International Journal of Innovation and Industrial Revolution
EISSN: 2637-0972
Volume 7 Issue 22 (September 2025) PP. 653-674
DOI 10.35631/IJIREV.722036

INTERNATIONAL JOURNAL OF INNOVATION AND INDUSTRIAL REVOLUTION (IJIREV)
www.ijirev.com

GLOBAL ACADEMIC EXCELLENCE

THE INFLUENCE OF CONTINUOUS IMPROVEMENT ON COST OF POOR QUALITY AND OPERATIONAL PERFORMANCE IN TURBINE GENERATOR MANUFACTURING INDUSTRY

Sutiman Abd Shukor[1*], Sabariah Yaakub[2]

[1] Othman Yeop Abdullah Graduate School of Business, Universiti Utara Malaysia, Kuala Lumpur, Malaysia
Email: sutiman_b_abd@oyagsb.uum.edu.my
[2] Othman Yeop Abdullah Graduate School of Business, Universiti Utara Malaysia, Kuala Lumpur, Malaysia
Email: y.sabariah@uum.edu.my
[*] Corresponding Author

Article Info:

Article history:
Received date: 23.06.2025
Revised date: 15.07.2025
Accepted date: 07.08.2025
Published date: 19.09.2025

To cite this document:

Abd Shukor, S., & Yaakub, S. (2025). The Influence of Continuous Improvement on Cost of Poor Quality and Operational Performance in Turbine Generator Manufacturing Industry. *International Journal of Innovation and Industrial Revolution, 7* (22), 653-674.

DOI: 10.35631/IJIREV.722036

Abstract:

Cost of poor quality (COPQ) has always had a negative image in the discussion of quality. This image, however, we contest, as GE has been using it as a tool for continuous improvement. COPQ can play a crucial role, as a lesson learned, in increasing continuous improvement effort in a company, consequently improving operational performance. This paper investigates the underlying role of COPQ, its effect on CI and the mediating role of CI in the relationship between COPQ and operational performance. A quantitative research approach utilizing a structured questionnaire gathered data from 375 personnel at GE. The collected data was analyzed using partial least squares structural equation modeling. This study demonstrates that Cost of Poor Quality (COPQ) significantly drives organizations to adopt Continuous Improvement (CI) initiatives, such as Lean and Six Sigma, to reduce inefficiencies and quality-related costs. CI serves as a mediator between COPQ and Operational Performance (OP), mitigating the adverse effects of poor quality and fostering a culture of continuous improvement. The findings highlight that reducing COPQ through CI strategies leads to enhanced operational performance, optimizing efficiency, productivity, and product quality. This study is one of the first to examine the impact of COPQ practices on continuous improvement and organizational performance within the selected turbine generator manufacturer in the context of global region. As such, it makes a valuable contribution to the literature by addressing calls to address competitiveness challenges in today's complex business environments. The results emphasize the necessity of a holistic approach to quality management, integrating COPQ considerations into CI strategies to optimize organizational performance. By elucidating these interactions, this research contributes to the broader discourse on quality management and CI, offering valuable insights for academia and industry. Simultaneously, the study's findings provide a foundation for future research and practical applications in diverse organizational contexts, reinforcing the need for proactive quality management strategies to enhance operational excellence.

Keywords:

Continuous Improvement, Cost of Poor-Quality, Operational Performance

Introduction

In today's dynamic business environment, companies face various challenges that impact profitability, growth, and the achievement of strategic goals, including intense competition, quality standards, legislation, technological advancements, and evolving consumer preferences (Blaga, 2020; Galli, 2019a). Initially, many organizations assumed that high-quality products required high production costs, leading to premium-priced goods accessible only to a limited market. However, this resulted in most consumers opting for cheaper, lower-quality alternatives. To address this, companies sought ways to reduce production costs while maintaining high quality, making products more affordable for a broader market (Mircea, 2022). The emphasis on quality is further driven by technological advancements, making it a key factor for businesses seeking a competitive advantage (Hasan et al., 2023). Poor-quality products can lead to significant negative consequences, while high-quality production fosters customer loyalty, satisfaction, and trust (Keke et al., 2023; Sürücü et al., 2019). Effective quality management is essential, with organizations ensuring adherence to standards through total quality management (TQM) frameworks (Sun et al., 2023), and the financial impact of quality issues being measured by the cost of poor quality (COPQ) (Pham, 2020).

The relationship between COPQ and operational performance has gained significant attention as organizations focus on continuous improvement. COPQ includes costs related to defects, failures, and inefficiencies due to poor quality, which can negatively affect both operational performance and business success (Olanrewaju & Lee, 2022). Poor quality increases operational costs, damages reputations, and reduces customer loyalty (Adem & Virdi, 2024), making effective quality management systems crucial to detect and resolve issues early (Iqbal & Asrar-ul-Haq, 2018). Additionally, operational capabilities, such as process optimization and resource management, play a key role in improving performance and reducing COPQ (Domenek et al., 2022). In industries like construction, poor quality leads to operational inefficiencies, emphasizing the need for rigorous quality control and training (Olanrewaju & Lee, 2022). Adapting service strategies to evolving customer expectations also enhances operational efficiency and reduces costs (Alshurideh et al., 2022). Operational excellence, which includes leadership, continuous improvement, and customer orientation, further minimizes COPQ and improves performance (Khatib et al., 2022). In manufacturing, integrating quality checks into processes helps identify defects early, reducing rework and enhancing productivity (Sontaga Makua & Dewa, 2023). Aligning organizational culture with operational strategies promotes innovation and better operational outcomes by fostering a quality-focused environment, thus reducing COPQ (L. F. Wu et al., 2019). Ultimately, organizations that adopt comprehensive quality management practices and focus on continuous improvement are better positioned to reduce COPQ and improve overall performance in a dynamic business environment.

International Journal of Innovation and Industrial Revolution
EISSN: 2637-0972
IJIREV
Volume 7 Issue 22 (September 2025) PP. 653-674
DOI 10.35631/IJIREV.722036
Continuous improvement is essential for maintaining market competitiveness (Bhushi et al., 2023). Ongoing quality development is crucial for businesses to stay competitive, with continuous innovation having a significant impact (Beyhan Yasar et al., 2019). However, organizations often focus on optimizing internal production processes, neglecting the broader effects on other areas (Hagström et al., 2023). Additionally, the sustainability of continuous improvement programs is challenged by the lack of understanding of causality and feedback from factors like human issues (Pandey & Kumar, 2016; Van Dyk & Pretorius, 2014). Choosing the right methodology for problem-solving and process improvement remains a challenge for both researchers and practitioners in manufacturing (Aichouni et al., 2021). Assessing continuous improvement is difficult due to the need for accurate quality cost methodologies, awareness, and guidance, along with the limited availability of objective metrics like quality cost data (Makhanya et al., 2018; Osteen et al., 2013a; Teli et al., 2013; Waichai & Yuklan, 2018). The lack of such data hinders effective research on continuous improvement as a mediator (Shrouty & Tiwari, 2017; Waichai & Yuklan, 2018). Continuous improvement (CI) methodologies, including Lean and Six Sigma, are widely utilized across industries to improve operational performance by systematically eliminating waste and optimizing processes. Integrating CI practices can significantly reduce poor quality costs, thus improving overall operational performance (Buer et al., 2021). For example, Lean manufacturing emphasizes waste reduction and value creation, which is directly linked to minimizing the costs associated with poor quality. Aligning CI practices with operational goals is essential for organizations aiming to achieve excellence in performance metrics.

In the case of turbine generator manufacturing industry (the context of the present study), a global conglomerate with diverse operations, the application of continuous improvement practices proves especially advantageous. This industry has long adopted various continuous improvement methodologies, which have played a key role in driving operational excellence across its numerous business units. This industry focus on quality and efficiency aligns with Lean and Six Sigma principles, which aim to reduce waste and enhance process capabilities (Alexander et al., 2019; Mui and Muthuveloo, 2020). While the impact of the cost of poor quality (COPQ) on organizational performance (OP) is well recognized, many organizations (including GE) face challenges in understanding the complex interplay between these elements and continuous improvement (CI) initiatives. Specifically, there is a need to examine how inefficiencies and defects contribute to quality costs and hinder CI efforts, as well as how CI practices can enhance OP by reducing waste and improving productivity. Furthermore, the mediating role of CI in mitigating the negative effects of COPQ on OP remains underexplored. This research aims to fill these gaps by investigating the relationships between COPQ, CI, and OP, offering valuable insights for organizations striving to optimize their quality management systems, improve operational performance, and maintain a competitive edge in the marketplace. This study seeks to elucidate the intricate relationship between Cost of Poor Quality (COPQ) and Operational Performance (OP), with Continuous Improvement (CI) serving as a mediating factor. The research endeavours to address the following overarching questions:

RQ1: Does COPQ have a significant relationship to CI?
RQ2: Does CI have a significant relationship to OP?
RQ3: Does CI mediate the relationship between the COPQ and OP?

International Journal of Innovation and Industrial Revolution
EISSN: 2637-0972
IJIREV
Volume 7 Issue 22 (September 2025) PP. 653-674
DOI 10.35631/IJIREV.722036
In line with its objectives, the article is organized as follows: Section two explains the concept of COPQ and provides the research background on COPQ, CI and operational performance. Section three outlines the research methodology, followed by section four, which presents the data analysis and results. Section five discusses the findings and presents the conclusions, while section six addresses the research limitations and suggestions for future research.

Literature Review

Prevention costs, on the other hand, are aimed at proactively preventing defects from occurring in the first place (Crowdle et al., 2023). These expenses include the development of quality plans, training programs, and investments in quality assurance systems designed to reduce the occurrence of defects during production (Sodhi et al., 2023). By focusing on preventing quality issues, organizations can reduce the likelihood of both internal and external failures, but these efforts require significant resource allocation in terms of time, money, and skilled personnel (Mittal & Gupta, 2024). Effective prevention not only minimizes defects but also contributes to a culture of continuous improvement within the organization.

Finally, Internal Failure Costs and External Failure Costs represent the financial consequences of defects identified during production and after the product has reached the customer, respectively. Internal failure costs include rework, scrap, and wasted resources (Tambunan, 2024), while external failure costs involve warranty claims, product recalls, and damage to customer relationships (Crowdle et al., 2023). Both categories highlight the critical importance of addressing quality issues at each stage of the process, as failure to do so can lead to increased operational costs, customer dissatisfaction, and long-term damage to the organization's reputation. Effectively managing and minimizing these costs is essential for improving both quality and operational performance.

Cost of Poor Quality and Continuous Improvement

Cost of Poor Quality (COPQ) is a major concern in the manufacturing industry, as it incurs high costs due to rejected parts, raw materials, and manpower (Bhushi et al., 2023; Teli et al., 2013). Continuous quality improvement (CI) initiatives are vital for maintaining competitive advantage by addressing quality issues, improving productivity, and enhancing overall product or service excellence (Bhushi et al., 2023; Teli et al., 2013). However, challenges such as quantification difficulties, lack of leadership support, and complex measurement processes hinder the effectiveness of these initiatives (Makhanya et al., 2018). Quality cost analysis can help identify areas for improvement (Teli et al., 2013). COPQ increases operational costs and reduces profitability, thus necessitating CI to mitigate its impact (K. Haider, 2024; Sörqvist, 1997). Effective CI can improve customer satisfaction and help organizations regain profitability (Crowdle et al., 2023). Six Sigma methodologies further support process improvements, helping companies address quality issues (Van Dyk & Pretorius, 2014). To optimize performance and enhance sustainability, organizations must prioritize CI to overcome COPQ challenges and drive continuous improvements (Hafida et al., 2022). Thus, this study hypothesized that:

H1: There is a significant relationship between COPQ to CI

Continuous Improvement and Company Performance

Continuous Improvement (CI) is recognized as a dynamic capability that significantly influences organizational and operational performance (Condé & de Toledo, 2023). The CI

Volume 7 Issue 22 (September 2025) PP. 653-674
DOI 10.35631/IJIREV.722036
philosophy enhances organizational performance, competitiveness, and long-term survival (Supriyanto & Prasetyawan, 2019). Lean tools and methods, such as Lean Manufacturing and Six Sigma, help manufacturing organizations improve operational processes, resulting in better cycle times, quality, cost reduction, customer loyalty, and responsiveness (Supriyanto & Prasetyawan, 2019). Key performance indicators (KPIs) are essential for measuring operational performance within CI (Kang et al., 2016). A comprehensive set of performance metrics is crucial for assessing operational efficacy, production volume, and system reliability, offering insights into productivity, quality, and maintenance effectiveness (Kang et al., 2016). Operational success involves key factors such as productivity, costs, quality, and distribution (Wilfred. J. Kaydos, 2000). Previous research has focused on metrics for OP measurement, including costs, quality, delivery, inventory optimization, and productivity (Al Majali, 2023; W. Kaydos, 2020; Wilfred. J. Kaydos, 2000; Shim & Kim, 2023). Studies have shown that CI systems enhance internal process performance, with management support reinforcing this relationship (Sesar & Hunjet, 2021). Additionally, research indicates that CI significantly mediates the relationship between innovation and financial performance, linking it to improved financial outcomes (Beyhan Yasar et al., 2019). Empirical studies highlight the positive impact of CI on operational performance (Lizarelli et al., 2020) and emphasize the importance of employee participation in CI initiatives to enhance performance (Galeazzo et al., 2021). Therefore, it is hypothesized that:

H2: There is a significant relationship between CI to OP

Mediating effect of Continuous Improvement on the relationship between Cost of Poor Quality and Company Performance

In manufacturing, strategically implementing quality enhancement methodologies, including analytical tools for root cause identification, productivity improvement, and process refinement, is crucial for maintaining competitive advantage and delivering superior products (Bhushi et al., 2023; Teli et al., 2013). The cost of poor quality (COPQ) in manufacturing is driven by factors like part rejection, resulting in higher costs than raw materials due to added manpower and operational expenses (Bhushi et al., 2023; Teli et al., 2013). One study suggests that the total COPQ can serve as a measure of organizational performance, linking quality costs to operational processes (Lari & Asllani, 2013). The impact of quality initiatives on performance varies by factors such as organization size and sector (Upadhyaya & Bhat, 2019). The effectiveness of quality initiatives depends on robust measurement, return on investment, and managerial support, all contributing to their success (Makhanya et al., 2018). Research shows that the aggregate COPQ is a comprehensive indicator of organizational performance, linking quality costs with operational processes and quality benchmarks like ISO 9001 certification (Lari & Asllani, 2013; Rehacek, 2017a; Tambunan, 2024). Further analysis of secondary data reveals that reducing COPQ over time results in improved quality outcomes and cost mitigation, demonstrating economies of scale (Sturm et al., 2019). Continuous improvement (CI) can act as a mediator in the relationship between COPQ and operational performance (OP) by identifying inefficiencies, addressing quality-related issues, and implementing strategies to reduce costs while improving productivity. CI initiatives, such as Lean and Six Sigma, help organizations optimize processes, thereby reducing COPQ and enhancing operational performance (Makhanya et al., 2018). However, obstacles to implementing cost of quality programs include deficiencies in measurement, ROI assessments, managerial support, awareness, and strategic alignment, highlighting areas for improvement in integrating these initiatives into continuous improvement efforts (Makhanya et al., 2018). In

International Journal of Innovation and Industrial Revolution
EISSN: 2637-0972
Volume 7 Issue 22 (September 2025) PP. 653-674
DOI 10.35631/IJIREV.722036
conclusion, early identification and tracking of COPQ can enable organizations to establish effective risk management programs, maximizing operational benefits through continuous improvement (CI) approaches. The later COPQ occurs, the greater its impact on the organization.

It is argued therefore that continuous improvement (CI) serves as a critical mediating variable in the relationship between cost of poor quality (COPQ) and operational performance (OP). While COPQ negatively impacts OP by diverting resources to inefficiencies, defects, and rework, CI intervenes by systematically improving processes, reducing waste, and enhancing quality. CI initiatives such as Lean, Six Sigma, and Total Quality Management (TQM) focus on identifying and eliminating the root causes of inefficiencies, thereby directly reducing COPQ. By addressing these quality issues and optimizing processes, CI reduces the costs associated with poor quality and enhances the overall productivity and efficiency of operations. Furthermore, CI fosters a culture of continuous learning and feedback, where ongoing improvements ensure that operational performance is consistently refined over time. As a result, CI not only mitigates the negative impacts of COPQ but also drives improvements in operational processes, leading to enhanced productivity, cost savings, and customer satisfaction. In this way, CI acts as a mediating variable, explaining the process through which the reduction in COPQ translates into better operational performance, making CI an essential factor in the successful management of quality and operational outcomes. Therefore, rather than COPQ having a direct negative effect on OP, CI provides a mechanism that alleviates this impact by improving processes, reducing inefficiencies, and optimizing performance over time. It is therefore hypothesized that:

H3: CI mediates the relationship between COPQ and OP

The research framework examining the relationship between the Cost of Poor Quality (COPQ) as the independent variable, Operational Performance (OP) as the dependent variable, and Continuous Improvement (CI) as the mediator is vital for understanding how quality management practices enhance operational efficiency, particularly in the context of General Electric. COPQ includes costs like rework, scrap, and lost sales due to poor quality, which negatively affect operational performance by increasing costs and reducing productivity (Galli, 2019a). Poor-quality practices lead to operational inefficiencies, diminishing performance across industries, including manufacturing (Olanrewaju & Lee, 2022). CI plays a crucial role as a mediator, aiming to improve processes and foster continuous refinement within organizations (Galli, 2021). Research shows that CI can mitigate the negative impact of COPQ on OP, contributing to operational performance by fostering a culture of quality and efficiency (Alaghbari et al., 2022). Studies also highlight how CI improves operational capabilities, thereby enhancing overall performance (Prester, 2023), demonstrating its pivotal role in enabling organizations to achieve greater efficiency and effectiveness. The conceptual framework is illustrated in Figure 1.

International Journal of Innovation and Industrial Revolution
IJIREV
EISSN: 2637-0972
Volume 7 Issue 22 (September 2025) PP. 653-674
DOI 10.35631/IJIREV.722036

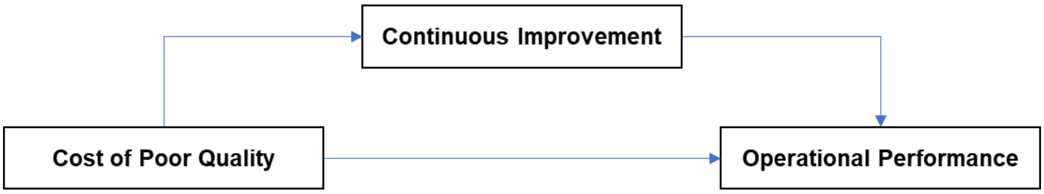

Figure 1: Conceptual Research Framework

Methodology

This study employed a quantitative research methodology through the use of a survey, which was developed based on a literature review of similar studies. The survey consisted of four sections. The first section gathered demographic information from respondents, containing ten items. The second section assessed the extent to which respondents implement COPQ practices, with 24 items. The third section included 24 items that evaluated continuous improvement indicators. Lastly, the fourth section evaluated 42 operational performance indicators. A 1–5 Likert scale was used to measure all constructs, with respondents asked to rate statements based on their observations of their company's management practices. On the Likert scale, a rating of 1 indicated "severely disagree" and 5 indicated "completely agree." To ensure content validity of the survey (Saunders et al., 2016), a pilot study of 30 respondents was employed and it was determined that the survey was clear and included all necessary items for each section.

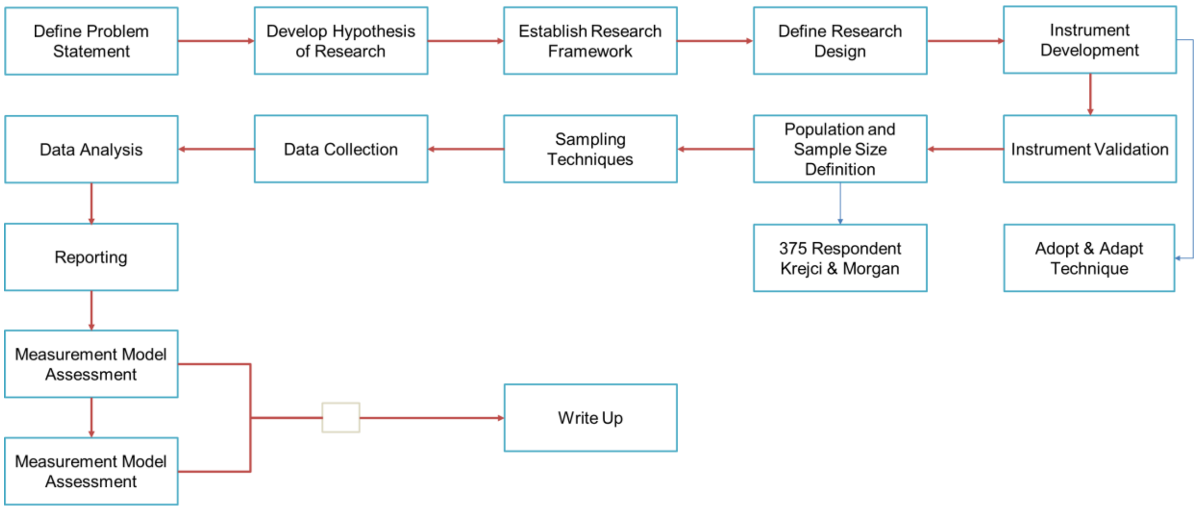

Figure 1: Flowchart of Research Methodology

This study was conducted among the turbine generator manufacturing services employees worldwide as they play a pivotal role in firms providing services to clients. In this study, the operational territories of GE will be categorized into five regions: North America (NAM), Latin America (LATAM), Middle East (MEA), Asia Pacific (APAC), and Europe Region (EU). The selected turbine generator manufacturing operations are divided into five separate regions, each of which has unique features and makes specific contributions to the company's worldwide strategy. There were 7,540 employees identified from various organization. Utilising stratified random sampling, 367 respondents were chosen as the sampling number following suggestions by Krejcie & Morgan, (1970). The survey was distributed to 400 eligible field services

International Journal of Innovation and Industrial Revolution
EISSN: 2637-0972
IJIREV
Volume 7 Issue 22 (September 2025) PP. 653-674
DOI 10.35631/IJIREV.722036
employees, both in person and via email, following initial contact by phone and email in order to achieve at least 367 respondents. Over a period of five months, a total of 375 completed surveys were collected. After conducting an outlier test, all surveys were included, which represents a response rate of 93.75%. Table 1 illustrates the proposed number of respondents according to region, and Table 2 provides demographic details of the participating field services employees.

Table 1: The Proposed Number of Respondents

No.	Regions	Populations	Percentage (%)	Proposed No. of Respondents
1	Asia	1518	20	74
2	Europe	1750	23	84
3	Latin America	1021	14	51
4	Middle East Africa	1168	15	55
5	North America	2083	28	103
Total		**7540**	**100**	**367**

International Journal of Innovation and Industrial Revolution
IJIREV
EISSN: 2637-0972
Volume 7 Issue 22 (September 2025) PP. 653-674
DOI 10.35631/IJIREV.722036

Table 2: Respondents Demographic

Attributes	Group	Frequency	Percentage
Gender	Male	*344*	*91.7*
	Female	*31*	*8.3*
		375	***100***
Age	26-35	*171*	*45.6*
	36-45	*184*	*49.1*
	46-55	*20*	*5.3*
		375	***100***
Education	College	*10*	*2.7*
	Associate Degree	*69*	*18.4*
	Bachelor Degree	*176*	*46.9*
	Master Degree	*106*	*28.3*
	Doctorate Degree	*14*	*3.7*
		375	***100***
Years of Service	1-5	*19*	*5.1*
	6-10	*112*	*29.9*
	11-15	*195*	*52.0*
	16-20	*49*	*13.1*
		375	***100***
Employment Status	Full Time	*375*	*100*
		375	***100***
Region	NAM	*105*	*28.0*
	LATAM	*53*	*14.1*
	MEA	*56*	*14.9*
	APAC	*75*	*20.0*
	EU	*86*	*22.9*
		375	***100***
Working Level	Supervisory	*150*	*40.0*
	Middle Management	*191*	*50.9*
	Senior Management	*29*	*7.7*
	Executive	*5*	*1.3*
		375	***100***
Accessibility	Yes	*375*	*100*
		375	***100***
Project Update	Yes	*375*	*100*
		375	***100***
Documentation	Yes	*375*	*100*
		375	***100***

Data Analysis and Result

The survey data were analyzed using Partial Least Squares Structural Equation Modeling (PLS-SEM), a technique for modeling complex relationships between observed and latent variables (Hair et al., 2014). The study aims to predict and explain target constructs or identify key drivers (Rigdon, 2012). PLS-SEM is suitable for complex structural models and abstract phenomena (Hair et al., 2017), and is recommended when exploring such relationships (Wong, 2013).

The first phase focused on ensuring that the constructs—Cost of Poor Quality (COPQ), Continuous Improvement (CI), and Operational Performance (OP)—were measured accurately and consistently through the measurement of model assessment.

International Journal of Innovation and Industrial Revolution
IJIREV
EISSN: 2637-0972
Volume 7 Issue 22 (September 2025) PP. 653-674
DOI 10.35631/IJIREV.722036

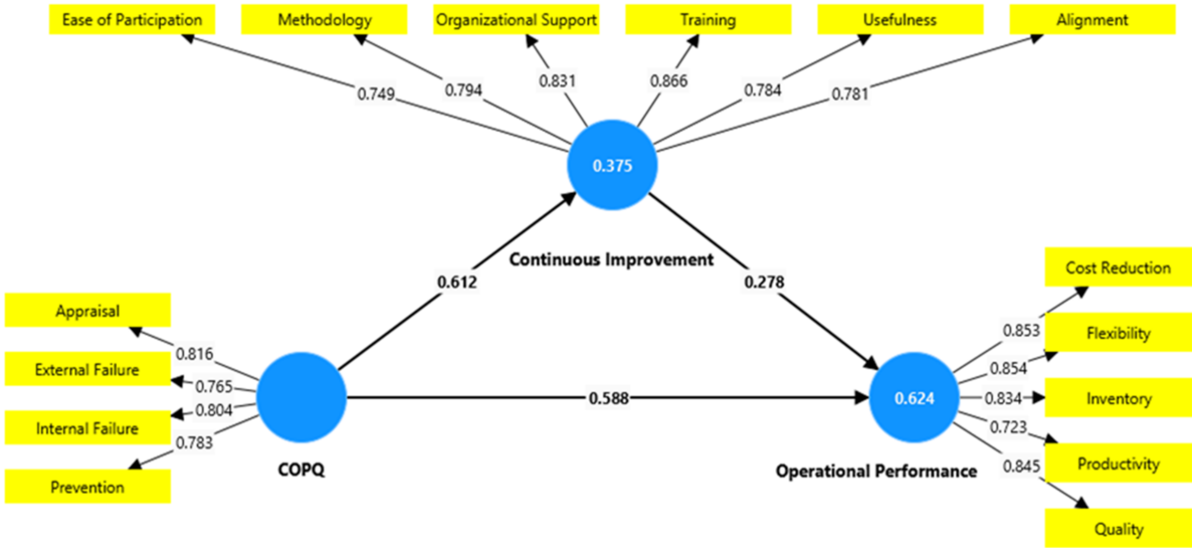

Figure 2: Structural Model Assessment

A common threshold for standardized outer loadings is 0.708, but values above 0.4 are acceptable for exploratory studies (Henseler et al., 2016). In this study, all loadings exceeded 0.4, confirming their acceptability. For discriminant validity, the Fornell-Larcker criterion compares each construct's AVE with squared inter-construct correlations (Fornell & Larcker, 1981). Results showed that the square roots of the AVEs exceeded their corresponding correlations, confirming discriminant validity (Hair et al., 2019; Lucy Matthew, 2017; Samani, 2016).

Table 3: Fornell Lacker Criterion

	COPQ	CI	OP
COPQ	***0.792***		
Continuous Improvement	*0.612*	***0.802***	
Operational Performance	*0.759*	*0.638*	***0.824***

The internal consistency of the measurement model is evaluated using composite reliability (CR). CR values range from 0 to 1, with higher values indicating higher reliability. It is typically interpreted similarly to Cronbach's alpha. Specifically, CR values above 0.60 are deemed acceptable in exploratory research (Sarstedt et al., 2016). Table 4 shows that all Cronbach's alpha and CR values for the tested research constructs meet the acceptable threshold. Convergent validity (CV) assesses the extent to which the items are closely related and compatible with one another (Hair et al., 2017) and is measured using the average variance extracted (AVE) value. An AVE value of 0.5 or higher indicates that a latent variable explains, on average, half or more of the variance of its indicators. Table 3 presents the results for the measurement model's convergent validity. All AVE values exceed 0.5, which is considered adequate (Fornell and Larcker, 1981; Hair et al., 2014).

International Journal of Innovation and Industrial Revolution
IJIREV
EISSN: 2637-0972
Volume 7 Issue 22 (September 2025) PP. 653-674
DOI 10.35631/IJIREV.722036

Table 4: VIF, Loading Factor, Cronbach Alpha, CR, AVE, R^2 and Q^2

Variable	VIF	Loading factor	Cronbach Alpha	CR	AVE	R^2	Q^2
Cost of Poor Quality (COPQ)			0.994	0.832	0.627		
Prevention	1.710	0.783					
Appraisal	1.481	0.816					
Internal failure	1.749	0.804					
External failure	1.659	0.765					
Continuous Improvement (CI)			0.978	0.894	0.643	0.375	0.348
Alignment	2.006	0.781					
Methodology	2.078	0.794					
Organizational support	2.224	0.831					
Training	2.623	0.866					
Usefulness	1.891	0.784					
Ease of Participation	1.777	0.749					
Operational Performance (OP)			0.976	0.888	0.678	0.624	0.570
Quality	2.315	0.845					
Flexibility	2.498	0.854					
Inventory	2.239	0.834					
Productivity	1.630	0.723					
Cost Reduction	2.360	0.853					

Discussion and Conclusions

The main aim of this research was to investigate the underlying relationship between COPQ, CI and OP and to determine whether CI mediates the relationship between COPQ and OP. To the best of the authors' knowledge, this study is the first to investigate the effect of COPQ and CI on operational performance of the turbine generator manufacturing industry, thus adding great values to case literatures. The overall hypotheses testing results is presented in Table 5 below:

Table 5: Path Coefficient Summary of Hypothesis Testing

No	Hypotheses	Std. Beta	Std. Error	*t*-value	*p*-value	Decision
H_1	*COPQ → CI*	0.612	0.071	8.594	0.000	*Supported*
H_2	*CI → OP*	0.278	0.083	3.366	0.001	*Supported*
H_3	*COPQ → CI → OP*	0.170	0.071	2.389	0.017	*Supported*

The relationship between Cost of Poor Quality (COPQ), Continuous Improvement (CI), and Operational Performance (OP) has garnered significant attention in recent empirical studies. COPQ encompasses all costs arising from inadequate quality, including prevention, appraisal, internal failure, and external failure costs. High levels of COPQ drive organizations to adopt CI strategies as a means of reducing inefficiencies and mitigating the negative financial implications of poor quality. Empirical findings have demonstrated that organizations

International Journal of Innovation and Industrial Revolution
IJIREV
EISSN: 2637-0972
Volume 7 Issue 22 (September 2025) PP. 653-674
DOI 10.35631/IJIREV.722036
experiencing elevated COPQ are incentivized to engage in CI initiatives, with a significant positive relationship between COPQ and CI (Bhushi et al., 2023; Khan et al., 2019). The results indicated that COPQ significantly influences CI, evidenced by a substantial effect size of 0.600 supporting Hypothesis 1. This aligns with the notion that CI activities, such as Six Sigma and Lean methodologies, are instrumental in identifying and addressing inefficiencies within processes, thereby reducing failure-related expenditures and contributing to a reduction in COPQ (Bris et al., 2022; Modhiya & Desai, 2016). By focusing on the elimination of waste and the reduction of process variability, CI strategies directly address the core components of COPQ, leading to a more efficient use of organizational resources.

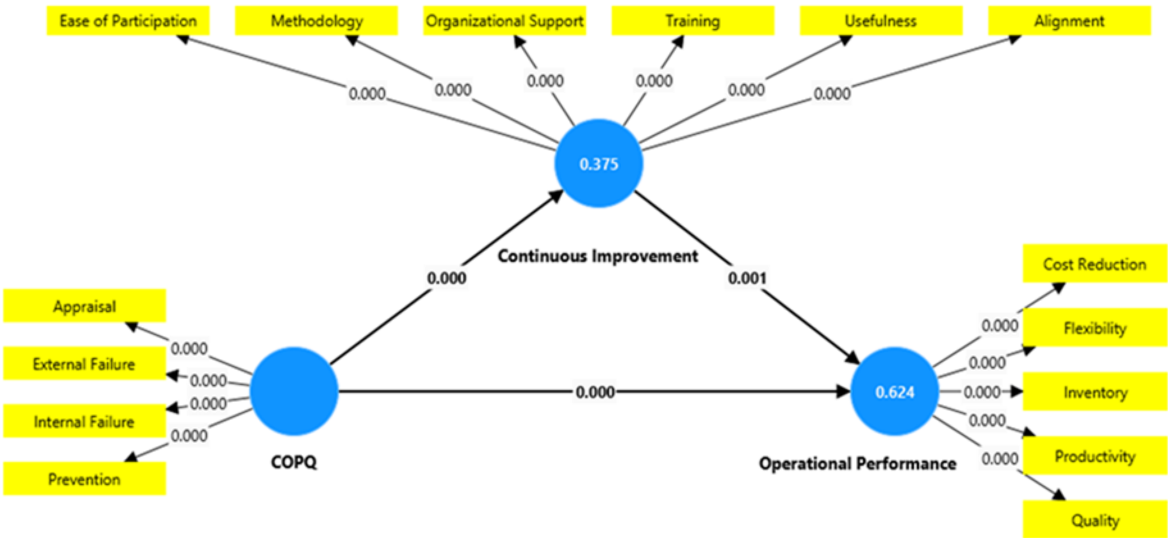

Figure 3: Path Coefficient & Hypothesis Testing

Furthermore, CI plays a critical role in improving operational performance (OP). The study's result indicate that CI has a strong positive impact on OP. The path analysis indicated a statistically significant connection (H2: $\beta = 0.278$, $t = 3.366$, $p = 0.001$). Despite a medium effect size ($f^2 = 0.129$), the results emphasize the significance of CI in improving operational performance. The implementation of CI techniques is closely linked to enhanced operational efficiency, productivity, and overall performance. This is in line with recent studies that has shown a statistically significant impact of CI on OP, emphasizing its importance in driving improvements across key operational indicators such as cost reduction, flexibility, and quality (Jurburg et al., 2015; Inan et al., 2022). CI methodologies not only reduce operational inefficiencies but also foster a culture of continuous learning and improvement, which is crucial for organizations seeking to maintain competitive advantage in dynamic markets. For instance, training programs and employee engagement in CI activities have been shown to enhance self-efficacy and participation in improvement processes, further contributing to positive outcomes in operational performance (Belekoukias et al., 2014; Aída et al., 2023). These efforts, when aligned with organizational goals, optimize resource utilization, streamline processes, and drive long-term operational improvements.

The mediating role of Continuous Improvement (CI) in the relationship between Cost of Poor Quality (COPQ) and Operational Performance (OP) is a critical area of organizational research that uncovers how quality-related costs can be mitigated through systematic, ongoing efforts to improve processes. COPQ, which includes prevention, appraisal, internal failure, and external failure costs, presents a substantial financial burden for organizations. When these

International Journal of Innovation and Industrial Revolution IJIREV
EISSN: 2637-0972
Volume 7 Issue 22 (September 2025) PP. 653-674
DOI 10.35631/IJIREV.722036
costs are high, they not only detract from profitability but also limit an organization's capacity to achieve operational excellence. However, CI, encompassing methodologies like Lean, Six Sigma, and Total Quality Management (TQM), offers organizations a powerful mechanism to address these inefficiencies. CI strategies focus on reducing waste, eliminating defects, and enhancing process reliability. By doing so, CI directly reduces the components of COPQ, which in turn alleviates the negative impacts on OP (Bris et al., 2022; Modhiya & Desai, 2016). CI functions as a bridge that mediates the detrimental effects of COPQ on OP by fostering a culture of continual process evaluation and improvement. Empirical studies support the notion that organizations with elevated COPQ levels are motivated to implement CI initiatives to mitigate these costs (Bhushi et al., 2023; Khan et al., 2019). CI enables organizations to proactively identify the root causes of inefficiencies and quality issues, addressing them before they escalate into significant problems. For instance, through Six Sigma's focus on reducing process variability and Lean's emphasis on eliminating waste, organizations can reduce internal and external failure costs—two major components of COPQ (Saleh et al., 2018). As CI initiatives progressively enhance quality, the reduction in COPQ directly translates to improved resource allocation, better cost control, and increased operational efficiency, all of which contribute to improved OP.

Moreover, CI contributes to OP improvement by embedding a mindset of continuous learning and engagement across all organizational levels. As CI activities are implemented, employees at all levels are encouraged to participate in improvement efforts, which helps identify areas where operational performance can be optimized. The role of employee involvement in CI initiatives is crucial in this context; studies show that when employees are actively engaged in CI processes, they are more likely to identify inefficiencies and propose solutions that contribute to long-term improvements (Jurburg et al., 2015; Belekoukias et al., 2014). In this way, CI not only mitigates COPQ but also enhances employee engagement, which in turn positively affects OP. Additionally, when organizations invest in training programs to equip their workforce with the skills needed to identify quality issues and implement improvement measures, they create a more capable and efficient workforce, directly influencing OP (Inan et al., 2022; Aída et al., 2023). The mediating effect of CI thus underscores the strategic role it plays in transforming the impact of COPQ into a driver for operational excellence. By addressing and reducing COPQ through continuous improvement efforts, organizations create a feedback loop where operational performance is continuously optimized. The combination of reducing costs associated with poor quality and fostering a culture of continuous improvement generates long-term benefits, including higher productivity, reduced operational costs, improved product quality, and better customer satisfaction (Cunha et al., 2023; Janee Ali et al., 2013). The research further corroborates this mediating function, as findings show that CI not only directly improves OP but also acts as a mechanism through which the negative impacts of COPQ are alleviated (Antony et al., 2021). Organizations that integrate CI methodologies into their strategic framework are better positioned to leverage the full potential of their operations, translating the reduction in COPQ into sustained improvements in performance across key operational metrics.

Limitation and Future Research Directions

While this study offers new insights into the relationship between COPQ, CI and OP in the context of turbine generator manufacturing industry, it has some limitations that provide opportunities for future research on COPQ-CI-OP nexus. The unique nature of this industry limits the generalizability of the results to other sectors. Therefore, future research could replicate this study in different manufacturing sectors within developing countries to further investigate the tested relationships. Additionally, future studies could revisit the relationships examined in this research using a longitudinal design to capture the changes in operational performance over a longer period. Moreover, this study gathered data only from turbine generator manufacturing field surveys employees, excluding the perspectives of customers and stakeholders. Future research could replicate this study by triangulating the results with inputs from customers and stakeholders to assess the level of operational performance improvements.

Practically, the study provides a validated framework and measurement model that organizations can adopt to systematically identify, quantify, and mitigate COPQ through targeted CI initiatives, thereby enhancing operational efficiency, competitiveness, and sustainability. The findings are particularly valuable for practitioners and policymakers seeking to integrate quality management and continuous improvement strategies, offering actionable insights that can inform the design of robust quality systems and foster a culture of ongoing enhancement. Ultimately, this research sets a foundation for future studies to explore the integration of digital technologies, organizational culture, and human factors in optimizing quality and operational outcomes in diverse industrial contexts.

Lastly, there is a need for future studies to include moderating variables such as financial strength and the availability of related quality method such as lean and kaizen, to explore their impact on the relationship between COPQ, CI and operational performance.

Acknowledgement
The authors express their sincere gratitude to all the participant for their substantial support and collaboration throughout this research endeavor. Their invaluable insights, resources, and expertise significantly contributed to the depth and quality of this study. The author particularly appreciates the assistance provided by the selected turbine generator manufacturing team in facilitating access to crucial data and industry perspectives. It should be noted that this research received no specific grant from any funding agency in the public, commercial, or not-for-profit sectors.

References

Adem, M. K., & Virdi, S. S. (2024). The structural link between TQM practices and financial performance: the mediating role of operational performance. *International Journal of Quality and Reliability Management*, *41*(1). https://doi.org/10.1108/IJQRM-08-2021-0290

Aichouni, A. B. E., Ramlie, F., & Abdullah, H. (2021). Process improvement methodology selection in manufacturing: A literature review perspective. *International Journal of Advanced and Applied Sciences*, *8*(3). https://doi.org/10.21833/ijaas.2021.03.002

Al-Zameli, A. A. H. H., Kadhim, H. O., & Hassoon, F. S. (2019). Continuous improvement technique and its role in costs reduction. *Opcion*, *35*(Special Issue 19).

Alexander, P., Antony, J., & Rodgers, B. (2019). Lean Six Sigma for small- and medium-sized manufacturing enterprises: a systematic review. In *International Journal of Quality and Reliability Management* (Vol. 36, Issue 3). https://doi.org/10.1108/IJQRM-03-2018-0074

Almasaeid, I. S. (2021). The Impact of Applying the Theory of Constraints on the Competitive Advantage: Evidence from Jordan. *International Journal of Academic Research in*

International Journal of Innovation and Industrial Revolution
IJIREV
EISSN: 2637-0972
Volume 7 Issue 22 (September 2025) PP. 653-674
DOI 10.35631/IJIREV.722036

Accounting, Finance and Management Sciences, *11*(4). https://doi.org/10.6007/ijarafms/v11-i4/11808

Alshammari, A., Redha, S., Hussain, S., Nazzal, T., Kamal, Z., & Smew, W. (2018). Quality improvement in plastic injection moulding industry: Applying Lean Six Sigma to SME in Kuwait. *Proceedings of the International Conference on Industrial Engineering and Operations Management*, *2018-March*.

Ayati, E., & Schiffauerova, A. (2014). Study of cost of quality behavior in manufacturing supply chain based on the quality maturity status. *ASME International Mechanical Engineering Congress and Exposition, Proceedings (IMECE)*, *14*. https://doi.org/10.1115/IMECE2014-39694

Bandi, N. H., Noor Kamar, A. N., & Kie, C. J. (2022). Investigating the Impact of Lean Manufacturing Practices on Operational Performance. *Journal of Modern Manufacturing Systems and Technology*, *6*(2). https://doi.org/10.15282/jmmst.v6i2.8563

Balaji, M., Dinesh, S. N., Raja, S., Subbiah, R., & Manoj Kumar, P. (2022). Lead time reduction and process enhancement for a low volume product. *Materials Today: Proceedings*, *62*. https://doi.org/10.1016/j.matpr.2021.12.240

Bhushi, U., Gaikwad, L., & Sunnapwar, V. (2023). Analysis of Poor-Quality Cost in Auto Industry: A Case Study. In *Lecture Notes in Mechanical Engineering*. https://doi.org/10.1007/978-981-19-7971-2_1

Blaga, P. (2020). The importance of human resources in the continuous improvement of the production quality. *Procedia Manufacturing*, *46*. https://doi.org/10.1016/j.promfg.2020.03.042

Bond, D. M., Hammond, J., Shand, A. W., & Nassar, N. (2020). Comparing a mobile phone automated system with a paper and email data collection system: Substudy within a randomized controlled trial. *JMIR MHealth and UHealth*, *8*(8). https://doi.org/10.2196/15284

Buer, S. V., Semini, M., Strandhagen, J. O., & Sgarbossa, F. (2021). The complementary effect of lean manufacturing and digitalization on operational performance. *International Journal of Production Research*, *59*(7). https://doi.org/10.1080/00207543.2020.1790684

Bujang, M. A., Omar, E. D., & Baharum, N. A. (2018). A review on sample size determination for Cronbach's alpha test: A simple guide for researchers. *Malaysian Journal of Medical Sciences*, *25*(6). https://doi.org/10.21315/mjms2018.25.6.9

Chaudhuri, A., Boer, H., & Taran, Y. (2018). Supply chain integration, risk management and manufacturing flexibility. *International Journal of Operations and Production Management*, *38*(3). https://doi.org/10.1108/IJOPM-08-2015-0508

Crowdle, M. M., McDermott, O., & Trubetskaya, A. (2023). A benefit costing process for Lean Six Sigma programs. *TQM Journal*, *35*(9). https://doi.org/10.1108/TQM-06-2023-0194

Eben-Chaime, M. (2013). A note on: The economic effects of quality improvements. *Total Quality Management and Business Excellence*, *24*(3–4), 374–377. https://doi.org/10.1080/14783363.2012.734952

Edwards, P. J., Roberts, I., Clarke, M. J., DiGuiseppi, C., Wentz, R., Kwan, I., Cooper, R., Felix, L. M., & Pratap, S. (2009). Methods to increase response to postal and electronic questionnaires. In *Cochrane Database of Systematic Reviews* (Issue 3). https://doi.org/10.1002/14651858.MR000008.pub4

Edwards, P. J., Roberts, I., Clarke, M. J., DiGuiseppi, C., Woolf, B., & Perkins, C. (2023). Methods to increase response to postal and electronic questionnaires. In *Cochrane*

Database of Systematic Reviews (Vol. 2023, Issue 11). https://doi.org/10.1002/14651858.MR000008.pub5

El Sharif, T. A. (2019). The Application of Quality Costs Accounting in Industrial Companies in Benghazi Libya. *OALib*, *06*(05). https://doi.org/10.4236/oalib.1105399

Emerson, R. W. (2019). Cronbach's Alpha Explained. In *Journal of Visual Impairment and Blindness* (Vol. 113, Issue 3). https://doi.org/10.1177/0145482X19858866

Emmanual, L., Kannan, V. K., & Ragunath, L. (2017). Quality cost analysis in an industry. *Pakistan Journal of Biotechnology*, *14*, 61–65.

Eze, E. I., Inyiama, O. I., & Ezugwu, I. (2024). Current Assets Management and Operational Performance of Consumer Goods Firms in Nigeria. *European Journal of Business and Innovation Research*, *12*(2). https://doi.org/10.37745/ejbir.2013/vol12n26783

Fabianová, J., Janeková, J., & Onofrejová, D. (2017). Cost analysis of poor quality using a software simulation. *Amfiteatru Economic*, *19*(44), 181–196.

Faden, C. (2014). Optimizing firm performance: Alignment of operational success drivers on the basis of empirical data. In *Optimizing Firm Performance: Alignment of Operational Success Drivers on the Basis of Empirical Data*. https://doi.org/10.1007/978-3-658-02746-9

Ferryanto, L. (2022). Sustainable continuous improvement programs. *International Journal of Six Sigma and Competitive Advantage*, *14*(2), 171–185. https://doi.org/10.1504/ijssca.2022.124973

Fryer, K., Ogden, S., & Anthony, J. (2013). Bessant's continuous improvement model: Revisiting and revising. *International Journal of Public Sector Management*, *26*(6). https://doi.org/10.1108/IJPSM-05-2012-0052

Galli, B. J. (2019). Optimization Methods in Continuous Improvement Models. *International Journal of Applied Industrial Engineering*, *6*(1). https://doi.org/10.4018/ijaie.2019010103

Galli, B. J. (2019). How Cost of Poor-Quality Factors into Continuous Improvement Models. *International Journal of Applied Management Sciences and Engineering*, *6*(1). https://doi.org/10.4018/ijamse.2019010101

Galli, B. J. (2021). Relationship Between Cost of Poor Quality and Continuous Improvement. *International Journal of Applied Logistics*, *11*(2). https://doi.org/10.4018/ijal.2021070103

Garrido-Vega, P., Ortega Jimenez, C. H., de Los Ríos, J. L. D. P., & Morita, M. (2015). Implementation of technology and production strategy practices: Relationship levels in different industries. *International Journal of Production Economics*, *161*, 201–216. https://doi.org/10.1016/j.ijpe.2014.07.011

Goettler, J. (2023). Continuous Improvement in Manufacturing. *Manufacturing Engineering*, *170*(2), 9–11.

Gummer, E. S., & Mandinach, E. B. (2018). Landscape view of the continuous improvement process. In *Data for Continuous Programmatic Improvement: Steps Colleges of Education Must Take to Become a Data Culture*. https://doi.org/10.4324/9780429455032-2

Guzmán, L. A. Z., Zavaleta, O. F. A., & Cruz, J. O. S. (2023). Continuous Improvement and Profitability at the Transportation Company Acopiadora Peruana Del Norte S.A.C. Trujillo 2021. *Proceedings of the LACCEI International Multi-Conference for Engineering, Education and Technology*, *2023-July*.

Volume 7 Issue 22 (September 2025) PP. 653-674
DOI 10.35631/IJIREV.722036
Grieves, M. (2023). Digital Twin Certified: Employing Virtual Testing of Digital Twins in Manufacturing to Ensure Quality Products. In *Machines* (Vol. 11, Issue 8). https://doi.org/10.3390/machines11080808

Grothkopp, M., Bernasconi, M., & Friedli, T. (2022). A Holistic View on Production Systems Management. *Proceedings of the Conference on Production Systems and Logistics*. https://doi.org/10.15488/12161

Ha, Y. M., & Ahn, H. J. (2014). Factors affecting the performance of Enterprise Resource Planning (ERP) systems in the post-implementation stage. *Behavior and Information Technology*, *33*(10). https://doi.org/10.1080/0144929X.2013.799229

Hafida, K., Ramdane, B., & Rachid, C. (2022). Application of Continuous Improvement Tools to Welding Processes: Case of ENGTP. *International Journal of Emerging Technology and Advanced Engineering*, *12*(4), 199–209. https://doi.org/10.46338/ijetae0422_24

Hagström, M. H., Bergsjö, D., Sathyanarayana, A., & Machado, C. (2023). Quantifying and visualizing wastes and losses in automotive production flows (across multiple plants and organisations) for increased accuracy in improvement prioritizations. *International Journal of Product Development*, *27*(3). https://doi.org/10.1504/IJPD.2023.133062

Haq, M. A. ul. (2022). To study Cost of Quality elements for designing and development of Quality by Operation project in English Biscuits Manufacturers Pvt Ltd. *International Journal of Experiential Learning & Case Studies*, *6*(2). https://doi.org/10.22555/ijelcs.v6i2.618

Henderson, K. M., & Evans, J. R. (2000). Successful implementation of Six Sigma: benchmarking General Electric Company. *Benchmarking: An International Journal*, *7*(4). https://doi.org/10.1108/14635770010378909

Hilverda, J. J., Roemeling, O., Smailhodzic, E., Aij, K. H., Hage, E., & Fakha, A. (2023). Unveiling the Impact of Lean Leadership on Continuous Improvement Maturity: A Scoping Review. In *Journal of Healthcare Leadership* (Vol. 15). https://doi.org/10.2147/JHL.S422864

Höse, K., Amaral, A., Götze, U., & Peças, P. (2023). Manufacturing Flexibility through Industry 4.0 Technological Concepts—Impact and Assessment. *Global Journal of Flexible Systems Management*, *24*(2). https://doi.org/10.1007/s40171-023-00339-y

Hollender, M., Chioua, M., Schlake, J., Merkert, L., & Petersen, H. (2016). KPI-based process operation: Management of highly automated processes. *GWF, Wasser - Abwasser*, *157*(9), 52–61.

Inan, G. G., Gungor, Z. E., Bititci, U. S., & Halim-Lim, S. A. (2022). Operational performance improvement through continuous improvement initiatives in micro-enterprises of Turkey. *Asia-Pacific Journal of Business Administration*, *14*(3). https://doi.org/10.1108/APJBA-11-2020-0394

Jacobs, B. W., Kraude, R., & Narayanan, S. (2016). Operational Productivity, Corporate Social Performance, Financial Performance, and Risk in Manufacturing Firms. *Production and Operations Management*, *25*(12). https://doi.org/10.1111/poms.12596

Jagusiak-Kocik, M. (2017). PDCA cycle as a part of continuous improvement in the production company - A case study. *Production Engineering Archives*, *14*(14). https://doi.org/10.30657/pea.2017.14.05

Jurburg, D., Viles, E., Jaca, C., & Tanco, M. (2015). Why are companies still struggling to reach higher continuous improvement maturity levels? Empirical evidence from high performance companies. *TQM Journal*, *27*(3), 316–327. https://doi.org/10.1108/TQM-11-2013-0123

International Journal of Innovation and Industrial Revolution
IJIREV
EISSN: 2637-0972
Volume 7 Issue 22 (September 2025) PP. 653-674
DOI 10.35631/IJIREV.722036
Jurburg, D., Viles, E., Tanco, M., Mateo, R., & Lleó, Á. (2019). Understanding the main organizational antecedents of employee participation in continuous improvement. *TQM Journal*, *31*(3). https://doi.org/10.1108/TQM-10-2018-0135

Kang, N., Zhao, C., Li, J., & Horst, J. A. (2016). A Hierarchical structure of key performance indicators for operation management and continuous improvement in production systems. *International Journal of Production Research*, *54*(21), 6333–6350. https://doi.org/10.1080/00207543.2015.1136082

Karkoszka, T. (2019). Identification of the Key Operational Parameters as an Element of Technological Process Operational Control. *System Safety: Human - Technical Facility - Environment*, *1*(1). https://doi.org/10.2478/czoto-2019-0065

Karkoszka, T. (2022). Identification of the Key Operational Parameters as an Element of Technological Process' Operational Control. In *System Safety: Human - Technical Facility - Environment*. https://doi.org/10.2478/9783110605402-065

Kehinde Andrew Olu-Lawal, Ifeanyi Onyedika Ekemezie, & Gloria Siwe Usiagu. (2024). Lean manufacturing in industrial engineering: A USA and African review. *GSC Advanced Research and Reviews*, *18*(2). https://doi.org/10.30574/gscarr.2024.18.2.0059

Khan, S. A., Kaviani, M. A., J. Galli, B., & Ishtiaq, P. (2019). Application of continuous improvement techniques to improve organization performance: A case study. *International Journal of Lean Six Sigma*, *10*(2). https://doi.org/10.1108/IJLSS-05-2017-0048

Khatib, M. el, Kherbash, A., Qassimi, A. al, & Mheiri, K. al. (2022). How Can Collaborative Work and Collaborative Systems Drive Operational Excellence in Project Management? *Journal of Service Science and Management*, *15*(03). https://doi.org/10.4236/jssm.2022.153017

Keke, Y., V., Putrianto, V., Basyar Azzuhri, M., Pratiwi Perwitasari, E., &. Y. (2023). An Analysis of Quality Control on Defective Products at PT. Signore. *KnE Social Sciences*. https://doi.org/10.18502/kss.v8i9.13396

Lai, N. Y. G., Foo, W. C., Tan, C. S., Kang, M. S., Kang, H. S., Wong, K. H., Yu, L. J., Sun, X., & Tan, N. M. L. (2022). Understanding Learning Intention Complexities in Lean Manufacturing Training for Innovation on the Production Floor. *Journal of Open Innovation: Technology, Market, and Complexity*, *8*(3). https://doi.org/10.3390/joitmc8030110

Lameijer, B. A., Boer, H., Antony, J., & Does, R. J. M. M. (2023). Continuous improvement implementation models: a reconciliation and holistic metamodel. *Production Planning and Control*, *34*(11). https://doi.org/10.1080/09537287.2021.1974114

Lapesa Barrera, D. (2022). Continuous Improvement Methodologies and Tools. In *Springer Series in Reliability Engineering*. https://doi.org/10.1007/978-3-030-90263-6_29

Lari, A., & Asllani, A. (2013). Quality cost management support system: An effective tool for organizational performance improvement. *Total Quality Management and Business Excellence*, *24*(3–4), 432–451. https://doi.org/10.1080/14783363.2012.733258

Liu, J., Zhuang, D., & Shen, W. (2023). The impact of quality management practices on manufacturing performance: an empirical study based on system theory. *Soft Computing*, *27*(7). https://doi.org/10.1007/s00500-021-06606-3

Mahmood, S., & Kureshi, N. I. (2014). Reducing hidden internal failure costs in road infrastructure projects by determination of Cost of Poor Quality, a case study. *2014 International Conference on Engineering, Technology and Innovation: Engineering Responsible Innovation in Products and Services, ICE 2014*. https://doi.org/10.1109/ICE.2014.6871608

International Journal of Innovation and Industrial Revolution
IJIREV
EISSN: 2637-0972
Volume 7 Issue 22 (September 2025) PP. 653-674
DOI 10.35631/IJIREV.722036
Mahmood, S., Ahmed, S. M., Panthi, K., & Kureshi, N. I. (2014). Determining the cost of poor quality and its impact on productivity and profitability. *Built Environment Project and Asset Management*, *4*(3), 296–311. https://doi.org/10.1108/BEPAM-09-2013-0034

Mahmood, S., Shahrukh, & Ishaque, A. (2015). Innovative system to determine hidden cost of poor quality to enhance labor productivity and profitability for construction entrepreneurs, a case study. *2013 International Conference on Engineering, Technology and Innovation, ICE 2013 and IEEE International Technology Management Conference, ITMC 2013*. https://doi.org/10.1109/ITMC.2013.7352676

Makhanya, B. B. S., Nel, H., & Pretorius, J. H. C. (2018). A Systematic Literature Review of the Implementation of Cost of Quality. *IEEE International Conference on Industrial Engineering and Engineering Management*, *2019-December*. https://doi.org/10.1109/IEEM.2018.8607298

Manoharan, K., Dissanayake, P., Pathirana, C., Deegahawature, D., & Silva, R. (2024). Assessing the performance and productivity of labor in building construction projects through the application of work-based training practices. *Construction Innovation*, *24*(2). https://doi.org/10.1108/CI-05-2022-0126

Mardani, A., Kannan, D., Hooker, R. E., Ozkul, S., Alrasheedi, M., & Tirkolaee, E. B. (2020). Evaluation of green and sustainable supply chain management using structural equation modelling: A systematic review of the state-of-the-art literature and recommendations for future research. *Journal of Cleaner Production*, *249*. https://doi.org/10.1016/j.jclepro.2019.119383

Martins, M., Varela, M. L. R., Putnik, G., Machado, J., & Manupati, V. K. (2019). Tools implementation in management of continuous improvement processes. In *Lecture Notes in Mechanical Engineering*. https://doi.org/10.1007/978-3-030-18789-7_29

Masudin, I., Sari, R. M., Zulfikarijah, F., & Restuputri, D. P. (2024). The effect of business environment and operational strategy on operational performance: Evidence from Indonesian manufacturing industry. *AIP Conference Proceedings*, *2927*(1). https://doi.org/10.1063/5.0192320

McDermott, O., Antony, J., Sony, M., & Healy, T. (2022). Critical failure factors for continuous improvement methodologies in the Irish MedTech industry. *TQM Journal*, *34*(7). https://doi.org/10.1108/TQM-10-2021-0289

McLean, R. S., Antony, J., & Dahlgaard, J. J. (2017). Failure of Continuous Improvement initiatives in manufacturing environments: a systematic review of the evidence. *Total Quality Management and Business Excellence*, *28*(3–4), 219–237. https://doi.org/10.1080/14783363.2015.1063414

McMillan, C. (2021). Winning hearts and minds for performance management. In *The Public Productivity and Performance Handbook*.

Mhlongo, N. G., & Nyembwe, K. D. (2023). *A Critical Reflection on the Prominent Cost of Poor Quality (COPQ) Incidents in the South African Automotive Industry in the Last Decade*. https://doi.org/10.52202/072261-0033

Mircea, R. B. (2022). Analysis of the Profitability of an SME from the Perspective of Quality Management. *Valahian Journal of Economic Studies*, *13*(2). https://doi.org/10.2478/vjes-2022-0019

Mittal, A., & Gupta, P. (2024). The effect of TQM practices on organizational performance: a case study of Deming awarded Indian industry. *International Journal of Business Excellence*, *32*(2). https://doi.org/10.1504/IJBEX.2024.136878

Volume 7 Issue 22 (September 2025) PP. 653-674
DOI 10.35631/IJIREV.722036
Mooney, J. W. (2013). Operational excellence: The key to success for oil and gas. *American Fuel and Petrochemical Manufacturers, AFPM - AFPM Annual Meeting 2013*, 755–759.

Opoku, R. K., Fiati, H. M., Kaku, G., Ankomah, J., & Agyemang, F. O.-. (2020). Inventory Management Practices and Operational Performance of Manufacturing Firms in Ghana. *Advances in Research*. https://doi.org/10.9734/air/2020/v21i1030246

Osteen, B. J., Jegannathan, K., & Ramanan, S. (2013). Optimizing the cost of software quality - A path to delivery excellence. *Proceedings of the 2013 10th International Conference on Information Technology: New Generations, ITNG 2013*, 754–756. https://doi.org/10.1109/ITNG.2013.118

Ottewell, S. (2022). Operational Excellence Programs Pay Off. *Chemical Processing*, *84*(11), 24–28.

Pandey, A., & Kumar, A. (2016). System Thinking Approach to Deal with Sustainability Challenges. *Proceedings of International Conference on Science, Technology, Humanities and Business Management*, *July*.

Panghal, M., Prasad, S., & Tilahun, S. (2022). Quantification of Cost of Quality: A Case Study in an Ethiopian Apparel Manufacturing Factory. *Journal of Textile and Apparel, Technology and Management*, *12*(3).

Peretz, D., Arnaert, A., & Ponzoni, N. N. (2018). Determining the cost of implementing and operating a remote patient monitoring programme for the elderly with chronic conditions: A systematic review of economic evaluations. In *Journal of Telemedicine and Telecare* (Vol. 24, Issue 1). https://doi.org/10.1177/1357633X16669239

Peter, O. I., & Oluwasesan Adeoti, A. (2023). Evaluation of Total Quality Management Practices on Organizational Performance of Wires and Cables Manufacturing Industries in Ondo State, Nigeria. *Journal of Engineering Research and Reports*, *25*(8). https://doi.org/10.9734/jerr/2023/v25i8954

Pinheiro, J., Lages, L. F., Silva, G. M., Dias, A. L., & Preto, M. T. (2022). Effects of absorptive capacity and innovation spillover on manufacturing flexibility. *International Journal of Productivity and Performance Management*, *71*(5). https://doi.org/10.1108/IJPPM-04-2020-0156

Pinto, M. J. A., & Mendes, J. V. (2017). Operational practices of lean manufacturing: Potentiating environmental improvements. *Journal of Industrial Engineering and Management*, *10*(4 Special Issue). https://doi.org/10.3926/jiem.2268

Pozzi, R., Rossi, T., & Secchi, R. (2023). Industry 4.0 technologies: critical success factors for implementation and improvements in manufacturing companies. *Production Planning and Control*, *34*(2). https://doi.org/10.1080/09537287.2021.1891481

Prajogo, D. I., McDermott, C. M., & Jayaram, J. (2014). The role of technological intensity in services on the capability to performance relationships - An examination in the Australian context. *Journal of Engineering and Technology Management - JET-M*, *31*(1), 58–72. https://doi.org/10.1016/j.jengtecman.2013.10.005

Rehacek, P. (2017). Quality costs in management system. *Journal of Engineering and Applied Sciences*, *12*(22), 6083–6087.

Rice, J., Martin, N., Raziq, M. M., & Fieger, P. (2023). A reconsideration of Jack Welch's managerial legacy. *EuroMed Journal of Business*. https://doi.org/10.1108/EMJB-02-2023-0055

Rollinson, T. J., Furnival, J., Goldberg, S., & Choudhury, A. (2021). Learning from lean: A quality improvement project using a Lean-based improvement approach to improve

Volume 7 Issue 22 (September 2025) PP. 653-674
DOI 10.35631/IJIREV.722036
discharge for patients with frailty in an acute care hospital. *BMJ Open Quality*, *10*(4). https://doi.org/10.1136/bmjoq-2021-001393

Sahoo, S. (2022). Lean practices and operational performance: the role of organizational culture. *International Journal of Quality and Reliability Management*, *39*(2). https://doi.org/10.1108/IJQRM-03-2020-0067

Santos, D. de C. L. e. P., Ihler, J. B., Soares, L. O., Alves, Y. A., Souza, C. G., & Boloy, R. A. M. (2022). Global Trends and Opportunities in Hybrid Microgrid Systems Using Renewable Energies. *International Journal of Energy Economics and Policy*, *12*(4). https://doi.org/10.32479/ijeep.13175

Santos, J. B., Lange, R. S., & Lourenço, C. E. (2023). BRK Ambiental Sumaré: Operational Excellence and Continuous Improvement. *Revista de Administracao Contemporanea*, *27*(3). https://doi.org/10.1590/1982-7849rac2023220097.en

Saunder, M. N. K., Philip, L., & Adrian, T. (2019). Research methods for business students. In *Pearson Education Limited: Vol. limi* (Issue 10).

Saunders, M., Lewis, P., & Thornhill, A. (2023). 2023 Research Methods for Business Students Preface and Chapter 4. In *Research Methods for Business Students* (Issue February).

Saunila, M., Ukko, J., Rantala, T., Nasiri, M., & Rantanen, H. (2020). Preceding operational capabilities as antecedents for productivity and innovation performance. *Journal of Business Economics*, *90*(4). https://doi.org/10.1007/s11573-019-00963-0

Schuh, G., Prote, J.-P., Busam, T., Lorenz, R., & Netland, T. H. (2019). Using Prescriptive Analytics to Support the Continuous Improvement Process. In *IFIP Advances in Information and Communication Technology* (Vol. 566). https://doi.org/10.1007/978-3-030-30000-5_6

Sesar, V., & Hunjet, A. (2021). Relationship between continuous improvement and internal process performance; the role of management support. *Tehnicki Vjesnik*, *28*(6), 2109–2114. https://doi.org/10.17559/TV-20201208132214

Shrouty, V., & Tiwari, P. (2017). Analysis of Cost of Poor Quality (COPQ) and Its Calculation: *International Research Journal of Engineering and Technology (IRJET)*, *4*(5).

Simwa, J. T., & Barasa, P. W. (2024). Effects of Inventory Management Practices on Operational Performance in Mombasa County Government, Kenya. *Asian Journal of Economics, Business and Accounting*, *24*(4). https://doi.org/10.9734/ajeba/2024/v24i41277

Sontaga Makua, E., & Dewa, M. (2023). *Process Improvement through Built in quality in Automotive Component Manufacturers*. https://doi.org/10.46254/af04.20230010

Sodhi, H. S., Singh, B. J., & Singh, D. (2023). SWOT analysis of Lean Six Sigma: a review. *International Journal of Business Excellence*, *29*(2). https://doi.org/10.1504/IJBEX.2023.10053491

Srinivasan, K., Sarulkar, P., & Yadav, V. K. (2024). Operational excellence of the steel industry using the Lean Six Sigma approach: a case study. *International Journal of Quality and Reliability Management*, *41*(3). https://doi.org/10.1108/IJQRM-08-2022-0250

Stadnicka, D., & Antosz, K. (2015). Continuous improvement practice in large enterprises: Study results. *International Journal for Quality Research*, *9*(1), 9–26.

Stricker, N., Pfeiffer, A., Moser, E., Kádár, B., & Lanza, G. (2016). Performance measurement in flow lines – Key to performance improvement. *CIRP Annals - Manufacturing Technology*, *65*(1), 463–466. https://doi.org/10.1016/j.cirp.2016.04.031

Sturm, S., Kaiser, G., & Hartmann, E. (2019). Long-run dynamics between cost of quality and quality performance. *International Journal of Quality and Reliability Management*, *36*(8). https://doi.org/10.1108/IJQRM-05-2018-0118

Sunder M, V., & Prashar, A. (2023). Characterization and Examination of Operational Excellence Deployment Failures: Mediation Effect of Technical and Behavioral Failure Factors. *IEEE Transactions on Engineering Management*, *70*(6), 2080–2092. https://doi.org/10.1109/TEM.2021.3071294

Sürücü, Ö., Öztürk, Y., Okumus, F., & Bilgihan, A. (2019). Brand awareness, image, physical quality and employee behavior as building blocks of customer-based brand equity: Consequences in the hotel context. *Journal of Hospitality and Tourism Management*, *40*. https://doi.org/10.1016/j.jhtm.2019.07.002

Tambunan, T. (2024). A conceptual framework of quality cost chain in strategic cost management. *TQM Journal*, *36*(3). https://doi.org/10.1108/TQM-09-2021-0281

Teli, S. N., Majali, V. S., Bhushi, U. M., Gaikwad, L. M., & Surange, V. G. (2013). Cost of Poor-Quality Analysis for Automobile Industry: A Case Study. *Journal of The Institution of Engineers (India): Series C*, *94*(4). https://doi.org/10.1007/s40032-013-0091-z

Teli, S. N., Majali, V. S., Bhushi, U. M., & Surange, V. G. (2014). Impact of poor-quality cost in automobile industry. *International Journal of Quality Engineering and Technology*, *4*(1), 21–41. https://doi.org/10.1504/IJQET.2014.059842

Trang, P. T. (2024). Training and continuous improvement: the moderation effect of transfer climate and the mediation influence of self-efficacy. *TQM Journal*, *36*(4). https://doi.org/10.1108/TQM-02-2023-0066

van Assen, M. F. (2021). Training, employee involvement and continuous improvement–the moderating effect of a common improvement method. *Production Planning and Control*, *32*(2). https://doi.org/10.1080/09537287.2020.1716405

van Dyk, D. J., & Pretorius, L. (2014). A system thinking approach to the sustainability of quality improvement programmes. *South African Journal of Industrial Engineering*, *25*(1). https://doi.org/10.7166/25-1-696

Waichai, W., & Yuklan, W. (2018). Total quality management and the future of China. In *Business Transformation in China: Volume 5* (Vol. 5). https://doi.org/10.4324/9780429429965-8

Yasa, I. K. (2019). The implementation of total quality management (TQM) in housekeeping department of W Bali-Seminyak. *International Research Journal of Management, IT and Social Sciences*, *6*(2). https://doi.org/10.21744/irjmis.v6n2.603

Zhu, C., Shen, L., & Shi, Y. (2022). Motivation Analysis of Market and Institution on Corporate Leasing Financialization from the Perspective of Regulatory Arbitrage: Evidence from Chinese Listed Companies. *Sustainability (Switzerland)*, *14*(19). https://doi.org/10.3390/su141912581