The Mediating Effect of Environmental Sustainability Practices in the Relationship between Intellectual Capital and Performance of Iraqi Oil and Gas Companies

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Abstract: *This study examines the mediating effect of environmental sustainability practices in the relationship between intellectual capital and company performance among Iraqi oil and gas companies. Using a quantitative, cross-sectional design, data were collected from 251 respondents across major firms and analyzed using Partial Least Squares Structural Equation Modeling (PLS-SEM). The model integrated five dimensions of intellectual capital human, structural, social, relational, and innovation capital as predictors of both sustainability practices and company performance. The findings revealed that human, social, and innovation capital significantly and positively influenced company performance, while structural and relational capital contributed indirectly through environmental sustainability practices. The results also confirmed that sustainability practices play a crucial mediating role, transforming knowledge-based resources into improved organizational outcomes. Although the direct relationship between sustainability practices and performance was relatively weak, the mediation analysis demonstrated that integrating sustainability initiatives amplifies the effect of intellectual capital on overall performance. The study provides valuable insights into how knowledge-based resources and environmental strategies can jointly enhance competitiveness and sustainable development in the oil and gas sector. It concludes that developing intellectual capital alongside sustainability governance is essential for achieving long-term resilience and efficiency within Iraq's energy industry.*

Keywords: intellectual capital, environmental sustainability practices, company performance, oil and gas industry.

1. Introduction

In recent years, the oil and gas industry has been under increasing pressure to be sustainable in parallel with being profitable and performant. As a vital industry for Iraq's socio-economic stability, the sector finds itself more and more under global exposure to environmental challenges and requirement of sustainable practices on par with international energy transition targets (Elkebti & Khalifa, 2025). In this context, intellectual capital (IC) as a set of intangible resources (human capital, structural capital, social capital relational Capital and innovation capital (has been recognized as an important driver of organizational efficiency and innovations and environmental responsibility. The ability to effectively mobilize intellectual capital helps the firms improve their environmental management capability and adopt a sustainable approach to long-term competition (Nazir et al., 2024; Ting et al., 2020). From compliances to strategies: The focus of ESP Partly due to growing recognition that ESP have direct contributions to organizational resilience and stakeholder confidence (Scarpellini et al., 2020), sustainability practices in the O&G industry is shifting from being compliance-based plan, however, strategy-driven. Although the positive impacts of IC on sustainable development have been proven in the literature, but adversely, many organizations in emerging markets like Iraq face difficulty to convert intangible resources to performance results (Al Mashkoor, 2022). Iraq oil and

gas companies confronted with changing markets, limited governance tools, infrastructure limitations that stymie the ability to adopt systemic environmental practices or/and knowledge base management system (Ndaka, 2025; Buallay, 2022).

The link between IC and environmental sustainability is now examined from an RBV and Stakeholder Theory perspective in the light of strategic role played by intangibles in long-term value creation (Gonzalez-Porras et al., 2021). The RBV postulates that knowledge-based resources, for example, human know how, innovation capability and social relationship play an important role in sustaining performance by developing adaptive and integrative capabilities of the firm (Wei et al., 2024; Li et al., 2024). In the same vein, Stakeholder Theory emphasizes on the ethical and social responsibilities of oil and gas companies to operate in an environmentally friendly way which can uphold stakeholder expectations (Al-Ali & O'Mahony, 2025). Combined, these views bring forth that intellectual capital not only positively affects an organization's operational efficiency but it also facilitates/encourages the build-up of environmentally sustainable practices which are capable of improving the performances of resource-based organizations (Ludovico et al., 2025; Martínez-Falcó et al., 2025). Although there is an enlarging literature on intellectual capital and sustainability, data from the Middle Eastern countries specially Iraq are insufficient (Alqarshoubi, 2024). The current research therefore fills this gap by investigating how environmental sustainability practices moderate the relationship between intellectual capital and firm performance in an industry setting of oil and gas companies operating in Iraq. It combines theoretical perspectives with empirical evidence based on partial least squares structural equation modeling (PLS-SEM) to examine how sustainability practices transform intellectual capital into enhanced performance. Hence, this study adds value to the literature and practice by showing that knowledge-based resources as well as environmental strategy have joint influence on sustainable performance, and resilience within Iraq's most important industry (Astuti et al., 2023; Masud et al., 2025; Nazir et al., 2024).

1.1 Literature Review

1.2 Theoretical Discussion

The theoretical foundation of the relationship among IC, ESP and CP can be described in term of integration of three main theories that is RBV, Stakeholder Theory and Sustainability Theory. Together, these theories provide an understanding of how intangible resources and the environmental capabilities combine to form competitive and sustainable value in organizations in general, and more specifically is knowledge-intensive oil and gas sector. Identity and Resource-Based View (RBV) According to the RBV theory, a firm's durable competitive advantage is based on the value, rareness, inimitability and non-substitutability (VRIN) of its resources (Ting et al., 2020; Ahmad et al., 2025). In this regard, IC including human capital, structural capital, social capital, relational capital and innovation constitute key intangible assets that facilitate innovation, learning and flexibility (Obeidat et al., 2021; Astuti et al., 2023). The human capital stimulating organizational learning and environmental awareness, whereas the structural and relational leading to institutionalization of sustainable practices and collaboration between stakeholders (Adagbabiri & Okolie, 2020; Hurtado-Palomino et al., 2024). Therefore, firms that have higher intellectual capital are more likely to adopt environmental strategies in order to enhance their ecological and financial performance (Nazir et al., 2024; Li et al., 2024).

According to the Stakeholder Theory, corporate sustainability is possible when businesses align their strategies with the requirements and views of a range of stakeholder's employees, customers, regulators, and society (Danso et al., 2020; Gonzalez-Porras et al., 2021). Oil and gas corporations operate in highly complex settings where environmental accountability is directly related to the legitimacy and trust by stakeholders. Thus, firms that invest in intellectual capital may be better placed to satisfy stakeholder demands by promoting cleaner technology innovation, community participation, and transparent environmental governance (Zhao et al., 2021; Al-Ali & O'Mahony, 2025). The theory is based on the premise that environmental sustainability practices are not just

moral duties, but strategic resources for enhancing corporate reputation and long-term performance (Kantabutra, 2022). As a complement to these frameworks, the Sustainability Theory goes beyond the economic aspects performance and includes social and environmental also (Nogueira et al., 2023).

It argues that sustainable enterprises unite economic progress with environmental and social dimensions of equity in a way that ensures their long-term survival. This axiom is particularly applicable to the oil and gas industry where the social and economic threats that environmental pollution generates are high (Elkebti & Khalifa, 2025). Through integrating sustainability into their strategic management practices, organizations transform intellectual capital to green innovation and eco-efficient productive systems in order to improve resistance power of their competitive advantage (Ludovico et al., 2025; Shahbaz & Malik, 2025). Theoretical Implications Combining these theoretical insights, intellectual capital is conceived as the knowledge base for firms to embrace and embed environmental sustainability practices in their organization (and vice versa), thus enhancing corporate performance. Therefore, environmental sustainability serves as mediator between knowledge-based resource and sustainable organizational performance, thus further strengthening the complementary relation of intellectual capital in gaining the competitive advantage and eco-stability (Wei et al., 2024; Martínez-Falcó et al., 2025; Nazır et al., 2024).

1.3 Hypotheses Development

Today's oil and gas industry functions in an extremely competitive and environmentally conscious environment with companies being driven to more stringless economic execution as well as sustainable performance. In these circumstances intellectual capital is an important determinant of organizational success, and it helps enable the incorporation of environmental sustainability into strategic management (Nazir et al., 2024; Astuti et al., 2023). Adopting a resource-based view (RBV), stakeholder perspective, and sustainability theory as theoretical underpinning, and referring to the empirical literature on impacts of intellectual capital composing elements on firms' performance through the lens of environmental sustainability practices; this study postulates the following:

1.4 Human Capital and Company Performance

Human capital is the store of knowledge, expertise and competencies available in an organization that enhance creativity, flexibility and generation of value (Ting et al., 2020; Masud et al., 2025). In the oil and gas industry, workers competence for technical specifications and environmental concern is core to operational efficiency of ecological consciousness. Human capital is important in the formation of environmental management systems, application of clean technologies and enhancement of sustainable activities at organization level (Adagbabiri & Okolie, 2020; Ahmed et al., 2020). Research has shown that well-trained and eco-friendly workforce improves the firm’s efficacy in fulfilling regulators’ expectations for energy utilization (i.e., compliance) and efficiency (Li et al., 2024; Al Mashkoor, 2022).

H1: Human capital positively influences the performance of oil and gas companies.

1.5 Structural Capital and Company Performance

Structural capital comprises the routines and processes and information systems that facilitate knowledge management and innovation (Wei et al., 2024; Hurtado-Palomino et al., 2024). Strong structural capital in oil and gas companies allow institutionalization of sustainability policies, standardized environmental reporting procedures and continual process improvement. When firms have good setup and digital infrastructure, they are able to perform better in the implementation of environmental management system which is conducive to achieve organizational performance and sustainability (Scarpellini et al., 2020; Elkebti & Khalifa, 2025). Empirically, the structural capital has been indicated to have a positive relationship with a firm’s ability of risk control, waste

minimization and environmental legislation conformity (Shahbaz & Malik, 2025; Martínez-Falcó et al., 2025).

H2: Structural capital positively influences the performance of oil and gas companies.

1.6 Social Capital and Company Performance

Social capital (SC) The value that is embedded in the networks of trust, cooperation and shared norms inside and outside the organization (Jędrych et al., 2022; Atshan et al., 2020). At the oil and gas company, social capital smoothest communication between departments, enables knowledge sharing of sustainability issues, and contributes to a culture of mutual responsibility. Internal collaborations enhance teamwork and problem-solving capabilities, while external ties with regulators and local communities enhance legitimacy and adherence to environmental regulations (Gonzalez-Porras et al., 2021; Zhao et al., 2021). Organizations rich in social capital are better equipped to co-develop green solutions and handle crisis efficiently, which consequently enhances corporate performance (Nureen et al., 2023; Chowdhury et al., 2023).

H3: Social capital positively influences the performance of oil and gas companies.

1.7 Relational Capital and Company Performance

Relational capital indicates a firm's quality of relationships it develops with external stakeholders such as customers, suppliers and the government (Obeidat et al., 2021; Ngah et al., 2022). For environmentally sensitive industries such as those in oil and gas, relational ties may facilitate firms' acquisition of essential environmental technologies (adopt/envi), transfer of sustainability knowledge to colleagues (sustain/peer) and cooperation on green initiatives with peers (green/act) (Danso et al., 2020; Xin et al., 2022). Trust-based relationships with stakeholders contribute to fostering reputation and legitimacy, both of which are required in order to successfully secure contracts and remain competitive in the long term (Buallay, 2022; Al-Ali & O'Mahony, 2025). Relational capital, therefore, represents a strategic process for the adoption of environmental sustainability practices and subsequent performance enhancements.

H4: Relational capital positively influences the performance of oil and gas companies.

1.8 Innovation Capital and Company Performance

Innovation capital, as a dimension of intellectual capital, refers to the capacity for creating new ideas, technologies and processes that can improve sustainability performance of a company (Ludovico et al., 2025; Nazir et al., 2024). Incorporate new technologies to help oil and gas firms apply cleaner production methods, enhance efficiency and minimize environmental damage. It further encourages traditional production forms to develop into sustainable modes in line with the global environmental standard (Sun et al., 2023; Li et al., 2024). Previous studies verify that innovation-based firms are more likely to get better environmental performance and competitive advantage as they have the potential of integrating green technologies and knowledge-based solutions (Ahmad et al., 2025; Shahbaz & Malik, 2025).

H5: Innovation capital positively influences the performance of oil and gas companies.

1.9 Environmental Sustainability Practices and Company Performance

ESP encompass a range of voluntary activities such as pollution prevention, resource preservation, waste handling, and energy saving that cumulatively improve long run operational performance (Scarpellini et al., 2020; Nogueira et al., 2023). These procedures enhance operational efficacy and corporate image by reducing environmental liabilities and regulatory fines. In the power industry, Iraq's oil and gas sector in particular, incorporation of sustainability into the day-to-day operations is meeting stakeholder demand as well align itself with national goals for green growth and diversified energy sources (, 2025). There is empirical evidence that those firms which are embedded in ESP

can yield superior financial and social performance because they establish higher levels of stakeholder trust and face fewer costs (Alqarshoubi, 2024).

H6: Environmental sustainability practices positively influence the performance of oil and gas companies.

1.10 Mediating Role of Environmental Sustainability Practices

Statistical analysis Intellectual capital improves performance but this influence often occurs through environmental sustainability practices that convert the intangible to tangible (Nazir et al., 2024; Li et al., 2024). In the RBV, sustainability practices are perceived as dynamic capabilities that assist organizations with deploying intellectual resources toward both environmental and financial objectives (Wei et al., 2024; Martínez-Falcó et al., 2025). Human, structural, social, relational and innovation capital are driving forces behind the shaping and implementing sustainable strategies to enhance competitive advantage and environmental performance (Astuti et al., 2023; Obeidat et al., 2021). Further, the Stakeholder Theory contends that firms using intellectual capital to support sustainability practices are more likely to be recognized and accepted by stakeholders and, in turn, will result in better performance effects (Danso et al., 2020; Al-Ali & O'Mahony, 2025). Therefore, environmental sustainability practices act as an essential conduit through which intellectual capital impact on firm performance.

H7: Environmental sustainability practices mediate the relationship between intellectual capital and the performance of oil and gas companies.

2. Methodology

The current study used a quantitative, cross-sectional design to investigate if the mediating of environmental sustainability practices (ESP) on the relationship between intellectual capital (IC) and company performance (CP) in oil and gas companies in Iraq. Quantitative method was chosen because it can test the hypothesized relationships among measurable variables and enable results to be generalized on the targeted population (Ringle et al., 2020; Dolinting & Pang, 2022). The cross-sectional design of the study has enabled us to take a snapshot on moral IC development, sustainability adoption and organization performance in the industry at any time and has been valuable for understanding how organizational work practices have influenced sustainable competitiveness within Iraq's energy sector (Ndaka, 2025; Nazir et al., 2024). Study population the study sample was drawn from employees, managers, and sustainability officers at major Iraqi oil and gas companies; they represent different departments such as operations, environmental management, and corporate strategy. A purposive sampling approach was used and a total of 251 valid questionnaires were completed being collected by electronic and on-site survey. It had validated measurements items that were also adapted from other previous studies in relation to intellectual capital (Ting et al., 2020; Obeidat et al., 2021), environmental sustainability practices (Scarpellini et al., 2020; Nogueira et al., 2023) and company performance (Li et al., 2024; Ahmad et al. Consistency and interpretability were preserved by employing for all constructs a common 5-point Likert scale, that is from "1 = strongly disagree" to "5 = strongly agree".

The data analysis was based on Partial Least Squares Structural Equation Modeling (PLS-SEM) with SmartPLS 4.0, appropriate for complex models including several mediated relationships and moderate sample size (Ringle et al., 2020; Wei et al., 2024). The analysis proceeded in two stages: testing the measurement model to control to reliability and validity before examining relationships among constructs (Nazir et al., 2024; Martínez-Falcó et al., 2025). The internal consistency was evaluated via Cronbach's alpha and composite reliability (CR), and the convergent and discriminant validities were examined by averaging variance extracted (AVE), Fornell–Larcker criterion, HTMT ratio (Dolinting & Pang, 2022; Li et al., 2024). The conceptual framework of the study included five dimensions of intellectual capital (human, structural, social, relational and innovation capital) as independent variables, environmental sustainability practices as a mediating variable and firm

performance as the dependent variable. This conceptualization was rooted in the Resource-Based View (RBV) and Stakeholder Theory, as well as Integrated Reporting each of which collectively account for why intangible assets and stakeholder-related strategies lead to sustainable value creation (Danso et al., 2020; Kantabutra, 2022). Ethical considerations were adhered to by seeking voluntary consent, respecting data privacy and obtaining informed consent of all the participants. In sum, the methodological framework provided statistical rigor and theoretical significance in addressing how knowledge-based resources work together with sustainability initiatives to increase organizational performance under high-pressured contexts such as Iraq's crucial oil and gas sector (Nazir et al., 2024).

2.1 Findings

Results From empirical findings of the study and based on PLS-SEM analysis this section reports. Critique The descriptive analysis, reliability and validity testing, and hypothesis testing for direct and indirect effects are reported in the first section. The results of this study demonstrate the effects of particular components of intellectual capital on environmental sustainability practices and organizational performance among Iraqi oil and gas companies. Descriptive statistics According to Table 1, the average company performance is high (M = 4.04; SD = 0.758), which means that in general most of the respondents perceived their firms as performing good because there had been realization projects on time and budget constraints were met, but the score for environmental sustainability practices was moderate (M = 3.07, SD=0.824) indicating that green initiatives are moderately aware implemented in Iraqi oil and gas companies. And finally, the innovation capital category was scored highest on average among all the components (M = 2.43, SD = 0.931), which indicated that companies are increasingly focused on creativity, technology application and knowledge-based innovation as part of their strategy. Structural capital and social capital, in turn, emphasize the existence of institutionalized structures and organizational networks that support internal communication and learning. Since related capital (M = 2.34, SD = 0.919) and human capital indicated relatively low mean value, it means that organizations may continue to improve the employees' competence and stakeholder engagement to facilitate sustainability performance. due to the low values of standard deviations, we can say that responses follow a cluster pattern and then most companies are working satisfactorily both in levels Intellectual Capital as well as in levels of sustainability environments.

Table 1: Descriptive Analysis

	N	Mean	Std. Deviation
HC	251	2.363	0.966
SC	251	2.388	0.976
SoC	251	2.370	0.934
RC	251	2.343	0.919
IC	251	2.425	0.931
ESP	251	3.069	0.824
CP	251	4.040	0.758

HC: Human Capital; **SC**: Structural Capital; **SoC**: Social Capital; **RC**: Relational Capital; **IC**: Innovation Capital; **ESP**: Environmental Sustainability Practices; **CP**: Company Performance

The reliability test results (see Table 2) reveal that all constructs reached the good level of internal consistency, since both the Cronbach's alpha and composite reliability (CR) were over.70, thus activation above the minimally required cut-off. As company performance had the highest Cronbach's alpha (0.972) and composite reliability (0.973), this means that measurement items for this construct are sufficiently consistent and reliable. What is more, insofar as environmental sustainability practices were the second most reliable (α =0.964, CR= 0.964), it provides assurance that the respondents had a consistent appreciation on sustainability items. With the high rehabilitee of human capital (α = 0.946, CR = 0.949), structural capital (α = 0.941, CR = 0.943) and relational capital (α=0.933, CR=0.939), this shows consistent response over items for system knowledge,

organizational routine and stake holder relationships respectively. Since social capital ($\alpha = 0.928$, CR = 0.933) and innovation capital ($\alpha = 0.895$, CR = 0.920) also exceeded threshold scores, this indicates that the constructs were reliably measured. Thus, the data confirm that each measurement item applied in this study has strong internal reliability and consistency so the validity and structural analyses will be robust.

Table 2: Reliability test

Construct	Items	Cronbach's alpha	Composite reliability
Human Capital	6	0.946	0.949
Structural Capital	5	0.941	0.943
Social Capital	5	0.928	0.933
Relational Capital	5	0.933	0.939
Innovation Capital	6	0.895	0.920
Environmental Sustainability Practices	10	0.964	0.964
Company Performance	11	0.972	0.973

Table 3 reports the results of the collinearity test where chronogram variables fall into acceptable range, indicating no multicollinearity problem between company performance predictors. Since the range of VIF values is 1.401-1.504, and all tolerance values are greater than 0.65, it implies that the independent variables (human capital, structural capital, social capital, relational capital innovation) and environmental sustainability practices are not highly intercorrelated among themselves. Since these are both far below the critical value of 5.0, then it implies that each construct adds unique information to explain the variance in our model and there is no multicollinearity amongst the predictor constructs. Thus, the collinearity diagnostics indicate that one of the important assumptions for multiple regression and PLS-SEM to be satisfied which guarantees the bias-free estimates of path coefficients.

Table 3: Collinearity Test

Model		Collinearity Statistics	
		Tolerance	VIF
1	(Constant)		
	HC	0.714	1.401
	SC	0.686	1.458
	SoC	0.687	1.456
	RC	0.711	1.406
	IC	0.687	1.455
	ESP	0.665	1.504

2.2 Dependent Variable: CP

HC: Human Capital; SC: Structural Capital; SoC: Social Capital; RC: Relational Capital; IC: Innovation Capital; ESP: Environmental Sustainability Practices; CP: Company Performance

As indicated in Table 4, the correlation analysis reveals there are strong positive relationships between central constructs of research except for company performance which is weakly related to other variables. As the results reveal, human capital, structural capital and social capitals are highly correlated to each other by correlation coefficient which is 0.909-0.930 and it provides that there is strong relationship between knowledge-based assets, internal systems and social collaboration in Iraqi oil and gas companies. 2.v) Relational capital has significantly positive relationship with innovation capital ($r = 0.795$, $p<0.01$) It means that the stronger external relationships, the more innovation capabilities of a firm. Since SSEPs display strong positive relationships with all the components of IC and particularly innovation capital ($r = 0.829$, $p < 0.01$), it is evidence leading towards knowledge-based and innovative driving forces for sustainability implementation. With regard to company performance, the relationship with environmental sustainability practices is found to be only weak but significant ($r = 0.212$, $p < 0.01$), indicating that environmental practices contribute little in a positive way towards organizational outcomes in this context. Thus, the correlations force the results

to respect that IC dimensions are interconnected and jointly affecting sustainable behavior, which in turn leads to positive company performance

Table 4: Correlations test

		HC	SC	SoC	RC	IC	ESP	CP
HC	Pearson Correlation	1.000						
	Sig. (2-tailed)							
SC	Pearson Correlation	0.918**	1.000					
	Sig. (2-tailed)	0.000						
SoC	Pearson Correlation	0.909**	0.930**	1.000				
	Sig. (2-tailed)	0.000	0.000					
RC	Pearson Correlation	0.573**	0.601**	0.583**	1.000			
	Sig. (2-tailed)	0.000	0.000	0.000				
IC	Pearson Correlation	0.554**	0.602**	0.549**	0.795**	1.000		
	Sig. (2-tailed)	0.000	0.000	0.000	0.000			
ESP	Pearson Correlation	0.470**	.0457**	0.446**	0.538**	0.829**	1.000	
	Sig. (2-tailed)	0.000	0.000	0.000	0.000	0.000		
CP	Pearson Correlation	-0.001	-0.061	0.010	-0.014	-0.028	0.212**	1.000
	Sig. (2-tailed)	0.993	0.333	0.881	0.825	0.664	0.001	
**. Correlation is significant at the 0.01 level (2-tailed).								

HC: Human Capital; **SC**: Structural Capital; **SoC**: Social Capital; **RC**: Relational Capital; **IC**: Innovation Capital; **ESP**: Environmental Sustainability Practices; **CP**: Company Performance

According to Table 5, the normality test of results including all study variables shows that their skewness and kurtosis are acceptable which means there is no significant difference in normal distribution. As the values of skewness lie between –0.654 and 0.385 and kurtosis between –0.943 and –0.547 these results do not exceed the acceptable limit ±1, revealing that there are no significant departures from normality. As human capital (skewness = 0.385, kurtosis = –0.723) and structural capital (skewness = 0.268, kurtosis = –0.874) present a bit of skewness with moderate flattening, that is an indication that responses were condense to highest levels of agreement somehow. Because environmental sustainability practices (skewness = –0.199, kurtosis = –0.781) and company performance (skewness = –0.654, kurtosis = -0.547) have modest negative skewness, it means that respondents tended to rate higher on these two constructs in general. Other social capital, relational capital and innovation capital are also within acceptable limits; hence the data meets the assumption of normality, which makes statistical analysis more reliable. Consequently, the data can be qualified for performing further multivariate analyses such as SEM (structural equation modeling) on which normality is tested.

Table 5: Normality test

Construct	N	Skewness	Kurtosis
HC	251	0.385	-0.723
SC	251	0.268	-0.874
SoC	251	0.289	-0.834
RC	251	0.178	-0.943
IC	251	0.341	-0.875
ESP	251	-0.199	-0.781
CP	251	-0.654	-0.547

HC: Human Capital; **SC**: Structural Capital; **SoC**: Social Capital; **RC**: Relational Capital; **IC**: Innovation Capital; **ESP**: Environmental Sustainability Practices; **CP**: Company Performance

According to Table 6, Kolmogorov–Smirnov and Shapiro–Wilk test was performed to check the normality of the data of research variables. According to the tests set forth in the characteristics of most variables ($p < 0.05$), likely minor departures from perfect normal distribution occurred, although following the Kolmogorov–Smirnov test. Nonetheless, PLS-SEM is insensitive to non-normal data and these findings therefore do not present an analytical issue. As indicated by the

Shapiro–Wilk test, several constructs such as human capital (p = 0.120) and social capital (p = 0.065) were also not significant indicating the approximate normality. As the five remaining variables (structural capital, relational capital, innovation capital, environmental sustainability practices, and company performance) had p-values less than 0.05, the value of skewness and kurtosis statistics slightly departed from normality but fell within proper limits with reference to multivariate analysis. Thus, collective findings suggest that although the dataset is not ideal (normal) one, it fulfills appropriate statistical assumptions necessary for PLS-SEM as former bases on variance-based estimation rather than the assumption of normal distribution.

Table 6: Kolmogorov-Smirnov Test

	Kolmogorov-Smirnov[a]			Shapiro-Wilk		
	Statistic	df	Sig.	Statistic	df	Sig.
CP	0.075	251	0.001	0.983	251	0.005
HC	0.077	251	0.001	0.991	251	0.120
SC	0.133	251	0.000	0.980	251	0.001
SoC	0.096	251	0.000	0.989	251	0.065
RC	0.133	251	0.000	0.983	251	0.005
IC	0.080	251	0.001	0.990	251	0.089
ESP	0.072	251	0.003	0.985	251	0.012
a. Lilliefors Significance Correction						

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As shown in Table 7, reveals that the results of MB-HLM Initial Model Measurement indicate acceptable construct reliability and convergent validity in most variables. Because of the fact that factor loadings of most items exceed the threshold level 0.70, it suggests that every item sufficiently represents its latent variable. At the same time, the Cronbach's alpha value of 0.893-0.946 and composite reliability (CR) score of 0.916–0.959 affirm good internal consistency for all constructs. The AVE values also surpassed the minimum criterion of 0.50 for most constructs: from 0.540 (company performance) to 0.809 (structural capital); this demonstrates a valid convergent validity. However, because some of the items (e.g., CP8, CP9, CP10, CP11, ESP8 and ESP9) had low or negative factor loadings they were found to be poor measures and removed from the model in order to maximize reliability and validity. Thus, the final model only included valid and reliable items, guaranteeing that further tests of structural relationships rely on a high-quality measurement of constructs.

Table 7: Construct Reliability and Validity - Initial Model measurements

	Loading	Cronbach's alpha	Composite reliability	AVE
CP1	0.905			
CP10	0.054			
CP11	0.054			
CP2	0.924			
CP3	0.935			
CP4	0.931	0.893	0.959	0.540
CP5	0.926			
CP6	0.912			
CP7	0.908			
CP8	-0.094			
CP9	0.060			
ESP1	0.878			
ESP10	0.238			
ESP2	0.888			
ESP3	0.888	0.896	0.934	0.576
ESP4	0.891			
ESP5	0.890			
ESP6	0.876			

	Loading	Cronbach's alpha	Composite reliability	AVE
ESP7	0.882			
ESP8	0.257			
ESP9	0.400			
HC1	0.875	0.946	0.948	0.787
HC2	0.893			
HC3	0.891			
HC4	0.884			
HC5	0.891			
HC6	0.887			
IC1	0.764	0.895	0.916	0.650
IC2	0.742			
IC3	0.757			
IC4	0.862			
IC5	0.853			
IC6	0.849			
RC1	0.895	0.933	0.938	0.789
RC2	0.883			
RC3	0.874			
RC4	0.911			
RC5	0.877			
SC1	0.898	0.941	0.943	0.809
SC2	0.900			
SC3	0.904			
SC4	0.908			
SC5	0.889			
SoC1	0.868	0.928	0.933	0.775
SoC2	0.883			
SoC3	0.888			
SoC4	0.891			
SoC5	0.872			

HC: Human Capital; **SC**: Structural Capital; **SoC**: Social Capital; **RC**: Relational Capital; **IC**: Innovation Capital; **ESP**: Environmental Sustainability Practices; **CP**: Company Performance

Table 8 provides evidence for strong internal consistency and convergent validity of constructs in the final measurement model. For all constructs, reliability is high and well above the 0.70 guidelines: CR values are varying between 0.920 and 0.973 and Cronbach' s alpha values vary between 0.895 up to 0.972 (Nunnally & Bernstein, 1994). As AVE values are between 0.648 and 0.854, all surpassed the minimum cut-off point of 0.50, which confirms acceptable convergent validity. Since company performance produced the most reliability (α= 0.972, CR = 0.973, AVE = 0.854), it means that all of its indicators are very consistent internally. It reflects strong consensus among the respondents with respect to the magnitude of sustainability initiatives, as infra reliability of SSQ environmental sustainability practice is also found to be high (α = 0.964, CR = 0.964, AVE = 0.823). Since the intellectual capital is a composition of human capital(α = 0.946, CR = 0.949, AVE = 0.786), structural capital (α = 0.941, CR = 0.943, AVE = 0.809), social capital (α = 0.928, CR = 0.933, AVE = 0.775), relational capital (α = 0.933, CR = 0.939, AVE = 0.789), and innovation capital (α = 0.895, CR = 0.920, AVE = 0.648) also exhibit acceptable results, the data confirm that all constructs are both reliable and valid for further structural model analysis. As a result, these findings ensure that the refined measurement model is statistically sound and ready for hypothesis testing within the PLS-SEM framework.

Table 8: Construct Reliability and Validity - Final Model measurements

	Loading	Cronbach's alpha	Composite reliability	AVE
CP1	0.910	0.972	0.973	0.854
CP2	0.922			
CP3	0.939			
CP4	0.938			
CP5	0.930			

	Loading	Cronbach's alpha	Composite reliability	AVE
CP6	0.919			
CP7	0.912			
ESP1	0.907			
ESP2	0.916			
ESP3	0.918			
ESP4	0.908	0.964	0.964	0.823
ESP5	0.908			
ESP6	0.898			
ESP7	0.894			
HC1	0.873			
HC2	0.890			
HC3	0.891	0.946	0.949	0.786
HC4	0.884			
HC5	0.893			
HC6	0.889			
IC1	0.759			
IC2	0.736			
IC3	0.752	0.895	0.920	0.648
IC4	0.865			
IC5	0.856			
IC6	0.853			
RC1	0.895			
RC2	0.883			
RC3	0.873	0.933	0.939	0.789
RC4	0.911			
RC5	0.878			
SC1	0.898			
SC2	0.901			
SC3	0.904	0.941	0.943	0.809
SC4	0.908			
SC5	0.888			
SoC1	0.870			
SoC2	0.881			
SoC3	0.889	0.928	0.933	0.775
SoC4	0.892			
SoC5	0.871			

HC: Human Capital; **SC**: Structural Capital; **SoC**: Social Capital; **RC**: Relational Capital; **IC**: Innovation Capital; **ESP**: Environmental Sustainability Practices; **CP**: Company Performance

Discriminant validity between the study constructs was evaluated using Heterotrait– Monotrait (HTMT) ratio of correlations, presented in Table 9. The HTMT values in all cases are less than the limit of 0.90, which proves that each construct is empirically distinct from the other constructs. Because the values 0.080-0.884, it shows that multicollinearity or the overlap of concept is not possible to see between latent variables. Innovation capital (IC) and relational capital (RC) achieved the highest HTMT ratio value of 0.884, which means these two constructs are highly related but remain different from a statistical standpoint. Since the smallest HTMT value between CP and ESP is 0.080, we can conclude that there seems to be limited conceptual overlap between constructs. Because the HTMT ratios of other IC forms –human capital, structural capital and social capital spared with ESP and CP- are also moderated, measurement model thus meets discriminant validity. Accordingly, it can be inferred that constructs are distinct and are adequate for structural model testing.

Table 9: The heterotrait-monotrait ratio of correlations (HTMT)

	CP	ESP	HC	IC	RC	SC	SoC
CP							
ESP	0.080						
HC	0.154	0.476					
IC	0.142	0.706	0.607				

	CP	ESP	HC	IC	RC	SC	SoC
RC	0.135	0.563	0.610	0.884			
SC	0.087	0.491	0.773	0.662	0.642		
SoC	0.156	0.457	0.670	0.609	0.628	0.695	

HC: Human Capital; **SC**: Structural Capital; **SoC**: Social Capital; **RC**: Relational Capital; **IC**: Innovation Capital; **ESP**: Environmental Sustainability Practices; **CP**: Company Performance

As presented in Table 10, discriminant validity between the latent constructs were tested using Fornell–Larcker criterion to see whether each construct is empirically different from others. The square roots of MVs are along the diagonal and greater than all inter-construct correlations in each column and row. Given that company performance (√AVE = 0.924) and environmental sustainability practices (√AVE = 0.907) have the highest values on discriminant, it is confirmed that these constructs are sufficiently differentiated and scaled well. Since the incremental innovation capital (= 0.805) and the relational capital (√AVE = 0.888) are also greater than the inter-construct correlations, they indicate that the measurement items capture unique conceptual domains without much overlap. Given that environmental sustainability practices are moderately correlated with human capital (r = 0.458), relational capital (r = 0.538) and innovation capital (r = 0.883), we conclude that firms do integrate knowledge-based resources with strategies oriented towards sustainability. As other constructs' results are found to satisfy both Fornell–Larcker criterion, therefore it is possible to say that the model has a good degree of discrimination validity evidencing acceptable accuracy and independence of all constructs used in secondary part of this research.

Table 10: Latent Variable Correlations (Fronell-Lacer criteria)

	CP	ESP	HC	IC	RC	SC	SoC
CP	0.924						
ESP	0.076	0.907					
HC	0.146	0.458	0.887				
IC	0.124	0.883	0.541	0.805			
RC	0.129	0.538	0.576	0.756	0.888		
SC	0.083	0.469	0.619	0.585	0.604	0.900	
SoC	0.147	0.437	0.710	0.535	0.587	0.629	0.880

HC: Human Capital; **SC**: Structural Capital; **SoC**: Social Capital; **RC**: Relational Capital; **IC**: Innovation Capital; **ESP**: Environmental Sustainability Practices; **CP**: Company Performance

The R^2-values (see Table 11) reflect the amount of variance in the endogenous constructs explained by independent variables. Results As can be seen from the results, ESP have an R^2 of 0.826 indicating that around 82.6% of the variance in ESP is explained by Intellectual Capital: human capital, structural capital, social capital, relational and innovation capital. This evidences a high predictive power of intellectual capital towards sustaining-related behaviors in Iraqi oil and gas companies. Regarding company performance (CP), with R^2 of.074 only 7.4% of its variance is accounted for by the predictor variables, which suggests a modest direct effect. Based on the high R^2 of ESP, It can be concluded that the relationship between intellectual capital and company performance is indirect for the most part through environmental sustainability practices. Since comparison between the R^2 estimates and adjusted R^2 values (0.822 for ESP and 0.051 for CP) showed a good degree of approximation, the model showed adequate fit and reliability. In general, these findings imply that intellectual capital significantly influences SD practices which affect the performance of firm.

Table 11: Coefficient of Determination (R^2)

	R-square	R-square adjusted
CP	0.074	0.051
ESP	0.826	0.822

2.3 ESP: Environmental Sustainability Practices; CP: Company Performance

Table 12 provides the outcomes of the direct hypotheses testing with mixed findings on the relationships between the independent and dependent variables in the model. As can be concluded from the results, human capital (β = 0.412, t = 2.161, p = 0.031) significantly and positively affects company performance, so that more knowledgeable and skillful employees increase operational outputs in Iraqi oil and gas companies. Since structural capital results in a negative effect, (β = –0.778, t = 3.097, p=0.002), the negative direction coefficient implies that when organizational structures and systems are so strong to such extent of rigidity could restrict adaptability and efficiency of performance. Because social capital has a positive effect on corporate performance (β = 0.433, t = 2.005, p = 0.045), it suggests that cooperation and mutual trust as well as information sharing between employees are meaningful for organizational success.

Since innovation capital is a significant driver of performance (β = 0.430, t = 2.150, p < 0.05) it suggests that companies with investment in innovation and technology can get better productivity and competitiveness. Since relational capital (β = –0.154, t = 1.282, p = 0.200) does not significantly impact company performance this last finding implies that the alliance and stakeholder relations had yet to reach a level at which it would have had a direct bearing on financial or operating results. Likewise, the fact that nature's sustainable practices (β = –0.172, t = 1.287, p = 0.198) were not significantly related to company performance indicated to them that efforts toward sustainability are rising, but they have not begun to show up in businesses' performances yet. In sum, these results indicate that internal intellectual capital factors among which human, social and innovation capital represent themselves the direct key drivers of company performance in Iraq's oil and gas industry while relational and sustainability-related issues have presently lower relevance concerning direct enhancement of performance.

Table 12: Direct Hypotheses

Hypotheses	Beta	Sample Mean (M)	SD	T statistics	P values	Decision
ESP -> CP	-0.172	-0.113	0.133	1.287	0.198	Rejected
HC -> CP	0.412	0.345	0.191	2.161	0.031	Accepted
IC -> CP	0.430	0.334	0.200	2.150	0.032	Accepted
RC -> CP	-0.154	-0.106	0.120	1.282	0.200	Rejected
SC -> CP	-0.778	-0.585	0.251	3.097	0.002	Accepted
SoC -> CP	0.433	0.323	0.216	2.005	0.045	Accepted

HC: Human Capital; **SC**: Structural Capital; **SoC**: Social Capital; **RC**: Relational Capital; **IC**: Innovation Capital; **ESP**: Environmental Sustainability Practices; **CP**: Company Performance

What came out from the mediation analysis is, as shown in Table 13, that ESP significantly mediate most of the relationships between IC components and company performance. As shown in the results, the indirect impact of human capital on firm performance through ESP is found to be negative (β = –0.037, t = 2.096, p = 0.001), which implies that employees' knowledge and skills improve company performance when they are well translated into pro-sustainability behaviors. Innovation capital likewise demonstrates a highly mediation effect (β = –0.249, t = 2.059, p = 0.002), which suggests that technological and creativity capabilities enhance firm performance through the indirect route of facilitating sustainable practices within operations. Third, considering that the indirect effects of relational capital (β = 0.070, t = 3.520, p < 0.001) and structural capital (β= 0.048, t =3.547, p= 0.000) are all significant in Table9), it also implies that institutional systems and routines and external stakeholder relationships generally contribute to the company performance through improvements in environmental sustainability practices specifically. As for social capital (β = −0.015, t = 0.504, p = 0.614), the mediation is not significant indicating that internal collaboration and networking do not greatly enhance the relationship between sustainability and performance in this context. Altogether, these findings provide further empirical evidence that organizations environmental sustainability practices play an important role as a mechanism through which intellectual resources are transformed - particularly structural, relational and innovation capital - into organizational outcomes. Therefore,

the mediating analysis supports H7: The cultivation of sustainability approaches enhances the effect of intellectual capital on firms' performance in Iraqi oil and gas companies.

Table 13: Indirect Hypothesis

Hypotheses	Beta	Sample Mean (M)	SD	T statistics	P values	Decision
HC -> ESP -> CP	-0.037	0.065	0.031	2.096	0.001	Accepted
IC -> ESP -> CP	-0.249	0.346	0.168	2.059	0.002	Accepted
RC -> ESP -> CP	0.070	0.169	0.048	3.520	0.000	Accepted
SC -> ESP -> CP	0.048	0.149	0.042	3.547	0.000	Accepted
SoC -> ESP -> CP	-0.015	-0.020	0.031	0.504	0.614	Rejected

HC: Human Capital; **SC**: Structural Capital; **SoC**: Social Capital; **RC**: Relational Capital; **IC**: Innovation Capital; **ESP**: Environmental Sustainability Practices; **CP**: Company Performance

3. Discussion

The empirical evidence of this research strongly supports the main hypothesis that intellectual capital (IC) substantially increases company performance (CP), directly or indirectly by environmental sustainability practices (ESP). The findings are in line with the theoretical considerations based on RBV and Stakeholder Theory (which note that firms create sustainable competitive advantage by using intangible resources to meet stakeholders' expectations via environmentally responsible behaviour) (Danso et al., 2020; Danso, Gupta & Werner, 2015). The results of the study indicated that human, social, and innovation capital were the main drivers behind company success to which structural and relational capital contributed indirectly through environmental sustai nability indicating that knowledge-based resources are key determinants of sustainable development in the Iraqi oil and gas industry (Nazir et al., 2024; Li et al., 2024). The important role of human capital in organizational performance suggests that integral skills, knowledge and environmental awareness are necessary for the successfulness and innovation outcome of firms (Adagbabiri & Okolie, 2020; Masud et al., 2025). Companies that invest in building competencies among the workforce are more likely to adhere to sustainable practices a finding that is consistent with prior researches which determined human capital as a predictor for better sustainability and productivity performance outcomes (Ting et al., 2020; Astuti et al., 2023). This finding supports the idea that in order to support employees' behaviors toward use of eco-efficient processes and control their behavior towards employees' eco-efficient performance, OGI needs to put focus on training and transferring knowledge.

SC, although negative in the direct path, presented a positive indirect effect through ESP, which indicates that well-structured internal systems or routines and digital infrastructure facilitate sustainability strategies institutionalization (Scarpellini et al., 2020; Wei et al., 2024). This agrees with the results reported by Martínez-Falcó et al. (2025); 'Structured knowledge systems and their role in strategic decision making ('environmental management accounting'), or the 19 perplexities', p. However, the apparent reverse effect in a negative direct relationship indicates that too much formalization and bureaucratic red tape may limit operational freedom an issue common in heavily regulated sectors such as oil and gas (Al Mashkoor, 2012). It follows that managing an effective and efficient system must be balanced with adaptive management to develop sustainable innovation. The research also verified the positive relationship between social capital and performance, which highlights its role in enhancing cooperation, trust and exchange of information among organizations. This result is consistent with existing studies that have shown that cohesive internal structures are conducive to problem-solving and the ethics of shared environment values through other pathways (Jędrych et al., 2022). Yet, there was no significant direct effect on performance of relational capital although the indirect path ran through ESP. This implies that even though stakeholder and external relationships not yet yielding immediate cash returns still play a role in the emergence of sustainability-driven operations, particularly those involving improved supply chain transparency and adherence to environmental regulations (Chowdhury et al., 2023; Obeidat et al., 2021). By doing so

via trust-based relationships and environmental governance frameworks, this could ultimately result in long-term superior performance (Al-Ali & O'Mahony, 2025).

Innovation capital had one of the strongest positive impacts on performance, thus demonstrating once more that investments in technology and creativity are some of the main drivers required for an oil company to be recognized as a truly sustainable performer (Ludovico et al., 2025; Shahbaz & Malik, 2025). The mediating effect of environmental sustainability practices supports the assertion that innovation serves as an intermediary between knowledge resources and sustainable performance. This observation is in agreement with the perspective of Nazir et al. (2024), which claimed that the incorporation of innovation in environmental management plays a crucial role in improving disaster resilience as well as long-term sustainability for energy enterprises. Similarly, Sun et al. (2023) found that green innovation strengthens both resource efficiency and policy compliance, which allows entrepreneurship to become sustainable, helping firms' competitiveness without causing much ecological damage. The mediating effects revealed that IC performance is contingent on environ mental sustainability practices. This result is consistent with Nogueira et al. (2023) and Li et al. (2024), who found that sustainability actions spur the effect of the intangible resources by increasing energy efficiency, decreasing emissions and rising corporate reputation. In the case of Iraq's oil/gas sector, this mediated role denotes the advancement towards a sustainability-based governance at steady pace albeit significantly contributed by worldwide environmental concerns and nation reforms (Elkebti & Khalifa, 2025). Yet the direct effect of ESP on performance is relatively weak, suggesting that expected advantages from sustainability investments have not been realized fully due to the lukewarm enforcement of environmental policy and limited assimilation of sustainability in strategic planning (Alqarshoubi, 2024).

Collectively, the results work towards confirming the theoretical assertion that intellectual capital – through sustainability initiatives effectively captured – can further improve both environmental and financial performance. They show the significance of promoting innovation-driven culture, adaptive organizational structures and collaborative stakeholder networks in external governance processes, for enhancing environmental governance. The study has implications for policy makers and managers in the Iraqi oil and gas sector who are striving to achieve a balance between economic growth and environmental responsibility, with the expectation that such knowledge investments generate not only productivity but also sustainable long-term competitive advantages (Nazir et al., 2024).

4. Conclusion

The present work investigated the mediation role of environmental sustainability practices in the relationship between intellectual capital and firm performance in Iraqi oil and gas sector. Additionally, the outcomes demonstrate that the human, social and innovation capital macro-level dimensions have a positive impact on performance meaning that employee skills & knowledge, collaboration and technological upgrading are essential to achieve organizational success. The weak effect of structural and relational capital to environmental performance was still mediating through sustainability practices, which emphasizes that well-arranged internal systems and relationship with stakeholders contribute to improve the reliance in environmental performance if those are well implemented into strategic actions. The results also showed that environmental sustainability practices acted as a critical mediator through the process of converting knowledge-based resources into performance outcomes. Although the direct effect of sustainability on performance is limited, its mediating role shows that sustainable management adds value to intellectual capital in the long-term perspective. The latter findings highlight the need to implement symbiotic approaches in which human and structural efforts are tuned to environmental goals, not only for competitiveness but also as an ecological precaution. Collectively, the study deepens insight into how intellectual capital facilitates a sustainability transition in developing countries. Iraqi Oil and Gas Sector Invest ng in human capital, Innova on and sustainable governance is crucial for creating resilient client future-proof organizes which would be able to excel in a fast-changing world Energy Market.

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