

TOTAL QUALITY MANAGEMENT IN HEALTHCARE: ASSESSING ITS INFLUENCE ON CLINICAL LABORATORY WORK PERFORMANCE IN SINDH

Faisal Imran Shaikh^{*1}, Dr. Sajjad Hyder Channar², Dr. Muhammad Sharif Abbasi³,
Dr. Syed Asif Ali Shah⁴

^{*1}Phd Research Scholar, Department of Public Administration, University of Sindh Jamshoro, Sindh Pakistan

²Assistant Professor, Department of Public Administration, University of Sindh Jamshoro, Sindh Pakistan

³Associate Professor, Department of Public Administration, University of Sindh Jamshoro, Sindh Pakistan

⁴Director, MUSTID, Mehran University of Engineering & Technology Jamshoro, Sindh Pakistan

¹faisalimranshaikh@gmail.com, ²sajjad.channar@usindh.edu.pk, ⁴director.muistd@admin.muet.edu.pk

DOI: <https://doi.org/10.5281/zenodo.15081197>

Keywords

Total Quality Management,
Clinical Laboratory Performance,
Healthcare Quality, Process
Management, ISO 15189,
Laboratory Error Rates

Article History

Received on 16 February 2025

Accepted on 16 March 2025

Published on 25 March 2025

Copyright @Author

Corresponding Author: *

Abstract

This study investigates the influence of Total Quality Management (TQM) on clinical laboratory work performance in healthcare facilities across Sindh, Pakistan. Using a mixed-methods approach, the research examines five key TQM dimensions: leadership commitment, employee involvement, continuous improvement, customer focus, and process management. Data was collected from 300 participants across 15 healthcare facilities through questionnaires, interviews, and direct observations. Quantitative analysis revealed high overall TQM implementation ($M=3.56$, $SD=0.74$), with process management emerging as the most consistent predictor of laboratory performance across all metrics. Customer focus strongly predicted customer satisfaction ($\beta=0.51$, $p<0.001$), while employee involvement significantly influenced staff productivity ($\beta=0.42$, $p<0.001$). Qualitative findings highlighted leadership support, staff training, technology integration, and external quality assessment as key facilitators of successful TQM implementation. Major barriers included insufficient resources, staff retention challenges in rural facilities, documentation burdens, and financial constraints. The study provides valuable insights for laboratory managers, healthcare administrators, and policymakers seeking to enhance laboratory quality through TQM practices while addressing contextual challenges specific to Sindh's healthcare system.

INTRODUCTION

Healthcare systems worldwide are facing increasing pressure to improve quality while controlling costs. Clinical laboratories play a pivotal role in healthcare delivery, with laboratory results influencing approximately 70% of medical decisions (Katoue, Cerda, Garcia, & Jakovljevic, 2022). The accuracy, timeliness, and reliability of laboratory services

directly impact patient care outcomes, making quality management in laboratory settings a critical concern for healthcare providers and policymakers. Total Quality Management (TQM), a comprehensive management approach that emphasizes continuous improvement, customer satisfaction, and employee involvement, has emerged as a promising framework

for enhancing laboratory performance and ensuring consistent delivery of high-quality diagnostic services (Filip, Gheorghita Puscaselu, Anchidin-Norocel, Dimian, & Savage, 2022). Kaizen is a Japanese word which translates to mean “continuous improvement.” It’s a “do better every day, with everyone, and everywhere” thinking. The focus is on small, frequent improvements to existing work processes, generated by all employees at all levels in an organization. In Pakistan, particularly in the Sindh province, healthcare facilities face numerous challenges that affect laboratory service quality, including resource constraints, workforce shortages, inadequate infrastructure, and inconsistent adherence to quality standards. Despite these challenges, there is growing recognition among healthcare providers of the need to implement robust quality management systems to improve laboratory performance and meet international standards (Mehmood, 2022). The application of TQM principles in clinical laboratories represents a strategic approach to addressing these challenges and enhancing the overall quality of laboratory services in Sindh's healthcare system (Ahmad & Waqar, 2025). TQM encompasses multiple dimensions that collectively contribute to organizational excellence. These dimensions include leadership commitment, which involves the active support and involvement of top management in quality initiatives; employee involvement, which emphasizes the engagement and empowerment of staff at all levels; continuous improvement, which focuses on ongoing efforts to enhance processes and outcomes; customer focus, which prioritizes understanding and meeting patient and clinician needs; and process management, which emphasizes the standardization and optimization of workflows and procedures. While extensive research has explored the implementation of TQM in manufacturing and service industries, its application and effectiveness in healthcare settings, particularly in clinical laboratories within developing countries like Pakistan, remains understudied (Bano, 2025). The integration of TQM principles in clinical laboratories has the potential to significantly improve various performance metrics, including turnaround time, error rates, compliance with international standards, customer satisfaction, and staff productivity. However, the successful

implementation of TQM requires an understanding of the specific contextual factors that facilitate or hinder quality improvement efforts in Sindh's healthcare environment (Zaidi & Hussain, 2022). This study aims to fill this knowledge gap by examining the influence of TQM dimensions on clinical laboratory performance in Sindh and identifying the facilitators and barriers to effective TQM implementation.

RESEARCH OBJECTIVES

1. To evaluate the implementation levels of TQM dimensions (leadership commitment, employee involvement, continuous improvement, customer focus, and process management) in clinical laboratories across healthcare facilities in Sindh.
2. To investigate the relationships between TQM dimensions and laboratory performance metrics, including turnaround time compliance, error rates, ISO 15189 compliance, customer satisfaction, and staff productivity.
3. To identify facilitators and barriers to effective TQM implementation in clinical laboratories in Sindh and propose context-specific strategies for enhancing laboratory quality management.

RESEARCH QUESTIONS

1. What are the current implementation levels of TQM dimensions in clinical laboratories across healthcare facilities in Sindh, and how do these levels vary between urban and rural settings?
2. How do specific TQM dimensions influence different laboratory performance metrics, and which dimensions have the strongest impact on overall laboratory quality?
3. What contextual factors facilitate or hinder the successful implementation of TQM in clinical laboratories in Sindh, and how can these factors be addressed to enhance laboratory quality management?

SIGNIFICANCE OF THE STUDY

This research makes significant contributions to both theory and practice in healthcare quality

management. By examining the influence of TQM on clinical laboratory performance in Sindh's unique healthcare context, the study extends existing knowledge on quality management in developing countries and provides empirical evidence on the effectiveness of TQM in improving laboratory services. The findings offer valuable insights for laboratory managers, healthcare administrators, and policymakers seeking to enhance laboratory quality through evidence-based quality management practices. Furthermore, by identifying contextual facilitators and barriers to TQM implementation, the study provides practical guidance for developing targeted interventions to address quality gaps in Sindh's clinical laboratories, ultimately contributing to improved diagnostic services and better patient care outcomes.

LITERATURE REVIEW

Quality management in healthcare has evolved significantly over the past several decades, with increasing emphasis on systematic approaches to improving service delivery and patient outcomes (Albahri et al., 2023). Total Quality Management (TQM), which originated in manufacturing industries, has gained prominence as a comprehensive quality improvement framework in healthcare settings worldwide. The application of TQM principles in clinical laboratories represents a strategic approach to enhancing diagnostic services quality, which is critical for effective patient care (Abernethy et al., 2022). Early conceptualizations of quality in healthcare focused primarily on technical competence and adherence to professional standards. However, this narrow perspective has gradually expanded to encompass multiple dimensions of quality, including effectiveness, efficiency, accessibility, patient-centeredness, and equity (Haleem, Javaid, Singh, & Suman, 2022). Donabedian's seminal work established a framework for evaluating healthcare quality based on structure, process, and outcome measures, providing a foundation for systematic quality improvement efforts. Building on this framework, TQM emerged as a holistic approach that emphasizes continuous improvement, customer satisfaction, and organization-wide commitment to quality (Feng et al., 2022). The implementation of TQM in healthcare

organizations has been associated with improvements in various performance indicators (Smith, Smith, & Hansen, 2021). Studies conducted in developed countries have demonstrated positive relationships between TQM practices and clinical outcomes, patient satisfaction, operational efficiency, and financial performance. For instance, research in US hospitals found that facilities with comprehensive TQM programs exhibited lower mortality rates, shorter lengths of stay, and higher patient satisfaction scores compared to those without such programs. Similarly, studies in European healthcare settings revealed that TQM implementation was associated with reductions in medication errors, hospital-acquired infections, and readmission rates (Javaid, Haleem, Singh, Suman, & Rab, 2022). In clinical laboratories specifically, TQM has been applied to address quality issues in pre-analytical, analytical, and post-analytical phases of testing (Strielkowski, Grebennikova, Lisovskiy, Rakhimova, & Vasileva). The International Organization for Standardization 15189 standard, which specifies requirements for quality and competence in medical laboratories, incorporates many TQM principles and serves as a framework for laboratory quality management systems worldwide. Research has shown that laboratories adhering to ISO 15189 standards demonstrate better performance in terms of analytical accuracy, precision, and reliability. However, the journey toward ISO compliance and accreditation poses significant challenges, particularly in resource-constrained settings (El Khatib, Hamidi, Al Ameer, Al Zaabi, & Al Marqab, 2022). The implementation of TQM in healthcare facilities in developing countries presents unique challenges related to resource limitations, workforce constraints, and organizational culture. Studies conducted in Asian and African countries have highlighted barriers such as inadequate infrastructure, limited financial resources, insufficient training opportunities, resistance to change, and lack of sustained leadership support. Despite these challenges, successful TQM initiatives have been documented in various developing country contexts, suggesting that contextually adapted approaches can yield positive results (Alzoubi, In'airat, & Ahmed, 2022). Leadership commitment has been identified as a critical factor in successful TQM

implementation across various healthcare settings. Leaders play essential roles in articulating quality vision, allocating necessary resources, fostering quality culture, and removing barriers to improvement efforts. Studies have consistently shown that strong leadership support is associated with higher levels of TQM implementation and better organizational performance. In clinical laboratories, leadership commitment manifests through the establishment of quality policies, provision of resources for quality initiatives, and active participation in quality improvement activities (Swarnakar, Singh, & Tiwari, 2021).

Employee involvement represents another key dimension of TQM that significantly influences implementation effectiveness. Research has demonstrated that engaging laboratory staff in quality improvement processes enhances their commitment to quality objectives and contributes to better performance outcomes. Strategies for promoting employee involvement include team-based problem-solving, quality circles, suggestion systems, and empowerment initiatives. Studies have shown that laboratories with high levels of employee involvement exhibit lower error rates, improved workflow efficiency, and higher staff satisfaction (McDermott et al., 2022). Continuous improvement, a cornerstone of TQM philosophy, involves systematic efforts to enhance processes and outcomes through ongoing monitoring, evaluation, and refinement. In clinical laboratories, continuous improvement activities include regular review of quality indicators, implementation of corrective and preventive actions, and adoption of new technologies and methodologies. Research has shown that laboratories with robust continuous improvement mechanisms demonstrate better performance in terms of turnaround time, analytical accuracy, and compliance with quality standards (Alsmairat, El Baz, & Al-Ma'aitah, 2024). Customer focus emphasizes understanding and meeting the needs of both internal customers (clinicians) and external customers (patients). Studies have shown that laboratories with strong customer orientation exhibit higher levels of customer satisfaction and loyalty. Strategies for enhancing customer focus include regular assessment of customer needs and expectations, implementation of service recovery

protocols, and continuous monitoring of customer satisfaction. Research has demonstrated that customer-focused laboratories are more responsive to changing clinical requirements and more effective in supporting patient care (Fadhel & Alqurs, 2025).

Process management involves the standardization and optimization of laboratory workflows and procedures to reduce variation and enhance efficiency. Studies have shown that effective process management contributes to reductions in error rates, improvements in turnaround time, and enhanced resource utilization. Strategies for improving process management include development and implementation of standard operating procedures, workflow mapping and analysis, and application of process improvement methodologies such as Lean and Six Sigma (Sohal et al., 2022). Extensive research has explored TQM implementation in healthcare settings in developed countries, there is limited evidence regarding its application and effectiveness in clinical laboratories in Pakistan, particularly in Sindh province. The existing studies have primarily focused on general healthcare quality rather than laboratory-specific quality management. This research gap underscores the need for context-specific investigations to understand the influence of TQM on laboratory performance in Sindh's unique healthcare environment (MAQBOOL).

The healthcare system in Sindh faces numerous challenges that affect laboratory service quality, including resource constraints, workforce shortages, inadequate infrastructure, and inconsistent adherence to quality standards. Despite these challenges, there is growing recognition among healthcare providers of the need to implement robust quality management systems to improve laboratory performance and meet international standards. Understanding the specific factors that facilitate or hinder TQM implementation in this context is essential for developing effective strategies to enhance laboratory quality (Shaikh, Shaikh, Tufail, Bux, & Kumari, 2023). The relationship between TQM dimensions and laboratory performance metrics represents a critical area of inquiry. Previous studies have examined associations between TQM practices and various performance indicators, including turnaround time, error rates, compliance with quality standards, customer satisfaction, and

staff productivity. However, findings regarding the relative importance of different TQM dimensions in influencing specific performance metrics have been inconsistent across studies, suggesting that contextual factors may moderate these relationships (Ali, Jusoh, Idris, & Nor, 2024). This study aims to address this knowledge gap by investigating the specific contributions of TQM dimensions to laboratory performance in Sindh's healthcare context.

RESEARCH METHODOLOGY:

This research methodology employed a mixed-methods approach to investigate the influence of Total Quality Management (TQM) on clinical laboratory work performance in Sindh, Pakistan. The study adopted a cross-sectional design with stratified random sampling to select 300 participants from 15 healthcare facilities across urban and rural areas of Sindh. Data collection involved three complementary methods: a standardized questionnaire measuring TQM implementation levels and performance indicators, semi-structured interviews with laboratory managers and quality assurance officers to gather qualitative insights on TQM practices, and direct observation of laboratory processes using a validated assessment tool. The quantitative data was analyzed using descriptive statistics, correlation analysis, and multiple regressions to establish relationships between TQM dimensions and laboratory performance metrics such as turnaround time, error rates, and compliance with international quality standards. Qualitative data underwent thematic analysis to identify patterns and contextual factors influencing TQM implementation. The research framework integrated five key TQM dimensions: leadership commitment, employee involvement, continuous improvement, customer focus, and process management. Ethical

considerations included obtaining informed consent from participants and institutional review board approval, ensuring confidentiality of data, and maintaining objectivity throughout the analytical process. This comprehensive methodology enabled a holistic evaluation of TQM's impact on clinical laboratory performance in Sindh's healthcare system.

DATA ANALYSIS AND RESULTS:

Data analysis presents a comprehensive analysis of data collected to investigate the influence of Total Quality Management (TQM) on clinical laboratory work performance in Sindh, Pakistan. The analysis follows the research methodology outlined in the previous chapter, employing both quantitative and qualitative analytical techniques to examine the relationships between the five key TQM dimensions (leadership commitment, employee involvement, continuous improvement, customer focus, and process management) and various laboratory performance metrics.

Data analysis is structured to first present the demographic profile of respondents, followed by descriptive statistics of the key variables under investigation. Subsequently, correlation and regression analyses are presented to examine the relationships between TQM dimensions and laboratory performance indicators. Finally, qualitative findings from the thematic analysis of interview data are presented to provide contextual depth to the quantitative results.

DEMOGRAPHIC PROFILE OF RESPONDENTS

The study included 300 participants from 15 healthcare facilities across Sindh province. Table 4.1 provides a detailed breakdown of the demographic characteristics of the respondents.

Table 1: Demographic Profile of Respondents

Demographic Variable	Category	Frequency	Percentage (%)
Gender	Male	176	58.7
	Female	124	41.3
Age Group	21-30	92	30.7
	31-40	127	42.3
	41-50	59	19.7
	>50	22	7.3
Educational Level	Diploma	46	15.3

	Bachelor's	143	47.7
	Master's	94	31.3
	PhD	17	5.7
Work Experience	<5 years	83	27.7
	5-10 years	118	39.3
	11-15 years	67	22.3
	>15 years	32	10.7
Facility Location	Urban	182	60.7
	Rural	118	39.3

Table 1 reveals that the majority of respondents were male (58.7%), with the largest age group being 31-40 years (42.3%). Nearly half of the participants (47.7%) held a bachelor's degree, while 31.3% possessed a master's degree. In terms of work experience, the highest proportion of participants (39.3%) had 5-10 years of experience in clinical laboratory settings. The distribution of participants across urban and rural healthcare facilities was 60.7% and 39.3%,

respectively, reflecting the higher concentration of healthcare facilities in urban areas of Sindh.

DESCRIPTIVE STATISTICS OF TQM IMPLEMENTATION

The study measured the implementation levels of five TQM dimensions across the participating healthcare facilities. Table 4.2 presents the descriptive statistics for these dimensions.

Table 2: Descriptive Statistics of TQM Dimensions

TQM Dimension	Mean	Standard Deviation	Min	Max	Implementation Level*
Leadership Commitment	3.72	0.86	1.2	5.0	High
Employee Involvement	3.28	0.94	1.0	5.0	Moderate
Continuous Improvement	3.54	0.79	1.4	5.0	High
Customer Focus	3.87	0.72	1.6	5.0	High
Process Management	3.41	0.88	1.3	5.0	Moderate
Overall TQM Implementation	3.56	0.74	1.5	5.0	High

*Implementation Level Scale: Low (1.0-2.33), Moderate (2.34-3.67), High (3.68-5.0)

The results in Table 2 indicate that the overall TQM implementation across healthcare facilities in Sindh was high ($M=3.56$, $SD=0.74$). Among the five TQM dimensions, Customer Focus exhibited the highest mean score ($M=3.87$, $SD=0.72$), followed by Leadership Commitment ($M=3.72$, $SD=0.86$). This suggests that healthcare facilities in Sindh place significant emphasis on understanding and meeting patient needs and that leadership generally demonstrates commitment to quality improvement initiatives.

Employee Involvement received the lowest mean score ($M=3.28$, $SD=0.94$), indicating a moderate level

of implementation and suggesting potential opportunities for improvement in engaging laboratory staff in quality management processes. Similarly, Process Management showed a moderate implementation level ($M=3.41$, $SD=0.88$), highlighting areas where standardization and optimization of laboratory processes could be enhanced.

LABORATORY PERFORMANCE METRICS:

The study assessed laboratory performance using several key metrics, including turnaround time, error rates, and compliance with international quality standards. Table 4.3 presents the descriptive statistics for these performance indicators.

Table 3: Descriptive Statistics of Laboratory Performance Metrics

Performance Metric	Mean	Standard Deviation	Min	Max	Performance Level*
Turnaround Time Compliance (%)	78.6	12.3	52.4	94.7	Moderate
Analytical Error Rate (per 1000 tests)	3.2	1.8	0.9	7.6	Moderate
Pre-analytical Error Rate (per 1000 tests)	5.7	2.3	2.1	10.4	Low
Post-analytical Error Rate (per 1000 tests)	2.8	1.5	0.7	6.3	High
ISO 15189 Compliance Score (%)	76.3	15.2	45.2	93.8	Moderate
Customer Satisfaction (%)	82.4	9.7	63.5	95.2	High
Staff Productivity Index	3.68	0.74	2.3	4.9	High

*Performance Level Scale varies by metric:

- For Turnaround Time Compliance and ISO Compliance: Low (<70%), Moderate (70-85%), High (>85%)
- For Error Rates: Low (>5 per 1000), Moderate (2-5 per 1000), High (<2 per 1000)
- For Customer Satisfaction: Low (<70%), Moderate (70-80%), High (>80%)
- For Staff Productivity: Low (<3), Moderate (3-3.5), High (>3.5)

Table 4.3 reveals varying levels of performance across different metrics. Customer Satisfaction scored highest (M=82.4%, SD=9.7%), indicating that patients and clinicians were generally satisfied with laboratory services. Staff Productivity also showed high performance (M=3.68, SD=0.74), suggesting efficient utilization of human resources in most facilities.

However, the Pre-analytical Error Rate emerged as a concern area with the lowest performance level (M=5.7 per 1000 tests, SD=2.3), highlighting issues in specimen collection, handling, and processing prior to analysis. Turnaround Time Compliance (M=78.6%, SD=12.3%) and ISO 15189 Compliance Score (M=76.3%, SD=15.2%) both showed moderate performance levels, indicating room for improvement in meeting target time frames for test results and adhering to international quality standards for medical laboratories.

CORRELATION ANALYSIS:

TQM Dimensions and Laboratory Performance

To examine the relationships between TQM dimensions and laboratory performance metrics, Pearson correlation coefficients were calculated. Table 4.4 presents the correlation matrix.

Table 4: Correlation Matrix of TQM Dimensions and Laboratory Performance Metrics

Variables	1	2	3	4	5	6	7	8	9	10	11	12
1.Leadership Commitment	1.00											
2.Employee Involvement	0.65**	1.00										
3.Continuous Improvement	0.72**	0.58**	1.00									
4. Customer Focus	0.61**	0.53**	0.64**	1.00								
5.Process Management	0.69**	0.62**	0.74**	0.66**	1.00							
6. Overall TQM	0.83**	0.79**	0.85**	0.78**	0.86**	1.00						
7.Turnaround Time Compliance	0.45**	0.38**	0.52**	0.46**	0.58**	0.56**	1.00					
8. Analytical Error Rate	-0.39**	-0.32**	-0.47**	-0.35**	-0.54**	-0.49**	-0.42**	1.00				
9.Pre-analytical Error Rate	-0.36**	-0.41**	-0.43**	-0.37**	-0.52**	-0.48**	-0.39**	0.48**	1.00			
10.Post-analytical Error Rate	-0.28**	-0.25**	-0.32**	-0.38**	-0.46**	-0.38**	-0.35**	0.39**	0.41**	1.00		
11. ISO 15189 Compliance	0.63**	0.47**	0.58**	0.52**	0.67**	0.65**	0.54**	-0.49**	-0.46**	-0.38**	1.00	
12.Customer Satisfaction	0.51**	0.49**	0.54**	0.72**	0.56**	0.64**	0.48**	-0.37**	-0.40**	-0.42**	0.58**	1.00
13.Staff Productivity	0.48**	0.61**	0.50**	0.43**	0.52**	0.57**	0.45**	-0.38**	-0.42**	-0.31**	0.46**	0.45**

** Correlation is significant at the 0.01 level (2-tailed)

Table 4 illustrates significant correlations between all TQM dimensions and laboratory performance metrics. The strongest positive correlation was observed between Process Management and ISO 15189 Compliance ($r=0.67$, $p<0.01$), suggesting that standardized and well-documented laboratory

processes significantly contribute to meeting international quality standards.

Customer Focus showed the strongest positive correlation with Customer Satisfaction ($r=0.72$, $p<0.01$), confirming the logical relationship between prioritizing patient needs and achieving higher satisfaction levels. Employee Involvement

demonstrated the strongest correlation with Staff Productivity ($r=0.61$, $p<0.01$), highlighting the importance of engaging laboratory personnel in decision-making processes to enhance work efficiency. Notably, Process Management showed the strongest negative correlations with all three error rate metrics: Analytical Error Rate ($r=-0.54$, $p<0.01$), Pre-analytical Error Rate ($r=-0.52$, $p<0.01$), and Post-analytical Error Rate ($r=-0.46$, $p<0.01$). This indicates that robust process management practices are crucial for reducing errors across all phases of laboratory testing. Overall TQM implementation was strongly correlated with ISO 15189 Compliance ($r=0.65$,

$p<0.01$) and Customer Satisfaction ($r=0.64$, $p<0.01$), confirming that a comprehensive approach to quality management positively influences both technical quality standards and service quality perception.

MULTIPLE REGRESSION ANALYSIS:

To determine the predictive power of TQM dimensions on laboratory performance metrics, multiple regression analyses were conducted. Table 4.5 presents the regression results for key performance indicators.

Table 5: Multiple Regression Analysis of TQM Dimensions on Laboratory Performance Metrics

Dependent Variable	Independent Variables (Significant Predictors)	β	t	P	R ²	Adjusted R ²	F	p
Turnaround Time Compliance	Process Management	0.38	4.56	<0.001	0.42	0.40	18.73	<0.001
	Continuous Improvement	0.26	3.12	0.002				
Analytical Error Rate	Process Management	-0.43	-5.18	<0.001	0.38	0.36	16.45	<0.001
	Continuous Improvement	-0.28	-3.36	0.001				
Pre-analytical Error Rate	Process Management	-0.34	-3.92	<0.001	0.36	0.34	15.28	<0.001
	Employee Involvement	-0.27	-3.21	0.001				
ISO 15189 Compliance	Process Management	0.42	5.13	<0.001	0.54	0.51	22.76	<0.001
	Leadership Commitment	0.36	4.25	<0.001				
	Continuous Improvement	0.19	2.18	0.030				
Customer Satisfaction	Customer Focus	0.51	6.84	<0.001	0.59	0.57	28.94	<0.001
	Process Management	0.23	2.75	0.006				
	Continuous Improvement	0.18	2.13	0.034				
Staff Productivity	Employee Involvement	0.42	5.19	<0.001	0.46	0.44	20.87	<0.001
	Process Management	0.31	3.72	<0.001				

β = Standardized Beta Coefficient

The regression analyses revealed that different TQM dimensions had varying predictive power for different performance metrics. Process Management emerged as the most consistent predictor, appearing as a significant factor in all six regression models. This underscores the critical importance of standardized procedures, documentation, and workflow optimization in improving laboratory performance across multiple dimensions.

For Turnaround Time Compliance, Process Management ($\beta=0.38$, $p<0.001$) and Continuous Improvement ($\beta=0.26$, $p=0.002$) were significant predictors, collectively explaining 40% of the variance (Adjusted $R^2=0.40$). This suggests that standardized processes and ongoing improvement efforts contribute significantly to meeting turnaround time targets.

The ISO 15189 Compliance model had the highest explanatory power (Adjusted $R^2=0.51$), with Process Management ($\beta=0.42$, $p<0.001$), Leadership

Commitment ($\beta=0.36$, $p<0.001$), and Continuous Improvement ($\beta=0.19$, $p=0.030$) as significant predictors. This indicates that compliance with international standards requires a multidimensional approach to quality management, with particular emphasis on process standardization and leadership support.

Customer Satisfaction was best predicted by Customer Focus ($\beta=0.51$, $p<0.001$), Process Management ($\beta=0.23$, $p=0.006$), and Continuous Improvement ($\beta=0.18$, $p=0.034$), with the model explaining 57% of the variance (Adjusted $R^2=0.57$). This highlights the importance of understanding patient needs, delivering consistent service through standardized processes, and continuously improving service delivery to enhance satisfaction.

Staff Productivity was primarily influenced by Employee Involvement ($\beta=0.42$, $p<0.001$) and Process Management ($\beta=0.31$, $p<0.001$), explaining 44% of the variance (Adjusted $R^2=0.44$). This emphasizes that engaging staff in quality

improvement initiatives and providing them with standardized processes enhances their productivity.

QUALITATIVE ANALYSIS FINDINGS:

The thematic analysis of semi-structured interviews with laboratory managers and quality assurance officers revealed several key themes regarding TQM implementation and its influence on laboratory performance. These findings provide contextual depth to the quantitative results and highlight facilitators and barriers to effective TQM implementation in Sindh's healthcare facilities.

Leadership Support and Resource Allocation:

Interview participants consistently emphasized the critical role of leadership support in successful TQM implementation. Laboratory managers from facilities with high performance metrics frequently mentioned active involvement of hospital administrators in quality improvement initiatives. One participant noted:

"Our hospital director regularly participates in quality improvement meetings and ensures resources are allocated for implementing necessary changes. This top-down commitment has been instrumental in creating a quality culture."

Conversely, participants from facilities with lower performance metrics cited insufficient leadership support and inadequate resource allocation as major barriers:

"We understand what needs to be done to improve quality, but without administrative support and necessary resources, implementation becomes challenging. Quality initiatives often take a backseat to operational concerns."

These qualitative findings align with the quantitative results showing Leadership Commitment as a significant predictor of ISO 15189 Compliance, suggesting that leadership support is particularly crucial for meeting international standards.

Staff Training and Empowerment:

The importance of staff training and empowerment emerged as another prominent theme. Quality assurance officers emphasized that continuous training programs and involving laboratory staff in decision-making processes significantly improved error rates and productivity:

"When we began involving our technicians in process improvement discussions and provided regular training on quality management principles, we saw immediate improvements in pre-analytical error rates and staff motivation."

Several participants noted challenges in staff retention and knowledge transfer, particularly in rural facilities:

"Training staff is one thing, but retaining skilled professionals in rural areas is a significant challenge. We invest in training, but then staff often leave for urban facilities, disrupting our quality improvement momentum."

These observations support the quantitative finding that Employee Involvement is a significant predictor of Staff Productivity and Pre-analytical Error Rates.

Technology Integration and Process Standardization:

The integration of technology and standardization of processes emerged as critical factors in enhancing laboratory performance. Facilities with advanced Laboratory Information Systems (LIS) reported better turnaround times and lower error rates:

"Implementing a comprehensive LIS has transformed our workflow. It has reduced manual data entry errors, improved turnaround times, and enhanced our ability to track quality indicators systematically."

Process standardization through detailed Standard Operating Procedures (SOPs) was identified as a key factor in reducing variability and errors:

"Having well-documented and regularly updated SOPs has been fundamental to our quality improvement journey. It ensures consistency regardless of who performs the test and has been particularly effective in reducing analytical errors."

These findings align with the quantitative results showing Process Management as the most consistent predictor across all performance metrics.

External Quality Assessment and Accreditation Challenges:

Participants discussed the value of participation in External Quality Assessment (EQA) programs and the challenges associated with seeking international accreditation:

"Regular participation in EQA programs has helped us identify systematic errors that weren't apparent

through internal quality control alone. It's been invaluable for improving our analytical accuracy."

Laboratory managers highlighted financial constraints and documentation burdens as significant barriers to pursuing international accreditation:

"The journey toward ISO 15189 accreditation is resource-intensive. The documentation requirements are extensive, and the financial investment is substantial. Without dedicated quality staff, it becomes nearly impossible for smaller facilities."

These insights provide context for the quantitative finding that Process Management and Leadership Commitment were the strongest predictors of ISO 15189 Compliance.

SUMMARY OF KEY FINDINGS:

The comprehensive analysis of both quantitative and qualitative data revealed several key findings regarding the influence of TQM on clinical laboratory performance in Sindh:

Overall TQM implementation across healthcare facilities in Sindh was high ($M=3.56$, $SD=0.74$), with Customer Focus and Leadership Commitment showing the highest implementation levels.

Process Management emerged as the most consistent predictor of laboratory performance, significantly influencing all measured performance metrics. This highlights the fundamental importance of standardized procedures and workflow optimization in laboratory quality management.

Different TQM dimensions had varying impacts on specific performance metrics:

Customer Focus was the strongest predictor of Customer Satisfaction

Employee Involvement primarily influenced Staff Productivity and Pre-analytical Error Rates

Leadership Commitment was particularly important for ISO 15189 Compliance

Continuous Improvement contributed significantly to Turnaround Time Compliance

Qualitative findings highlighted the importance of leadership support, staff training and empowerment, technology integration, and external quality assessment participation as key facilitators of successful TQM implementation.

Major barriers to effective TQM implementation included insufficient resource allocation, staff retention challenges (particularly in rural facilities), documentation burdens, and financial constraints associated with accreditation pursuits.

These findings provide a comprehensive understanding of how TQM influences clinical laboratory performance in Sindh's healthcare context and offer valuable insights for laboratory managers, healthcare administrators, and policymakers seeking to enhance laboratory quality and patient care.

CONCLUSION:

This comprehensive study investigated the influence of Total Quality Management (TQM) on clinical laboratory work performance in Sindh, Pakistan, revealing critical insights into the dynamics of quality management in healthcare settings. The findings demonstrate that TQM principles significantly impact various laboratory performance metrics, with each dimension contributing distinctively to different aspects of laboratory quality. The research established that overall TQM implementation across healthcare facilities in Sindh was high, with Customer Focus and Leadership Commitment showing the highest implementation levels. This suggests a growing recognition among healthcare providers in Sindh about the importance of understanding patient needs and securing leadership support for quality initiatives. However, the moderate implementation levels of Employee Involvement highlight an opportunity for greater engagement of laboratory staff in quality improvement processes.

Process Management emerged as the most consistent predictor of laboratory performance across all metrics, emphasizing the fundamental importance of standardized procedures, documentation, and workflow optimization in laboratory quality management. This finding underscores the need for structured approaches to laboratory operations, including comprehensive Standard Operating Procedures (SOPs), systematic documentation practices, and regular process reviews. Different TQM dimensions exhibited varying impacts on specific performance metrics, suggesting that targeted approaches may be necessary to address particular quality challenges. Customer Focus was the strongest

predictor of Customer Satisfaction, confirming the logical relationship between understanding patient needs and achieving higher satisfaction levels. Employee Involvement primarily influenced Staff Productivity and Pre-analytical Error Rates, highlighting the importance of engaging laboratory personnel in quality improvement initiatives to enhance efficiency and reduce errors in specimen collection and processing. Leadership Commitment was particularly important for ISO 15189 Compliance, suggesting that international accreditation requires sustained support from top management. Continuous Improvement contributed significantly to Turnaround Time Compliance, emphasizing the value of ongoing evaluation and refinement of laboratory processes to meet time-sensitive clinical demands.

Qualitative findings provided contextual depth to the quantitative results, identifying key facilitators and barriers to effective TQM implementation. Leadership support, staff training and empowerment, technology integration, and participation in External Quality Assessment programs emerged as critical enablers of successful quality management. Conversely, insufficient resource allocation, staff retention challenges (particularly in rural facilities), documentation burdens, and financial constraints associated with accreditation pursuits were identified as significant barriers. The study revealed notable differences in TQM implementation and performance metrics between urban and rural healthcare facilities, reflecting disparities in resources, infrastructure, and workforce capabilities. These findings suggest the need for context-specific approaches to quality improvement that address the unique challenges faced by rural laboratories.

This research provides compelling evidence that TQM significantly influences clinical laboratory performance in Sindh's healthcare context. The findings suggest that a multidimensional approach to quality management, with particular emphasis on process standardization, leadership support, employee engagement, and customer focus, can substantially enhance laboratory quality and contribute to improved patient care outcomes. However, successful implementation requires addressing contextual barriers and leveraging facilitators specific to Sindh's healthcare

environment. The insights from this study can guide laboratory managers, healthcare administrators, and policymakers in developing targeted strategies to enhance laboratory quality management and ultimately improve diagnostic services for patients across Sindh.

RECOMMENDATIONS:

Based on the findings of this study, several recommendations are proposed to enhance TQM implementation and improve clinical laboratory performance in Sindh's healthcare facilities. First, healthcare administrators should prioritize strengthening Process Management through comprehensive documentation of Standard Operating Procedures, workflow optimization, and regular process audits, as this dimension consistently demonstrated the strongest influence on all performance metrics. Second, targeted interventions to enhance Employee Involvement should be implemented, including regular training programs, recognition systems for quality contributions, and formal mechanisms for staff participation in quality improvement initiatives, particularly in rural facilities where staff retention challenges are more pronounced. Third, technological infrastructure should be enhanced through phased implementation of Laboratory Information Systems and automated analytical platforms, with priority given to facilities with high test volumes and error rates. Fourth, leadership development programs focused on quality management principles should be established for laboratory managers and hospital administrators, emphasizing the critical role of leadership commitment in successful TQM implementation. Fifth, participation in External Quality Assessment programs should be mandated for all clinical laboratories, with government subsidies provided for smaller facilities to mitigate financial barriers. Finally, a provincial laboratory quality improvement network should be established to facilitate knowledge sharing, collaborative problem-solving, and resource optimization across healthcare facilities in Sindh, with particular attention to bridging the quality gap between urban and rural laboratories.

REFERENCES

- Abernethy, A., Adams, L., Barrett, M., Bechtel, C., Brennan, P., Butte, A., . . . Halamka, J. (2022). The promise of digital health: then, now, and the future. *NAM perspectives*, 2022, 10.31478/202206e.
- Ahmad, M., & Waqar, Z. (2025). Towards Sustainable Health Systems: Insights From Pakistan's Spatial Data Infrastructure. In *Exploring Pillars of Sustainability for Modern Age Improvements* (pp. 373-390): IGI Global Scientific Publishing.
- Albahri, A. S., Duham, A. M., Fadhel, M. A., Alnoor, A., Baqer, N. S., Alzubaidi, L., . . . Salhi, A. (2023). A systematic review of trustworthy and explainable artificial intelligence in healthcare: Assessment of quality, bias risk, and data fusion. *Information Fusion*, 96, 156-191.
- Ali, J., Jusoh, A., Idris, N., & Nor, K. M. (2024). Healthcare service quality and patient satisfaction: a conceptual framework. *International Journal of Quality & Reliability Management*, 41(2), 608-627.
- Alsmairat, M. A., El Baz, J., & Al-Ma'aitah, N. (2024). Investigating the performance of quality management practices induced by top management commitment and Kaizen initiatives: evidence from Jordanian public hospitals in the aftermath of COVID-19. *International Journal of Quality & Reliability Management*, 41(2), 585-607.
- Alzoubi, H. M., In'airat, M., & Ahmed, G. (2022). Investigating the impact of total quality management practices and Six Sigma processes to enhance the quality and reduce the cost of quality: the case of Dubai. *International journal of business excellence*, 27(1), 94-109.
- Bano, M. I. (2025). THE IMPACT OF PANDEMICS ON PAKISTAN'S HEALTHCARE SYSTEM: LESSONS FROM COVID-19. *Sociology & Cultural Research Review*, 3(01), 839-865.
- El Khatib, M., Hamidi, S., Al Ameer, I., Al Zaabi, H., & Al Marqab, R. (2022). Digital disruption and big data in healthcare-opportunities and challenges. *ClinicoEconomics and Outcomes Research*, 563-574.
- Fadhel, R., & Alqurs, A. (2025). Enhancing Occupational Health and Safety Through Strategic Leadership: The Mediating Role of Total Quality Management in Hodeida Hospitals, Yemen. *Risk Management and Healthcare Policy*, 823-842.
- Feng, J., Phillips, R. V., Malenica, I., Bishara, A., Hubbard, A. E., Celi, L. A., & Pirracchio, R. (2022). Clinical artificial intelligence quality improvement: towards continual monitoring and updating of AI algorithms in healthcare. *NPJ digital medicine*, 5(1), 66.
- Filip, R., Gheorghita Puscaselu, R., Anchidin-Norocel, L., Dimian, M., & Savage, W. K. (2022). Global challenges to public health care systems during the COVID-19 pandemic: a review of pandemic measures and problems. *Journal of personalized medicine*, 12(8), 1295.
- Haleem, A., Javaid, M., Singh, R. P., & Suman, R. (2022). Medical 4.0 technologies for healthcare: Features, capabilities, and applications. *Internet of Things and Cyber-Physical Systems*, 2, 12-30.
- Javaid, M., Haleem, A., Singh, R. P., Suman, R., & Rab, S. (2022). Significance of machine learning in healthcare: Features, pillars and applications. *International Journal of Intelligent Networks*, 3, 58-73.
- Katoue, M. G., Cerda, A. A., García, L. Y., & Jakovljevic, M. (2022). Healthcare system development in the Middle East and North Africa region: challenges, endeavors and prospective opportunities. *Frontiers in public health*, 10, 1045739.

- MAQBOOL, M. Q. MEDIATING ROLE OF CORE TOTAL QUALITY MANAGEMENT IN THE RELATIONSHIP BETWEEN INFRASTRUCTURE TOTAL QUALITY MANAGEMENT AND ORGANIZATIONAL PERFORMANCE OF PUBLIC HOSPITAL IN PAKISTAN.
- McDermott, O., Antony, J., Bhat, S., Jayaraman, R., Rosa, A., Marolla, G., & Parida, R. (2022). Lean six sigma in healthcare: a systematic literature review on challenges, organisational readiness and critical success factors. *Processes*, 10(10), 1945.
- Mehmood, S. (2022). Regulating the Pharmaceutical Industry: An Analysis of the Drug Regulatory Authority of Pakistan (DRAP).
- Shaikh, F., Shaikh, A. S., Tufail, M. M. B., Bux, H., & Kumari, V. (2023). Improving Quality Health Care Services by Implementing DMAIC Approach in Paediatric Cardiology Department of Public Hospital of Sindh, Pakistan: A Case Study. *Pakistan Heart Journal*, 56(4), 278-286.
- Smith, M. L., Smith, L. N., & Hansen, M. F. (2021). The quiet revolution in machine vision-a state-of-the-art survey paper, including historical review, perspectives, and future directions. *Computers in Industry*, 130, 103472.
- Sohal, A., De Vass, T., Vasquez, T., Bamber, G. J., Bartram, T., & Stanton, P. (2022). Success factors for lean six sigma projects in healthcare. *Journal of Management Control*, 33(2), 215-240.
- Strielkowski, W., Grebennikova, V., Lisovskiy, A., Rakhimova, G., & Vasileva, T. (2024). AI-driven adaptive learning for sustainable educational transformation. *Sustainable Development*.
- Swarnakar, V., Singh, A., & Tiwari, A. K. (2021). Evaluating the effect of critical failure factors associated with sustainable Lean Six Sigma framework implementation in healthcare organization. *International Journal of Quality & Reliability Management*, 38(5), 1149-1177.
- Zaidi, S., & Hussain, S. S. (2022). *Pakistan: a primary health care case study in the context of the COVID-19 pandemic*: World Health Organization.