

Enhancing Employee Performance Through Lean Technical and Social Practices: A Case Study in Oil and Gas Laboratory Services

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ABSTRACT: This study examines the application of Lean Technical and Social Practices in enhancing employee performance within the oil and gas laboratory services sector. The oil and gas industry plays a crucial role in Indonesia's economy, yet it faces operational challenges due to fluctuating global oil prices and stringent regulations. The research investigates strategies for improving efficiency and productivity in the sector, with a focus on Total Quality Management (TQM), Just in Time (JIT), and Lean Social Practices. The problem addressed is the need for enhanced operational efficiency and labor productivity in oil and gas laboratory services. This paper fills the gap in research regarding the direct effects of TQM and JIT on employee performance in the oil and gas laboratory services context. While these practices have been widely studied in manufacturing, their impact on employee performance in this specific service sector remains underexplored. A quantitative research approach was employed, using structured questionnaires to gather data from 77 participants involved in oil and gas laboratory services. The results show that while TQM significantly improves employee performance both directly and indirectly, JIT only yields positive outcomes when mediated by Lean Social Practices. The study advances the understanding of socio-technical integration by showing that combining technical and social practices delivers sustainable performance gains and practical management benefits in oil and gas laboratory services.

Keywords: Total Quality Management, Just in Time, Lean Social Practices, Employee Performance, Oil and Gas Laboratory.



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INTRODUCTION

The oil and gas industry is a fundamental sector in Indonesia's economy, not only serving as the primary energy provider and a major source of state revenue through taxes, royalties, and production-sharing agreements ([Iskatrinah & Supriyo, 2022](#)), but also relying heavily on the effectiveness of its supporting services. Among these, laboratory services play a vital role in ensuring product quality, regulatory compliance, and operational continuity. As the industry confronts significant challenges, such as fluctuating oil prices, the global shift toward renewable

energy, and increasingly stringent energy transition policies ([Iskatrinah & Supriyo, 2022](#)), the performance of employees in laboratory services becomes essential to maintain efficiency and competitiveness across power generation, manufacturing, transportation, and household sectors ([Soesanto et al., 2022](#)).

These conditions have forced companies to adopt operational efficiency measures to sustain their business ([Soesanto et al., 2022](#)). In Indonesia, oil and natural gas production has been declining in recent years. Data reveals that oil production dropped from 273.5 million barrels in 2019 to 221.1 million barrels in 2023, while natural gas production decreased from 2,834 MMSCF to 1,963 MMSCF during the same period ([GoodStats, 2024](#)). This trend indicates challenges in the exploration and exploitation of oil and gas resources, including decreasing reserves and rising operational costs to maintain production. Consequently, operational efficiency has become a critical necessity for companies in the oil and gas sector, including laboratory services that test production quality and regulatory compliance. Therefore, strategies aimed at improving cost efficiency and labor productivity are crucial aspects that need further exploration in this study.

As part of the oil and gas industry's value chain, testing laboratories play a strategic role in ensuring product quality and regulatory compliance. The strict standards in this industry require laboratories to conduct accurate, efficient, and sustainable testing to meet market demands and increasingly stringent environmental policies ([Lesmana & Fuady, 2023](#)). With rising operational complexity and tighter regulations, oil and gas laboratory companies must manage their resources effectively, and one potential solution is implementing strategies for cost efficiency and labor productivity improvement ([Widyaningsih & Putra, 2020](#)).

Over the past five years, financial performance data from an oil and gas laboratory company has shown positive growth, despite profitability fluctuations. Revenue increased from IDR 17.98 billion in 2020 to IDR 26.45 billion in 2024, reflecting market expansion and higher demand for laboratory services. However, as revenues rise, maintaining profitability has proven challenging due to increasing operational costs and the need for more efficient management of resources. This operational paradox—where growth in revenue is offset by rising costs and declining employee productivity—highlights a pressing research problem. Most Lean management studies focus on manufacturing or general service settings, leaving a gap in understanding how Lean Technical and Social Practices can address performance bottlenecks in highly regulated, technical service sectors like oil and gas laboratory services ([Widyaningsih & Putra, 2020](#); [Lesmana & Fuady, 2023](#)). Therefore, this study investigates these persistent operational challenges as an opportunity to advance Lean theory by exploring how workforce effectiveness and process optimisation can be achieved in an underexplored empirical context.

However, profits did not consistently align with revenue growth, with a decrease from IDR 2.08 billion in 2020 to IDR 1.35 billion in 2021, before recovering to IDR 2.83 billion in 2024. This indicates cost pressures impacting financial efficiency. Additionally, operational costs have risen, with total costs increasing from IDR 15.89 billion in 2020 to IDR 23.58 billion in 2024. Production/service costs surged from IDR 5.98 billion in 2021 to IDR 14.58 billion in 2024, signaling the need for more efficient management. Raw material and equipment costs also rose

from IDR 5.58 billion in 2020 to IDR 13.80 billion in 2024, highlighting the company's dependency on expensive consumables and laboratory equipment.

A close examination of internal company data from 2020 to 2024 reveals a concerning operational paradox: despite substantial increases in revenue, the laboratory's efficiency and employee productivity have shown a marked decline. Internal records indicate that total equipment downtime rose dramatically, starting at just 28 hours per month in 2020 and escalating to 120 hours per month by 2024. The average downtime per critical equipment unit has more than tripled, increasing from 1.9 hours to 6.7 hours per month. This escalation in downtime is mirrored by a significant deterioration in the reliability of laboratory equipment. The mean time between failures (MTBF)—a key indicator of equipment and operational performance—fell steeply from 40 hours in 2020 to only 10.7 hours in 2024, while the frequency of equipment failures grew from 4 to 15 incidents per year. These trends, based on internal data, point to serious weaknesses in maintenance and employee performance. Issues include poor preventive procedures, low adherence to SOPs, and declining staff discipline.

The frequent and increasingly severe equipment breakdowns have disrupted laboratory workflows, delayed testing processes, and forced the organisation to incur higher indirect costs, including overtime pay, process rework, and repeat client requests. These inefficiencies are evidenced by internal company data showing that, between 2020 and 2024, average equipment downtime rose from 28 to 120 hours per month, and mean time between failures fell from 40 to just 10.7 hours, with the frequency of equipment failures growing from 4 to 15 incidents annually. These operational setbacks have directly increased indirect costs through overtime, rework, and repeat client requests. Therefore, targeted interventions are urgently required, such as implementing structured preventive maintenance programmes, enhancing staff training in standard operating procedures, and instituting regular internal quality audits to improve workforce discipline and procedural compliance, ultimately restoring operational efficiency in the oil and gas laboratory environment.

Given these rising cost pressures, the oil and gas laboratory industry must seek solutions to enhance operational efficiency without sacrificing service quality. One potential approach is the application of Lean Technical and Social Practices, focusing on process optimization, workforce skill improvement, and waste reduction in various operational aspects ([Arumugam et al., 2020](#)). Previous research has demonstrated that Total Quality Management (TQM) positively influences employee performance through mechanisms such as job satisfaction, affective commitment, and employee engagement ([Khan et al., 2019](#); [Shammout & Jawazneh, 2022](#); [Ghani Al-Saffar & Obeidat, 2020](#)). TQM, when properly implemented through employee training, incentive systems, and recognition, can enhance work motivation and individual productivity ([Shammout & Jawazneh, 2022](#)). Additionally, TQM contributes to overall organizational performance through continuous improvement strategies and top management commitment to maintaining quality standards ([Ghani Al-Saffar & Obeidat, 2020](#); [Kalu et al., 2021](#)). However, in the oil and gas laboratory services context, the implementation of TQM faces challenges, particularly in aligning practices with strict industry regulations and specific workforce needs.

On the other hand, Just in Time (JIT) is more commonly applied in manufacturing to improve operational efficiency and production flexibility ([Phan et al., 2019](#)). Research shows that integrating JIT with TQM enhances organizational flexibility, leading to improved operational efficiency. However, much of the research focuses on JIT's impact on production and waste reduction, with limited exploration of its direct effects on individual employee performance ([Phan et al., 2019](#)). The effectiveness of TQM and JIT is also highly dependent on the industry context and organizational culture, indicating a gap in research within the oil and gas laboratory services sector ([Shammout & Jawazneh, 2022](#)).

Although numerous studies highlight the positive impacts of TQM and JIT on operational efficiency and organizational productivity, findings regarding their direct influence on employee performance are inconsistent. Some studies suggest that TQM can improve employee engagement and job satisfaction through continuous training and reward systems ([Khan et al., 2019](#); [Shammout & Jawazneh, 2022](#)), while others indicate that overly rigid TQM implementation may increase work pressure, potentially lowering employee motivation over time ([Ghani Al-Saffar & Obeidat, 2020](#)). Similarly, while JIT is claimed to enhance flexibility and work efficiency, other studies show that its implementation can increase work stress due to tight time demands and reduced stock buffers, which requires employees to work faster and more responsively to changing demands. These inconsistent findings suggest that the impact of TQM and JIT on employee performance depends heavily on contextual factors, such as organizational culture, training levels, and leadership involvement in supporting system changes.

To address this research gap, further studies are needed to explore how TQM and JIT contribute to improving employee performance in the oil and gas laboratory services sector. Additionally, future research should investigate the role of Lean Social Practices, particularly Lean Leadership and Lean Training, as mediating variables that can bridge the relationship between Lean Technical Practices and employee performance. This study aims to analyze how Lean Technical Practices, including TQM and JIT, can enhance employee performance in the oil and gas laboratory services industry and to explore the role of Lean Social Practices in mediating the relationship between Lean Technical Practices and employee performance.

Employee Performance

Employee performance is a critical factor in the oil and gas laboratory services industry, determining operational sustainability and competitiveness. Optimal performance reflects not only individual productivity but also ensures that laboratory services meet strict quality standards and efficiency demands, especially as pressure mounts to reduce costs without compromising accuracy and speed in analysis. With the increasing complexity of work systems and evolving technology, employees must adapt to new challenges and continually update their skills to remain relevant in a dynamic industry. Without high performance, laboratories risk errors, delays, and non-compliance with regulatory standards, threatening their reputation and business sustainability. Studies have defined employee performance in various ways, emphasizing its importance in achieving organizational goals. [Arumugam et al. \(2020\)](#) highlight the role of lean practices in improving employee effectiveness, while [Liu \(2023\)](#) defines it in terms of task achievement, efficiency, and

contributions to strategic goals. [Tuffaha \(2020\)](#) links performance to the ability to produce high-quality output, influenced by motivation and a supportive environment. [Triansyah et al. \(2023\)](#) focus on meeting company expectations, including productivity, work quality, customer satisfaction, and innovation. [Lehyani et al. \(2023\)](#) argue that employee performance is shaped by TQM, knowledge management, and adaptability to change. This research defines employee performance as the effectiveness and efficiency of employees in executing tasks, covering productivity, work quality, engagement, and adaptability, and explores how lean technical and social practices can enhance these aspects.

Total Quality Management (TQM)

In the oil and gas laboratory services industry, Total Quality Management (TQM) is an essential strategy for improving operational efficiency, ensuring compliance with quality standards, and creating more effective work systems. TQM not only focuses on enhancing service quality but also emphasizes continuous improvement, employee involvement, and optimal resource management. The industry faces challenges in ensuring the accuracy of laboratory tests, maintaining strict quality control, and managing the efficient use of equipment and consumables. The implementation of TQM enables laboratories to reduce errors in the analysis process, increase service speed, and maintain regulatory compliance. Furthermore, TQM plays a crucial role in fostering a disciplined, standard-based work culture.

The precision required at every stage of analysis directly influences the validity of test results, impacting strategic decisions and company reputation. With evolving laboratory technology and the digitalization of testing processes, integrating TQM principles becomes vital to adapt to changes and maintain competitiveness. This research highlights that the successful implementation of TQM depends not only on the management system but also on how Lean Social Practices, such as Lean Leadership and Lean Training, mediate the relationship between Lean Technical Practices and employee performance. The study will analyze how TQM can contribute to enhancing employee performance through continuous improvement mechanisms, leadership supporting work efficiency, and training that ensures employee competence in applying stringent quality standards.

TQM is a managerial approach focused on overall quality improvement through continuous improvement, employee involvement, and process optimization. In the oil and gas laboratory services industry, TQM is vital to ensure operational efficiency and compliance with stringent quality standards. Effective TQM implementation not only improves service quality but also directly contributes to enhancing employee performance by fostering a disciplined and systematic work culture ([Khan et al., 2019](#); [Shammout & Jawazneh, 2022](#)). TQM allows organizations to create a more structured work environment, where employees are encouraged to develop their skills through continuous training and quality-based evaluation mechanisms. With continuous improvement, employees become more engaged in decision-making processes aimed at efficiency and innovation. Previous studies have shown that organizations with well-implemented TQM experience increased labor productivity, reduced operational errors, and improved work motivation due to clearer reward systems ([Ghani Al-Saffar & Obeidat, 2020](#)).

In the oil and gas laboratory industry, the accuracy of test results is crucial to maintaining business reputation and sustainability. Therefore, TQM not only enhances individual performance but also strengthens the efficiency-based work system. By adopting TQM principles, laboratories can optimize work processes, reduce resource waste, and improve employee effectiveness in performing tasks to high-quality standards ([Phan et al., 2019](#)). Additionally, management involvement in supporting TQM implementation is key to building employee commitment to organizational goals ([Arumugam et al., 2020](#)). However, the effectiveness of TQM in improving employee performance is highly dependent on contextual factors, such as organizational culture, workforce readiness, and leadership support. Without adequate management support and strong employee understanding, TQM implementation may face obstacles, such as resistance to change or difficulties aligning quality standards with existing work practices ([Shammout & Jawazneh, 2022](#)). This research aims to analyze the extent to which TQM contributes to improving employee performance in the oil and gas laboratory services industry. Based on the literature and theoretical logic that has been presented, the following hypothesis is formulated:

H1: There is a positive effect of Total Quality Management (TQM) on Employee Performance.

Just in Time (JIT)

In the oil and gas laboratory services industry, operational efficiency is crucial for business sustainability and competitiveness. One key strategy to improve efficiency is the implementation of Just in Time (JIT), aimed at reducing waste, enhancing flexibility, and ensuring resources are only used when needed. While JIT has traditionally been applied in manufacturing, it is increasingly being adopted in service sectors, including oil and gas laboratories ([Phan et al., 2019](#)). By applying JIT, laboratories can optimize workflow, reduce waiting times in testing processes, and ensure timely delivery of analytical results. In this industry, testing often involves complex coordination between various work units. Without an efficient system, delays in procuring consumables, sample management errors, and long waiting times can lead to operational inefficiencies. By implementing JIT, laboratories can schedule tests more optimally, ensure timely availability of chemicals and testing equipment, and reduce the risk of work backlogs, all while helping control operational costs by avoiding excessive inventory and reducing chemical waste ([Arumugam et al., 2020](#)).

The adoption of JIT also contributes to improved employee performance by creating a more organized and structured work environment. By eliminating non-value-added activities, workers can focus more on their core tasks without being distracted by system inefficiencies. JIT encourages better communication and coordination across teams, which boosts productivity and reduces the likelihood of operational errors. However, applying JIT in oil and gas laboratory services presents challenges, such as the need for more advanced IT integration and a cultural shift toward greater adaptability to dynamic systems. Studies have defined JIT from various perspectives, emphasizing its role in improving operational performance. According to [Susanty et al. \(2022\)](#), JIT enhances operational and business performance by reducing process variability and optimizing resources.

[Al-Hakimi et al. \(2023\)](#) view JIT as a blend of technical and human lean practices that improve operational efficiency. [Abdallah et al. \(2021\)](#) highlight JIT's broader role in process improvement, waste reduction, and managerial effectiveness. [Arumugam et al. \(2020\)](#) emphasize JIT's role in continuous improvement and customer satisfaction, which are crucial in the oil and gas laboratory context. This study defines JIT as a supply chain management system focused on efficiency and waste elimination, with the potential to improve service timeliness, reduce operational inefficiencies, and enhance company competitiveness in the laboratory services sector. Based on existing literature, the hypothesis proposed is:

H2: There is a positive effect of Just in Time (JIT) on Employee Performance.

Lean Social Practices

In the oil and gas laboratory services industry, the implementation of lean social practices plays a crucial role in supporting the success of efficiency-based management systems. Lean social practices focus on leadership, training, and employee involvement in creating a productive work culture oriented towards continuous improvement. In a high-precision and efficiency-demanding work environment, the social aspects of lean implementation are vital to ensure that employees not only understand technical procedures but also have a mindset aligned with lean management principles. Lean social practices, which include Lean Leadership and Lean Training, are essential in fostering employee engagement, improving work efficiency, and achieving organizational goals. [Chiarini et al. \(2022\)](#) emphasize that these practices connect lean principles with social sustainability, enhancing employee empowerment and participation in continuous process improvement. [Lizarelli et al. \(2023\)](#) highlight that lean social practices create an inclusive work environment by integrating ongoing training and lean-based leadership, while [Sheth & Mehta \(2023\)](#) define them as approaches that focus on human resource management within lean systems. [Holmemo et al. \(2022\)](#) and [Bianco et al. \(2021\)](#) discuss the importance of Lean Leadership in building a culture of continuous improvement and employee involvement, which contributes to operational efficiency and innovation. Based on these definitions, this study defines lean social practices as a combination of Lean Leadership and Lean Training aimed at improving efficiency, employee engagement, and the sustainability of lean implementation in organizations.

The impact of Total Quality Management (TQM) and Just in Time (JIT) on lean social practices is also significant in enhancing employee performance. TQM, focusing on continuous improvement and customer satisfaction, plays a key role in developing a collaborative culture within organizations, which is essential for the success of lean social practices. [Chiarini et al. \(2022\)](#) argue that lean social practices ensure the sustainability of TQM by fostering employee involvement through leadership and training. [Lizarelli et al. \(2023\)](#) suggest that lean training within TQM builds employee competence in consistently applying high-quality standards. TQM also strengthens the relationship between employees and management, promoting innovation and process improvement ([Sheth & Mehta, 2023](#)). Similarly, JIT, which aims to optimize operational efficiency by reducing waste, impacts lean social practices by requiring active leadership and structured training to support flexibility and efficient work processes ([Holmemo et al., 2022](#)). The successful implementation of JIT relies heavily on Lean Leadership and Lean Training, which help

employees adapt to the demands of a more flexible work system. Therefore, this research hypothesizes that lean social practices play a crucial role in mediating the relationship between TQM, JIT, and employee performance, as well as strengthening the connection between these practices and improved organizational performance. Based on the literature, the following hypotheses are proposed:

H3: There is a positive impact of Total Quality Management (TQM) on Lean Social Practices.

H4: There is a positive impact of Just in Time (JIT) on Lean Social Practices.

H5: Lean Social Practices have a positive impact on Employee Performance.

H6: Lean Social Practices mediate the relationship between TQM and Employee Performance.

H7: Lean Social Practices mediate the relationship between JIT and Employee Performance.

METHOD

This study adopts a quantitative approach using structured Likert-scale questionnaires to gather data on Total Quality Management (TQM), Just in Time (JIT), Lean Social Practices, and Employee Performance from all employees involved in oil and gas laboratory services. This method enables systematic and objective analysis of the relationships between key management practices and workforce outcomes, ensuring findings that are both statistically robust and directly relevant to industry needs ([Creswell & Creswell, 2018](#); [Saunders et al., 2019](#)).

In this study, the population spans multiple organisational levels, including top management (2 individuals), operation leaders (9 individuals, consisting of lab managers, supervisors, and group leaders), other managers (2 individuals: QHSE and Purchasing), field technicians (26 individuals), support team members (22 individuals from HRD, Finance, Marketing, Quality, HSE, and Purchasing), and other related positions (11 individuals), resulting in a total of 72 participants. This diverse group reflects the various organisational functions directly engaged in laboratory operations and is considered highly relevant for analysing lean management implementation in the oil and gas laboratory services sector.

This research adopts a census sampling technique, whereby all members of the identified population (72 individuals) are selected as research respondents. This approach is justified by the relatively small population size and the direct involvement of all members in the management systems under investigation, thereby ensuring that the data collected is both comprehensive and representative ([Creswell & Creswell, 2018](#)). Utilising a saturated sampling method minimises potential biases that could arise from using only a subset of the population and increases the accuracy and validity of the results ([Saunders et al., 2019](#)). As a result, the study can provide an in-depth and reliable assessment of lean management practices and their influence on employee performance in this context.

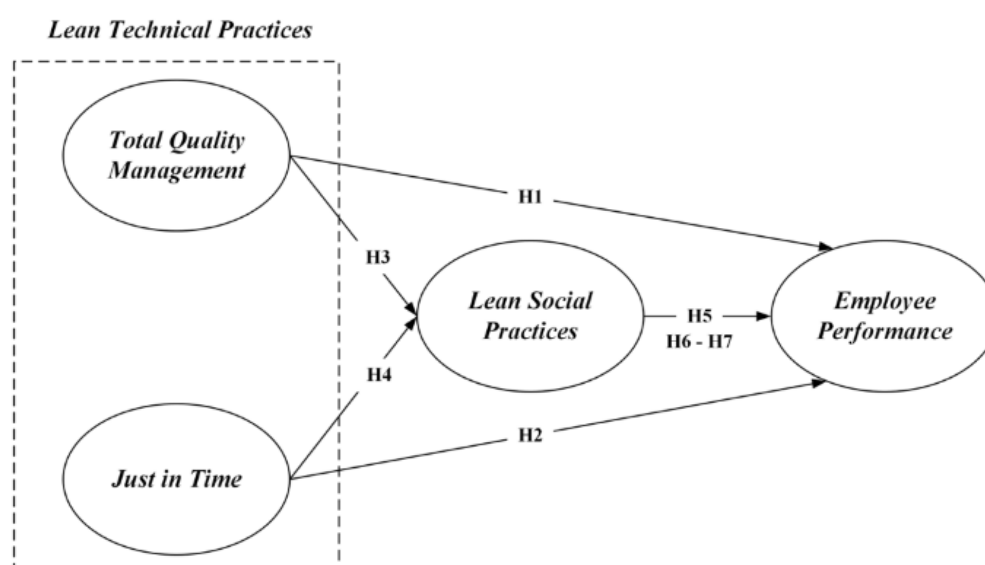


Figure 1. Structural Conceptual Frameworks

The operational definitions of the variables in this study are as follows: Employee performance in the oil and gas laboratory services industry refers to the effectiveness and efficiency of employees in completing their tasks while maintaining high-quality standards and adapting to changes in work systems. This includes productivity, work quality, innovation and initiative, adaptability to change, and team engagement and cooperation, all of which are measured on a Likert scale from 1 to 5, drawing from sources such as [Arumugam et al. \(2020\)](#), [Triansyah et al. \(2023\)](#), [Liu \(2023\)](#), [Lehyani et al. \(2023\)](#), and [Tuffaha \(2020\)](#). Total Quality Management (TQM) is defined as a systematic approach to ensuring compliance with quality standards, improving operational efficiency, and promoting continuous improvement. The indicators for TQM include continuous improvement, leadership and management commitment, customer focus, lean practices in quality management, and integration of innovation and quality control strategies, all assessed on a Likert scale from 1 to 5, with sources from [Schwartz et al. \(2023\)](#), [Arumugam et al. \(2020\)](#), [Abdallah et al. \(2021\)](#), [Al-Hakimi et al. \(2023\)](#), and [Susanty et al. \(2022\)](#).

Just in Time (JIT) in this context refers to strategies that improve efficiency by ensuring that samples are tested and processed on time, minimizing delays. Indicators include reducing wait times, eliminating non-value-adding activities, integrating technical and social strategies, aligning production schedules with customer demand, and optimizing production capacity and resource utilization. This variable is also assessed on a Likert scale from 1 to 5, with sources from [Susanty et al. \(2022\)](#), [Abdallah et al. \(2021\)](#), [Al-Hakimi et al. \(2023\)](#), and [Arumugam et al. \(2020\)](#). Lean Social Practices combine lean leadership and continuous training to enhance operational efficiency and employee engagement. Indicators for Lean Leadership include commitment to implementing lean principles, employee empowerment in decision-making, leadership styles that foster a culture of continuous improvement, and building effective team collaboration. Lean Training includes the quality, frequency, and consistency of training programs, their impact on productivity, and their alignment with workforce needs. These are measured using a Likert scale from 1 to 5, drawing from [Chiarini et al. \(2022\)](#), [Lizarelli et al. \(2023\)](#), [Sheth & Mehta \(2023\)](#), [Holmemo et al. \(2022\)](#), and [Bianco et al. \(2021\)](#).

RESULT AND DISCUSSION

Model Evaluation

In this study, normality was assessed using skewness, excess kurtosis, and the p-value from the Cramér-von Mises test. The results showed that all indicators across the four variables—Total Quality Management (TQM), Just in Time (JIT), Lean Social Practices (LSP), and Employee Performance (EP)—had skewness values ranging from -0.072 to -0.878 and excess kurtosis values from -0.681 to 0.745. These values indicate that all items are within the acceptable range for statistical normality. While some indicators, such as EP3, exhibited a slight left-skew (skewness = -0.878), and others like JIT2 presented marginally higher kurtosis (excess kurtosis = 0.742), all values remain within tolerable limits. Other items, including LSP1 and TQM3, demonstrate a near-symmetrical and flat distribution, suggesting a balanced response spread among participants. Thus, the data in this study are statistically normal based on skewness and kurtosis. However, considering the use of a Likert scale and the application of the PLS-SEM approach, normality is not an absolute requirement for analysis (Hair et al., 2022; Sarstedt et al., 2020). Therefore, the chosen methodology is appropriate and robust for the data characteristics.

The measurement model was evaluated to determine the validity and reliability of the indicators representing each latent construct. In the context of Partial Least Squares Structural Equation Modeling (PLS-SEM), an adequate measurement model requires outer loadings greater than 0.70 to be considered indicator-valid (Hair et al., 2022). As shown in Table 1, all indicators for the four main constructs—TQM, JIT, LSP, and EP—exhibited strong outer loadings, all above 0.80. For instance, TQM indicators ranged from 0.864 to 0.914, JIT from 0.903 to 0.951, LSP from 0.862 to 0.920, and EP from 0.807 to 0.875, demonstrating substantial contributions to their respective constructs.

Table 1. Measurement Model Evaluation

Variable(s)	Item(s)	Loadings	CA	CR (rho_a)	CR (rho_c)	AVE
<i>Total Quality Management (TQM)</i>	TQM1	0.904	0.936	0.937	0.952	0.797
	TQM2	0.864				
	TQM3	0.897				
	TQM4	0.914				
	TQM5	0.885				
<i>Just in Time (JIT)</i>	JIT1	0.903	0.961	0.962	0.969	0.864
	JIT2	0.932				
	JIT3	0.936				
	JIT4	0.951				
	JIT5	0.924				
<i>Lean Social Practices (LSP)</i>	LSP1	0.885	0.961	0.961	0.967	0.785
	LSP2	0.891				
	LSP3	0.873				
	LSP4	0.862				
	LSP5	0.872				
	LSP6	0.92				

Variable(s)	Item(s)	Loadings	CA	CR (rho_a)	CR (rho_c)	AVE
<i>Employee Performance (EP)</i>	LSP7	0.909	0.907	0.91	0.931	0.729
	LSP8	0.873				
	EP1	0.807				
	EP2	0.861				
	EP3	0.856				
	EP4	0.875				
	EP5	0.868				

Convergent validity was confirmed through Average Variance Extracted (AVE), where all constructs exceeded the recommended minimum value of 0.50. Specifically, JIT had the highest AVE (0.864), followed by TQM (0.797), LSP (0.785), and EP (0.729), as presented in Table 1. These results confirm that each construct adequately explains the variance of its indicators. Reliability was evaluated using Cronbach's Alpha, Composite Reliability (rho_a), and Composite Reliability (rho_c). All constructs met the reliability threshold (>0.70), indicating high internal consistency. For example, JIT recorded Cronbach's Alpha of 0.961, rho_a of 0.962, and rho_c of 0.969; LSP showed Cronbach's Alpha of 0.961 and rho_c of 0.967, affirming the high consistency of the indicators. Discriminant validity was established using the Heterotrait-Monotrait Ratio (HTMT), with all inter-construct values below 0.90 and the confidence intervals not exceeding 1.00, further confirming that the constructs are empirically distinct from one another.

After establishing the validity and reliability of the measurement model, the next step was to evaluate the structural model to assess the strength of relationships between the latent constructs and the explanatory power of the independent variables. The results indicate that Lean Social Practices had an R-square value of 0.875 (adjusted 0.874), meaning that 87.5% of the variance in Lean Social Practices can be explained by Total Quality Management and Just in Time. Employee Performance achieved an R-square of 0.639 (adjusted 0.632), signifying that 63.9% of the variance in Employee Performance is accounted for by Total Quality Management, Just in Time, and Lean Social Practices. Although an R-square of 87.5% reflects strong explanatory power, it also raises the possibility of model overfitting or dominance by a particular independent variable, especially given the relatively small sample size and the focused organisational context. Therefore, while the findings demonstrate robust model fit and predictive capability, they should be interpreted with caution and validated by further studies in broader and more diverse settings.

According to the guidelines by Hair et al. (2022), these R-square values represent strong and substantial explanatory power. In terms of predictive relevance, the Q-square values for Lean Social Practices (0.680) and Employee Performance (0.452) both surpass the recommended threshold of 0.35, indicating that the model possesses good predictive capability for these endogenous constructs. As expected, Q-square values for Just in Time and Total Quality Management are 0.000, since both serve as exogenous variables in the model.

To ensure the overall model fit, the Standardized Root Mean Square Residual (SRMR) value was found to be 0.047 for both the saturated and estimated models, which is well below the acceptable threshold of 0.08, reflecting a low level of residual error and strong alignment between the model and the empirical data. The Normed Fit Index (NFI) was recorded at 0.860, which also meets the

requirements for an adequate model fit. Taken together, these results demonstrate that the structural model exhibits robust explanatory and predictive power, as well as a high degree of statistical and empirical fit, providing a strong foundation for hypothesis testing and further interpretation of the relationships between constructs within the theoretical framework.

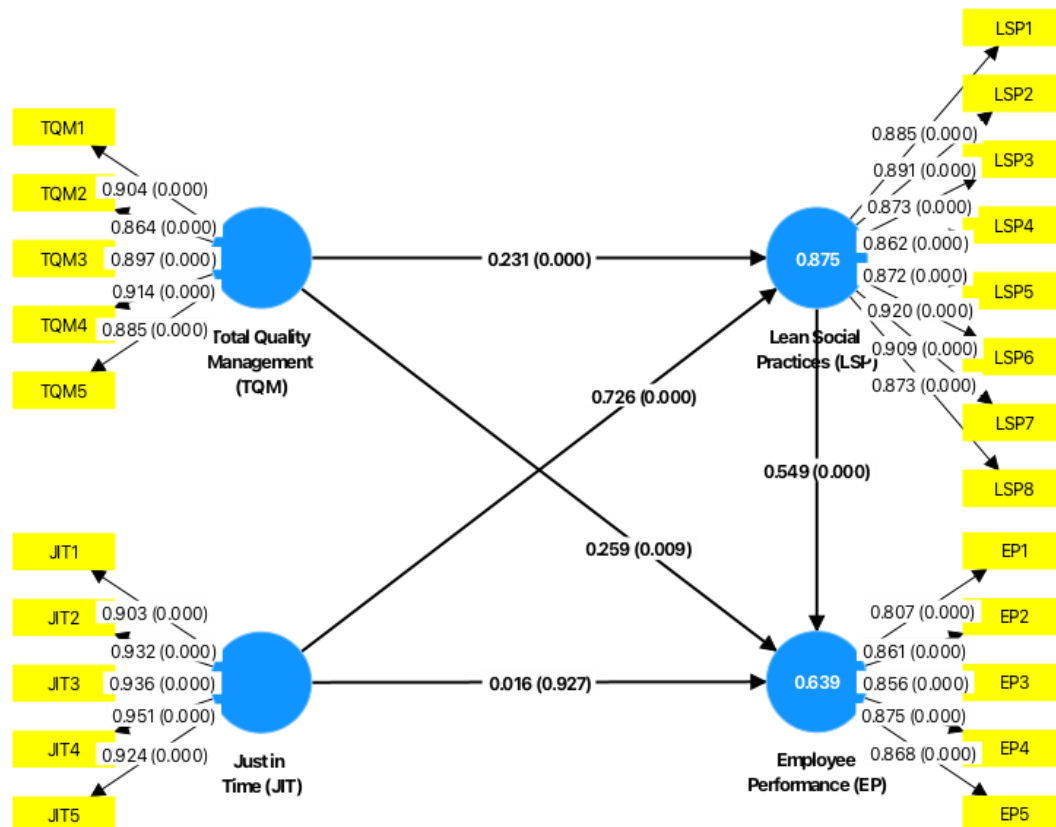


Figure 2. Bootstrapping Results

Note: R-square LSP = 0.875 (adjusted 0.874), EP = 0.639 (adjusted 0.632); Q^2 LSP = 0.680, EP = 0.452, JIT = 0.000, TQM = 0.000; SRMR = 0.047, NFI = 0.860 (in both saturated and estimated models).

The structural model estimation provides a comprehensive understanding of the relationships between Total Quality Management (TQM), Just in Time (JIT), Lean Social Practices, and Employee Performance. As recommended by [Hair et al. \(2022\)](#), significance in the structural model is generally indicated by t-values greater than 1.96 and p-values less than 0.05. The findings indicate that TQM has a significant direct positive effect on Employee Performance, with a path coefficient of 0.259 ($t = 2.606$, $p = 0.009$), exceeding the recommended statistical threshold for significance. In contrast, the direct effect of JIT on Employee Performance is negligible and not statistically significant (path coefficient = 0.016, $t = 0.091$, $p = 0.927$), suggesting that JIT, on its own, does not directly influence performance outcomes among employees in this context. This finding aligns with [Arumugam et al. \(2020\)](#), who also reported that TQM significantly enhances employee productivity by improving system efficiency.

The analysis further demonstrates that both TQM and JIT significantly influence Lean Social Practices. TQM's effect on Lean Social Practices is reflected in a path coefficient of 0.231 ($t = 3.550$, $p < 0.001$), while JIT exerts a much stronger effect, with a path coefficient of 0.726 ($t = 11.488$, $p < 0.001$). These results confirm that efforts to improve technical processes and time management are strongly associated with the development of a lean-oriented organisational culture, as underlined by Hair et al.'s guidelines for interpreting large effect sizes (path coefficients above 0.20 are considered meaningful in practical terms). The findings indicate that TQM has a significant direct positive effect on Employee Performance. In contrast, JIT, on its own, does not directly influence performance outcomes—possibly due to the absence of supporting social mechanisms or limited employee readiness to adopt JIT practices

Importantly, Lean Social Practices are shown to have a robust and statistically significant impact on Employee Performance (path coefficient = 0.549, $t = 3.812$, $p < 0.001$), indicating that improvements in leadership, training, and collaborative culture directly enhance individual and group effectiveness in laboratory operations. The mediating role of Lean Social Practices is also confirmed, as both indirect effects are significant: TQM's indirect effect on Employee Performance through Lean Social Practices has a coefficient of 0.127 ($t = 2.482$, $p = 0.013$), and JIT's indirect effect is even stronger, with a coefficient of 0.399 ($t = 3.625$, $p < 0.001$). According to [Hair et al. \(2022\)](#), such mediation effects are considered substantial when both the indirect path and the total effect are significant, supporting the argument that Lean Social Practices are a key mechanism through which technical and process improvements translate into better employee outcomes.

Table 2. Hypothesis Testing

H	Path	Original Sample	T Statistics	P Values	Notes
H1	<i>Total Quality Management</i> → <i>Employee Performance</i>	0.259	2.606	0.009	Accepted
H2	<i>Just in Time</i> → <i>Employee Performance</i>	0.016	0.091	0.927	Rejected
H3	<i>Total Quality Management</i> → <i>Lean Social Practices</i>	0.231	3.550	0.000	Accepted
H4	<i>Just in Time</i> → <i>Lean Social Practices</i>	0.726	11.488	0.000	Accepted
H5	<i>Lean Social Practices</i> → <i>Employee Performance</i>	0.549	3.812	0.000	Accepted
H6	<i>Total Quality Management</i> → <i>Lean Social Practices</i> → <i>Employee Performance</i>	0.127	2.482	0.013	Accepted
H7	<i>Just in Time</i> → <i>Lean Social Practices</i> → <i>Employee Performance</i>	0.399	3.625	0.000	Accepted

The explanatory and predictive power of the structural model is further supported by R-square and Q-square values. The model explains 87.5% of the variance in Lean Social Practices (R-square = 0.875) and 63.9% in Employee Performance (R-square = 0.639), both of which are classified as strong according to [Hair et al. \(2022\)](#), who suggest that R-square values of 0.75, 0.50, and 0.25 can be described as substantial, moderate, and weak, respectively. Similarly, the Q-square values for

Lean Social Practices (0.680) and Employee Performance (0.452) exceed the threshold of 0.35, indicating good predictive relevance as per [Chin's \(1998\)](#) recommendation and reaffirmed by Hair et al. The fit of the overall model is also satisfactory, with SRMR at 0.047 (well below the maximum of 0.08) and NFI at 0.860, both supporting a strong model-data fit.

Crucially, the statistical results reveal the unique and significant mediating role of Lean Social Practices in linking both TQM and JIT to employee performance. This mediating effect not only distinguishes the current research from previous Lean studies but also provides novel empirical evidence of how social mechanisms are essential for translating technical initiatives into workforce outcomes in oil and gas laboratory services

CONCLUSION

This study aimed to address operational inefficiencies and employee performance issues in oil and gas laboratory services by examining the impact of TQM, JIT, and Lean Social Practices. Using a quantitative SEM-PLS approach, the results demonstrate that TQM has both direct and indirect positive effects on employee performance, while JIT exerts a significant effect only through the mediation of Lean Social Practices. These findings reinforce the socio-technical systems theory ([Cherns, 1987](#); [Hackman & Wageman, 1995](#)), which argues that organisational performance improvement is most sustainable when technical systems are integrated with supportive social structures. Furthermore, this study's empirical evidence supports the proposition that Lean Social Practices—such as lean leadership, continuous training, and participative culture—are essential mechanisms linking technical interventions to performance outcomes ([Arumugam et al., 2020](#); [Al-Hakimi et al., 2023](#)).

Of the seven hypotheses tested, six were accepted, highlighting the centrality of social mechanisms, including ongoing training, participative leadership, and team collaboration, in bridging technical initiatives and actual performance improvements ([Arumugam et al., 2020](#); [Al-Hakimi et al., 2023](#); [Bianco et al., 2021](#)). The only hypothesis rejected was H2, which posited a direct positive effect of Just in Time (JIT) on Employee Performance. The data showed that JIT did not significantly influence employee performance when acting alone (path coefficient = 0.016, $t = 0.091$, $p = 0.927$), suggesting that technical strategies like JIT require the support of Lean Social Practices to yield performance benefits. This underscores that TQM and JIT alone are insufficient for achieving high employee performance; rather, Lean Social Practices play a crucial mediating role, consistent with earlier research on the importance of empowerment and engagement for successful lean implementation ([Chiarini et al., 2022](#); [Ghani Al-Saffar & Obeidat, 2020](#)). The explanatory power of the model is substantial, with 87.5% of the variance in Lean Social Practices and 63.9% in Employee Performance accounted for, surpassing thresholds for strong effect sizes as suggested by [Hair et al. \(2022\)](#) and supported by [Chin \(1998\)](#) regarding predictive relevance. The robustness of the structural model is further supported by satisfactory fit indices (SRMR and NFI), confirming the reliability of the findings ([Ramayah et al., 2017](#)).

Theoretically, this research enriches the literature by integrating socio-technical systems theory and Lean Thinking into the relatively underexplored context of oil and gas laboratory services ([Chiarini](#)

[et al., 2022](#); [Al-Hakimi et al., 2023](#); [Arumugam et al., 2020](#)). Uniquely, the study expands the Total Quality Management (TQM) framework by empirically demonstrating that employee performance gains in service sectors are not driven by technical interventions alone, but are maximised when complemented by social mechanisms such as leadership and continuous training. Furthermore, by applying PLS-SEM modelling, this research offers a robust statistical foundation for examining complex mediating effects in service environments—providing novel evidence of how Lean Social Practices function as a critical bridge between managerial initiatives and measurable workforce outcomes ([Sheth & Mehta, 2023](#); [Bianco et al., 2021](#); [Chiarini et al., 2022](#)). These findings advance Lean and quality management theory by clarifying the integrated pathways through which technical and social practices jointly achieve sustainable change in high-reliability service contexts ([Phan et al., 2019](#); [Ghani Al-Saffar & Obeidat, 2020](#)).

Managerially, these findings provide actionable guidance for leaders and practitioners. Organisations are encouraged to reinforce TQM not only as a system of procedures, but as a broader organisational culture that prioritises ongoing training, internal quality audits, and cross-functional engagement ([Khan et al., 2019](#); [Ghani Al-Saffar & Obeidat, 2020](#)). The implementation of JIT should be coupled with investments in Lean Social Practices—such as effective communication, lean training, and inclusive leadership—to ensure that technical efficiency translates into workforce productivity and adaptability ([Phan et al., 2019](#); [Arumugam et al., 2020](#); [Al-Hakimi et al., 2023](#)). Recommended practical steps include internal quality audits, regular lean training programmes, and feedback systems, all of which have been shown to enhance operational and employee outcomes ([Lizarelli et al., 2023](#); [Bianco et al., 2021](#); [Arumugam et al., 2020](#)).

However, this study's generalisability is limited by its single- organisation focus and reliance on cross-sectional, self- reported data, which may introduce bias. Future research should include multi-site samples and integrate objective performance metrics to validate and broaden these findings. Additional research that explores moderating variables such as organisational culture, leadership style, or employee engagement—and includes broader service and industrial settings—would further validate and enrich these findings ([Al-Hakimi et al., 2023](#); [Chiarini et al., 2022](#)). This study's limitation in being conducted at a single organization opens opportunities for longitudinal and multi-context studies to enhance generalizability

In summary, this research provides robust evidence that sustainable improvements in employee performance in oil and gas laboratory services are best achieved through the strategic alignment of Lean Technical and Social Practices. By integrating TQM, JIT, and Lean Social Practices within a socio-technical systems framework ([Cherns, 1987](#); [Hair et al., 2022](#); [Arumugam et al., 2020](#)), organisations can achieve operational excellence and high workforce effectiveness, offering a valuable roadmap for both researchers and practitioners in high-reliability, complex service environments.

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