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Impact of Quality Management Practices on Production Quality Performance: Examining the Role of Process Improvement and Lean Six Sigma

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ABSTRACT

The study aimed to investigate the impact of quality management practices on production quality performance with a mediating effect of process improvement. We have also evaluated the Lean Six Sigma moderating effects. SPSS was used for both demographic and inferential analysis to empirically examine the hypothesis. Using a convenient sampling technique, data were collected from 275 employees of SMEs through structured questionnaires. Regression results show that quality management practices positively and significantly impact production quality performance and process improvement. On the other hand, process improvement also positively and significantly influences production quality performance. The indirect mediating effect of process improvement also mediates between quality management practices and production quality performance. In addition, moderation analysis shows that Lean Six Sigma positively strengthens the relationship between process improvement and production quality performance. These findings indicate that the incorporation of both process improvement and Lean Six Sigma significantly enhances the effectiveness of quality management practices in improving production quality performance. Furthermore, the study provides practical insights to SMEs manufacturing companies to optimize their production quality performance by focusing on process improvement and the utilization of Six Sigma roles.

1. Introduction

In recent times, production quality performance (PQP) has become one of the important factor for sustainability and competitiveness of the organizations [47]. It helps fulfill the customer's standards and expectations about the product [55]. It is only possible when the companies produce high quality goods because high level of PQP not only ensures customer satisfaction but it also directly contributes to reduced defect rates, lower rework costs, minimized waste, and enhanced brand loyalty which strengthen the organization market position with high market share [26]. In a globalized marketplace characterized by heightened consumer expectations and intense

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competition, maintaining consistent product quality is more important because it has become a strategic imperative [40]. Conversely, companies that fail to maintain high-quality production could incur significant economic losses due to returns, recalls, and warranty claims [47]. In lighting the view of PQP importance, the current study covered a major area of concern to explore how the PQP of the small and medium enterprises (SMEs) could be increased.

Prior literature cited that PQP could be enhanced by various factors, but among those, quality management practices (QMP), process improvement (PI), and lean six sigma (LSS) are more important to increase the PQP [17; 69; 85]. Among these practices, QMP constitutes a systematic set of practices that aims to improve the quality of production [53; 79]. This practice consisted of top management support, customer focus, and employee involvement, which helped to increase the PQP [65]. Other researchers also supported that QMP helps to increase the PQP after reducing process variability and increasing customer satisfaction [30]. QMP also provides various principles through increasing a culture rooted in shared responsibility, accountability, and data-driven decision-making, which helps to increase the PQP through improving product conformance and reduce quality-related costs [84]. In light of the literature, QMP has been conceptualized that it increases the PQP through establishing rigorous internal standards, nurturing cross-functional coordination, and reducing process-related errors before they impact the final product [101]. Therefore, the study focused on the influence of QMP on the PQP of SMEs.

Even though QMS serves as a strategic framework for quality, its true influence is realized by means of the tactical implementation of continuous process improvement and quality objectives [23]. Process improvement involves technical improvement of workflows, technology use and resources allocation to increase efficiency and rid of non-value added activities [56]. In addition, Hossain [39] debates that the integration of PI and QMS lead to higher operational efficiency and sustainable performance. The reason behind that it is the transformative nature of process improvement that results in reducing lead time, improving preventive measures, and standardizing procedures [83]. Moreover, manufacturing companies that implement process improvement measures adapt swiftly to market and customer expectations while optimizing internal operations [1]. Hence, the current study demonstrates that PI makes QMP successful by enhancing tangible production quality outcomes. Even though a well-designed quality management system (QMS) failed to produce higher production quality outcomes in a complex and dynamic environment, without process improvement measures. As a result, the current study investigates the impact of QMP on PQP with the mediation of PI.

Furthermore, the implementation of structured approaches such as Lean Six Sigma (LSS) is a powerful tool that can enhance the influence of process improvement on production quality [48]. Moreover, this approach integrates the lean principles of waste reduction and operational efficiency with the defect-elimination and problem-solving principles of Six Sigma [67]. In this way, this hybrid methodology enables companies to streamline their operational processes to align their outcomes with customers' expectations. To extend this concept, researchers stated that LSS acts as a disciplined and data-driven methodology that enables organizations to achieve operational excellence [100]. In addition, organizations adopting the LSS approach beat their competitors in terms of product consistency, customer satisfaction, and reliability [88]. These prior studies indicate that LSS methodology enhances the effectiveness of PI because it provides the structure, measurement, and control mechanisms that confirm high-quality production performance. Hence, the integration of LSS in the conceptual framework provides a stronger understanding on the impact of PI measures on PQP when supported with moderating methodologies. Thus, in the current study, LSS was used as a moderating variable between PI and PQP.

Although QMP, PI, and LSS are recognized for their individual effects, but following gaps were observed in the prior literature related to their combined influence on PQP. For instance, existing research which are conducted by Lakhal et al. [50]; Zhou and Li [104], Patyal and Koilakuntla [69] and [92] have mainly concentrated on the individual effect on PQP, while limited studies have been conducted on the combined effect of these factors on PQP. Therefore, this study focused on addressing these factors in one study. On the other hand, most of the studies have mainly concentrated on the direct effect of QMP [15; 27; 29]. While these studies have overlooked the mediating effect of process improvement between QMP and PQP. Other studies also highlighted that the role of process improvement as a mediator between QMP and production quality is still under-theorized and under-researched [12]. These oversights leave practitioners with limited guidance on how best to integrate quality initiatives with improvement tools for maximum impact. Therefore, this study contributed mediating effect of process improvement between QMP and PQP. In other words, how LSS moderates the relationship between PI and PQP remains underexplored [11; 61]. The moderating effect of LSS has been tested in the study Sim et al. [85]Sim et al. [86]Sim et al. [86]Sim et al. [86]Sim et al. [86]Sim et al. [6], but tested with other variables. To address this, the current study theoretically contributed moderating effect of LSS between process improvement and PQP. Based on previous gaps, this study aims to investigate the impact of quality management practices on production quality performance with a mediating effect of process improvement. We have also evaluated the LSS moderating effect.

The study is a highly significant contribution. Initially, it contributes to the prior literature by accounting for the direct impact of strategic QMP, process improvement as a mediated effect, and LSS as a moderating approach. Practically, these study findings will be particularly useful for managers and practitioners in quality-intensive industries such as manufacturing, healthcare, and services, where even minor quality lapses can have significant repercussions. The study findings could also help to contribute to evidence-based management through offering actionable recommendations for how organizations can structure their quality systems to achieve optimal performance. In doing so, it could contribute to bridging the gap between theory and practice, which could help firms to navigate the complexities of modern production environments with greater confidence and strategic clarity. The study is further divided into four chapters, a literature review where the discussed literature is from both theoretical and empirical perspectives. Research methods were third chapter, the fourth chapter is relevant to study findings, and the fifth chapter consists of the discussion and implications of the study.

2. Literature Review

2.1 Quality Management Practices and Production Quality

The quality management practices (QMP) consisted of various activities designed to control the organization's quality [88]. In other words, it also consisted of continuous improvement, top management commitment, employee involvement, customer focus, and process management [91]. [53; 79] also defined QMP as an effort from the organization to instill a quality-oriented culture, which aims to achieve long-term success through customer satisfaction. Similarly, Kaynak [42] emphasizes QMP as a strategic framework that aligns operations and management to consistently deliver quality outputs. Likewise, Qureshi [74] also claimed that effective QMP ensures standardization of procedure, minimizes variations, and induces accountability and excellence culture in the production process that could enhance production quality performance. In addition, Qamar et al. [72] asserted that certain QMS practices, i.e., supplier quality insurance, employee training, and effective quality controls directly improved production quality performance. Therefore, these practices highlighted that final products meet customer expectations, which increases the quality standards.

Furthermore, To et al. [96] declared that organizations having exceptional quality management systems tend to achieve better performance. Moreover, Keinan and Karugu [43] asserted that the proper implementation of a quality management system (ISO standards) enables organizations to bring their production quality to a global level. In addition, Rivera et al. [77] also examined that QMP directly influences customer satisfaction and production performance. Likewise, Ali [7] explored that internal quality matrix like defect rates and rework, can only be improved by the adoption of effective quality management practices. Similarly, [63] also described that quality-focused companies must identify their customers and outperform their competitors in terms of attracting customers and bringing production excellence to their production system. Furthermore, Xie et al. [102] noted that quality-sensitive industries consider QMP as a vital aspect to improve production quality performance in small and medium-sized enterprises (SMEs). Finally, Egwunatum et al. [21] found that TQM practices not only impact the internal organizational matrix but also improve finished goods quality in diverse industrial sectors. [53; 79] further found that total quality management practices significantly influence both internal process outcomes and the final product quality across different sectors. Therefore, the current study examines the impact of QMS on PQP.

2.2 Quality Management Practices and Process Improvement

In addition, process improvement (PI) refers to the structural approach to performance improvement that involves the initiative-taking identification, analysis, and optimization of existing business processes [34]. Similarly, [62] asserted that PI acts as a well-designed approach that identifies and removes inefficiencies and useless activities. In addition, Hammer and Champy [35] radically redesign the core of process improvement by exploring business process re-engineering to achieve essential and dramatic business improvement. Furthermore, Antony and Gupta [10] claimed that QMP enhances PI as it ensures that organizations have appropriate performance metrics, structured methods, and a continuous improvement approach. Additionally, Hossain [39] explored that QMP enhances PI by promoting systematic problem solving and cross-functional team effort. Correspondingly, Ali [7] asserted that quality-driven culture promoted by quality management practices produce better production quality performance as a result of process standardization and defect elimination. Kharub and Sharma [44] research also emphasized that strong QMP helps companies to enhance productivity during the manufacturing process in a short time frame. Haque [36] study also highlighted that QMP also improves the production process, which increases the company's quality control, which improves the company's competitive advantage. Hossain [39] study also stated that QMS leads to greater operational efficiency with the help of the internalization of quality values within the production process. These previous studies highlighted that aligning strategic goals with process capabilities, QMP helps to raise process improvement, which leads to enhance PQP.

2.3 Process Improvement and Production Quality

Process improvement (PI) consisted of a systematic approach that identifies the activities that help increase production performance [99]. [89] further defined that PI helps to eliminate those activities which are not add values and also reduces waste. Rogalewicz et al. [78] study also highlighted that PI also helps to reduce the defects, which increases the effects to improve production capacity. Qian et al. [73] study further also emphasized that PI is an integral component in achieving production quality excellence. Qamar et al. [72] further supported the view to define that a well-structured PI helps to minimize production defects, which helps to increase product reliability. Similarly, Aichouni et al. [2] declared that process improvement points out the root cause of the problem to prevent its recurrence through standardization and a feedback loop. Shivam and Gupta [83] suggested that PI leads to higher quality production, and a much lower scrap rate leads to substantial improvement in production outcomes. Amjad et al. [9] also identified that a structured procedure brings a notable improvement in production quality assurance and control. Moreover, Rahardjo et al. [75] stated that process improvement by reducing product variability improves finished products' quality standards across companies. Hasan et al. [37] study also explored that PI brings operational improvements that led to production excellence and higher consistency in manufacturing. The above findings demonstrate that PI is a key determinant of production quality.

2.4 Process Improvement as Mediation

It has been highlighted that QMP significantly improves the production quality performance and PI. As the QMP sets the strategic framework for quality, PI operationalizes this framework by refining activities, procedures, and workflows [57]. Moreover, Psomas et al. [71] claimed that without effective process improvements, the full benefits of QMP may not be realized in terms of production outcomes. Another study also highlighted that QMP directly contributes to PI by fostering continuous assessment and refinement of processes [93; 98]. These improved processes, in turn, lead to higher production quality through standardization, waste elimination, and defect prevention. Moreover, Sahoo [80] found that QMP improves production quality directly and indirectly through PI, indicating a partial mediation. Furthermore, Potkany et al. [70] highlighted that PI strengthens the relationship between QMP and product quality in manufacturing firms. Correspondingly, Hamdoun et al. [33] demonstrated that organizations that invest in both QMP and PI achieve better outcomes than those focusing on one alone. Similarly, Zhao et al. [103] showed that improvements in workflow and coordination, driven by QMP, result in better process outcomes and higher product quality. Likewise, Sundar and Prabhu [90] provided evidence that QMP enhances employee involvement in process changes, which significantly boosts product consistency. Ultimately, Kwilinski and Kardas [49] also indicated that the impact of QMP on quality is amplified when process performance is improved through structured methodologies. These findings emphasize the significant role of PI in explaining QMP into tangible quality improvements. Therefore, this study focused on the mediating effect of PI.

2.5 Lean Six Sigma as Moderation

The relation between PI and PQP is not clear, which shows that there is a need for a relationship in other contexts. In this context, Aldaihani et al. [5] study also identified that when the relationship between exogenous and endogenous variables is not clear, then there is a need for a moderating variable. Hence, lean six sigma (LSS) practices could be used as a moderating variable. Moreover, Gomaa [28] demonstrated that LSS combines Lean principles of waste reduction with Six Sigma's statistical quality control to achieve optimized processes and high-quality outputs. In addition, Singh et al. [86] proved that LSS as a management philosophy that integrates the speed and efficiency of Lean with the accuracy and defect-reduction focus of Six Sigma. Likewise, [88] described that it as a robust framework that enhances organizational performance by eliminating variation and improving responsiveness to customer needs. As a moderating variable, LSS enhances the effect of process improvement on production quality by introducing advanced tools such as process mapping, root cause analysis, and statistical control charts. These tools ensure that process changes are not only implemented but also sustained and continuously monitored for improvement [60]. Other authors also highlighted that companies with higher LSS played an integral role in increasing the production performance [38].

Sarman and Soediantono [82] research also identified that companies who are actively using the LSS activities in their companies then those companies could lead to improve the production quality. Ghaleb et al. [27] research also emphasized that LSS provide a good way to improve the production process, which increases production of manufacturing companies. Sankala [81] further highlighted that LSS tools also increases the impact of PI on reducing defects and increasing process reliability which increase the production of companies. [22] study results also identified that companies who are adopting LSS report higher efficiency and better-quality metrics than firms with conventional PI efforts. Guzman [31] on the other hand confirmed that LSS improves the impact of PI on final product quality by ensuring data-driven decision-making and process ownership at all levels. Another study highlighted that LSS could be used as a moderate variable [4]. In other sense, Sim et al. [85] already tested the moderating effect of found a significant positive strengthening impact, which highlights that it could be used as a moderating variable. These studies collectively confirm that LSS significantly enhances the effectiveness of process improvement initiatives on production quality. Therefore, this study focused on the moderating effect of LSS.

3. Research Framework and Hypothesis

The literature has lacks comprehensive research on the integrated impact of QMP, PI, and LSS on PQP, particularly in the context of PQP. Few studies explore the mediating role of PI between QMP and PQP. Additionally, there is limited empirical evidence on how LSS moderates the relationship between QMP and PI. This gap presents an opportunity for a more detailed framework to examine these combined effects on PQP. Moreover, a theory of dynamic capabilities introduced by Teece et al. [95] supports the theoretical framework by highlighting that organizations reengineer their internal process to conform with a complex and dynamic environment. Furthermore, this theory supposes that continuous process improvement and innovation help to sustain competitive advantage, thus aligning with the interplay of QMS, PI, LSS, and PQP. In addition, the theory supports that narrative that organizations develop dynamic capabilities like process improvement and adopt Lean Six Sigma strategy, remain competitive in the market and gain higher production quality. Therefore, the above study variables are predicted in Figure 1 below,

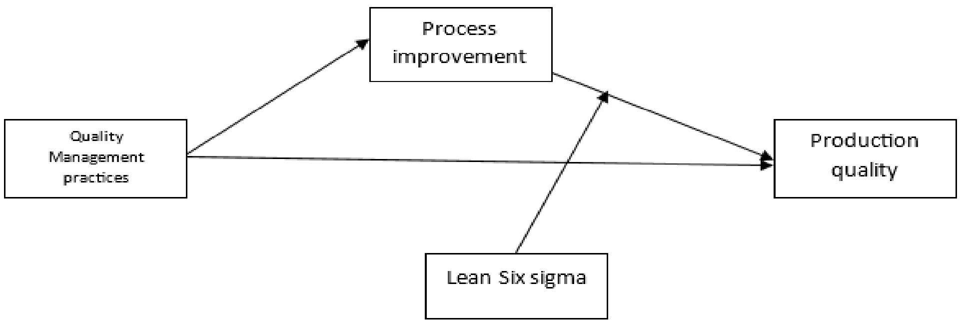

Fig.1. Research Framework

Study has following hypothesis below,

H1: Quality management practices significantly improve the production quality.

H2: Quality management practices significantly improve the process improvement.

H3: Process improvement significantly improves production quality.

H4: Quality management practices significantly improve the production quality with mediation of process improvement.

H5: Production improvement and production quality relationship significantly strengthen with moderating effect of lean sigma.

4. Research Methodology

4.1 Research approach and Design

From the study specific objective perspectives, researchers employed the quantitative deductive approach. Creswell and Creswell [18] emphasized that quantitative research is suitable when the hypotheses are tested based on the existing theories. On the other hand, this quantitative approach also supports to the scholars in collecting structured data which could increase the results generalizability [51]. In this regards, study employed the quantitative deductive approach. Moreover, cross sectional research design used to collect data at one point of time aligning with the study objective to examine the relationship among variables. As per Aljazzazen and Schmuck [8], cross sectional research design is well suited for hypothesis testing when having time and cost constraints. Therefore, cross sectional data collection procedure selected for the present study.

4.2 Research Instrument Development

The research instrument was adopted from previous literature, where it was already used and tested. Lean sigma comprises six items Kumar et al. [48], process improvement comprises from three dimensions. From these dimensions, waste elimination comprised 5 items, time reduction also comprised 5 items, and error deduction comprised 2 items and all these dimensions' questions were adopted from [66]. Quality management practices also comprise from 3 dimensions, namely customer focus, quality human resource practices, and core quality practices. Customer focuses and quality human resource practices were comprised from 5 items. While core quality practices were comprised 10 items. Each of the above items were taken from [94]. Lastly quality performance comprised 6 items [85]. Each items measured on five point Likert Scale.

4.3 Sampling Technique

The population of the study comprised of employees of manufacturing SMEs. From the defined population, sample was selected using convenient sampling technique. This sampling technique seems to be more efficient than random sampling hen the population of the study is not defined [97]. Convenient sampling also enables scholars to point out eligible respondents having deep knowledge of the research problem, and are willing to provide information based on their experience or knowledge [14; 19; 64]. Questionnaires were distributed among 350 employees of SMEs using convenient sampling technique and among those 275 questionnaires were returned back. This response is quite enough for mediated-moderation analysis. Furthermore, scholars believe that response rates above 60% seem to be desirable for finding credibility and reliability [6; 25; 54]. By taking this into consideration, this response rate is appropriate for this study.

5. Data Analysis and Results

5.1 Demographic profile

This section shown the demographic characteristics of the respondents who the employees of SMEs manufacturing. The survey instrument was results shown that (64.73%) respondents are male and remaining (34.18) were females. This shown that manufacturing SMEs have male dominant employees not a female dominant. The largest age group was 36–45 years (24.73%), closely followed by those aged 26–35 (24.00%) and 18–25 (22.18%), suggesting a relatively young to mid-career workforce. Education-wise, the majority held a Bachelor's degree (34.18%) or Diploma (28.73%), indicating a well-educated employee base. In terms of job roles, Operators (35.27%) and Technicians (21.45%) formed the bulk of respondents, which is typical for manufacturing environments. Regarding work experience, most employees had between 7–10 years (28.00%) or over 10 years (21.82%) of experience, reflecting a skilled and seasoned workforce capable of engaging with continuous improvement and quality initiatives effectively. The Demographic results are presented in the Table.1 below,

Table 1
Demographic Characteristics

Category	Subcategory	Count	Percentage
Gender	Male	178	64.73%
	Female	97	35.18%
Age Group	36–45	68	24.73%
	26–35	66	24.00%
	18–25	61	22.18%
	46–55	45	16.36%
	56+	35	12.73%
Education	Bachelor’s	94	34.18%
	Diploma	79	28.73%
	Master’s	53	19.27%
	High School	42	15.27%
	PhD	7	2.55%
Job Role	Operator	97	35.27%
	Technician	59	21.45%
	Supervisor	55	20.00%
	Engineer	36	13.09%
	Manager	28	10.18%
Experience	7–10 years	77	28.00%
	10+ years	60	21.82%
	4–6 years	54	19.64%
	1–3 years	53	19.27%
	<1 year	31	11.27%

5.2 Harmon’s One factor analysis

To assess the potential presence of common method bias in the data, Harman’s single-factor analysis was conducted. The common method biases results, showing that there is only 4.91% change of the total variance, which is significantly below the commonly accepted threshold of 50%. This indicates that no single factor dominated the variance among the measured items, suggesting that common method variance is unlikely to be a serious threat to the validity of the results. On the other hand, the variable multicollinearity was less than 3.33, which also shows that there is no issue of multicollinearity. These results show that the model does not appear to suffer from substantial common method bias, and the responses can be considered reliable for further analysis.

5.3 Reliability Analysis

Before testing the study hypothesis, it is essential to check the reliability of the construct that could be analyzed from factor loadings and reliability, which shows the internal consistency [16]. The recommended factor loading value is greater than 0.50, which shows that every item is contributing significantly to the underlying factor [32]. In other words, Cronbach’s alpha is used for the internal consistency assessment, where value above 0.70 is considered good, and above 0.90 indicate excellent reliability [45], while values above 0.95 show that there is correlation or redundancy in the items. Each alpha value is less than 0.90, which shows that the construct fulfills the requirements of discriminant validity [45], and it could be identified from Table 2 below.

Table 2
Reliability Analysis Results

Construct	Item	Factor Loading	Cronbach's Alpha
Lean Six Sigma LSS	LSS1	0.821	0.812
	LSS2	0.853	
	LSS3	0.891	
	LSS4	0.772	
	LSS5	0.713	
	LSS6	0.644	
Waste Elimination	WE1	0.732	0.793
	WE2	0.864	
	WE3	0.742	
	WE4	0.744	
	WE5	0.844	
Time Reduction	TR1	0.715	0.854
	TR2	0.733	
	TR3	0.895	
	TR4	0.745	
	TR5	0.763	
Error Detection	ED1	0.884	0.882
	ED2	0.733	
Customer Focus	CF1	0.854	0.827
	CF2	0.755	
	CF3	0.744	
	CF4	0.863	
	CF5	0.775	
TQM HR Practices	HR1	0.723	0.832
	HR2	0.845	
	HR3	0.835	
	HR4	0.743	
	HR5	0.815	
Core Quality Practices	CQMP1	0.883	0.833
	CQMP2	0.753	
	CQMP3	0.935	
	CQMP4	0.723	
	CQMP5	0.905	
	CQMP6	0.903	
	CQMP7	0.845	
	CQMP8	0.854	
	CQMP9	0.763	
	CQMP10	0.893	
Production Quality Performance	QMP1	0.873	0.873
	QMP2	0.825	
	QMP3	0.823	
	QMP4	0.813	
	QMP5	0.833	
	QMP6	0.823	

5.4 R Square

R Square values in the regression have been depicted in the current and this shows the proportion of variance in the endogenous variable due to exogenous variables [16]. Before moderation R square values was 0.56 which shows the 56% of the variance in the outcome variable which was explained by the predictor(s) alone. After introducing the moderating variable, the R^2 increased to 0.72, meaning 72% of the variance is now explained. This improvement indicates that the moderating variable has a significant effect by enhancing the explanatory power of the model.

The increase of 0.16 in R^2 demonstrates a strengthening effect of the moderating variable, which suggests that it significantly increases the relationship of the independent and dependent variables [3]. Such a change supports the presence of moderation and implies that the effect of the predictor on the outcome depends on the level of the moderator. Moderating and without moderating effect R-squared values are presented in the Table 3 below,

Table 3
R-squared Values Before and After Moderation

Model	R-squared (R^2)
Before Moderation	0.56
After Moderation (with Moderator)	0.72
Change in R^2 (ΔR^2)	0.16

5.5 Hypothesis Results

Multiple regression results on manufacturing SMEs highlighted that QMP significant positive influence on the PQP and PI. Accordingly, **Hypothesis 1 (QMP → PQP)** and **Hypothesis 2 (QMP → PI)** are accepted. Moreover, PI also exerts a **significant positive influence** on PQP, which supports **Hypothesis 3 (PI → PQP)**. The mediating role of process improvement is confirmed by the acceptance of **hypothesis 4 (QMP → PI → PQP),** which indicates that QMP indirectly enhances PQP through improved processes.

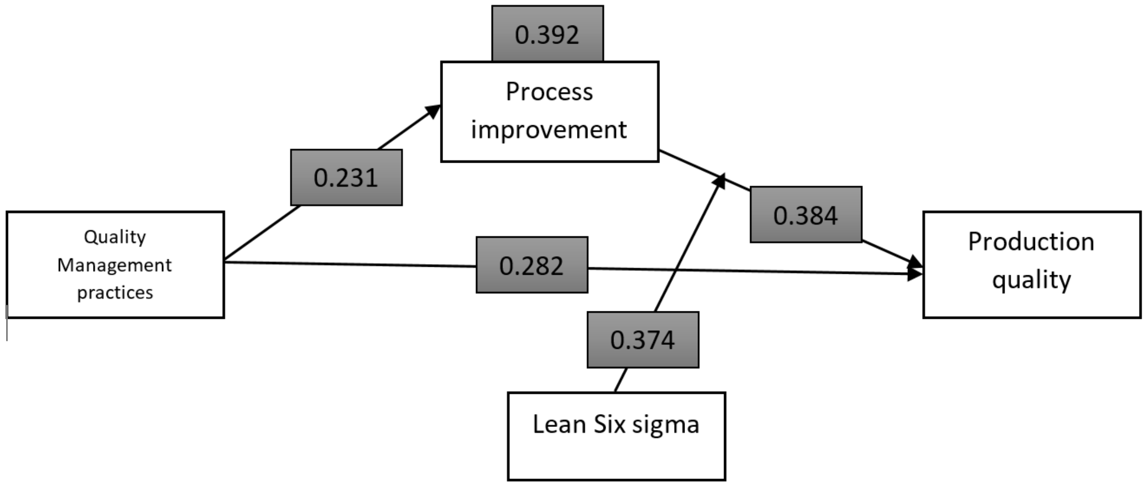

Fig.2. Beta Coefficients

Furthermore, the interaction between PI **and LSS (PI × LSS)** shows a **significant positive influence** on PQP, which supports **hypothesis 5** and highlights the strengthening effect of LSS on the PI-PQP relationship. These previous studies highlighted those critical values of QMP, PI, and LSS in driving superior production quality within manufacturing SMEs, and the results are supported in the Table 4.

Table 4
Hypothesis Results

Relationship	B	SE	T	Result
QMP → PQP	0.282	0.089	3.161***	Supported
QMP→ PI	0.231	0.084	2.753***	Supported
PI → PQP	0.324	0.098	3.302***	Supported
QMP → PI → PQP	0.392	0.083	4.722***	Supported
PI × LSS→ PQP	0.374	0.081	4.617***	Supported

Note: QMP-quality management practices, PQP-production quality, PI-process improvement, LSS-lean six sigma.

6. Discussion

The research aimed to evaluate the impact of quality management practices (QMP) on production quality performance (PQP). We have also assessed the mediating role of process improvement (PI) and the moderating role of Lean Six Sigma (LSS). The study results show that QMP practices significantly increase the PQP of SME manufacturing companies. The results highlighted that SMEs that adopt structured QMP, such as process standardization, regular quality audits, and employee quality training, experience a noticeable improvement in the quality of their outputs. When quality is embedded into the daily operations of SMEs, the consistency and reliability of their products improve, which enables firms to meet customer expectations more effectively and reduce defect rates. The results are also important for the SMEs because these companies often work in cost-effective markets, and therefore, for these companies, product quality could become a key competitive advantage to compete in the international market after providing export-quality goods. Previous arguments and study results are particularly aligned with the study of Dhieu [20], which established a strong link between the implementation of QMP and PQP which is asserting that quality-focused practices contribute to organizational performance by reducing variability in processes. Modgil and Sharma [59] also argued that QMP improves operational outcomes like production quality. The relevance of these findings to other companies' studies is reinforced by Bagodi et al. [13], who emphasized that QMPs are positively correlated with both internal performance and customer satisfaction. These findings reinforced that SMEs should invest in the QMP because SMEs investing in QMP can expect tangible benefits in terms of product excellence and competitiveness.

Moreover, the study further indicates that QMP has a significant positive influence on PI within manufacturing SMEs. This relationship suggests that organizations committed to QMP principles are more likely to engage in ongoing evaluations and refinements of their operational processes. Furthermore, findings indicate that QMP nurtures the culture of employee empowerment, continuous process improvement, and quality-focused decision making that is essential to identify and eliminate non-value-added practices. Moreover, organizations that adopt structured procedures tend to reengineer their internal processes to align their strategic, operational, and methodological approach. This finding is supported by Mitra [58] study, which demonstrated that standardization and process control help QMP to directly contribute to operational improvements. Furthermore, the finding is also in line with Jimoh et al. [41] who asserted that quality training and top management support are vital elements of QMP that lead to internal process efficiency in manufacturing SMEs. In the same vein, Qamar et al. [72] described that operational efficiency is driven by effective QMP. Based on the above studies, it is indicated that QMP increases process improvement, thus highlighting that manufacturing SMEs should focus on their operational strategies to sustain their competitive advantage globally.

Moreover, the results further show that PI positively and significantly impacts production quality, which indicates that continuous improvement led to improved production quality performance. This finding suggests that manufacturing SMEs should focus on continuous improvement to reduce errors and scrap to ensure superior product quality. Furthermore, PI not only reduces product variations but also standardizes processes and increases responsiveness to operational problems. This finding is supported by the view of Fannon et al. [24]; Qamar et al. [72], who asserted that there is an integral role of quality control and feedback loops in strengthening the direct link of PI on PQP in manufacturing SMEs. Likewise, this finding is also in line with Knizkov and Arlinghaus [46] highlighted that production and design process improvement is effective for SMEs having resource constraints, leading to superior product quality and customer satisfaction. Based on the above findings, continuous improvement increases production quality. Thus, it is emphasized that manufacturing SMEs must focus on their process improvement strategies to enhance production quality performance.

In addition, the study finding also shows that PI positively and significantly mediates the relationship between QMP and PQP. This finding suggested that QMP does not enhance PQP alone but also requires continuous process improvement to realize its full impact on PQP. Furthermore, none of the SMEs could ever achieve production quality by merely implementing QMP; they also require process improvement that results in superior production excellence. Similarly, the mediating role of PI highlighted the importance of PI, which translates QMP into a successful operational process. Lee et al. [52] supported this finding, emphasizing that the PI mediating role is crucial to understand the relationship between QMP and PQP in which found that it is vital for manufacturing SMEs to achieve production excellence. Based on the previous studies, the study findings indicate that SMEs must focus on quality-based implementation of quality standards to increase quality outcomes, which in turn lead to sustaining competitive advantage.

Lastly, the finding highlights that LSS is significantly and positively moderated between PI and PQP. The study proposes that when PI efforts integrate with LSS, higher quality outcomes are achieved by manufacturing SMEs. Furthermore, LSS sets up organizations with structured tools like statistical control and root cause analysis to increase the efficacy of process reengineering. Additionally, the combined effect of PI and LSS helps organizations minimize product variation, improve quality performance. Moreover, this finding is supported by the view of Rasheed et al. [76], who claim that the incorporation of Six Sigma methodology results in radical improvements in PQP. In the same manner, Orji and U-Dominic [68] supported the view they highlighted that LSS enables firms to increase their value chain by aligning their strategic and operational goals effectively. Hence, based on the previous studies, the current study indicated that a combination of PI and LSS is highly effective in achieving high-quality standards for manufacturing SMEs.

7. Implications and Recommendations

The findings from the study provide considerable evidence that the implementation of QMP has a significant impact on both PQP and PI. This means that QMP should not only be regarded as a requirement for compliance, but as a strategic property that directly contributes to operating results. For SME companies, which often meet tight resource shortages and intensive market competition, the focus on QMP can lead to better product reliability that can increase customer satisfaction and reduce production waste. The direct connection between QMP and PQP suggests that when fixed, formalized processes perform quality audits, and link employees to quality training, they are more likely to fulfill or are more than industry standards. In addition, a strong link between QMP and PI indicates that these practices function as a catalyst for internal innovation, which can develop market requirements for regular review, assessment, and improvement of their current processes. The study results also indicated that PI serves as a mediator in the relationship between QMP and PQP, which highlights that QMP must be translated into CI efforts to realize their full potential. This mediation effect emphasized the importance of viewing quality not just as a set of rules, but as a dynamic approach to problem-solving and performance enhancement. The interaction between LSS and PI in influencing PQP further reinforces this concept. When PI is combined with structured methodologies such as LSS, SMEs benefit from data-driven decision-making, root cause analysis, and waste reduction, which leads to measurable improvements in PQP. This is particularly important for SMEs in emerging economies or highly competitive sectors, where operational excellence can significantly influence long-term sustainability. As such, the findings advocate for an integrated approach where quality, process innovation, and Lean Six Sigma principles work in harmony to elevate performance.

Along with contributions to study results, various recommendations are also highlighted that could be helpful to policymakers and business consultants. Firstly, SME leaders should make QMP a core strategic priority by allocating dedicated resources for quality control, training, and documentation. This includes engaging employees in quality initiatives and promoting a culture of continuous improvement. Secondly, firms should establish formal CI mechanisms that regularly assess and optimize production workflows, involving key stakeholders from different departments. These improvements should be guided by performance metrics and feedback systems. Thirdly, the adoption of LSS tools should be encouraged, especially in SMEs with growth potential, to ensure that process improvements are grounded in scientific, repeatable methods. To facilitate this, governments and business support organizations should provide accessible training, funding, and mentorship programs to help SMEs overcome resource limitations. These efforts will not only strengthen individual enterprises but also contribute to broader industrial development, competitiveness, and innovation within the SME sector. Therefore, it is argued that SME manufacturing companies should focus on these strategies to increase their competitive advantage in the international market. Furthermore, a study conducted on SMEs ignored other sectors. Therefore, further research could be conducted on another manufacturing sector, like textiles, to increase the study scope.

8. Conclusion

Based on the dynamic capabilities theory study aimed to address the role of quality management practices on production quality performance. The study also examined the mediating role of process improvement and the moderating role of Lean Six Sigma in the relationship between QMP and PQP among SME manufacturing firms. To accomplish this objective, the study employed a quantitative and deductive research design. The study collected data from 275 QC engineers or process improvement professionals of SMEs. The findings show that quality management practices positively and significantly enhance production quality. It means that QMP acts as an integral factor in enhancing PQP. Furthermore, QMP also positively enhances process improvement. Similarly, PI positively and significantly impacts PQP. It proves that PI is a vital component that QMP translates into better outcomes, especially in the competitive market of SMEs manufacturing firms. Moreover, the impact of QMP on PQP is evaluated by integrating process improvement and shows that process improvement significantly and positively enhances PQP. Lean Six Sigma also positively moderates the relationship between PI and PQP, showing that structured quality controls and PI further strengthen this relationship. Therefore, the indirect impact of QMP on PQP by integrating PI becomes more considerable in the presence of Lean Six Sigma. Hence, SME manufacturing companies adopting lean Six Sigma culture are prone to attain superior production outcomes using effective and efficient quality management and process improvement. These findings indicate that the incorporation of both PI and LSS significantly enhances the effectiveness of QMP in improving PQP. Furthermore, the study provides practical insights to SMEs manufacturing companies to optimize their production quality performance by focusing on process improvement and utilization of Sig Sigma roles.

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