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Quality Information and Quality Performance: Roles of Process Control as a Mediator and Shop Floor Leadership as a Moderator

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Abstract
This study investigates (1) the effect of quality information on quality performance through process control and (2) the moderating role of shop floor leadership on the relationship between quality information and quality performance in the context of manufacturing plants on a global basis. The moderated mediation analysis with a bootstrapping approach was employed to analyse data for hypotheses testing. The data is from the fourth-round dataset of the High-Performance Manufacturing Project, collected from manufacturing plants worldwide. The results indicate that (1) quality information is positively associated with quality performance through process control, and (2) shop floor leadership (i.e., supervisory interaction facilitation) positively moderates the indirect effect of quality information on quality performance; that is, the shop floor leadership practice strengthens the effect of quality information on quality performance through process control. This study also has a practical implication for top managers who should consider the vital role of leadership practices adopted by shop floor supervisors in implementing total quality management practices and should raise awareness that leadership practices are not only for the 'C-suite' but also for shop floor supervisors.

Keywords
Total quality management, leadership, quality performance, High-Performance.

Introduction

Total quality management (TQM) is often regarded as a "holistic quality management approach" that considers the entire value chain and emphasises human factors (Dahlgaard-Park et al., 2018). Despite the plethora of critical success factors found for TQM implementation, researchers have also highlighted that the firm's level of TQM success is low and inconsistent due to insufficient conditions for success in turbulent environments (Dahlgaard-Park, 2011; Dayton, 2001; Fuentes-Fuentes et al., 2004). Scholars have called to re-examine the link among quality management (QM) practices and explore potential moderating factors on these relationships in the changing nature of quality management (e.g., Zhang et al., 2012). Thus, the authors claim that there is a vital necessity to examine the nature of the relationship among QM practices, if any, whose mechanisms enhance organisational performance, more specifically, quality performance.

Quality is a multidimensional construct with varying definitions in the extant literature (Ebrahimi & Sadeghi, 2013; Reeves & Bednar, 1994). Based on the user-based approach, quality is defined as "meeting or exceeding customers' expectations" (Reeves & Bednar, 1994, p. 439).

The mainstream of research on the adoption of QM practices have focused on leadership practices adopted by senior managers and their impacts on firm performance. However, the stream of study on the adoption of leadership practices at the shop floor level and its impacts on firm performance is under-researched (Bello-Pintado et al., 2018). In the present study, the authors argue that adopting such leadership prac-

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tices at the lower level (i.e., shop floor level) can contribute to firm performance improvement. Also, the authors argue that supervisors can adopt leadership practices to enhance the efficacy of QM practices. In this study, the authors also address whether transformational leadership style, adopted by supervisors on the shop floor, might contribute to the success of QM practices such as quality information and process control.

In the extant literature, QM practices can be distinguished into two main categories: (1) enablers, which refers to practices that can drive other practices to archive a certain goal (e.g., quality performance), and (2) moderators, which refer to practices to catalyse the strength of relationships between other practices (van Assen & de Mast, 2019). The authors focus on the adoption of QM practices at the shop floor level such as quality information, process control, and supervisory interaction facilitation in this study. Quality information, as a enabler, can be defined as a set of practices used to feedback timely information to shop floor personnel about the performance of manufacturing processes (Flynn et al., 1994; Naor et al., 2008; Zu, 2009). Next, process control, as another enabler, can be defined as using techniques and tools for controlling manufacturing processes to reduce process variation (Flynn et al., 1994; Schroeder & Flynn, 2001). As a moderator, supervisory interaction facilitation indicates whether supervisors successfully encourage workers to work as a team, including expressing their opinions and cooperating to improve production (Flynn & Flynn, 1999; Flynn et al., 1994; Matsui, 2002; Morita et al., 2011).

The main purposes of this study are to examine: (1) How quality information enhances process control to improve quality performance, and (2) whether the relationships among quality information, process control, and quality performance are independent of or contingent on, shop floor leadership. The authors utilise the latest database of the High-Performance Manufacturing (HPM) Project to investigate the mechanism of how quality information can contribute to plant performance (i.e., quality performance). This study provides empirical evidence on how the leadership style of supervisors acts as a catalyst for strengthening the positive effects of quality information not only on process control but also on quality performance.

The remainder of this paper is organised as follows: The second section presents the theoretical background and hypotheses development. The third section describes construct measurements, data collection, sample profile, and measurement analysis and hypotheses testing strategies. The results of data analysis are presented in the fourth section, and the discussion and conclusion are placed in the last section.

Theoretical background and hypotheses development

The socio-technical systems (STSs) theory was developed from open system theory (Von Bertalanffy, 1950). The seminal works of STSs theory were developed by (Pasmore, 1988; Trist & Bamforth, 1951). STSs theory posits that an organisation is an open system consisting of two interacting subsystems: Technical subsystem (tools, techniques and knowledge) and social subsystem (people) to produce goods and services that are valued by customers (Manz & Stewart, 1997). STSs theory has been widely adopted in the QM research to study how QM technical-oriented practices interact with social-oriented practices to enhance a firm's performance (Chaudhuri & Jayaram, 2019; Kull & Narasimhan, 2010; Liu et al., 2010; Zu, 2009). In this study, STSs theory can be considered an appropriate theoretical lens to investigate how the interaction between technical-oriented QM practices (i.e., quality information and process control) and social-oriented practices (i.e., supervisory interaction facilitation) concomitantly affects quality performance.

Another theoretical lens relevant to this study is the contingency theory. According to Dahlgaard-Park et al. (2018, p. 9), the contingency approach to management is "based on the view that management effectiveness is contingent or dependent upon the interplay between application of behaviours and specific situations". The contingency approach has been widely adopted in quality management studies (Jayaram et al., 2010; Joiner, 2007). More specifically, the theme of studying contingent factors affecting the successful QM implementation has recently emerged as an important research agenda (Dahlgaard-Park et al., 2018). The contingency approach emphasises the importance of contingent factors (contextual factors) influencing the effect of one QM practice on another to achieve the desired outcomes. As such, lack of understanding of contingent factors will lead to failures of QM practices adoption, thus desired outcome could not be archived (Lagrosen & Lagrosen, 2003; Zhang et al., 2012). This study intends to investigate the efficacy of technical QM practices in obtaining better quality performance, contingent on shop floor leadership practice (as a social-oriented QM practice), which can generate a supportive working environment at the shop floor level.

The relationship between quality information and quality performance: The mediating role of process control

From STSs perspective, quality information and process control have been considered technical-oriented QM practices (e.g., Cho et al., 2017) both quality information and process control are widely accepted as critical factors for implementing QM successfully (Hietschold et al., 2014). However, the mechanism underlying the relationship of quality information with quality performance has not been adequately explained in the extant literature. The direct or indirect effect of quality information on quality performance is inconsistent and unclear (Ebrahimi & Sadeghi, 2013). Previous empirical studies have highlighted that quality information had positive and direct relation to inventory management, strategic quality planning and process management (Kim et al., 2012; Lee et al., 2003), product/service design (Kim et al., 2012), and operations and business results (Fening et al., 2008). Specifically, Kaynak (2003) posited that quality information had direct and positive relation to supplier quality management, process management, and product/service design, but is not directly related to quality performance. However, .()Zu (2009) found that quality information had a direct impact on quality performance. In the same view, Ho et al. (2001) found that quality information played a mediating role for other QM factors such as employee relations and training on quality performance. For further understanding, this study considers the interrelationship among QM practices based on the framework of TQM implementation (Hietschold et al., 2014). Quality information is considered one of the supporting tasks and process control as one of the core tasks so that quality information acts as a supportive factor for process control to deliver outputs (e.g., quality performance).

QM scholars have agreed that "management-by-facts" is one of the philosophies underpinned by QM (Dahlgaard et al., 1998); specifically, managers should make quality decisions based on the analysis of relevant data (Sadikoglu & Zehir, 2010). Previous empirical studies have posited that firms that consistently collected and analysed quality data were more successful than firms that did not (Fening et al., 2008; Kaynak, 2003). Different types of quality information have to be given to key users at the different organisational levels to help complete their tasks, modifying or improving processes (Kaynak, 2003; Lee et al., 2003; Sadikoglu & Zehir, 2010). On the shop floor level, operators require to receive timely and perceivable feedback (in short, fast feedback loops) on current performance such as process performance data (e.g., machine breakdown frequency) and quality performance data (e.g., defect rates, scraps and reworks) in order to manage and improve manufacturing processes in obtaining a better quality performance (Forza & Filippini, 1998; van Assen & de Mast, 2019). Also, the availability of performance feedback in visualised forms (such as charts, graphs) on the shop floor, which facilitates the shared understanding of objectives and current performance among operators and supervisors, are critical elements of process control and improvement (Bititci et al., 2016; Fugate et al., 2009; Phan & Matsui, 2011). Besides, process management heavily relies on collecting and analysing quality performance and process information at the source to take problem-solving action immediately (Flynn et al., 1994).

The relationship between process control and quality performance has been well established in the previous empirical study (Ebrahimi & Sadeghi, 2013; Naor et al., 2008). Previous empirical evidence posited that process control had a direct positive impact on quality conformance (Forza & Filippini, 1998), internal and external quality outcome (Ahire & Dreyfus, 2000), quality performance (Kaynak, 2003), overall performance (Goncalves et al., 2019), operational performance goals (Baird et al., 2011), innovation (Kim et al., 2012), and financial performance (Wilson & Collier, 2000).

From the discussion above, the authors hypothesise that process control plays a key role of mediator to develop the indirect relationship between quality information and quality performance, even though no strong direct link exists between them. The first hypothesis can be established as follows:H1: The positive effect of quality information on quality performance is mediated by process control.

Shop floor leadership as a moderator

Previous studies have highlighted the emerging role of quality (management) leadership as a driver of the success of QM implementation, aiming to enhance quality and firm performance on the way to excellence (Formby et al., 2018; Para-González et al., 2018). Several research approaches were employed to investigate how such leadership contributed to the success of QM implementation, such as behavioural perspective, contingency perspective, competency perspective, transformational perspective, and implicit leadership perspective. Among these approaches, transformational leadership has emerged as the predominant approach to ensure the successful adoption of QM practices and implementation of business excellence models (Teoman & Ulengin, 2018) due to the fitness between the current group work and the leadership style characterised by intrinsic motivation and follower development (Bass & Riggio, 2014).

The term' transformational leadership' was first coined in the seminal work of Downton (1973). Based on Downton's work, Burns (1978) proposed two main political leadership styles, transformational and transactional leadership, which developed later in organisational management by Bass (1985). In this study, the authors consider the characteristics of transformation leadership, which are based on Bass and Riggio (2014)'s model, consisting of (1) charisma or idealised influence; (2) inspirational motivation; (3) intellectual stimulation, (4) individualised consideration.

The transformational leadership style has increased recognition in the success of QM implementation (Teoman & Ulengin, 2018; van Assen, 2018). However, scholars in the field of QM have considered leadership from top management's view predominatly, and have paid little attention to leadership styles of supervisors (Bello-Pintado et al., 2018). Thus, there is a need to investigate what the supervisors actually do, rather than should do, in the business context (Harding et al., 2014). This study mainly focuses on investigating how supervisors with transformational leadership style (i.e., adopting supervisory interaction facilitation) can contribute to the success of QM practices implementation on the shop floor level.

Adopting supervisors interaction facilitation aims to create a pleasant working atmosphere and structure communication to reach a mutual understanding among employees about working activities (Bowers & Seashore, 1966; Fugate et al., 2009; Zeng et al., 2013). Moreover, supervisors characterised as transformational leaders can create a supportive environment for employees to exchange ideas openly and freely (Joiner, 2007) and promote information and knowledge creation. Supporting employees to apply existing or new knowledge to solve job-related problems can improve work processes Birasnav, 2014). Furthermore, the facilitation of supervisors can build trust among operators and supervisors for sharing information, and employees can benefit from such tacit knowledge from direct supervisors to complete their tasks and take action in problem-solving (Simard & Rice, 2006; Zeng et al., 2013). This enhances the efficiency of using the information in order to improve the process control.

Employee participation in quality programs depends on managers's supports and encouragements. Indeed, supervisors can change their position as controllers of operators into facilitators, coordinators and trainers (Flynn et al., 1994; Forza, 1996). The changing position brings benefits in two ways: (1) it helps operators perform their tasks to avoid process variances or undesired defective products; and (2) it motivates operators to be involved in quality problems solving and quality improvement programmes (Linderman et al., 2004; Zu et al., 2010).

Based on the preceding, the following hypotheses are proposed:

H2: The positive effect of quality information on process control is strengthened in plants with high-level shop floor leadership than in plants with weak shop floor leadership.

H3: The indirect and positive effect of quality information on quality performance via process control is more significant in plants with strong shop floor leadership than in plants with weak shop floor leadership.

The three hypotheses are summarised in Fig. 1, which presents the conceptual model.

Methods

Data

The data used to test the established hypotheses was extracted from the fourth-round database of the High-Performance Manufacturing (HPM) project, an international research project started in 1988 (first round data collection in The United States). The fourth round of HPM data collection is conducted during 2013–2016 with a stratified sampling technique targeting both world-class and traditional manufacturing plants. Each plant should have more than 100 employees to ensure that the plant has a sophisticated organisational structure. The HPM data set was

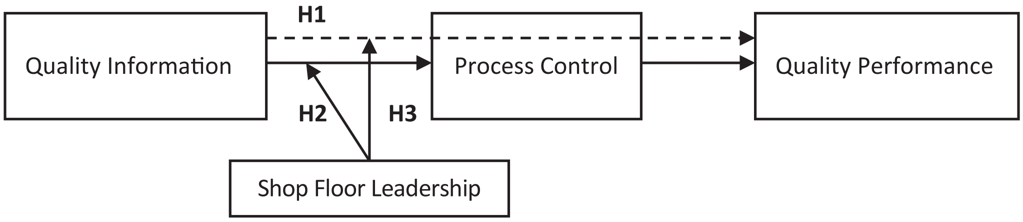

Fig. 1. Conceptual model

constructed from multi-respondents for the questionnaire to avoid the potential of common method bias. Finally, the dataset consists of 304 manufacturing plants in three industrial categories (i.e., transportation components, machinery, and electronics) from thirteen countries worldwide. Further description of the HPM project can be found at Schroeder & Flynn (2001).

The current study is based on a sample consisting of 252 plants due to missing data. A small number of missing data (less than 5%) were replaced by known values, while some missing data (more than 5%) were not imputed to avoid dilution (Hair, 2014).

The sample demographics are presented in Table 1.

Table 1
Distribution of plants by industry and country

Country	Industry		
	Electronics	Machinery	Transportation components
Brazil	2	5	8
China	10	15	3
Spain	5	6	7
Finland	6	6	5
Germany	5	10	8
Israel	5	0	2
Italia	7	16	5
Japan	6	5	9
Korea	8	5	13
Sweden	4	2	1
Taiwan	19	10	1
United Kingdom	3	5	4
Vietnam	9	5	7
Total	89	92	71

Median (number of personnel employed): 373 ($n = 218$)
Mean (total sale of production): 229, 649. 476 (USD$ 000) ($n = 172$)

Measures

This study uses four HPM measurement scales to test proposed hypotheses as follows:

Quality information: This scale measures the extent of organisation ensure the availability of reliable, adequate, high-quality, and timely data and information for all shop floor personnel to drive quality excellence and performance (e.g., Flynn et al., 1994; Schroeder & Flynn, 2001). The quality manager of manufacturing plants evaluated this scale.

Process control: This scale measures the use of techniques and tools (e.g., statistical process control, "foolproof" process, self-inspection) for controlling manufacturing processes in order to reduce process variation (e.g., Flynn et al., 1994; Schroeder & Flynn, 2001). The quality manager of manufacturing plants evaluated this scale.

Supervisory interaction facilitation: This scale measures whether supervisors successfully encourage workers to work as a team, including exchanging their ideas and cooperating to improve work processes (e.g., Flynn et al., 1994; Schroeder & Flynn, 2001). The plant manager of manufacturing plants evaluated this scale.

Quality performance: This scale measures the ability to achieve a quality level/ reputation, one of the most critical criteria for customers to select and rely on the company (e.g., Flynn et al., 1994; Schroeder & Flynn, 2001). The downstream supply chain manager of manufacturing plants evaluated this scale.

Each survey respondent was asked to give the evaluation on a 5-point Likert scale (1-Totally disagree. 5-Totally agree) for most of the question items.

Measurement analysis

A confirmatory factor analysis was conducted to evaluate the construct validity of the study variables (quality information, process control, supervisory interaction facilitation, and quality performance) using IBM – SPSS AMOS 24.0. The acceptance criteria were set as suggested in (Hu & Bentler, 1999). The maximum likelihood ratio chi-square for the model was statistically significant ($\chi^2 = 74.228$, df = 45, $p < 0.001$). The good-of-fit indices for the 4-factor model indicated a good fit with the data (RMSEA = 0.047, SRMR = 0.046, CFI = 0.979, PClose = 0.574).

Content validity: All measurement scales were adopted from the existing literature, developed and modified by the members of the HPM project to ensure that the test matches the content of the domain of the target construct.

Construct validity: Convergent validity and discriminant validity are two aspects of construct validity (Campbell & Fiske, 1959). For convergent validity, most final factor loadings of question items for each construct are greater than 0.5, except for one question item for the construct "quality performance" has a factor loading of 0.45. However, the authors decided to retain this question item because the value was higher than 0.5 as a suggested cut-off point, and the question items for the construct "quality performance" were

Table 2
Descriptive statistics and correlations

Variables	Descriptive statistics				Correlation analysis			
	Min	Max	Mean	SD	1	2	3	4
1. Quality information	2.00	5.00	3.631	0.592	[0.730]			
2. Supervisory interaction facilitation	1.20	5.00	4.105	0.678	0.406***	[0.760]		
3. Process control	1.67	5.00	3.631	0.934	0.722***	0.280***	[0.820]	
4. Quality performance	1.00	5.00	4.288	0.592	0.198***	0.356***	0.241***	[0.794]

Note. N = 252; * $p \leq 0.05$, ** $p \leq 0.01$, *** $p \leq 0.001$ (one-tailed). SD: standard deviation.
Value on the diagonal of the correlation matrix is the square root of the average variance extracted (AVE).

developed and widely used in the HPM framework (Schroeder & Flynn, 2001). Also, the average variance extracted (AVE) was computed to identify discriminant validity and convergent validity. In Table 2, all the constructs' AVE values are greater than 0.5, and the square roots of the AVEs are greater than the inter-construct correlations among constructs (Fornell & Larcker, 1981).

Construct reliability. Composite reliability and Cronbach's alpha were computed to verify the reliability of the constructs. All constructs have composite reliability and Cronbach's alpha above the cut-off point 0.70 as suggested by Fornell and Larcker (1981), Hair (2014), and Nunnaly (1978). Construct reliability and validity assessment results are presented in Appendix. The results show that all of the criteria are satisfied, and data can be used for further analysis.

Hypotheses testing

Hypothesis 1 is tested by conducting mediation analysis following the specific procedure proposed by Baron and Kenny (1986)'s procedure and Hayes (2018)'s bootstrapping method. According to Baron and Kenny (1986), three criteria should be met for mediation testing: (a) the independent variable (i.e., quality information) has to have a significant relationship with the mediator (i.e., process control); (b) process control has to have a significant relationship with quality performance after controlling for quality information; (c) the relationship of quality information with quality performance should decrease when process control is included in the model. A bootstrap approach tests the indirect relationship between quality information and quality information through process control using the PROCESS macro v3.2 for IBM – SPSS created by Hayes (2018). Hypothesis 2 and Hypothesis 3 are tested by moderated mediation analysis adopting the proposed procedure (Hayes, 2018), even though Hypothesis 2 could be tested by simple moderation analysis. The four conditions to test moderated mediation model of this study are as follows: (a) the quality information should be related to process control; (b) the process control should be related to quality performance after controlling for quality information; (c) the relationship between quality information and process control should depend on shop floor leadership; (d) the indirect relationship between quality information and quality performance through process control should depend on shop floor leadership. The conditional indirect relationship between quality information and quality information through process control was tested by a bootstrapping approach using the PROCESS macro v3.2 for IBM – SPSS created by Hayes (2018). For probing significant interaction terms, the authors employed a direct extension of the simple slopes method (Aiken et al., 1991) and the region of significance approach based on the Johnson–Neyman technique (Johnson & Neyman, 1936).

Results

First, three regression models are formulated to test the hypotheses, and the results are presented in Table 3. In Model 1, quality information is significantly related to process control ($b = 0.818$, $p < 0.001$). Model 2 indicates that quality information is not significantly related to quality performance ($b = 0.046$, $p = 0.161$). Model 3 shows that process control is significantly related to quality performance ($b = 0.136$, $p = 0.006$). The relationship of quality information with quality performance exhibit lower in Model 3 than in Model 2, also not statistically significant at the 5% level by one-tailed test.

To examine whether the indirect relationship between quality information and quality performance through process control is significant, the authors computed a bootstrap bias-corrected confidence inter-

Table 3
OLS regression results for the mediation analysis and moderated mediation analysis

	Process control	Quality performance		Process control
	Model 1	Model 2	Model 3	Model 4
Constant	0.564 (0.266)**	2.941 (0.227)***	2.865 (0.226)***	3.416 (0.043)***
Quality information	0.818 (0.054)***	0.046 (0.046)	−0.066 (0.063)	0.825 (0.054)***
Supervisory interaction facilitation	−0.022 (0.066)	0.288 (0.056)***	0.291 (0.056)***	0.005 (0.067)
Process control			0.136 (0.054)**	
Quality information × Supervisory interaction facilitation				0.124 (0.065)†
F	135.363***	18.577***	14.810***	92.432***
R^2	0.521***	0.130***	0.152***	0.528***

Note. N = 252; † p ≤ 0.1, * p ≤ 0.05, ** p ≤ 0.01, *** p ≤ 0.001 (one-tailed). Unstandardized coefficients are reported; Parentheses: standard errors.

val (based on 5000 samples) using SPSS PROCESS macro v3.2 with model 4 template settings (Hayes, 2018, p. 585). As presented in Table 4, the indirect relationship of quality information on quality performance via process control, measured by a product of two regression coefficients (1) the regression coefficient of quality information on process control in Model 1 in Table 3 and (2) the regression coefficient of process control on quality performance controlling for quality information in Model 3 in Table 3, could be taken significant at the 5% level by one-tailed test (b = 0.106, SE = 0.48) with 90% bootstrap confidence interval of [0.028, 0.184], because the bootstrap confidence interval does not include zero. These results (presented in Table 3 and Table 4) satisfy all conditions for testing the mediation effect proposed by Baron and Kenny (1986) and Hayes (2018). The analytical findings suggest that process control significantly mediates the relationship between quality information and quality performance. Therefore, Hypothesis 1 should be accepted.

Model 4 in Table 3 was formulated to examine the moderating role of supervisory interaction facilitation in the relationship between quality information and process control to address the moderating effect. The interaction term between quality information and supervisory interaction facilitation had a positive coefficient for process control ($b = 0.124$, $p < 0.05$). To further examine the significance of interaction terms, the authors conducted moderation analysis to test conditional effects. Table 5 shows that the conditional effect of quality information on process control is stronger in plants with high-level supervisory interaction facilitation (90% bias-corrected confidence interval of [0.791, 1.027]) than in plants with low-level supervisory facilitation (90% bias-corrected confidence interval of [0.629, 0.852]).

The graphs are plotted to explore further the nature and magnitude of the moderating effect based on the Aiken et al. (1991)'s technique. As such, the sample was divided into two groups: (a) plants with high-level shop floor leadership (higher than the mean plus one standard deviation); (b) plants with low-level shop floor leadership (lower than the mean minus one standard deviation). The moderating role of supervisory interaction facilitation on the relationship between quality information and process control is illustrated in Fig. 2.

Table 4
Bootstrapped results for testing indirect effect of quality information on quality performance via process control (as a mediator)

With mediator	The indirect effect of quality information on quality performance		
	Coefficient (standard error)[a]	90% confidence interval[b]	
		LL	UL
Process control	0.106 (0.048)	0.028	0.184

Note. [a] Unstandardised coefficient is reported; Parentheses: standard error. [b] by bias-corrected confidence interval.

Table 5
Bootstrapped results for the conditional effects between quality information and process control (moderated by shop floor leadership)

Moderator	Independent variable	Process control		
		Coefficient (standard error)[a]	Bootstrapped confidence interval[b] [90%]	
			LL	UL
Low SIF	Quality information	0.740 (0.067)***	0.629	0.852
Medium SIF		0.825 (0.054)***	0.736	0.913
High SIF		0.909 (0.071)***	0.791	1.027

Note. SIF: supervisory interaction facilitation. *** p $\leq$ 0.01. [a] Unstandardised coefficient is reported; Parentheses: standard error. [b] by bias-corrected confidence interval.

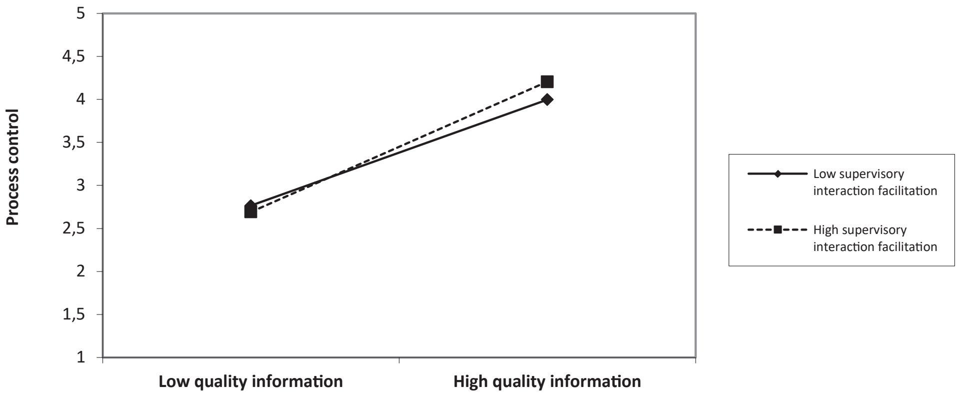

Fig. 2. Moderating role of supervisory interaction facilitation on the quality information – process control relationship

Fig. 2 shows that quality information was more strongly associated with process control in plants with high-level supervisory interaction facilitation implementation (more engaged supervisor) than in plants with low-level supervisory interaction facilitation (less engaged supervisor). Therefore, Hypothesis 2 can be accepted.

To address moderated mediation effect, the authors conducted moderated mediation analysis to test the strength of the indirect conditional effects by using Hayes (2018) PROCESS macro v3.2 as the results presented in Table 6. The authors found that the indirect effect of quality information on quality performance is stronger in plants with high-level supervisory interaction facilitation (90% bias-corrected confidence interval of [0.034, 0.200]) than those with low-level supervisory facilitation (90% bias-corrected confidence interval of [0.028, 0.164]). The index of moderated mediation with 5000 bootstrapping samples was calculated to quantify the relationship between the indirect effect and supervisory interaction facilitation (as a moderator). It is measured by a product of two

Table 6
Results for the test of the conditional indirect relationship between quality information and quality performance

Moderator	Independent variable	Quality performance		
		Coefficient (standard error)	Bootstrapped confidence interval[a] [90%]	
			LL	UL
Low SIF	Quality information	0.096 (0.042)	0.028	0.164
High SIF		0.118 (0.051)	0.034	0.200
		Index (standard error)	LL	UL
Index of moderated mediation		0.016 (0.010)	0.002	0.034

Note. SIF: supervisory interaction facilitation. [a] Unstandardised coefficient is reported; Parentheses: standard error. [b] by bias-corrected confidence interval.

regression coefficients (1) the regression coefficient of an interaction term (i.e., quality information x supervisory interaction facilitation) in Model 3 in Table 3 and (2) the regression coefficient of supervisory interaction facilitation in Model 4 in Table 3. The index was positive and significant (index = 0.016, 90% bias-corrected confidence interval of [0.002, 0.034]) because the confidence interval excludes zero (Hayes, 2015). Therefore, Hypothesis 3 should be accepted, and the authors can conclude that the indirect and positive effect of quality information on quality performance via process control will be more significant in plants with strong shop floor leadership than in plants with weak shop floor leadership.

Discussions, limitations and future research

From the STSs perspective, two technical-oriented QM practices, i.e., quality information and process control, interacted with social-oriented QM practices, i.e., supervisory interaction facilitation, to achieve the higher level of quality performance. This approach has enabled better explanations of integrating technical-oriented practices with social-oriented practices in the QM implementation for achieving expected performance. That is, the authors should consider the compatibility among QM practices before adopting specific practices.

Based on the STSs approach and the contingency approach, this study has attempted to address how and when quality information effectively contributes to quality performance in manufacturing settings globally.

From the contingency perspective, the effective implementation of QM practices on the shop floor depends on the supervisory leadership. This approach proposes a better explanation for the strength of the quality information-process control relationship depending on supervisory interaction facilitation.

This study contributes to quality management literature by resolving mixed findings of the relationships among quality information, process control, and quality performance (Ebrahimi & Sadeghi, 2013).

First, the results indicate that quality information directly and positively affects process control, leading to quality performance consistent with previous studies (e.g., Ahire & Dreyfus, 2000; Kim et al., 2012), but inconsistent with Zu et al. (2008).

This study provides conclusive empirical evidence to reconcile unequivocal relationships among quality information, process control, and quality performance by indicating that process control fully mediates the quality information – quality performance relationship. In other words, quality information contributes to quality performance by improving process control. The meditating role of process control has not been studied well in the extant literature.

Second, this study extends the quality information – process control relationship by considering a moderating role of supervisory leadership, i.e., supervisory interaction facilitation. The result indicates that the positive effect of quality information on process control depends on supervisory interaction facilitation. Two main mechanisms are underlying to explain this empirical result. Supervisory interaction facilitation establishes a supportive and pleasant environment that creates open communication and reduces employee conflicts (Bowers & Seashore, 1966; Zeng et al., 2013).

The less tense conflicts have made the shop floor employees express their opinions freely and exchange ideas and information to find the root causes of process problems and correct their errors in performing works. Consequently, it helps to reduce the chances of job errors in the production process and reduces process variance, leading to improved quality performance (Bello-Pintado et al., 2018; Zeng et al., 2013).

The benefit of supervisory interaction facilitation is to reduce the negative effects of behavioural issues in adopting improvement practices. The extant literature widely accepted that implementing improvement practices effectively led to better performance (e.g., quality performance) (Goncalves et al., 2019). However, Tiwari and Tiwari (2018) indicated several issues in adopting improvement practices related to employees' behaviour, such as resistance to change, lack of involvement, and lack of motivation.

With strong supervisory interaction facilitation to create a working environment where the employees perceive a safe and welcoming atmosphere for expressing their ideas for improvement, they are more likely to engage in process improvement programs (Stadnicka & Sakano, 2017; Tiwari & Tiwari, 2018). As a result, the manufacturing processes are quickly stabilised, and process variation is reduced, which is translated to the improvement of quality performance.

This finding complements another way to engage employees in process improvements (Stadnicka & Sakano, 2017). It is rooted in psychological incentives, rather than financial incentives (i.e., cash or prizes). The financial incentives are not always working to engage employees in pursuing improvement. In such a case, the psychological employee supports play as supportive reinforcement to the financial incentives approach (Stadnicka & Sakano, 2017).

The results provide significant implications for practitioners in exploring quality information for process control and quality performance improvement. First, the results show that process control efficiency largely depends on how well-informed shop floor personnel about quality information improves the performance. Manufacturing managers should consider making more efforts to utilising information to enhance process control aiming to improve quality performance.

Second, the findings suggest the need to adopt the transformational leadership style by supervisors responsible for controlling and improving manufacturing processes on the shop floor. Also, supervisors encourage shop floor employees to improve their sensing and awareness of the flow of quality information to obtain better quality performance.

The present study is not free of limitations. Firstly, the cross-sectional character of the data used in this study limits the explanation of the causal relationship among process management practices, quality information management practices, and quality performance. The HPM project collected both objective and subjective data on the operational performance of the manufacturing plants that participated in the HPM survey. However, because of the large differences in the products made by these manufacturing plants, only subjective performance data can be used in this study. Future studies should use both objective and subjective data and longitudinal data to investigate the role of quality information management in promoting other core quality management practices and quality performance measures (e.g., customer satisfaction, innovation performance and so on), and other organisational capabilities such as information management capability, process management capability. Also, future studies could investigate and compare how the different contextual factors such as plant size, industry, and national culture influence the inter-relationship among quality information, process control, shop floor leadership, and quality performance.

Conclusions

This study emphasizes that the vital adoption of quality information practices improves process control aiming to achieve a higher quality performance level. The results indicate that transformation leadership practice adopted by supervisors plays a catalyst factor and contributes to the quality information/process control relationship, which, as a result, enhances the quality information/quality performance relationship. Besides, the authors have adopted the moderated mediation analysis in this study to explore further the nature of inter-relationship among QM practices and their impacts on manufacturing performance, providing a new insight into investigating the success of the implementation of QM practices. The results provide some implications for managers. First, quality managers would enhance quality performance by implementing quality information as a foundation practice to achieve the higher level of process control. Second, the current study provides justifications for top managers to consider that supervisors' roles and leadership styles on the shop floor can contribute to the success of QM practices implementation.

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Appendix: Measurement Analysis

Table A1. Descriptive statistics and correlations

Measurements	FSL
Quality information (CR = 0.820; AVE = 0.533; α = 0.790)	
Charts showing defect rates are posted on the shop floor.	0.84
Charts showing schedule compliance are posted on the shop floor.	0.79
Charts plotting the frequency of machine breakdowns are posted on the shop floor.	–
Information on quality performance is readily available to employees.	0.73
Information on productivity is readily available to employees.	0.68
Supervisory interaction facilitation (CR = 0.805, AVE = 0.579, α = 0.802)	
Our supervisors encourage the people who work for them to work as a team.	0.59
Our supervisors encourage the people who work for them to exchange opinions and ideas.	0.56
Our supervisors frequently hold group meetings where the people who work for them can really discuss issues and share ideas.	0.68
Our supervisors rarely encourage us to get together to solve problems.	–

Table A1 [cont.] Descriptive statistics and correlations

Measurements	FSL
Process control (CR = 0.861, AVE = 0.674, α = 0.860)	
Processes in our plant are designed to be "fool-proof".	–
A large percent of the processes on the shop floor are currently under statistical quality control.	–
We make extensive use of statistical techniques to reduce variance in processes.	0.96
We use charts to determine whether our manufacturing processes are in control.	0.90
We monitor our processes using statistical process control.	0.84
Quality performance (CR = 0.763, AVE = 0.631, α = 0.713)	
Quality is the most important criterion used by our customers in selecting us as a supplier.	–
Our customers involve us in their quality improvement efforts.	–
Our customers can rely on us for quality products.	0.66
We are selected by our customers because of our reputation for quality.	0.45

Note. CR, composite reliability; AVE, average variance extracted; α, Cronbach's alpha; –, eliminated item

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