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ENVIRONMENTAL UNCERTAINTY AND SUSTAINABLE PERFORMANCE: THE DUAL ROLE OF ENVIRONMENTAL MANAGEMENT ACCOUNTING

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Abstract
In resource-dependent economies, the interplay between factors such as environmental uncertainty (EU), environmental management accounting (EMA), and sustainable performance (SP) is understudied, especially in high-risk industries like oil and gas. This study examines the relationship between these factorsin the Iraqi oil and gas business, which is institutionally fragile, environmentally vulnerable, and dependent on fossil fuel exports. The effects ofEU on EMA and SP, as well as the direct and mediating role of EMA on SP. The study population is represented by middle managers of these companies. A total of 119 responses were collected via survey questionnaires and analysed using Smart PLS 4. The finding showed that the EU and its dimensions of technology uncertainty and competitive uncertainty have a significant positive impact on SP. The EU also positively affected the EMA, which in turn positively affected SP and mediated the effect of the EU on SP. This study contributed to the literature by combining internal and external environments using contingency theory and resource-based view theory. Institutionalising EMA in strategic and operational frameworks with innovative capability, governance procedures, and stakeholder interaction is emphasized. The study suggests legislative reforms, tax incentives, and capacity-building to encourage EMA implementation.

Keywords: Sustainable Performance, Environmental Uncertainty, Environmental Management accounting, Market uncertainty, SDGs

1. Introduction

Due to environmental issues, resource scarcity, and climate change, sustainability has become a global priority. Following the UN's 2030 Sustainable Development Goals (SDGs), states should pursue economic growth while protecting the planet's environmental systems. SDG 7 (Affordable and Clean Energy) and SDG 13 (Climate Action) require a clean energy transition and urgent climate mitigation (Yumnam et al., 2024). All sectors must participate in this agenda, with the oil and gas industry under investigation due to its large environmental footprint. Due to its significant contribution to greenhouse gas emissions, particularly methane (CH_4), the industry is vital for global sustainability goals. As methane has a larger global warming potential than CO_2, its management is crucial for climate strategies (Farooq et al., 2021). The IEA estimates that oil and gas activities cause 30% of worldwide methane emissions, air and water pollution, biodiversity loss, and ecosystem degradation(Oyewunmi, 2023). These environmental effects remain despite developments in mining and processing technologies, highlighting the need for greater regulatory oversight and cleaner industrial operations (Awewomom et al., 2024).

Iraq is one of the top five polluters; the country emits 8% of global oil and gas methane (Chen et al., 2023). Old oil exploitation, high gas flaring, and lax environmental restrictions add to this impact (Al-Khafaji et al., 2024).It causes air, water, and soil pollution, as well as public health problems, especially in oil-producing regions. Since Iraq relies on oil earnings for economic stability, economic priorities typically outperform environmental concerns (AL-Saadi et al., 2022). In such a climate, sustainable performance (SP), an organization's ability to reconcile economic viability, environmental stewardship, and social responsibility (Purnama, 2024), is crucial and difficult. SP is a strategic imperative for oil and gas firms to survive in a highly regulated and environmentally concerned global energy market.

Environmental uncertainty (EU), which refers to unpredictable external influences that affect corporate decision-making and operational stability, complicates oil and gas sector sustainability, especially in Iraq. EU includes market, technological, and competitive uncertainty (Alaarj et al., 2017).Oil and gas pricing, global demand, and consumer energy preferences create market volatility. Unstable conditions impact investment, cost management, and environmental financing (Liu & Chen, 2022). Pollution management, carbon reduction, and energy efficiency technologies are promising yet advancing swiftly, risking obsolescence and misplaced spending. New market entrants and rivals may breach long-term sustainability goals with short-term actions (Boehlje & Roucan-Kane, 2009). In Iraq, institutional difficulties, limited adoption of advanced management practices, and uneven environmental enforcement are challenges. Environmental Management Accounting (EMA) uses environmental cost data and performance evaluations to inform financial and management decisions to detect, measure, and control environmental consequences (Bresciani et al., 2023).

Environmental reporting transparency, compliance, and cleaner technology investment increase when EMA incorporates environmental and economic performance (Asiaei et al., 2022). EMA enables oil and gas firms to calculate the complete cost of environmental consequences, from emissions and waste management to resource consumption, to meet sustainability goals (Köseoglu et al., 2013). Data-driven insights from EMA enable organisations to respond to turbulent markets, new technology, and competitive threats. This study analyses how EMA mediates EUandSP. In resource-dependent economies with substantial environmental risk, studying these links in the Iraqi oil and gas industry fills a major need in the research. The findings could assist industry stakeholders in balancing economic and environmental requirements through sustainable accounting and management research and regulation.

Literature Review

2.1 Theoretical Framework

This study uses the Resource-Based View (RBV) and contingency theory to explain the association among the variables. Contingency theory suggested that matching internal processes to external situations boosts performance. RBV demonstrates how scarce resources may maintain a competitive advantage using internal skills. Combining these techniques illustrates how organisations may utilise EMA to enhance sustainability under unpredictable environmental settings. Contingency theory says that internal and external systems impact organisation performance (Hutaibat & Alhatabat, 2019; Donaldson, 2001; Hutaibat&Alhatabat, 2019). To thrive, organisations must adapt their strategies, structures, and processes to rapid legislative changes, market demands, technology breakthroughs, and competitive threats (Latan et al., 2018).

EU requires adaptive management systems that can sustainably analyse complex environmental data. Sustainable decision-making requires environmental and social performance, which traditional accounting lacks. To inform strategic and operational decisions, EMA collects, evaluates, and publishes physical and monetary environmental data (Qian et al., 2018). Previous studies linked EMA implementation to corporate EU. (Solovida & Latan, 2017)found that EMA helps companies meet stakeholder expectations, comply with changing laws, and align operations with sustainability goals in high-uncertainty contexts. EMA turns dynamic external conditions into practical solutions that maximise resource utilisation, reduce environmental impact, and increase regulatory compliance to limit uncertainty on SP.

The RBV bases sustained competitive advantage on internal capabilities, while contingency theory highlights external circumstances. According to RBV, valuable, rare, inimitable, and non-substitutable (VRIN) resources help companies beat competition (Mahoney & Pandian, 1992). This notionviews EMA as a strategic resource and dynamic talent that enables organisations to adjust to environmental volatility and function sustainably. Environmental and financial information from EMA fulfils VRIN criteria. It cuts costs, increases resource efficiency, and protects the environment. Few businesses have completely built EMA systems that generate high-quality environmental data. Uniquely executed, it demands specific skills, customised systems, and organisational synergy. Alternative systems lack environmental depth and cannot make sustainability-focused judgements (Saputra et al., 2023; Schaltegger et al., 2022).

Dynamic EMA allows businesses to integrate, create, and reorganise resources in response to external changes (Teece et al., 1997). EMA measures environmental performance in real time, helps oil and gas firms comply with changing regulations, and supports environmental management innovation. Both theories give two viewpoints on how companies might act sustainably in unpredictable environments. Contingency theory explains why businesses must adapt to external situations, whereas RBV illustrates how they may leverage unique abilities like EMA. Environmental unpredictability drives this integrated system's adaptation. EMA is proposed to mediate the effect ofEU on SP. Contingency theory highlights EMA's environmental alignment, whereas RBV emphasises its strategic usefulness in long-term competitive and sustainability benefits. These views demonstrate how EMA helps businesses achieve economic, environmental, and social goals while managing uncertainty.

2.2 Conceptual Framework

This study proposes that EU has a significant effect on the SP and EMA. The study also proposes that EMA will directly affect the SP and mediate the effect of EU on SP. These propositions are based on contingency theory and RBV. This study is motivated by the gaps in the literature. The oil and gas sector has lacked research on EU, EMA, and SP (Latan et al., 2018; Qian et al., 2018; Saputra et al., 2023). Given the sector's high environmental impact, worldwide volatility, and growing regulatory scrutiny, this is a major oversight. Although Iraq is a major oil producer with serious environmental and economic issues, there is little empirical evidence from developing economies (Al-Khafaji et al., 2024).EMA mediates environmental strategy and performance, although its significance in linking EU to SP in high-risk, resource-dependent enterprises is understudied. Addressing this gap is crucial to understanding how enterprises in such circumstances might use environmental accounting to turn environmental instability into competitive and sustainability benefits.Figure 1 shows the conceptual framework.

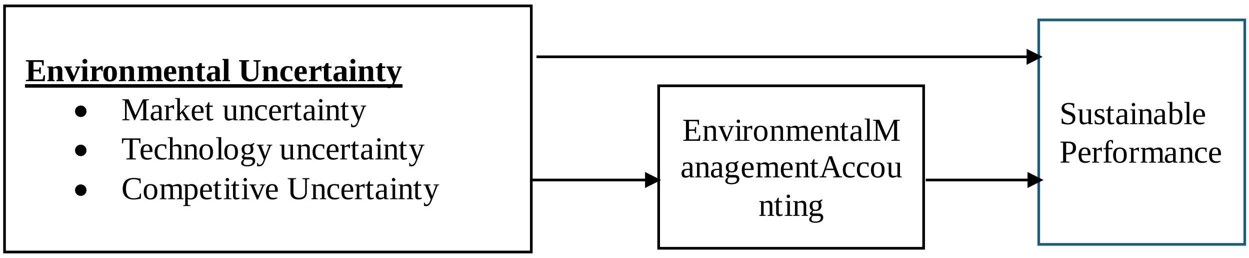

Figure 1: Conceptual Framework

2.2.1 Environmental Uncertainty and Sustainability

Regulatory changes, environmental threats, and socio-economic fluctuations can affect organisational decision-making and operational performance, causing EU. Depending on how an organisation behaves, uncertainty can increase or hurt sustainability. Contingency theory suggests that companies must match internal tactics to external situations to maximise results (Latan et al., 2018). Due to environmental instability, public expectations, laws, and industry norms require sustainable practices (Al Omoush et al., 2018). EU can help or hurt sustainability. Solovida and Latan (2017)showed that proactive company environmental initiatives increase environmental results under uncertainty. Chen et al. (2023)pointed out that environmental unpredictability hinders organisational growth without adaptive systems. Geopolitical instability, resource price fluctuations, and regulatory scrutiny increase environmental volatility in high-risk industries like oil and gas (Thabit & Ibraheem, 2019). Strategic adaptation creates resilience and innovation from unpredictability. Therefore, this study suggests:

H1: Environmental uncertainty has a substantial influence on sustainability.

2.2.1.1 Market Uncertainty and Sustainable Performance

Demand, price, and competition make sustainability goals hard to attain. Contingency theory suggests that companies entering such markets must adjust to be competitive and meet long-term environmental and social goals (Latan et al., 2018). Active and resilient measures can prevent market pressures from deprioritizing sustainability (Solovida & Latan, 2017). Market unpredictability reduces sustainability but boosts innovation and flexibility. Despite demand unpredictability, Chen et al. (2023)showed that flexible resource allocation and operational approaches may preserve environmental performance. Uyar (2020)advised companies to improve efficiency, diversify supply chains, and invest in sustainable technology to prevent volatility. Changes improve resilience and sustainability, especially in resource-dependent businesses. Therefore, the following is proposed:

H1a: Market uncertainty significantly impacts sustainable performance.

2.2.1.2 Technology Uncertainty and Sustainable Performance

Rapid technological breakthroughs and unforeseen changes affect industry standards, customer preferences, and operations. Due to uncertainty, companies use cleaner manufacturing, energy-efficient systems, and digital technologies to improve resource consumption and environmental performance (Latan et al., 2018). Eco-innovation and operational efficiency for sustainability may come from technical uncertainty. Companies experiencing a technological revolution are more likely to embrace green methods. Solovida and Latan (2017)discovered that quick technology advancement encourages organisations to produce sustainably to stay competitive. Tze San et al. (2022)noted that technological uncertainty promotes growth and innovation, which promotes sustainable development.

Proactive technological adaptation reduces obsolescence and benefits sustainability-focused markets. Therefore, this study suggests:

H1b: Technology uncertainty affects sustainability greatly.

2.2.1.3 Sustainable Performance and Competitive Uncertainty

Fast industry changes, market competition, and shifting client expectations create competitive uncertainty. Sustainable practices help companies stand out, meet regulatory obligations, and attract environmentally conscious customers (Koç, 2022). Sustainable competitive strategies help organisations adapt to external challenges and market instability. Research reveals that competitive uncertainty sustains innovation and process improvement. Uyar (2020) and Darvishmotevali et al. (2020) suggested that competitive companies use environmental efforts to stay relevant. Chen et al. (2023)showed that competition-driven, sustainability-driven innovation improves agility and viability. These upgrades help firms stand out and thrive. Therefore, the following is proposed:

H1c: Competitive uncertainty affects sustained performance greatly.

2.2.2 Environmental Management Accounting and Environmental Uncertainty

EU pushes firms to employ EMA to identify, quantify, and control environmental costs. EMA handles complicated environmental concerns to meet rules and public expectations. EMA usage grows under unexpected environmental situations because it helps organisations monitor and incorporate environmental risks into decision-making (Latan et al., 2018). Solovida and Latan (2017)pointed out that EMA mediates environmental strategy and performance, enabling organisations to achieve SP. Environmental monitoring, audits, and controls improve environmental change reporting and operational responses (Qian et al., 2018). In this study, the following is hypothesized:

H2: Environmental uncertainty has a significant impact on EMA.

2.2.3 EMA and Sustainable Performance

EMA improves environmental data accuracy, decision-making, and operational efficiency for sustainability. EMA improves environmental, social, and economic performance by assessing environmental costs, allocating resources, and reducing waste. EMA makes environmental techniques viable (Solovida & Latan, 2017). Openness and accountability improve stakeholder confidence and regulatory compliance at EMA (Uyar, 2020). Sustainable competitive markets benefit from EMA carbon management and transparency (Qian et al., 2018). Therefore, this study proposes that EMA will have a positive impact on SP.

H3: EMA significantly impacts sustainability.

2.2.4 EMA as a Mediator

EMA is essential for linking EU to sustainable behaviour. Using uncertainty, organisations may design systematic environmental solutions. Environmental risk assessment guides EMA's operational decisions, integrating sustainability goals with external expectations. Empirical evidence supports the mediating role of EMA. EMA adoption enhances risk management and resource efficiency amid uncertainty (Latan et al., 2018; Solovida & Latan, 2017). Institutional forces promote EMA adoption and help enterprises retain legitimacy and performance in unstable contexts (Qian et al. 2018). The study suggests the following:

H4: EMA mediates the effect of environmental uncertainty on sustainable performance.

3. Research Methodology

This quantitative, cross-sectional study examines how EU and EMA help Iraqi oil and gas businesses achieve SP. The primary data collection instrument was a designed questionnaire to capture managerial opinions, attitudes, and practices. This approach allows data gathering from a wide, geographically scattered population, improving generalisability (Zikmund et al., 2013). Based on validated instruments from earlier EMA and sustainability studies, the questionnaire was tailored to the Iraqi oil and gas sector.The target population included Iraqi state-owned oil and gas company departmental and branch managers in finance, business, environmental safety and health, and quality management. The Ministry of Oil identifies 136 national enterprises across Iraq's 18 governorates. These are the population of this study. Stratified random samplingwas deployed to collect the data.

The measurement of the variables was adopted from several sources. Measurement of EU, which includes market uncertainty, technology uncertainty, and competitive uncertainty, was adopted from Köseoglu et al. (2013). In addition, the measurement of EMA was adopted from Doan et al. (2023). Furthermore, the measurement of SP was adopted from Iqbal and Ahmad (2021). The measurements were translated into Arabic using back-to-back translation. In addition, the measurement was validated by experts, and a pilot study was conducted to assess the Cronbach's alpha. The findings showed that all the measurements have acceptable Cronbach's alpha.

For the data collection, managerial staff in the selected companies received questionnaires in person and via official email channels. Participants gave informed consent in compliance with ethical research norms. A total of 126 responses were collected. These responses were examined for missing values and outliers. This has resulted in 119 valid responses to be included in the analysis of this study. The data was also checked for normality and multicollinearity. As shown in Table 1, all the variables have Skewness and Kurtosis of less than one (1), indicating that the data is normally distributed. In addition, the value of tolerance and variation inflation factor (VIF) indicates that tolerance is greater than 0.20 and VIF less than five (5), supporting the notion that there are no multicollinearity issues among the variables of this study.

Table 1: Normality and Multicollinearity

Variable	N	Normality		Multicollinearity	
		Skewness	Kurtosis	Tolerance>0.20	VIF<5
Environmental Uncertainty	119	-0.474	-0.073	0.485	2.062
Market Uncertainty	119	-0.477	-0.040	0.395	2.531
Technology Uncertainty	119	-0.480	-0.349	0.462	2.164
Competitive Uncertainty	119	-0.773	0.039	0.374	2.676
Sustainable Performance	119	-0.588	-0.776	0.315	3.170

4. Findings

The findings of this study are presented in this section. It includes the descriptive information of the respondents as well as the assessment of the measurement and structural model using Smart PLS 4.

4.1 Profile of the Respondents

A total of 119 respondents have participated in this study. Table 2 shows the profile of the respondents. The table shows that the age of respondents is distributed between 30-40 years (47.1%) and 41-50 years (47.1%). The majority of the respondents are males (81.5%). In terms of experience, a total of 37.8% have experience between 12-15 years, while 31.1% have experience between 8-11 years. A total of 6.3% have experience of less than 3 years. Regarding the position, the respondents indicated that 62.2% are in the middle management level, while 16% are head of department, and similarly, 16% are accounting manager.

Table 2: Profile of Respondents

Variable	**Description**	**Frequency (N= 119)**	**Percent**
Age	30-40 years	56	47.1
	41-50 years	56	47.1
	51-60 years	7	5.9
Gender	Male	97	81.5
	Female	22	18.5
Experience	Less than 3 years	7	5.9
	3-7 years	30	25.2
	8-11 years	37	31.1
	12-15 years	45	37.8
Position	Head of department	19	16.0
	Accounting manager	19	16.0
	Top management level	4	3.4
	Middle management level	74	62.2
	Other	4	3.4

4.2 Measurement Model

The measurement model was assessed by checking the factor loading. All the items loaded well on their variables, and none of the items were deleted. The reliabilities and validities were also checked. Cronbach's Alpha, as shown in Table 2, is above 0.70. Similarly, the composite reliability is above 0.70. To assess the convergent validity, the average variance extracted was checked (AVE). The findings, as shown in Table 2, showed that the values of AVE are larger than 0.50, indicating that the convergent validity is achieved. Further to assess the discriminant validity, the HTMT's correlation, which is supposed to be less than 0.85, was checked. All the values of HTMT's correlation are less than 0.85, indicating that the discriminant validity is achieved. Similar procedures were repeated to check the measurement model of the second order. As shown in Table 2, all the criteria were achieved.

Table 2: Assessment of Measurement Model

Variable	**CA**	**CR**	**AVE**	**CU**	**EMA**	**MU**	**SP**	**TU**
First Order								
CU	0.84	0.85	0.92	-				
EMA	0.85	0.86	0.89	0.651				
MU	0.83	0.85	0.79	0.610	0.523			
SP	0.86	0.88	0.83	0.751	0.597	0.684		
TU	0.84	0.85	0.87	0.609	0.611	0.508	0.766	-
Second Order								
	CA	**CR**	**AVE**	**EMA**	**EU**	**SP**		
EMA	0.905	0.906	0.892	-				
EU	0.902	0.903	0.777	0.624				
SP	0.906	0.909	0.830	0.897	0.767	-		

Note: CU: Competitive Uncertainty, EMA: Environmental Management Accounting, MU: Market uncertainty, SP: Sustainable Performance, TU: Technology uncertainty, EU: Environmental Uncertainty.

4.3 Structural Model

The structural model was assessed by examining the R-square. As shown in Figure 2, the R-square of EMA is 0.383, indicating that 38.3% of the variation in EMA can be explained by EU. In addition, a total of 85.9% of the variation in SP can be explained by both the EMA and EU. In terms of F-square, the findings as shown in Table 3 indicate that all the paths have an effect size above 0.02 except for the path of market uncertainty→SP. This is an early indication that the hypotheses are supported, except for the effect of market uncertainty on SP.

This study tested two structural models. The first is related to the effect of first-order variables on SP, while the second is related to the effect of second-order variables and the mediating role of EMA between EU and SP. Figure 2 shows the structural model and the mediating role of EMA between EUandSP.

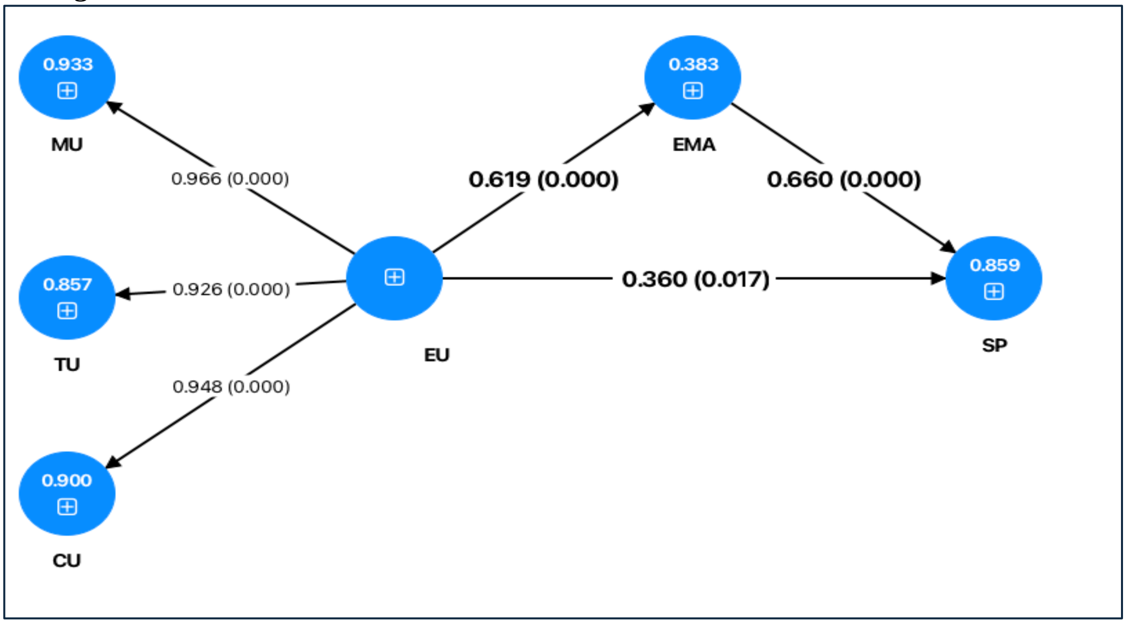

Figure 2: Structural Model of the Study

Table 3 combines the results of testing the dimension of EU and the results of testing the mediating role of EMA between EU and SP.

Table 3: Results of Hypotheses Testing

H	Path	B	Std.	T-statistics	P values	Conclusion
H1	EU -> SP	0.360	0.151	2.387	0.017	Supported
H1a	MU -> SP	-0.416	0.224	1.851	0.064	Rejected
H1d	TU -> SP	0.652	0.302	2.156	0.031	Supported
H1c	CU -> SP	0.604	0.275	2.195	0.028	Supported
H2	EU -> EMA	0.619	0.094	6.550	0.000	Supported
H3	EMA -> SP	0.660	0.144	4.575	0.000	Supported
H4	EU -> EMA -> SP	0.408	0.104	3.929	0.000	Supported

The results, as shown in Table 3, indicate that H1, which proposed a direct positive relationship between EU and SP, was found to be supported by the analysis (B = 0.360, t = 2.387, p = 0.017). Adaptive strategies, flexible resource allocation, and innovative operational practices are likely to improve the SP of organisations operating in environments with higher levels of EU. On the other hand, H1a, which looked at how market uncertainty affected SP, was not supported (B = -0.416, t = 1.851, p = 0.064). The negative coefficient suggests that

increased market uncertainty may impede SP, perhaps as a result of price volatility, increased competition, and decreased demand stability, all of which shift managerial attention from long-term sustainability goals to short-term survival tactics. On the other hand, both H1d and H1c, which evaluated how TU and CU affected SP, received support. The significant positive impact that TU had on SP (B = 0.652, t = 2.156, p = 0.031) highlighted how technological dynamism can spur efficiency gains, product innovation, and process enhancements that lead to sustainability outcomes. Additionally, CU had a positive impact on SP (B = 0.604, t = 2.195, p = 0.028), indicating that competitive pressures push businesses to stand out from the competition by adopting eco-friendly practices, which leads to better SP.
In terms of the effect of EU on EMA, H2 demonstrated a robust positive correlation between EU and EMA (B = 0.619, t = 6.550, p < 0.001). H3 also confirmed that EMA significantly improves SP (B = 0.660, t = 4.575, p< 0.001), which is in line with earlier studies that highlight how crucial accurate environmental data is for resource optimisation, regulatory compliance, and well-informed decision-making. Significantly, H4 validated EMA's mediating function in the EU-SP relationship (B = 0.408, t = 3.929, p < 0.001), suggesting that EMA helps explain how EU results in better SP. The mediation is partial because the direct and indirect effects of EU on SP are significant.

5. Discussion

This study used contingency theory and the RBV to examine the direct and indirect relationships between EU, EMA, and SP in the Iraqi oil and gas sector. The findings bring nuance to sustainability management literature in resource-dependent, high-risk situations where environmental volatility, institutional fragility, and regulatory inconsistency coincide.The EU has a strong positive effect on SP, suggesting that external turbulence can spur organisational innovation, adaptive capacity, and sustainability-focused decision-making. This supports the idea that strategic uncertainty management can boost competitiveness and the environment (Solovida & Latan, 2017). Political instability, fluctuating global oil prices, and changing environmental regulations may drive more flexible operational processes, improved environmental safeguards, and efficiency-driven strategies in the Iraqi oil and gas sector. According to contingency theory, organisations work best when internal systems match external environmental needs (Donaldson, 2001).
The link between uncertainty and SP varies with dimension. Market uncertainty had a negative but statistically insignificant association with SP, suggesting that volatility in market demand, pricing, and competitive dynamics may undermine sustainability goals by shifting managerial attention to financial stability over long-term environmental and social goals. This supports previous studies showing market volatility can disrupt sustainability initiatives, especially in resource-dependent and institutionally weak situations (Chen et al., 2023). The conclusion underscores the idea that not all uncertainty promotes innovation or sustainability; some may act as limitations without strong internal capabilities.Conversely, technological uncertainty and competitive uncertainty positively affected SP. TU's beneficial impact shows that quick technological breakthroughs motivate enterprises to invest in cleaner production methods, digital solutions, and energy-efficient systems, boosting environmental and operational outcomes (Latan, 2018). Technological dynamism encourages eco-innovation and organisational transformation. The positive effect of CU on SP shows that competitive market dynamics encourage enterprises to define themselves via sustainability, which may boost brand recognition, stakeholder trust, and long-term viability (Darvishmotevali et al., 2020; Koc et al., 2022). These results imply that whilemarket uncertainty is difficult, TU and CU can provide sustainability for proactive and creative businesses.

The EU-EMA relationship displays EMA's strategic adaptability in turbulent times. This supports earlier findings that environmental instability drives companies to utilise sophisticated environmental management systems to decrease risk, increase compliance, and optimise resource utilisation (Qian et al., 2018). In the Iraqi oil and gas sector, where environmental liabilities are high, public scrutiny is expanding, and regulatory enforcement is uneven, EMA provides a framework for integrating environmental cost and performance data into strategic decision-making. EMA quantifies environmental and economic consequences to assist managers in designing cost-effective sustainability initiatives that fulfil regulatory and stakeholder requirements. This study supports contingency theory by showing how EU influences internal processes (EMA adoption) to make organisations robust to volatility.

EMA boosts SP, validating the RBV's assertion that unique and strategically valued skills may boost competitiveness and sustainability (Barney, 1991). EMA meets VRIN standards with accurate, relevant, and timely environmental data for strategic decision-making, operational efficiency, and environmental reporting transparency. Bresciani et al. (2023; Solovida& Latan, 2017) found that EMA enhances environmental stewardship, social accountability, and economic performance. With the Iraqi oil and gas sector under intense environmental scrutiny, EMA's incorporation into organisational processes may assist in maintaining legitimacy, regulatory compliance, and sustainability.

EMA partially mediates the EU-SP link, suggesting that external uncertainty might stimulate sustainability-oriented reform provided internal processes are supportive. External pressures become data-driven SP-enhancing initiatives with EMA. Latan et al. (2018) and Solovida& Latan (2017) found that EMA addresses environmental constraints and sustainability. To benefit from environmental instability, businesses require creativity, stakeholder participation, and leadership commitment since mediation is partial. Contingency theory and RBV describe organisational change to environmental unpredictability. The findings suggest aligning internal systems (EMA) with dynamic external conditions to improve performance. RBVs use EMA to derive competitive and sustainability advantages from environmental challenges. Dual-theoretical methods emphasise external fit and internal capability development for sustained performance in high-risk, resource-dependent industries like oil and gas. These findings support institutionalising EMA in Iraqi oil and gas businesses' strategic and operational frameworks. EMA's planning, resource allocation, and performance evaluation may include environmental factors in daily decision-making, improving sector resilience and sustainability. The partial mediation research advises integrating EMA with advanced environmental technology, better governance frameworks, and stakeholder partnerships to maximise its effect in chaotic conditions.

6. Implications

The findings support contingency theory by showing that EU affects organisational performance differentially depending on its nature and adaptive processes.Technological uncertainty and competitive uncertainty positively and significantly affected SP, while market uncertainty negatively affected SP but was statistically insignificant. This divergence emphasises the need for contingency-based models to break down EU into its many aspects, which may need different organisational responses. This method advances the theoretical knowledge that some environmental turbulence can spur innovation and sustainability-oriented change, while others might hinder strategic decision-making without strong internal processes and skills.

The study reinforces and extends the RBV by establishing EMA as a strategic organisational skill that meets VRIN criteria. The results show that EMA is a dynamic skill that helps enterprises turn environmental instability into a structured, practical sustainability strategy.

The partial mediation result refines RBV theory by showing that EMA is crucial to SP under uncertainty, but it does not act alone. To properly transform environmental concerns into long-term competitive and sustainability advantages, it must work with other organisational capabilities, including innovation capability, stakeholder involvement, and leadership commitment.

Integratingcontingencyand RBV theories into a single empirical model representalignment of SP external and internal capabilities. The results show that high-risk firms optimise organisational adaptation by fitting internal systems such as EMA to external environmental conditions and leveraging unique, inimitable resources to create enduring competitive advantage.. This integrative theoretical approach integrates contingency and RBV theories to provide a more complete explanation of how organisations can succeed in volatile and resource-dependent contexts.

This study is in line with UN's 2030 SDGs and fills a sustainability and environmental accounting literature geographical and sectoral gap. Most empirical studies on EMA and SP have focused on industrial or service sectors in developed or emerging economies with solid institutional frameworks. The Iraqi oil and gas sector, with its high environmental liabilities, regulatory inconsistency, and economic dependence on fossil fuel exports, provides context-specific insights that broaden the applicability of existing theories to high-risk, resource-dependent, and institutionally fragile environments.

From a practical perspective, the study generates various managerial recommendations for businesses looking to improve SP in uncertain environmental environments. The favourable impact of technology uncertainty and Competitive Uncertainty shows that managers should regard technological dynamism and competitive pressures as strategic levers for eco-innovation and efficiency benefits. This means prioritising cleaner manufacturing technology, digital monitoring systems, and process automation to improve environmental performance and save operational costs. By doing so, corporations can respond to external forces to improve environmental stewardship and market position. The beneficial relationship between EUand EMA adoption emphasises the necessity to institutionalise EMA in strategic and operational frameworks. Embed EMA processes into budgeting, resource allocation, and performance evaluation systems to incorporate environmental factors into everyday decision-making. EMA's reliable, timely, and relevant environmental information helps firms manage risks, comply with changing requirements, and preserve stakeholder trust.

In addition, since EMA only partially mediates the EU-SP relationship, it should be seen as part of a sustainability strategy rather than a single solution. Companies should support EMA with strong governance, innovation-driven culture, and stakeholder engagement. Integrating EMA with enterprise-wide risk management frameworks or sustainability-focused innovation pipelines could boost an organization's environmental resilience. The findings obviously affect policy and regulation. Through targeted incentives and institutional reforms, resource-dependent governments and regulatory bodies like Iraq can promote EMA adoption. Tax credits or subsidies for environmental management system investments, mandatory environmental cost disclosures by international reporting frameworks like the Global Reporting Initiative (GRI) and the International Sustainability Standards Board (ISSB), and sector-specific environmental accounting guidelines are possible measures. These approaches could harmonise reporting standards, increase cross-firm comparability, and improve sector sustainability reporting.Finally, industrial groups and professional bodies are crucial to building EMA implementation-ready human capital. Customised training, certification, and knowledge-sharing platforms could give managers and accountants the technical skills to integrate EMA into organisational decision-making. These capacity-building initiatives can accelerate the diffusion of best practices, foster a culture of environmental accountability, and improve sector-wide sustainability performance in Iraq, where environmental accounting awareness and technical capacity are still emerging.

7. Conclusion

This study examined the direct and mediated relationships between EU, EMA, and SP in the Iraqi oil and gas sector, which is high-risk, institutionally fragile, and fossil fuel-dependent. The research used contingency theory and the RBV to determine if EMA is a strategic capacity that helps businesses turn environmental turmoil into sustainability.The findings offer numerous crucial insights. First, the EU had a strong beneficial influence on SP overall, while its dimensions had different effects. Technological uncertainty and competitive uncertainty drove SP, showing that innovation- and competition-driven pressures can improve environmental and operational outcomes. Market uncertainty had a detrimental, albeit statistically insignificant, effect, suggesting that volatility may distract organisations from long-term sustainability goals and focus on short-term survival.

Second, there was a considerable positive effectof EU on EMA, highlighting EMA's critical relevance in volatile circumstances. Third, EMA greatly improved SP, supporting RBV's claim that unique, valuable, and inimitable talents create long-term competitive and sustainability advantages. Finally, EMA partially mediated the relationship between EU and SP, showing that while EMA can mitigate some of the negative effects of environmental turbulence, it works best when combined with other organisational capabilities like innovation capacity, governance quality, and stakeholder engagement.These findings integrate external fit (contingency theory) and internal capability (RBV) perspectives to show that high-risk sectors perform best when organisations align internal processes with dynamic environmental conditions and leverage unique strategic resources. The findings establish a compelling business argument for institutionalising EMA as part of a sustainability strategy and for policymakers to create supportive regulatory frameworks.

The work provides theoretical and practical insights, but its limits allow for future investigation.First, the study limits itself to Iraq's oil and gas sector, which has distinct political, economic, and institutional characteristics. Future studies need to examine the findings' applicability to other sectors or nations, especially those with more solid institutional frameworks or lower environmental risk. To test the model's resilience and transferability, future studies could duplicate it in other high-impact industries, including mining, manufacturing, and utilities, and in countries with various legislative and cultural environments.Second, the study was cross-sectional, collecting associations at one time. This approach ignores the dynamic nature of Environmental uncertainty, EMA adoption, and SP, which may change with legislation, market conditions, and stakeholder expectations. A longitudinal study may reveal how these interactions evolve and how organisations respond to changing environments.

Third, managerial respondents' self-reported data, which may be vulnerable to social desirability or recall bias, but capture perceptions and practices. To improve survey validity and reliability, future research should include audited sustainability reports, validated environmental impact assessments, or third-party EMA implementation evaluations.Fourth, EMA was the single EU–SP mediator. The results indicate its mediating role; however, the partial mediation effect shows additional factors impact this association. Future research could include environmental governance, innovative capability, supply chain integration, and organisational culture in multi-mediator models. Moderated mediation frameworks could examine if leadership style, stakeholder pressure, or digitalisation affect EMA's mediation.Finally, budgetary practices are conceptually relevant to turning sustainability plans into actionable resource allocations, although this study did not specifically analyse them. Future studies could examine how budgetary control systems and EMA improve SP under environmental turbulence.

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