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Linking Petroleum Engineering Expertise to Organizational Performance through an Inclusive Work Environment: A Study of Libyan Oil Companies

[1]Masoud Khalleefah Aboubakr Imrar, [2]Dhakir Abbas Ali,
[3]Fatimah Ahmed Salim Imrar
[1,2] *School of Business & Management, Lincoln University College, Petaling Jaya, Malaysia*
[3] *Libyan Academy for Postgraduate Studies, Libya*
**Corresponding Author:* msoudmrar@gmail.com*

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Abstract
The oil and gas industry operates in an environment marked by high technical complexity, operational risk, and increasing performance pressures, making petroleum engineering expertise a vital organizational resource. However, the effectiveness of such expertise in driving organizational performance depends largely on the organizational conditions that enable its utilization. This study examines the relationship between petroleum engineering expertise and organizational performance, with a particular focus on the mediating role of an inclusive work environment in the context of Libyan oil companies. A quantitative, cross-sectional research design was adopted, and data were collected through a structured questionnaire distributed to employees across Libyan oil companies. A total of 380 valid responses were analyzed using Partial Least Squares Structural Equation Modeling (PLS-SEM) to assess both the measurement and structural models. The results indicate that petroleum engineering expertise has a significant positive effect on organizational performance and also positively influences the inclusiveness of the work environment. In addition, the inclusive work environment was found to have a significant positive impact on organizational performance and to partially mediate the relationship between petroleum engineering expertise and organizational performance. These findings suggest that technical expertise alone is insufficient to maximize performance outcomes unless supported by organizational climates that promote inclusion, collaboration, and knowledge sharing. The study contributes to the literature by providing empirical evidence from an underexplored, oil-dependent economy and by highlighting the importance of inclusive work environments as a strategic mechanism for translating technical human capital into sustained organizational performance.

1. Introduction

The oil and gas industry remains one of the most technically complex and strategically significant sectors of the global economy, with organizational performance heavily dependent on the depth and effective utilization of engineering expertise. In petroleum-based economies, particularly in

developing and transition contexts, the ability of firms to translate specialized technical knowledge into sustained organizational outcomes has become a critical managerial challenge. Petroleum engineering expertise is no longer confined to operational efficiency alone but is increasingly linked to strategic decision-making, risk management, and long-term organizational resilience in the energy sector (Yew et al., 2025). As the industry faces pressures arising from energy transition, technological disruption, and geopolitical uncertainty, the strategic role of petroleum engineers has become more pronounced (Boersma et al., 2025). Recent research highlights that engineering expertise constitutes a form of strategic human capital capable of enhancing organizational outcomes when effectively leveraged (Masiko et al., 2022). Studies in oil and gas project environments demonstrate that technical competencies contribute directly to project success and performance outcomes (Abdulla et al., 2023). Leadership and executive decision-making grounded in engineering expertise have also been associated with improved corporate risk management and performance stability (Dissanayake et al., 2025). Despite this growing body of evidence, empirical research suggests that technical expertise alone is insufficient to guarantee superior organizational performance, particularly in complex organizational and institutional environments.

One explanation for this limitation lies in the organizational context within which expertise is deployed. Human capital theory emphasizes that the productivity of specialized knowledge depends on supportive organizational conditions that enable expertise utilization (Rejab & bin Arshad, 2024). The resource-based view similarly argues that valuable resources, including technical capabilities, only generate competitive advantage when they are effectively embedded within organizational systems and cultures (Ahn et al., 2022). In oil and gas firms, where operations rely on multidisciplinary collaboration, safety-critical decision-making, and knowledge sharing, the work environment plays a decisive role in determining whether engineering expertise translates into performance gains (Al-Hanshi et al., 2022). An inclusive work environment has emerged as a key organizational condition that facilitates the effective use of expertise. Workplace inclusion promotes psychological safety, knowledge sharing, and collaboration, all of which are essential for leveraging highly specialized technical skills (Rezai et al., 2023). Empirical studies show that inclusive organizational cultures enhance employee performance and contribute to competitive advantage by enabling individuals to contribute their full capabilities (Syakbandy & Rahmah, 2023). In knowledge-intensive settings, inclusion has been shown to reduce knowledge-hiding behavior and improve expertise utilization (Miminoshvili & Černe, 2022). Engineering-focused research further suggests that inclusive teaming practices are essential for effective problem-solving and innovation in technical environments (Rodríguez-Simmonds et al., 2023).

The relevance of inclusion is particularly pronounced in the oil and gas sector, where hierarchical structures, safety pressures, and cultural diversity can inhibit open knowledge exchange. Evidence indicates that inclusive leadership and supportive climates significantly enhance job performance and organizational outcomes (Alghofeli et al., 2024). Studies examining workplace inclusion across different contexts confirm its positive influence on employee performance and organizational effectiveness (Maj, 2023). Social and organizational climate research further supports the argument that performance outcomes are shaped not only by individual competence but also by the quality of the work environment (Sökmen & Kılıç, 2025). Within this context, the Libyan oil industry presents a particularly compelling setting for investigation. Libya's economy remains heavily dependent on the petroleum sector, which

operates under conditions of political instability, institutional fragility, and operational risk (Waddams, 2023). These conditions amplify the importance of maximizing the performance returns of scarce engineering expertise while maintaining organizational cohesion. Strategic leadership and organizational practices in Libyan oil companies have been shown to influence financial and operational performance, yet significant performance variability persists across firms (Naja & ungku Ahmad, 2024). This suggests that contextual organizational factors, such as inclusion, may play a critical mediating role in shaping performance outcomes.

Despite the recognized importance of petroleum engineering expertise and inclusive work environments, empirical studies examining their combined effects on organizational performance remain limited, particularly within oil-dependent and politically complex contexts. Existing research tends to examine technical competencies, organizational culture, or performance outcomes in isolation, leaving the mechanisms linking these constructs underexplored. This study addresses this gap by examining whether an inclusive work environment mediates the relationship between petroleum engineering expertise and organizational performance in Libyan oil companies. Accordingly, this paper makes three key contributions. First, it extends human capital and resource-based perspectives by empirically demonstrating how petroleum engineering expertise influences organizational performance through an inclusive work environment. Second, it contributes contextual evidence from the Libyan oil sector, a setting that remains underrepresented in empirical management research. Third, it offers practical insights for oil and gas leaders seeking to enhance organizational performance by aligning technical capability development with inclusive organizational practices. The remainder of this paper is structured as follows. The next section reviews the relevant literature and develops the study hypotheses. The methodology and findings are then presented, followed by a discussion of the results and concluding implications.

2. Literature Review

2.1 Theoretical Discussion

The theoretical foundation of this study is grounded in the Resource-Based View, Human Capital Theory, and perspectives on inclusive organizational culture, which together provide a coherent framework for understanding how petroleum engineering expertise contributes to organizational performance through an inclusive work environment. In knowledge-intensive industries such as oil and gas, organizational performance increasingly depends on the effective deployment of specialized human capabilities rather than on physical assets alone. Petroleum engineering expertise represents a critical strategic resource due to its scarcity, complexity, and direct relevance to operational safety, efficiency, and innovation in energy firms (Yew et al., 2025). The Resource-Based View posits that firms achieve sustained performance advantages when they possess valuable, rare, inimitable, and non-substitutable resources that are effectively embedded within organizational systems. Technical capabilities, particularly in engineering-driven sectors, meet these criteria when they are supported by appropriate organizational structures and cultures (Ahn et al., 2022). In the petroleum industry, engineering expertise functions as a core organizational capability that enables firms to manage complex reservoirs, mitigate operational risks, and

respond to technological and environmental challenges (Boersma et al., 2025). However, RBV also emphasizes that resources do not generate value automatically; their contribution to performance depends on organizational mechanisms that facilitate their utilization.

Human Capital Theory further explains the role of specialized expertise in organizational outcomes by emphasizing the productivity-enhancing potential of employee knowledge, skills, and competencies. In oil and gas contexts, engineering competencies have been empirically linked to productivity, innovation, and performance outcomes, particularly in emerging petroleum industries (Masiko et al., 2022). Technical competence among engineers and project managers has also been shown to enhance project success and organizational effectiveness in oil and gas operations (Abdulla et al., 2023). Nevertheless, human capital theory recognizes that the returns on expertise are contingent upon supportive work environments that allow employees to apply their skills effectively (Rejab & bin Arshad, 2024). Organizational culture and climate theories provide further insight into the conditions under which expertise translates into performance. An inclusive work environment is characterized by fairness, respect, psychological safety, and opportunities for meaningful participation, which collectively enable employees to contribute their knowledge without fear of exclusion or marginalization. Workplace inclusion has been shown to enhance employee performance and organizational competitiveness by fostering engagement and collaboration (Syakbandy & Rahmah, 2023). In contrast, exclusionary climates can suppress knowledge sharing and reduce the effective use of expertise, particularly among minority or less powerful organizational members (Miminoshvili & Černe, 2022).

The role of inclusion is especially salient in engineering-intensive organizations, where performance depends on teamwork, cross-disciplinary coordination, and open communication. Research in engineering education and practice demonstrates that inclusive teaming practices improve problem-solving and innovation by enabling diverse expertise to be fully integrated into decision-making processes (Rodríguez-Simmonds et al., 2023). From a managerial perspective, inclusive leadership and climates for inclusion have been found to strengthen employee outcomes and organizational performance by aligning individual capabilities with collective goals (Alghofeli et al., 2024). Knowledge management perspectives further reinforce the importance of inclusive environments in enabling expertise utilization. Expertise recognition by leaders has been shown to influence how knowledge is shared and applied within teams, directly affecting performance outcomes (Ye & Zhao, 2023). Inclusive work environments reduce barriers to knowledge exchange and encourage proactive contribution, thereby enhancing the value derived from specialized human capital. Empirical evidence also suggests that inclusive organizational climates improve performance outcomes by strengthening social and psychological conditions at work (Sökmen & Kılıç, 2025).

In the context of oil and gas firms operating in developing and transitional economies, these theoretical arguments gain additional relevance. The Libyan oil sector operates under conditions of political uncertainty, operational risk, and institutional constraints, which heighten the importance of maximizing the performance returns of scarce engineering expertise (Waddams, 2023). Organizational performance in such environments depends not only on technical capability but also on the extent to which firms cultivate inclusive and supportive work environments that enable expertise deployment. Strategic leadership in Libyan oil companies has been shown to influence performance outcomes, indicating that

organizational context plays a critical role in shaping the effectiveness of technical resources (Naja & ungku Ahmad, 2024). Taken together, the Resource-Based View, Human Capital Theory, and inclusion-focused organizational perspectives suggest that petroleum engineering expertise contributes to organizational performance indirectly through enabling organizational conditions. An inclusive work environment functions as a critical mediating mechanism by facilitating knowledge sharing, collaboration, and effective expertise utilization. This integrated theoretical perspective underpins the conceptual framework of the present study and provides the basis for the hypotheses developed in the following section.

2.2 Hypotheses Development

2.2.1 Petroleum Engineering Expertise and Organizational Performance

Petroleum engineering expertise represents a critical organizational capability in oil and gas firms, where operational effectiveness, safety management, and strategic decision-making rely heavily on advanced technical knowledge. Contemporary petroleum engineering roles extend beyond routine operational tasks to encompass reservoir optimization, risk mitigation, and long-term asset management, all of which have direct implications for organizational performance (Yew et al., 2025). As energy companies confront technological disruption and increasing environmental and economic pressures, firms with stronger engineering expertise are better positioned to maintain operational stability and performance (Boersma et al., 2025). Empirical research in oil and gas project environments demonstrates that technical competencies among engineers and project managers contribute positively to project success and organizational outcomes (Abdulla et al., 2023). Engineering-driven decision-making has also been associated with improved risk management and performance consistency at the corporate level (Dissanayake et al., 2025).

From a human capital perspective, specialized engineering knowledge enhances productivity and efficiency when effectively deployed within organizational processes (Masiko et al., 2022). These findings suggest a direct relationship between petroleum engineering expertise and organizational performance. In the context of oil-dependent economies, the strategic value of engineering expertise becomes even more pronounced due to limited access to alternative competitive resources. Studies of the Libyan oil sector highlight the importance of managerial and technical capabilities in shaping firm performance under conditions of instability and operational uncertainty (Naja & ungku Ahmad, 2024).

H1: Petroleum engineering expertise has a positive effect on organizational performance.

2.2.2 Petroleum Engineering Expertise and Inclusive Work Environment

While petroleum engineering expertise is a valuable resource, its effective utilization depends on the organizational environment in which engineers operate. The Resource-Based View emphasizes that strategic resources generate value only when supported by complementary organizational conditions (Ahn et al., 2022). In knowledge-intensive industries, technical experts require environments that encourage participation, voice, and collaboration to fully contribute their expertise. An inclusive work environment is characterized by fairness, respect, and psychological safety, which collectively enable

employees to share knowledge and engage in problem-solving without fear of exclusion. Research on workplace inclusion indicates that inclusive organizational cultures enhance employee engagement and capability utilization (Syakbandy & Rahmah, 2023).

In contrast, exclusionary climates can inhibit communication and suppress the contribution of specialized expertise, particularly in hierarchical and high-risk industries such as oil and gas (Miminoshvili & Černe, 2022). Engineering-focused studies further suggest that inclusive teaming practices are essential for effective knowledge integration and performance in technical environments (Rodríguez-Simmonds et al., 2023). Leadership recognition of expertise has been shown to influence how technical knowledge is shared and applied within teams, reinforcing the role of organizational climate in enabling expertise utilization (Ye & Zhao, 2023). These insights indicate that higher levels of petroleum engineering expertise are likely to be associated with stronger inclusive work environments, as organizations seek to create conditions that facilitate effective knowledge use.

H2: Petroleum engineering expertise has a positive effect on the inclusive work environment.

2.2.3 Inclusive Work Environment and Organizational Performance

The relationship between inclusive work environments and organizational performance has received increasing attention in organizational and management research. Inclusive workplaces foster collaboration, trust, and psychological safety, which enhance individual and collective performance outcomes. Empirical evidence demonstrates that inclusive organizational cultures contribute to improved employee performance and organizational competitiveness (Syakbandy & Rahmah, 2023). Workplace inclusion has also been shown to reduce knowledge-hiding behavior and enhance knowledge sharing, which are critical drivers of performance in knowledge-intensive industries (Miminoshvili & Černe, 2022). Studies across diverse organizational contexts indicate that inclusive environments strengthen employee motivation and engagement, leading to higher levels of job performance (Maj, 2023).

Research on social and organizational climate further supports the view that performance outcomes are shaped by the quality of interpersonal and organizational relationships at work (Sökmen & Kılıç, 2025). In oil and gas firms, where performance depends on coordinated action, safety compliance, and effective communication, inclusive work environments play a particularly important role. Inclusive leadership and climates for inclusion have been linked to positive employee outcomes that ultimately translate into improved organizational performance (Alghofeli et al., 2024). These findings suggest that inclusive work environments function as performance-enhancing organizational conditions in petroleum-based organizations.

H3: An inclusive work environment has a positive effect on organizational performance.

2.2.4 The Mediating Role of Inclusive Work Environment

Although petroleum engineering expertise is expected to influence organizational performance directly, theoretical perspectives suggest that this relationship is also indirect and contingent upon organizational context. Human Capital Theory emphasizes that the productivity of specialized knowledge depends on

supportive environments that enable skill application and collaboration (Rejab & bin Arshad, 2024). Similarly, organizational culture research suggests that performance outcomes are shaped by the mechanisms through which individual capabilities are integrated into collective processes (Ghumiem et al., 2023). Inclusive work environments provide a critical mechanism through which petroleum engineering expertise can be translated into organizational performance. By fostering trust, participation, and psychological safety, inclusive climates enable engineers to share knowledge, contribute to decision-making, and engage in problem-solving activities that enhance performance.

Knowledge management research supports this view by demonstrating that organizational contexts that facilitate expertise recognition and utilization strengthen performance outcomes (Andrej et al., 2023). In complex and uncertain operating environments such as the Libyan oil sector, inclusive work environments may be particularly important in mediating the relationship between expertise and performance. Political instability, operational risk, and workforce diversity increase the need for organizational conditions that support collaboration and effective knowledge use (Waddams, 2023). Without inclusive environments, the potential performance benefits of petroleum engineering expertise may remain underutilized.

H4: The inclusive work environment mediates the relationship between petroleum engineering expertise and organizational performance.

3. Methodology

This study employed a quantitative, cross-sectional research design to examine the relationships between petroleum engineering expertise, inclusive work environment, and organizational performance within Libyan oil companies. A survey-based approach was adopted as it is appropriate for testing theory-driven hypotheses and assessing mediation effects in organizational research. Quantitative designs have been widely used in energy-sector studies to examine how human capital capabilities influence performance outcomes (Masiko et al., 2022). The research was conducted in the context of the Libyan oil and gas industry, which represents a strategically critical sector operating under conditions of political uncertainty, operational risk, and institutional constraints. These characteristics make the Libyan oil sector an appropriate setting for investigating how organizational conditions shape the effectiveness of technical expertise in driving performance outcomes (Waddams, 2023). Data were collected from employees working in Libyan oil companies, including petroleum engineers, technical specialists, and managerial staff who were directly involved in operational and organizational processes. A non-probability sampling approach was used due to access limitations commonly encountered in the oil and gas industry, particularly in unstable environments (Naja & ungku Ahmad, 2024). A total of 380 valid responses were obtained and retained for analysis, exceeding the minimum sample size requirements for structural equation modeling.

Measurement instruments for all constructs were adapted from previously validated scales and tailored to the oil and gas context. Petroleum engineering expertise was measured using items capturing technical knowledge, professional competence, and problem-solving capabilities relevant to petroleum engineering functions. Engineering expertise has been conceptualized as a multidimensional capability

reflecting both depth of knowledge and its effective application in complex operational environments (Yew et al., 2025). The inclusive work environment construct was measured through items assessing fairness, participation, respect, and psychological safety at work, consistent with established inclusion research (Rezai et al., 2023). Organizational performance was measured using perceptual indicators related to operational effectiveness, productivity, and overall organizational outcomes, which are commonly used in performance research within the energy sector (Abdulridha & Fathi, 2024). All measurement items were rated on a five-point Likert scale ranging from strongly disagree to strongly agree.

Data analysis was conducted using Partial Least Squares Structural Equation Modeling (PLS-SEM), which is suitable for prediction-oriented research and the examination of mediation relationships involving latent constructs. PLS-SEM has been recommended for human resource and organizational studies where the research objective is theory development and where data may not strictly satisfy normality assumptions (Legate et al., 2023). The analysis followed a two-stage procedure in which the measurement model was first evaluated for reliability and validity, followed by assessment of the structural model to test the hypothesized relationships. The mediating role of the inclusive work environment was examined using a bootstrapping technique, which provides robust estimates of indirect effects in mediation analysis (Manzoor et al., 2025). This methodological approach ensured analytical rigor and provided a reliable basis for evaluating the proposed conceptual framework.

4. Findings

This section presents the empirical findings of the study based on data collected from employees working in Libyan oil companies. The analysis was conducted using Partial Least Squares Structural Equation Modeling (PLS-SEM). The results are reported sequentially, beginning with preliminary data screening to assess normality, followed by evaluation of the measurement and structural models. Prior to hypothesis testing, the normality of the data was examined using skewness and kurtosis statistics for the main study constructs. As shown in Table 1, the skewness and kurtosis values for all variables fell within acceptable thresholds, indicating no severe deviations from normality. Petroleum engineering expertise exhibited a skewness value of 0.029 and a kurtosis value of −1.086. Inclusive work environment showed a skewness of −0.242 and a kurtosis of −0.306. Organizational performance recorded a skewness value of −0.091 and a kurtosis value of 0.653. These results suggest that the data distribution was suitable for subsequent multivariate analysis using PLS-SEM

Table 1. Normality test

	N	Skewness	Kurtosis
PEE	380	0.029	-1.086
IWE	380	-0.242	-0.306
OP	380	-0.091	0.653

PEEE: Petroleum Engineering Expertise; IWE: Inclusive Work Environment; OP: Organizational Performance

Descriptive statistics were examined to summarize respondents' perceptions of the main study variables. As presented in Table 2, petroleum engineering expertise recorded a mean value of 3.703 with a standard deviation of 0.558, indicating a relatively high level of perceived technical competence among respondents. The inclusive work environment construct reported a mean score of 3.583 and a standard deviation of 0.748, reflecting moderately positive perceptions with greater variability across respondents. Organizational performance exhibited a mean value of 3.644 with a standard deviation of 0.602, suggesting generally favorable assessments of performance outcomes within the surveyed oil companies. Overall, the descriptive results indicate that respondents perceived petroleum engineering expertise, inclusive work environment, and organizational performance to be present at moderate to high levels across the sampled organizations

Table 2. Descriptive Analysis

Items	N	Mean	Std. Deviation
PEE	380	3.703	0.558
IWE	380	3.583	0.748
OP	380	3.644	0.602

PEEE: Petroleum Engineering Expertise; IWE: Inclusive Work Environment; OP: Organizational Performance

The measurement model was evaluated to assess indicator reliability and construct validity prior to testing the structural relationships. The first-order measurement model results, as illustrated in Figure 1, indicate that the majority of indicators loaded strongly on their respective constructs. All retained items exhibited standardized factor loadings that met or exceeded commonly accepted thresholds, demonstrating adequate indicator reliability. The observed loading patterns confirm that the measurement items appropriately represented their underlying latent constructs, namely petroleum engineering expertise, inclusive work environment, and organizational performance. The results of the first-order model evaluation provided sufficient evidence to proceed with further reliability and validity assessment and subsequent structural model analysis

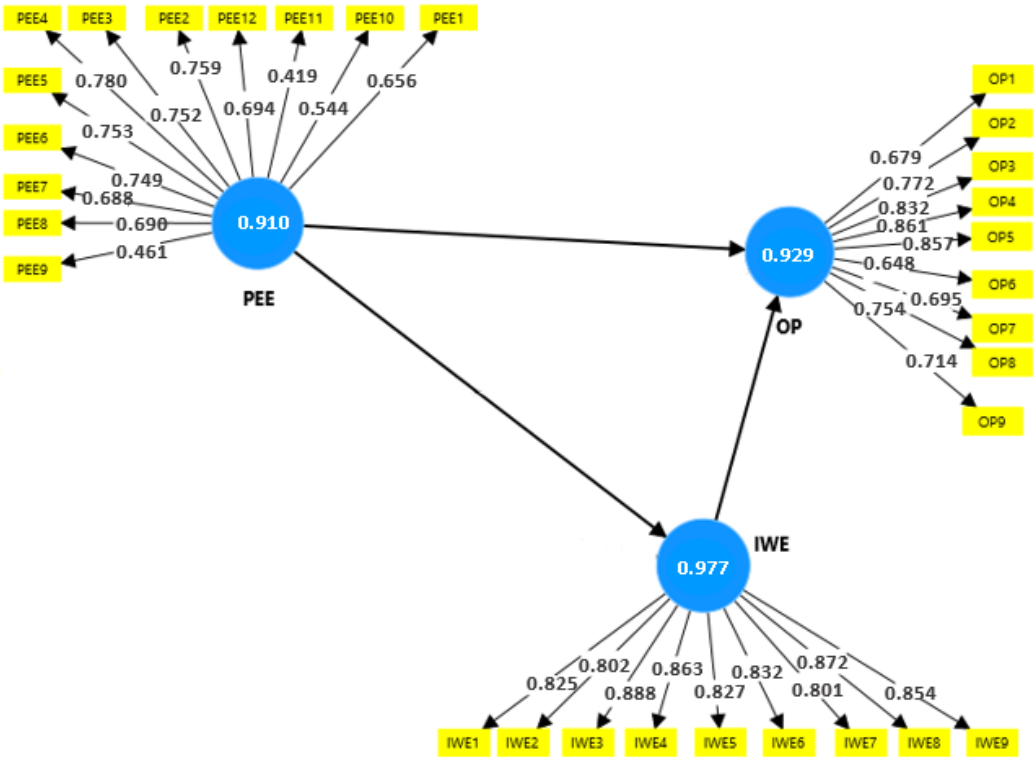

Figure 1. Evaluation of Measurement Model (First order)

Construct reliability and convergent validity were assessed using indicator loadings, Cronbach's alpha, composite reliability, and average variance extracted (AVE). As reported in Table 3, the inclusive work environment construct demonstrated strong internal consistency, with a Cronbach's alpha of 0.977 and a composite reliability value of 0.982, while its AVE value of 0.674 exceeded the recommended threshold, indicating satisfactory convergent validity. Organizational performance also exhibited high reliability, with a Cronbach's alpha of 0.929 and a composite reliability of 0.936, alongside an AVE value of 0.551, supporting adequate convergent validity. Petroleum engineering expertise showed acceptable internal consistency, with a Cronbach's alpha of 0.910 and a composite reliability of 0.917. Although the AVE value for petroleum engineering expertise was 0.431, this value is considered acceptable given the strong composite reliability and the exploratory nature of multidimensional technical capability constructs. Overall, the results indicate that the measurement model demonstrated adequate reliability and convergent validity, supporting its suitability for subsequent structural model analysis

Table 3. Construct Reliability and Validity -Initial Model measurements

	Loading	Cronbach's alpha	Composite reliability	Average variance extracted (AVE)
IWE1	0.825	0.977	0.982	0.674
IWE2	0.802			
IWE3	0.888			
IWE4	0.863			
IWE5	0.827			
IWE6	0.832			
IWE7	0.801			
IWE8	0.872			
IWE9	0.854			
OP1	0.679	0.929	0.936	0.551
OP2	0.772			
OP3	0.832			
OP4	0.861			
OP5	0.857			
OP6	0.648			
OP7	0.695			
OP8	0.754			
OP9	0.714			
PEE1	0.656	0.910	0.917	0.431
PEE10	0.544			
PEE11	0.419			
PEE12	0.694			
PEE2	0.759			
PEE3	0.752			
PEE4	0.780			
PEE5	0.753			
PEE6	0.749			
PEE7	0.688			
PEE8	0.690			
PEE9	0.461			

PEEE: Petroleum Engineering Expertise; IWE: Inclusive Work Environment; OP: Organizational Performance

Following the assessment of the first-order measurement model, a second-order measurement model was evaluated to confirm the hierarchical structure of the study constructs. As illustrated in Figure 2, the second-order model demonstrated adequate indicator loadings, indicating that the lower-order dimensions contributed meaningfully to their respective higher-order constructs. The observed loading patterns support the appropriateness of modeling petroleum engineering expertise, inclusive work environment, and organizational performance as higher-order constructs. The results of the second-order

measurement model evaluation confirmed the robustness of the construct structure and provided further support for proceeding to the assessment of discriminant validity and the structural mode.

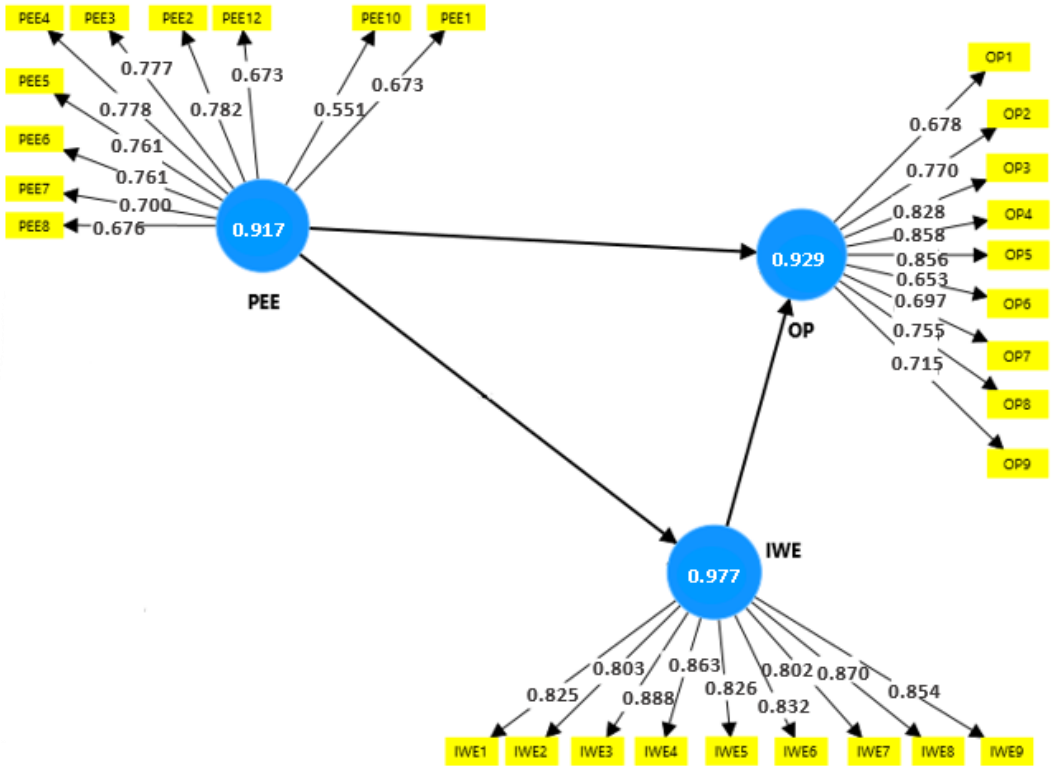

Figure 2. Evaluation of Measurement Model (Second Order)

The final measurement model was assessed to confirm the reliability and convergent validity of the refined constructs. As presented in Table 4, all retained indicators exhibited satisfactory standardized loadings on their respective constructs. The inclusive work environment construct demonstrated strong internal consistency, with a Cronbach's alpha of 0.977 and a composite reliability value of 0.982, while its average variance extracted (AVE) value of 0.674 exceeded the recommended threshold. Organizational performance also showed high reliability, with a Cronbach's alpha of 0.929 and a composite reliability of 0.935, alongside an AVE value of 0.550, indicating adequate convergent validity. Petroleum engineering expertise achieved acceptable internal consistency, with a Cronbach's alpha of 0.917 and a composite reliability of 0.923. Although the AVE value for petroleum engineering expertise was 0.489, this value was considered acceptable in light of the construct's strong composite reliability and the multidimensional nature of technical expertise. Overall, the final measurement model demonstrated satisfactory reliability and convergent validity, supporting its suitability for subsequent discriminant validity assessment and structural model evaluation

Table 4. Final Model measurements

	Loading	**Cronbach's alpha**	**Composite reliability**	**Average variance extracted (AVE)**
IWE1	0.825	0.977	0.982	0.674
IWE2	0.803			
IWE3	0.888			
IWE4	0.863			
IWE5	0.826			
IWE6	0.832			
IWE7	0.802			
IWE8	0.870			
IWE9	0.854			
OP1	0.678	0.929	0.935	0.550
OP2	0.770			
OP3	0.828			
OP4	0.858			
OP5	0.856			
OP6	0.653			
OP7	0.697			
OP8	0.755			
OP9	0.715			
PEE1	0.673	0.917	0.923	0.489
PEE10	0.551			
PEE12	0.673			
PEE2	0.782			
PEE3	0.777			
PEE4	0.778			
PEE5	0.761			
PEE6	0.761			
PEE7	0.700			
PEE8	0.676			

PEEE: Petroleum Engineering Expertise; IWE: Inclusive Work Environment; OP: Organizational Performance

Discriminant validity was assessed using the heterotrait–monotrait ratio of correlations (HTMT). As reported in Table 5, all HTMT values were below the recommended threshold, indicating adequate discriminant validity among the study constructs. The HTMT value between inclusive work environment and organizational performance was 0.347, while the HTMT value between petroleum engineering expertise and inclusive work environment was 0.303. The HTMT value between petroleum engineering expertise and organizational performance was 0.294. These results confirm that each construct was

empirically distinct from the others and that discriminant validity was satisfactorily established for the measurement model

Table 5. The heterotrait-monotrait ratio of correlations (HTMT)

	IWE	OP	PEE
IWE			
OP	0.347		
PEE	0.303	0.294	

PEEE: Petroleum Engineering Expertise; IWE: Inclusive Work Environment; OP: Organizational Performance

Discriminant validity was further examined using the Fornell–Larcker criterion. As presented in Table 6, the square roots of the average variance extracted (AVE) for each construct were greater than the corresponding inter-construct correlations. The square root of AVE for inclusive work environment was 0.801, which exceeded its correlations with organizational performance (0.323) and petroleum engineering expertise (0.281). Organizational performance exhibited a square root of AVE of 0.724, which was higher than its correlation with petroleum engineering expertise (0.270). Petroleum engineering expertise showed a square root of AVE of 0.683, exceeding its correlations with inclusive work environment (0.281) and organizational performance (0.270). These results provide additional evidence that discriminant validity was satisfactorily established among the study constructs

Table 6. Latent Variable Correlations (Fronell-Lacer criteria)

	IWE	OP	PEE
IWE	0.801		
OP	0.323	0.724	
PEE	0.281	0.270	0.683

PEEE: Petroleum Engineering Expertise; IWE: Inclusive Work Environment; OP: Organizational Performance

The explanatory power of the structural model was assessed using the coefficient of determination (R^2). As shown in Table 7, petroleum-engineering expertise explained 35.9% of the variance in inclusive work environment, with an adjusted R^2 value of 0.356. Organizational performance exhibited an R^2 value of 0.158, indicating that petroleum engineering expertise and inclusive work environment jointly explained 15.8% of the variance in organizational performance, with an adjusted R^2 of 0.150. These results indicate that the model demonstrated acceptable explanatory power for both inclusive work environment and organizational performance within the studied context.

Table 7. Coefficient of Determination R Square (R^2)

	R-square	R-square adjusted
IWE	0.359	0.356

OP	0.158	0.150

PEEE: Petroleum Engineering Expertise; IWE: Inclusive Work Environment; OP: Organizational Performance

The significance of the structural relationships was examined using the path model results obtained from the bootstrapping procedure. As illustrated in Figure 3, petroleum engineering expertise demonstrated a statistically significant positive effect on organizational performance, supporting the proposed direct relationship. Inclusive work environment also showed a significant positive effect on organizational performance, indicating its importance as a predictor of performance outcomes. In addition, petroleum engineering expertise exhibited a significant positive effect on inclusive work environment, confirming its influence on organizational climate conditions. The indirect path from petroleum engineering expertise to organizational performance through inclusive work environment was also found to be statistically significant, providing evidence of a mediation effect. Overall, the path model results supported all hypothesized relationships and confirmed the robustness of the proposed structural model

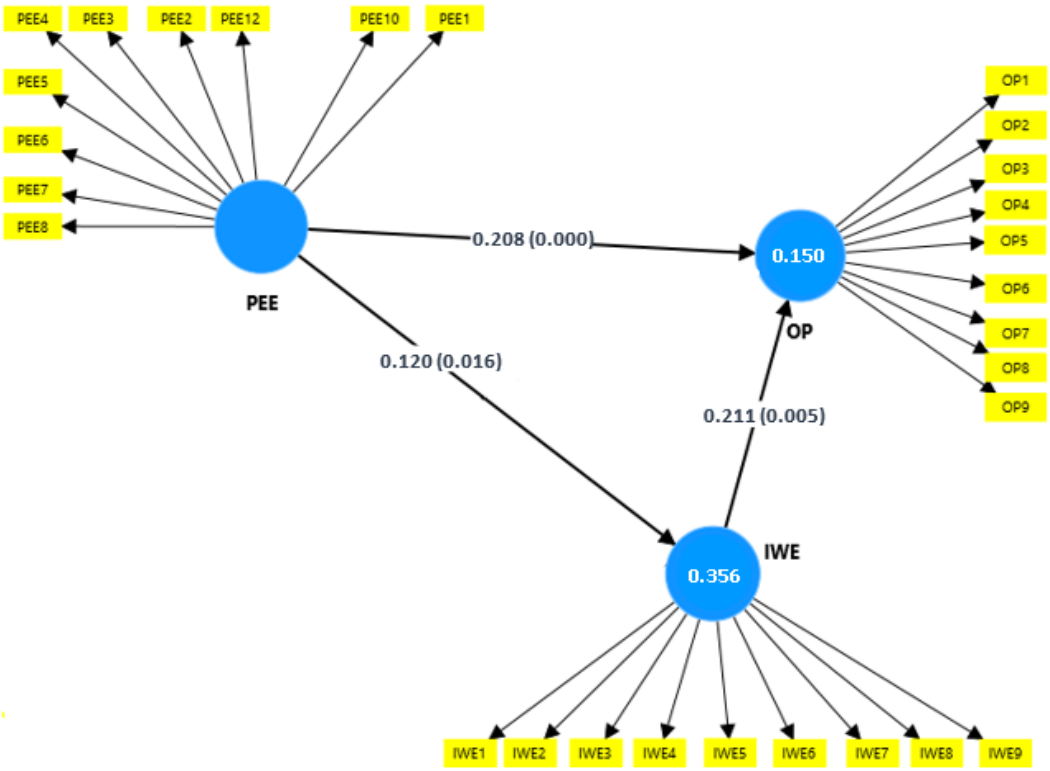

Figure 3. Path Model Significance Results

The results of hypothesis testing are presented in Table 8. The direct effect of petroleum engineering expertise on organizational performance was positive and statistically significant ($\beta = 0.208$, $t = 3.991$, $p < 0.001$), providing support for Hypothesis 1. Petroleum engineering expertise also demonstrated a significant positive effect on inclusive work environment ($\beta = 0.120$, $t = 2.549$, $p = 0.016$), supporting

Hypothesis 3. The relationship between inclusive work environment and organizational performance was found to be positive and significant (β = 0.211, t = 2.962, p = 0.005), confirming Hypothesis 2. Furthermore, the indirect effect of petroleum engineering expertise on organizational performance through inclusive work environment was statistically significant (β = 0.039, t = 2.332, p = 0.027), indicating the presence of a mediation effect and supporting Hypothesis 4. Overall, all proposed hypotheses were empirically supported, confirming the adequacy of the proposed structural model

Table 8. Summary result of all hypothesis Testing

Hypothesis	Paths	Std. Beta	Std. Deviation	T-Value	P values	Decision
H1	**PEE -> OP**	0.208	0.055	3.991	0.000	Accepted
H3	**PEE -> IWE**	0.120	0.049	2.549	0.016	Accepted
H2	**IWE -> OP**	0.211	0.075	2.962	0.005	Accepted
H4	**PEE -> IWE -> OP**	0.039	0.018	2.332	0.027	Accepted

PEEE: Petroleum Engineering Expertise; IWE: Inclusive Work Environment; OP: Organizational Performance

5. Discussion

This study examined how petroleum engineering expertise influences organizational performance in Libyan oil companies and demonstrated that this relationship is both direct and indirect through an inclusive work environment. The findings provide empirical evidence that technical expertise alone is not sufficient to maximize organizational performance unless it is supported by organizational conditions that enable effective expertise utilization. The significant positive effect of petroleum engineering expertise on organizational performance confirms the strategic importance of engineering capability in energy-sector organizations, particularly in technically complex and risk-intensive environments (Yew et al., 2025). This result reinforces the view that petroleum engineers play a critical role not only in operational efficiency but also in shaping broader organizational outcomes in the oil and gas industry (Boersma et al., 2025).

The direct relationship between petroleum engineering expertise and organizational performance is consistent with prior research highlighting the performance-enhancing role of technical competence in oil and gas projects and organizations. Technical competencies among engineers and project managers have been shown to contribute meaningfully to project success and operational effectiveness in petroleum contexts (Abdulla et al., 2023). Engineering-led decision-making has also been associated with improved risk management and performance stability at the corporate level, supporting the argument that technical expertise functions as a strategic human capital resource (Dissanayake et al., 2025). In the Libyan oil sector, where operational disruptions and institutional challenges are common, the ability of firms to rely on strong engineering expertise appears particularly important for sustaining performance.

Beyond this direct effect, the findings highlight the critical role of the inclusive work environment as an enabling organizational mechanism. The significant relationship between petroleum engineering

expertise and inclusive work environment suggests that organizations with stronger technical capabilities are more likely to cultivate environments that support participation, respect, and collaboration. From a resource-based perspective, this indicates that firms invest in organizational conditions that allow valuable technical resources to be effectively deployed (Ahn et al., 2022). Engineering expertise, when recognized and supported, can contribute to the development of inclusive climates that facilitate knowledge sharing and collective problem-solving (Ye & Zhao, 2023). The positive effect of inclusive work environment on organizational performance further underscores the importance of organizational climate in translating individual capabilities into collective outcomes. Inclusive workplaces have been shown to enhance employee performance by fostering psychological safety, engagement, and collaboration (Syakbandy & Rahmah, 2023). In knowledge-intensive industries, inclusion reduces barriers to communication and mitigates knowledge-hiding behaviors that can undermine performance (Miminoshvili & Černe, 2022). The present findings suggest that in Libyan oil companies, inclusive work environments play a vital role in supporting coordination and performance across technically diverse teams.

The mediation analysis provides particularly important theoretical insight by demonstrating that inclusive work environment partially mediates the relationship between petroleum engineering expertise and organizational performance. This finding aligns with human capital theory, which emphasizes that the productivity of specialized knowledge depends on the organizational context in which it is embedded (Rejab & bin Arshad, 2024). Even highly skilled engineers may be unable to fully contribute to organizational goals if they operate in exclusionary or rigid environments. By contrast, inclusive work environments enable engineers to apply their expertise more effectively through collaboration, voice, and shared decision-making (Rodríguez-Simmonds et al., 2023). These results also extend organizational culture and climate research by positioning inclusion as a strategic capability rather than merely a social or ethical consideration. Prior studies have shown that inclusive leadership and climates for inclusion strengthen employee outcomes and organizational effectiveness (Alghofeli et al., 2024). The current findings build on this literature by demonstrating that inclusion serves as a mechanism through which technical expertise is converted into performance outcomes in the oil and gas sector. This insight is particularly relevant in developing and transitional economies, where institutional constraints may limit the effectiveness of formal structures and place greater importance on informal organizational processes (Ghumiem et al., 2023).

The Libyan context adds further depth to the interpretation of these findings. Libya's oil industry operates under conditions of political instability, workforce fragmentation, and operational risk, which heighten the need for effective coordination and trust within organizations (Waddams, 2023). The significant mediating role of inclusive work environment suggests that inclusion may help mitigate some of these contextual challenges by fostering cooperation and reducing internal friction. Strategic leadership research in Libyan oil firms has emphasized the importance of organizational practices in shaping performance outcomes, and the present study provides empirical support for this argument by identifying inclusion as a key organizational lever (Naja & ungku Ahmad, 2024). From a practical perspective, the findings imply that oil company leaders should view investments in engineering capability development and inclusive organizational practices as complementary rather than independent initiatives. Developing future-ready petroleum engineers requires not only technical training but also organizational

environments that encourage participation and knowledge sharing (Yew et al., 2025). Inclusive work environments can enhance the return on investment in technical human capital by ensuring that expertise is effectively utilized rather than underexploited. In energy-sector organizations facing increasing complexity and uncertainty, aligning technical capability development with inclusive organizational design may be essential for sustaining performance.

6. Conclusion

This study examined the relationship between petroleum engineering expertise and organizational performance in Libyan oil companies, with particular attention to the mediating role of an inclusive work environment. The findings demonstrate that petroleum engineering expertise contributes directly to organizational performance and also exerts an indirect influence by shaping the inclusiveness of the work environment. These results highlight that technical capability alone is not sufficient to achieve optimal organizational outcomes unless it is supported by organizational conditions that enable effective expertise utilization. The study makes several important contributions. It advances understanding of how technical expertise functions as a strategic organizational resource by showing that its performance effects are partly contingent on inclusive organizational climates. By positioning the inclusive work environment as a mediating mechanism, the study moves beyond traditional views that treat engineering expertise and organizational performance as a simple direct relationship. Instead, it emphasizes the importance of organizational context in translating individual and collective technical capabilities into sustained performance outcomes. From a practical standpoint, the findings suggest that leaders in oil and gas organizations should adopt a holistic approach to performance improvement. Investments in developing petroleum engineering expertise should be complemented by efforts to foster inclusive work environments that encourage participation, collaboration, and knowledge sharing. Such alignment can enhance coordination across technical teams, improve decision-making, and maximize the performance returns of specialized human capital, particularly in complex and high-risk operating environments.

The Libyan oil sector provides a unique and underexplored context for this research. Operating under conditions of political uncertainty and operational challenges, Libyan oil companies face significant pressure to optimize the use of scarce technical expertise. The results of this study indicate that inclusive organizational practices can play a critical role in strengthening organizational performance under such conditions. By fostering environments that support trust and cooperation, oil companies may be better positioned to navigate uncertainty and sustain performance. Despite its contributions, this study has limitations that offer directions for future research. The cross-sectional design limits the ability to draw causal inferences, and future studies could adopt longitudinal approaches to examine changes over time. Additionally, future research may extend this model to other energy-producing countries or explore additional organizational mechanisms that influence the relationship between technical expertise and performance. Overall, this study provides valuable insights into how petroleum engineering expertise and inclusive work environments jointly shape organizational performance in the oil and gas industry.

7. References

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