (2008)	226	0.91	0.93	0.63	0.685	191.264
Zu (2009)	226	0.91	0.93	0.63	0.685	191.264
Jayaram et al. (2010)	394	0.785	0.85	0.48	0.588	262.897
Talib et al. (2013)	172	0.896	0.879	0.518	0.583	135.515
Sadikoglu and Olcay (2014)	242	0.81	0.86	0.46	0.551	168.577
Process management						
Flynn et al. (1995)	42	0.89	0.75	0.25	0.306	28.035
Ahire and Dreyfus (2000)	418	0.78	0.87	0.67	0.813	283.655
Kaynak and Hartley (2008)	263	0.84	0.99	0.569	0.624	218.711
Naor et al. (2008)	189	0.87	0.65	−0.06	−0.080	106.880
Zu et al. (2008)	226	0.86	0.93	0.7	0.783	180.755
Zu (2009)	226	0.86	0.93	0.69	0.772	180.755
Talib et al. (2013)	172	0.833	0.879	0.491	0.574	125.940
Sadikoglu and Olcay (2014)	242	0.87	0.86	0.43	0.497	181.064
Product design and management						
Flynn et al. (1995)	42	0.89	0.75	0.4	0.490	28.035
Ahire and Dreyfus (2000)	418	0.855	0.87	0.383	0.443	310.929
Kaynak and Hartley (2008)	263	0.8	0.99	0.588	0.661	208.296
Naor et al. (2008)	189	0.81	0.65	−0.02	−0.028	99.509
Zu et al. (2008)	226	0.87	0.93	0.63	0.700	182.857
Zu (2009)	226	0.87	0.93	0.63	0.700	182.857
Jayaram et al. (2010)	394	0.9	0.85	0.52	0.595	301.410
Talib et al. (2013)	172	0.902	0.879	0.598	0.672	136.372
Quality data analysis						
Flynn et al. (1995)	42	0.76	0.75	0.39	0.517	23.940
Kaynak and Hartley (2008)	263	0.78	0.99	0.506	0.576	203.089
Naor et al. (2008)	189	0.87	0.65	0.02	0.027	106.880
Zu et al. (2008)	226	0.96	0.93	0.53	0.561	201.773
Zu (2009)	226	0.96	0.93	0.53	0.561	201.773
Jayaram et al. (2010)	394	0.82	0.85	0.64	0.767	274.618
Talib et al. (2013)	172	0.874	0.879	0.466	0.532	132.138
Supplier quality management						
Flynn et al. (1995)	42	0.74	0.75	0.45	0.604	23.310
Dow et al. (1999)	698	0.725	0.623	0.063	0.094	315.269
Kaynak and Hartley (2008)	263	0.81	0.99	0.583	0.651	210.900
Naor et al. (2008)	189	0.8	0.65	0.17	0.236	98.280
Zu et al. (2008)	226	0.83	0.93	0.61	0.694	174.449
Zu (2009)	226	0.83	0.93	0.61	0.694	174.449
Jayaram et al. (2010)	394	0.76	0.85	0.38	0.473	254.524
Talib et al. (2013)	172	0.91	0.879	0.297	0.332	137.581
Sadikoglu and Olcay (2014)	242	0.84	0.86	0.39	0.459	174.821
Customer focus						
Flynn et al. (1995)	42	0.66	0.75	0.23	0.327	20.790
Dow et al. (1999)	698	0.755	0.623	0.247	0.360	328.315
Kaynak and Hartley (2008)	263	0.86	0.99	0.429	0.465	223.918
Naor et al. (2008)	189	0.78	0.65	0.07	0.098	95.823
Zu et al. (2008)	226	0.84	0.93	0.46	0.520	176.551
Zu (2009)	226	0.84	0.93	0.46	0.520	176.551
Jayaram et al. (2010)	394	0.83	0.85	0.55	0.655	277.967
Talib et al. (2013)	172	0.902	0.879	0.657	0.738	136.372
Sadikoglu and Olcay (2014)	242	0.86	0.86	0.48	0.558	178.983

Note: Qα is the reliability of QM practices; PPα is the reliability of product quality.

repeating activities on repetitive and continuous flow processes, organizations adopting these activities can improve quality performance, financial performance, and operational performance with a higher process efficiency through reducing process variation, rework and waste cost, and eliminating non-value-added processes (Kaynak, 2003). Furthermore, these organizations could shorten the product or service development cycle through accumulated knowledge sharing, which enables them to respond quickly to customer needs (Nair, 2006; Kim et al., 2012). On the other hand, enhancing activities focus on innovation and continuous improvement on simple and flexible processes (Kim et al., 2012). With the focus of enhancing activities on job shop and batch flow processes, organizations can adapt in a high-velocity market with a higher process flexibility (Eisenhardt and Martin, 2000).

Product design and management positively influences aggregate performance, financial performance, operational performance, and product quality. Product design and management involves two objectives: manufacturability and quality design including quality dimensions such as product reliability, product features and serviceability (Flynn et al., 1995; Nair, 2006). Efforts on these objectives result in simplifying and standardizing components, and incorporating customer needs, which improves product quality (Kim et al., 2012; Kaynak, 2003; Zu et al., 2008). Furthermore, increased product quality enhances organization reputation that enables organizations to charge a premium price and improve their profitability (Shetty, 1988). The cross-functional personnel involved in product design and management achieves a higher efficiency (Flynn et al., 1995). However, the sample in our study limited our ability to investigate the relationship between product design and management and customer service.

Customer focus was positively associated with aggregate performance, financial performance, operational performance, and product quality. In manufacturing plants, customer focus contributes to product quality by involving customers in product design in initiation stage to reduce process variability, by allowing customers to determine critical specifications and tolerances, and by adding new features to meet better customer requirements and expectations (Flynn et al., 1995; Zu, 2009; Jayaram et al., 2010; Sadikoglu and Olcay, 2014). However, efforts on customer focus failed to improve customer service. This is because customer service is provided by employees. When employees are not committed to organizational goals during communication with customers, customers would not be satisfied. Possibly, people management mediates the effect of customer focus on customer service.

The rapidly changing business environment evolving from information technological innovations necessitates an examination of the role of key components of quality management theory. With the incorporation of information technology, QM implementation becomes effective, efficient, and adaptive. Especially, technology positively influences "soft QM practices" - management leadership, supplier quality management,

Table 7
Overall meta-analysis of correlation results.

QM practices	n	N	r	r'	$\bar{e}$	RATIO1	RATIO2
Management leadership						≫2	1.70
Financial performance	9	1952	0.324	0.377	0.05	4.63	0.44
Operational performance	8	1468	0.25	0.307	0.007	3.42	0.47
Customer service	6	1768	0.466	0.557	0.003	3.75	0.12
Product quality	9	2452	0.454	0.524	0.004	3.56	0.14
People management						9.85	0.70
Financial performance	10	2341	0.294	0.341	0.005	4.42	0.46
Operational performance	7	1437	0.287	0.353	0.006	4.41	0.5
Customer service	6	1768	0.451	0.551	0.003	6.1	0.29
Product quality	11	2920	0.39	0.45	0.004	1.71	0.06
Process management						6.38	0.40
Financial performance	8	2004	0.35	0.413	0.004	2.84	0.17
Operational performance	5	1100	0.323	0.388	0.006	3.31	0.3
Customer service	4	1068	0.449	0.568	0.004	7.79	0.43
Product quality	8	1778	0.541	0.621	0.003	2.62	0.05
Product design and management						5.07	0.36
Financial performance	5	957	0.271	0.324	0.006	2.88	0.33
Operational performance	4	550	0.278	0.34	0.009	8.91	0.86
Customer service	1	Insufficient data for analysis					
Product quality	8	1930	0.496	0.561	0.003	3.17	0.1
Quality data analysis						3.33	0.26
Financial performance	8	1487	0.227	0.27	0.007	2.43	0.45
Operational performance	7	1226	0.218	0.281	0.009	4.15	0.66
Customer service	3	1039	0.476	0.585	0.003	2.63	0.05
Product quality	7	1512	0.494	0.559	0.004	3.06	0.1
Supplier quality management						≫2	2.24
Financial performance	8	1925	0.297	0.356	0.005	3.36	0.31
Operational performance	6	1098	0.336	0.404	0.006	3.65	0.34
Customer service	4	1388	0.386	0.482	0.003	2.33	0.07
Product quality	9	2452	0.376	0.443	0.005	2.1	0.09
Customer focus						4.79	0.34
Financial performance	7	1227	0.315	0.367	0.007	2.58	0.24
Operational performance	4	578	0.303	0.368	0.008	≫2	1.01
Customer service	2	636	0.643	0.767	0.004	0.99	0.01
Product quality	9	2452	0.421	0.498	0.004	3.57	0.17

Note: n is the number of studies; N is total sample size.

Table 8
Comparisons between Nair (2006) study and post 2005 publications meta-analysis on the positive paired relationships without moderator existence.

QM practices	Organizational performance	RATIO1	RATIO2
Nair (2006) study			
Process management	Financial performance	11.433	0.835
Process management	Customer service	14.475	0.799
This study			
Management leadership	Financial performance	≫2	1.7
Management leadership	Operational performance	≫2	3.74
People management	Financial performance	≫2	2.31
Process management	Aggregate organizational performance	≫2	1.1
Process management	Operational performance	16.96	0.82
Product design and management	Financial performance	≫2	1.81
Product design and management	Operational performance	≫2	37.45
Quality data analysis	Financial performance	13	0.9
Quality data analysis	Operational performance	≫2	1.21
Supplier quality management	Aggregate organizational performance	100.5	0.99
Supplier quality management	Financial performance	≫2	2.3
Customer focus	Operational performance	12.13	0.88

people management, customer focus - with better teamwork planning and communication channels (Pérez-Aróstegui et al., 2015). It potentially explains the strengthened relationships between QM practices and performance when we compared our results with those from Nair (2006) study.

The integration of interactive technologies and smart phone apps facilitates communications between organizations and customers. For example, mobile augmented reality improves customer focus by allowing customers to integrate virtual products (e.g., furniture) and physical environment (e.g., real room) at real time (Zhou et al., 2008). These technologies enable product customization and enhance consumer behaviors as well (Huang and Liu, 2014), resulting in the increase in financial performance and operational performance.

Technology also facilitates supplier quality management through the development of communication abilities, including integration of the software programs, and easy access to databases (Dewhurst et al., 1999). Some IT systems such as electronic data interchange process information require trust and complex coordination which makes competitors difficult to imitate (Pérez-Aróstegui et al., 2015).

Smart manufacturing implementation of QM practices has evolved and, thus, changes, such as real time data collection, were incorporated in traditional applications of QM techniques, such as control charts, histograms, and scatter diagrams. In addition, in the era of big data, technology and analytics advance impact management leadership and people management as evidenced by enhanced performance due to new management approaches such as analysis of email and calendar data which improves team collaboration and encourage information sharing. Moreover, advanced analytics enhance quality data analysis which in turn enhances business processes. The use of some technologies such as barcodes, card memberships, and social media increases quality information availability, while the use of other technologies such as Internet of Things improves data analysis (e.g. constructing quality control charts) by applying real-time data (Curry et al., 2019). All of these technologies are likely to improve financial performance, operational performance, and product/service quality. For instance, Ping An, an insurance company in China, saved more than $750 million last year through the use of big data and artificial intelligence in automated auto inspection (Chandler, 2019).

Technology benefits process management by providing better statistical control with the use of developed IT infrastructure (computing technologies, network systems and Internet). Meanwhile, technology enables organizations to have the same processes in different locations, which helps to achieve business globalization (Pérez-Aróstegui et al., 2015).

Evan's and the Editorial Board of the *Quality Management Journal* (2013) suggested the need for the development of quality management theory where quality was viewed as a macro construct termed Big Q that encompasses other constructs. While the MBNQA partially captures this concept, the article stated it did so only at the organizational level and that an operations level view would provide additional insights. The current research partially answers that call for research. In addition, the ongoing evolution of technology has changed QM and such changes have penetrated into practices. More importantly, technology strengthens the impacts of QM practices on organizational performance, and eventually helps organizations sustain competitive advantages.

5.1. Limitations and suggestions for future research

There are limitations in this study, but despite these limitations the work provides insights into important future research streams in quality management. First, despite a thorough literature search for all suitable studies, it is still possible that other peripheral studies related to the area of focus in this meta-analysis. Because of the limited number of articles that examine the relationship between customer focus practice and customer service performance, which is a dimension of organizational performance, additional studies on quality management are necessary to include this pair to provide sufficient data to investigate the effects of quality management practices on organizational performance. Second, the sample limits our ability to analyze potential moderators, such as firm size, industry type, cultural differences, and quality award winners. Future empirical studies with the first-hand information categorized on different types of contingency factors are needed in the QM field to generate more practical guidelines for industry. For example, there is lack of information about whether a sampled organization received a quality award. As a result, the data does not allow determining if the results differ for quality-award winning organizations and non-award winning organizations. Scholars can conduct future research to test the similarities and differences on the effectiveness of quality management practices by classifying organizations on such factors as award winning or not. Third, the extant literature limits our ability to study mediation effects because of the lack of generalization of specific mediators for specific pair of relationship. Future empirical studies on mediation effect are needed.

6. Conclusions

This study contributes to quality theory development by providing a better understanding of the effectiveness of QM practices on organizational performance at both the aggregated and individual level. Prior studies have focused on the influence of a QM program on organizational performance and the interdependence among QM practices. Utilizing meta-analysis methods, this study not only explores the role of quality management on organizational performance based on prior research results, but also investigates direct linkages between individual QM practices and organizational performance dimensions. The results provide numerous insights for quality theory development by investigating current quality management literature in the rapidly changing business environment. The results emphasize the superior importance of management leadership and supplier quality management in the QM system. The results also suggest that management leadership and supplier quality management not only positively influence organizational performance and different dimensions of performance, but their influence is consistent and not moderated by contingency factors.

Credit author statement

Each author contributes equally.

Apendix. Summary of the sample articles

Article (1995–2015)	Sample and unit of analysis	Method	Operationalizing quality management practices	Operationalization of performance	Findings
Anderson et al. (1995)	41 manufacturing plants (respondents: individuals with different job titles and responsibilities)	Path analysis	1. Visionary leadership; 2. internal & external cooperation; 3.process management; 4.employee fulfillment	customer satisfaction	Results provide support for several of the proposed relationships among TQM factors and the relationship with customer satisfaction
Flynn et al. (1995)	42 plants (respondents:	Path analysis	Core quality management practices: 1. Process flow management; 2. Product design process; 3.statistical control/ feedback Quality management infrastructure practices: 1. Customer relationship; 2. Supplier relationship; 3.work attitudes; 4.workforce management; 5. Top management support	Performance outcomes: 1. Perceived quality market outcomes; 2. Percent of items that pass final inspection without requiring rework; 3. Competitive advantage	Perceived quality market outcomes were primarily related to statistical control/ feedback and the product design process, while percent of items that passed final inspection without requiring rework was strongly related to process flow management and to statistical control/feedback. Supplier relationships and work attitudes were also related to some of the core quality practices and quality performance measures.
Choi and Eboch (1998)	339 manufacturing plants (respondents: plant managers)	SEM	TQM practices: 1. Process quality; 2. Human resource; 3. Strategic quality planning; 4. Information and analysis	Plant performance: 1. Quality; 2. Cost; Customer satisfaction: 1. Quality; 2. Delivery; 3. Cost	TQM practices have a stronger impact on customer satisfaction than they do on plant performance.
Dow et al. (1999)		SEM	Quality management practices: 1. Workforce commitment; 2.	Quality outcome: 1. The percentage of defects at final	"Employee commitment," "shared vision," and "customer

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Article (1995–2015)	Sample and unit of analysis	Method	Operationalizing quality management practices	Operationalization of performance	Findings
	698 manufacturing sites (respondents: site managers)		Shared vision; 3. Customer focus; 4. Use of teams; 5. Personnel training; 6. Co-operative supplier relations; 7. Use of benchmarking; 8. Use of advanced manufacturing systems; 9. Use of just-in-time principles	assembly; 2. The cost of warranty claims; 3. The total cost of quality; 4. An assessment of the defect rate relative to competitors.	focus" combine to yield a positive correlation with quality outcomes. However, other "hard" quality practices, such as "benchmarking," "cellular work teams," "advanced manufacturing technologies," and "close supplier relations" do not contribute to superior quality outcomes.
Ahire and Dreyfus (2000)	418 manufacturing plants (responents: managers)	SEM	TQM components: 1. Design management; 2. Quality training; 3. Product design performance; 4. Process quality management	1. Internal quality (quality assessed before shipping, such as scrap, rework, defects, performance); 2. External quality (quality assessed by customers, such as complaints, warranty, litigation, market share)	Results show that both design and process management efforts have an equal positive impact on internal quality outcomes and external quality outcomes. Contingency analysis shows that the proposed model of synergies between design and process management holds true for large and small firms, for firms with different levels of TQM experience; and in different industries with varying levels of competition, logistical complexity of production, or production process characteristics.
Das et al. (2000)	290 manufacturing firms (respondents: quality directors and vice presidents)	SEM	Quality practices: 1. Supply chain management practices; 2. Quality resources & evaluation; 3. Quality training; 4. Customer commitment	1. Customer satisfaction performance (customer retention, customer satisfaction, on-time delivery); 2. Firm performance (market share, ROA, market share increase)	Quality practices are positively related to customer satisfaction performance. International competition was found to moderate the relationship between quality practices and customer satisfaction performance.
Martinez-Lorente et al. (2000)	223 companies (respondents: quality managers, general managers, quality department representatives, staff members)	Kendall tau-c coefficients	TQM dimensions: 1. Employee relations; 2. Organization; 3. Product design process; 4. Quality information; 5. Supplier relationship; 6. Process instruments; 7. Design instruments	Business performance: 1. Market share growth; 2. Unit costs; 3. Operational profits	The results show that the most important TQM dimensions are the system of employee relations and the use of quality management-related design tools.
Ho et al. (2001)	25 electronics companies with 50 responses (respondents: managers from quality department, production or marketing department)	Hierarchical regression	Supportive quality management practices: 1. Employee relations; 2. Training; Core quality management practices: 1. Quality data and reporting; 2. Supplier quality management	Quality performance (performance, reliability, conformance to specifications, and durability)	The results showed that the effect of training and employee relations on quality performance might be largely transmitted by certain core quality management practices. Core TQM practices mediate the effect of supportive TQM practices on quality performance.
Kaynak (2003)	214 firms (respondents: the majority of respondents are president, vice president, director, manager, and coordinator)	SEM	TQM practices: 1.management leadership; 2. Training; 3. Employee relations; 4.quality data & reporting; 5. Supplier quality management; 6. Product/service design; 7. Process management	Performance measures: 1. Financial & market performance; 2. Quality performance; 3. Inventory management performance	This study identifies the direct and indirect effects of TQM practices on the various dimensions of performance. The findings suggest that a positive relationship exists between the extent to which companies implement TQM and firm performance.
Sánchez-Rodríguez and Martínez-Lorente (2004)	306 firms (respondents: purchasing managers)	Bivariate correlation analysis	Quality management practices in purchasing: 1. Management commitment to total quality; 2. Cross-functional coordination; 3. Personnel management; 4. Supplier management; 5. Quality information; 6. Benchmarking	1. Operational performance; 2. Service quality; 3. Business performance (ROA, ROS, production costs, market share)	The results suggest that all six quality management practices in purchasing were positively correlated with operational performance. Meanwhile, all six quality management practices except supplier management were positively correlated with internal customer satisfaction. Finally, results suggest that management commitment, cross-functional coordination,

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Article (1995–2015)	Sample and unit of analysis	Method	Operationalizing quality management practices	Operationalization of performance	Findings
					and personnel management were positively correlated with overall business performance.
Molina et al. (2007)	197 firms(respondents: CEOs, quality managers, and other top-level executives)	SEM	QM practices: 1. Suppliers cooperation; 2.teamwork; 3. worker autonomy; 4.process control; 5.customers cooperation	Performance (with regard to ROA, ROE, sales, market share)	The study analyzes the relationship between QM and knowledge transfers. Specifically, the results do not confirm the relationship between teamwork and knowledge transfer, but other factors including supplier cooperation, autonomy, process control, and customer cooperation are positively related to knowledge transfer. In addition, both external knowledge transfer and internal knowledge transfer are positively related to performance.
Arumugam et al. (2008)	122 responses from ISO 9001:2000 certified manufacturers (respondents: the quality management representatives)	multiple regression analysis	TQM practices: 1. Process management; 2.information analysis; 3.customer focus; 4. leadership; 5.supplier relationships; 6.quality system improvement; 7.people involvement; 8 continual improvement	Quality performance	The findings revealed that TQM practices were found to be partially correlated with quality performance. In addition, customer focus and continual improvement were perceived as dominant TQM practices in quality performance.
Benner and Veloso (2008)	75 firms(respondents: public data)	Regression	1. ISO 9000 adoption; 2. Customer concentration	Financial performance: 1.ROS; 2. ROA	Late adopters of ISO 9000 no longer gain financial benefits from the ISO practices; Firms that have a very narrow or very broad technological focus have fewer opportunities for complementary interactions that arise from process management practices and thus benefit less than those with limited breadth in technologically related activities.
Jung and Hong (2008)	230 responses(respondents: employees)	SEM	1. Leadership; 2. People management; 3. Customer focus; 4. Process management; 5. Information and analysis	Performance (includes: 1. Soft-performance, involves customer satisfaction, employ morale, and productivity; 2. Hard-performance, involves operational numeric measures, such as defect rate and warranty claim rate.	The results show that “soft TQM elements” have more significant impact than “hard TQM elements” toward firm’s performance
Kaynak and Hartley (2008)	263 firms (respondents: the majority of respondents are president, vice president, director, manager, or coordinator)	SEM	1. Management leadership; 2. Training; 3. Employee relations; 4. Customer focus; 5. Quality data and reporting; 6. Supplier quality management; 7.product/service design; 8. Process management	1. Inventory management performance; 2. Quality performance; 3. Financial and market performance	Both customer focus and supplier quality management positively influence quality performance, supporting the importance of internal and external integration for QM.
Naor et al. (2008)	189 manufacturing plants (respondents: top management, supervisors, and shop floor employees)	SEM	Infrastructure quality management practices: 1. Top management support; 2. workforce management; 3. supplier involvement; 4. custome involvement; Core quality management practices: 5.quality information; 6. process management; 7. product design	Manufacturing performance: 1. Cost; 2.quality; 3.delivery; 4. flexibility	Infrastructure quality management practices have a significant effect on manufacturing performance. In addition, infrastructure quality mediate the effect of culture on performance.
Zu et al. (2008)	226 manufacturing plants (respondents: plant managers, operations managers, quality managers, Six Sigma master black belts and black belts)	SEM	Traditional QM practices: 1. Top management support; 2. custoemr relationship; 3. supplier relationship; 4. workforce management; 5. quality information; 6.product/ service design; 7.process management	1. Quality performance; 2. business performance	The results suggest that the Six Sigma practices complement the traditional quality management practices in improving quality performance and business performance.
		SEM			

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Article (1995–2015)	Sample and unit of analysis	Method	Operationalizing quality management practices	Operationalization of performance	Findings
Bou-Llusar et al. (2009)	446 companies (respondents: CEOs, quality managers)		EFQM criteria variables within the enabler domain: 1. Leadership; 2. People; 3. Policy and strategy; 4.parternship and resources; 5.process	EFQM criteria variables within the result domain: 1.customer results; 2.people motivation; 3. people achievement; 4.people satisfaction; 5.financial results; 6. society results; 7.external results; 8.processes results	Social and technical TQM dimensions are intercorrelated and jointly enhance results, suggesting that EFQM Excellence Model really are TQM frameworks.
Zu (2009)	226 manufacturing plants (respondents: plant managers, operations managers, quality managers, Six Sigma master black belts and black belts)	SEM	Infrastructure quality management practices: 1. Top management support; 2. customer relationship; 3. Supplier relationship; 4. workforce management. Core quality management practices: 5.quality information; 6. process management; 7. product/service design	Quality performance	The analysis shows that the core QM directly leads to improved quality performance, and the infrastructure QM contributes to quality performance by supporting the core QM.
Jayaram et al. (2010)	394 plants (respondents: quality managers, plant/production/technical managers, etc.)	SEM	TQM constructs: 1. Top management commitment; 2. Customer focus; 3. Design management; 4. Training; 5. Empowerment; 6. Supplier quality management; 7. Process quality management; 8.quality information usage	1. Design performance; 2. Product quality; 3. Customer satisfaction	This study suggests that four contingencies (firm size, TQM duration, unionization, and industry type) moderate the influence of total effects of quality system design (design management, training, empowerment, quality information usage, supplier quality management, and process quality management) on final outcomes (process quality, product quality, and customer satisfaction). This study also suggests that these contingencies moderate the influence of total effects of culture (top management commitment, customer focus, and trust) on final outcomes.
Sadikoglu and Zehir (2010)	373 responses(respondents: employees)	SEM	TQM practices: 1. Leadership; 2. Training; 3. Employee management; 4. Information & analysis; 5. Supplier management; 6. Process management; 7. Customer focus	Firm performance(includes operating performance, quality performance, and customer satisfaction)	Employee performance and innovation performance partially mediate the relationship between TQM practices and firm performance.
Parast et al. (2011)	31 responses(respondents: managers)	Multiple regression analysis	1. Top management support; 2. Strategic quality planning; 3. Quality information availability; 4. Quality information usage; 5. Employee training; 6. Employee involvement; 7. Product/process design; 8. Supplier quality; 9. Customer orientation; 10. Quality citizenship; 11. Benchmarking	1. Internal quality results (operational performance); 2. external quality results(business performance)	The results indicate that top management support, employee training, and employee involvement are significant variables explaining the variability of operational performance. The study also shows that top management support is a significant predictor of business performance. In addition, customer orientation is not significant related to business performance in the petroleum industry.
Jaafreh and Al-abedallat (2012)	384 responses (respondents: employees)	multiple regression analysis	QM dimensions: 1. Top management; 2. Stragetic planning; 3. Quality management overall; 4. Customer focus; 5. Supplier quality; 6. Employee relation; 7. Process management	Organizational performance with multiple dimensions, including product and service outcomes, financial and market outcomes, customer-focused outcomes, process effectiveness outcomes, workforce-focused outcomes, and leadership outcomes.	The results indicate that the top management, strategic planning, employee relation, and customer focus have a significant impact on organizational performance.
Parast and Adams (2012)	31 responses(respondents: managers)	SEM	1. Top management support; 2. Quality information availability; 3. Benchmarking; 4. Quality citizenship	1. Internal quality results (operational performance, including defect rates, processing rate, production lead time, and productivity); 2. External quality results(refers to the improvement of the firm, which is measured by	The study found that top management support is positively related to external quality results.

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Article (1995–2015)	Sample and unit of analysis	Method	Operationalizing quality management practices	Operationalization of performance	Findings
				competitive market position and profitability)	
Talib et al. (2013)	172 responses (respondents: Directors, project manafers, operations managers, quality managers, ect.)	multiple regression analysis	TQM practices: 1. Top management commitment; 2. Customer focus; 3. Training and education; 4. Continuous improvement and innovation; 5. Supplier management; 6. Employee involvement; 7. Information and analysis; 8. Process management; 9. Benchmarking; 10. Quality culture; 11. Human resource management; 12. Strategic planning; 13. Employee encouragement; 14. Teamwork; 15. Product and service design; 16. Communication; 17. Quality system	quality performance	Quality culture was perceived as the dominant TQM practice in quality performance. In addition, the other practices such as quality systems, training and education, teamwork, and benchmarking showed a positive relationship with quality performance.
Akgün et al. (2014)	193 firms (respondents: employees)	SEM	TQM practices: 1.process management; 2.leadership; 3. customer focus; 4.strategic planning; 5.information and analysis; 6.people management; 7.managerial commitment	Firm financial performance	The study found that organizational learning capability and business innovativeness in a firm mediate the relationship between TQM and the firm's financial performance.
Sadikoglu and Olcay (2014)	242 responses(respondents: top managers, middle managers, quality managers, sales and marketing managers, finance and accounting managers, ect.)	multiple regression analysis	TQM practices: 1. Leadership; 2. Knowledge and process management; 3. Training; 4. Supplier quality management; 5. Customer focus; 6. Strategic quality planning	Firm performances: 1. Operational performance; 2. Inventory management performance; 3. Customer results; 4. Market and financial performance	This study has shown that different TQM practices significantly affect different performance outcomes.
Peng and Prybutok (2015)	161 responses(respondents: the City of Denton employees)	PLS-SEM	MBNQA categories: 1. Leadership; 2. Customer focus; 3. Workforce focus	Results (in the aspects of customer satisfaction, employee satisfaction, financial performance, ect.)	The results studies the relative effectiveness of the Baldrige categories on results. Leadership, workforce focus and operations focus have directly positive influences on results with correlation coefficient values of 0.15, 0.53, and 0.29, respectively. Customer focus does not have significant direct influence. However, it has significant indirect positive influence on results.

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