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Article

The Integration of Engineering Accounting and Cost Accounting to Improve the Accuracy of Environmental Cleanup Costs in Iraqi Oil Companies

Iman Shakir Mohammed[1]

1. Accounting Department, College of Administration and Economic Al-Iraqia University, Baghdad, Iraq
* Correspondence: iman.alridha@aliraqia.edu.iq

Abstract: This study aims to explore the integration of engineering accounting and cost accounting to enhance the accuracy of environmental cleanup costs in Iraqi oil companies. Through quantitative and qualitative data analysis, the research examines the effectiveness of this integration, using a case study that combines semi-structured interviews with senior accountants and environmental engineers, along with internal reports' data analysis and environmental and economic impact assessments.The findings reveal a mixed relationship between engineering data integration and perceived benefits, with positive perceptions prevailing despite limited demographic variables' statistical impact.The study highlights significant future implications for oil companies, which face challenges in determining actual environmental cleanup costs due to reliance on traditional accounting methods. The integration of engineering and cost accounting is expected to improve environmental cost accuracy, boost operational efficiency, enhance transparency and accountability in environmental reporting, and mitigate potential risks in Iraqi oil companies

Keywords: Engineering Accounting. Cost Accounting. Environmental Cleanup Costs, Iraqi Oil Companies, Engineering data integration.

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1. Introduction

Iraqi oil companies face significant challenges in accurately calculating environmental cleanup costs, impacting operational efficiency and environmental cost reduction. Environmental damages, biodiversity rehabilitation expenses, and negative environmental impacts often result from oil operations. As a primary global energy provider, the oil industry, particularly in countries like Iraq, contributes substantially to environmental pollution. Key environmental concerns include pollution, greenhouse gas emissions, and other detrimental effects on ecosystems, human health, and socio-economic development. Addressing these pressing environmental concerns necessitates innovative approaches beyond traditional methods (Almagtome et al., 2020), However, corporate social responsibility management strategies aim to prevent such negative impacts and proactively assess positive contributions towards sustainable development. Engineering accounting encompasses direct, indirect and hidden costs, property damage, natural resource depletion, training, insurance, recycling and pollution control. This interdisciplinary solution combines engineering and accounting expertise. Developing and training professionals in 'engineering accounting' will enable specialized accountants to measure, record and interpret environmental sustainability information. Engineering accounting is a new concept that brings the engineering concept with the best accounting to capture the costs and impacts on the environment. It is a valuable means of aiding oil companies in determining and managing their environmental costs and risks with less

probability. Engineering accounting contributes to corporate sustainability, which has become the decisive point for the evolution of the environmentally responsible approach and the disclosure of the work processes (Mohammed ,2024). Engineering accounting has been portrayed as a specialized field of accounting designed to deal with complex technical, social and political accounting problems (J. Hřebíček., et al.,2013). The challenges posed by climate change and increased carbon emissions resulting from the operations of Iraqi oil companies necessitate engineering expertise. This expertise is essential for estimating the technical aspects of pollution accounting related to water, air, and all environmental sustainability measures. It helps in measuring the harmful impacts on society and the environment. Specifically, engineers provide the data that accountants use to improve the accuracy of environmental cost calculations."Engineering accounting" will be embodied in all its recognized aspects, including education and training for technical mastery, independence of perspective, and support for the public interest, in addition to recognizing the importance of members' needs (Ngwakwe, 2012). It will also include a system for measuring, evaluating, recording, and interpreting sustainability information with a focus on cost aspects, contributing to improving the accuracy of environmental cost calculations (Vinkhuyzen et al, 2012). The behaviors of actors in the water sector and the important environmental aspect of sustainability, as well as the proposed future of global tensions competing with those on oil, can be assessed through a combination of engineering and accounting expertise. This combination is seen as a way to illustrate how "engineering accounting" can help understand the causes and behaviors of actors in this field. While discussing engineering accounting, it is possible to address the importance of the concept for Iraqi oil companies. This paper provides the necessary context to understand the environmental, social, and political issues in Iraq, a country with one of the largest oil reserves in the world, which only exacerbates the consequences of the oil sector. In this regard, through engineering accounting practices, Iraqi oil companies should be able to prioritize sustainability and thus serve as a model for other companies in the region and the world (Al-Noor et al., 2024). It is beneficial to better assess environmental costs, which enhances the investment and policy-making process and increases awareness of sustainability to receive more economic and environmental benefits in the future. This change emphasizes the importance of engineering accounting in creating a positive change in sustainability practices in the oil industry; thus, it qualifies as an innovation for sustainable environmental management in Iraq and other similar environments worldwide.

Literature Review:

Engineering accounting, which is the application of engineering principles in accounting, is gradually gaining acceptance as a powerful tool in addressing environmental issues. These new interdisciplinary fields are particularly valuable in industries with significant environmental impacts, where the costs of these impacts can be easily reduced to measurable values, such as the oil industry. For example, Andersen and Gulbrandsen (2020) attempted to shift the focus towards the role that engineering data can play in enhancing current accounting models and addressing the environmental costs of industries. These studies emphasize that through engineering accounting, it becomes possible to gain a better understanding of resource consumption, waste disposal, and improvements in emission reduction while placing technical information in a financial context. Developing and training professionals in 'Engineering Accounting' will reduce accountants' reliance on engineers and enhance their ability to adapt to evolving stakeholder requirements, such as societal and professional expectations (J. Hřebíček et al., 2013). This proposes creating specialized accountants equipped to measure, record, and interpret organizational environmental sustainability information. These professionals will be educated through tailored university courses, professional certifications, and continuing professional development programs. The accounting pollution practices gap can be better understood by considering traditional financial accounting methods, which

fail to disclose pollution's true costs. For instance, Obaid (2022) highlighted emission manipulation and fluctuating environmental cleanup costs. Such practices distort societal perceptions and undermine environmental stewardship. Environmental reporting often falls short in providing decision-makers with a comprehensive picture of business operations' ecological consequences, including ecosystem degradation and biodiversity impacts. These gaps necessitate this study, as despite the feasibility of integrating engineering data into accounting practices, limited research explores its implementation within Iraq's oil industry, a vital sector characterized by significant environmental implications. This study fills existing gaps by analyzing the implementation and adaptation of engineering accounting within Iraqi oil organizations to enhance environmental disclosure policies and sustainable development (Mohammed, 2024). The research aims to contribute to discussions on environmental impact cost accounting in the oil industry, proposing a practical and effective cost-accounting method to enhance accuracy, transparency and corporate environmental accountability.

Research Objectives in the Context of Integrating Engineering Accounting and Cost Accounting to Improve the Accuracy of Environmental Cleanup Cost Estimation in Iraqi Oil Companies:

1. Develop an Integrated Accounting System: Accurately determine environmental cleanup costs and enhance operational efficiency through reduced waste and increased resource utilization.

2. Enhance Decision-Making: Improve decision-making processes by analyzing costs and benefits, identifying economically viable environmental investments and cleanup strategies.

3. Assess Integration Impact: Examine the impact of integrating engineering accounting and cost accounting on environmental cleanup cost estimation accuracy.

As environmental and economic challenges increase, it becomes essential for oil companies to adopt integrated and effective accounting systems. The research questions in this context are as follows:

1. How can engineering accounting be integrated with cost accounting to improve the accuracy of environmental cleanup cost estimation in Iraqi oil companies, and contribute to improving operational efficiency and reducing waste in oil companies?

2. How can engineering insights enhance the accuracy of environmental cost accounting?

2. Materials and Methods

The paper addresses the assembly of a team of accountants and engineers to study the feasibility of applying specialized engineering accounting to one of the world's largest oil resources, such as Iraq. The research problem being addressed is that Iraqi oil companies face significant challenges in accurately determining the actual costs of environmental cleanup operations. These companies rely on traditional accounting systems that may not be sufficient to accurately determine costs, leading to inaccurate estimates and increased overall costs. Therefore, the lack of integration between accounting systems, especially the absence of integration between engineering accounting and cost accounting, results in difficulty in determining actual costs. The lack of accurate and comprehensive data on environmental costs makes it challenging to determine costs accurately. This research employs an integrated approach to analyze the impact of engineering accounting and cost accounting on environmental cleanup costs in Iraqi oil companies.This research employs a mixed-methods approach to ensure that the analysis of adopting engineering accounting and cost accounting principles among Iraqi oil companies meets the depth and breadth of the research questions (Bridge et al., 2018). The

research methodology includes the collection and analysis of both quantitative and qualitative data, providing a rich framework with the strengths of both approaches.

Quantitative Research: This work's quantitative part is based on a data set containing 100 rows of data obtained from different P&F sections of the Iraqi oil companies under study. Such information may comprise data on emissions, waste disposal, resource consumption, and financial costs of environmental protection. The quantitative research method will be used to analyze the data using SPSS, and the results will be presented as regression analysis, ANOVA, and correlation to reveal the relationship and the effects of integrating engineering data into accounting practice (Fethi & Rahuma, 2020). The results will aid in realizing the numerical values and trends that come up when the integration is done.

Qualitative Research: Qualitative analysis is also conducted in the study, and this part includes three interviews with senior accountants and environmental engineers working in the oil sector. These interviews aim to obtain more in-depth qualitative data on the real issues, advantages, and administrative consequences of applying engineering accounting. Thematic analysis will be applied to analyze the data, and responses will be coded to reveal perceptions, experiences, and potential solutions regarding reporting environmental cleanup costs.

The research hypothesis is as follows: Integrating engineering accounting with cost accounting in Iraqi oil companies will improve the accuracy of environmental cleanup cost estimation, contributing to reducing overall costs and increasing operational efficiency. This hypothesis can be tested by collecting and analyzing data to determine the impact of this integration on cost accuracy and operational efficiency.

4- Data Collection and Analysis

4-1 Types of Data:

The research employs both primary and secondary data collection methods to illustrate the integration of engineering accounting with cost accounting practices in Iraqi oil companies.

4-2 Quantitative Data:

Quantitative data includes performance indicators such as emissions, resource consumption, waste management data, and all financial data related to environmental management activities. This data is collected from the internal reports of oil companies because it is realistic and numerical and is used for statistical analysis. To determine the environmental impacts and economic costs of their operations, a dataset consisting of 100 rows containing different companies, their departments, and functions will be used (Haque & Ntim, 2018).

4-3 Qualitative Data: Semi-structured interviews are conducted with senior accountants and environmental engineers to gain an in-depth understanding of the situation. These interviews aim to explore the qualitative aspects of respondents' experiences, beliefs, and feelings about engineering accounting practices. Primary data includes policies, reports on environmental cleanup costs, and compliance records to explore the integration of engineering accounting and cost accounting to improve the accuracy of environmental cleanup cost estimation, as well as the frameworks and environment in which accounting takes place.

4-4 Data Analysis

Quantitative Analysis: The study will use various statistical methods in the SPSS program to analyze quantitative data. The analysis will begin by measuring the basic characteristics of the data or descriptive statistics to reveal some features of the distribution and central tendencies of the data. Proposals will be formulated and analyzed, and a correlation between engineering practices and cost accounting will be established using

regression analysis and variance analysis. This phase aims to quantitatively confirm the effectiveness of all integrated practices.

Qualitative Analysis: The interviews and document reviews will include a thematic analysis of the texts. This method involves dividing the data into themes that represent the collected information. Using the framework will help compare and contrast perceptions about integrating engineering concepts into accounting. These practices will be understood using the thematic framework created to determine how they are perceived and implemented within the organizational culture of Iraqi oil companies (Ibrahim et al., 2019). Combined, these methods will provide a comprehensive approach to identifying the current situation and potential improvements in engineering accounting for environmental sustainability in the oil sector. This dual approach helps conduct the analysis based on the collected physical evidence and complements it with information from within the industry.

3. Results

5-1 Quantitative Analysis / Correlation Analysis

The correlation matrix reveals several interesting insights into the relationships between various factors related to the integration of engineering accounting and cost accounting. Most correlations appear to be statistically insignificant, indicating limited linear relationships between these factors within the dataset. The notable exception is the correlation between understanding how to integrate engineering data into environmental cost accounting and the belief that this integration helps make better financial decisions regarding environmental management, which is significant ($r = -0.241$, $p = 0.016$). This indicates a negative relationship, suggesting that greater understanding may be associated with less belief in the benefits, possibly reflecting a realistic perspective on the challenges involved (Kamble et al., 2018).

Table 1: Correlations Analysis

Correlations										
		Position	**Department**	**Years of Experience in the Oil Industry**	**I am aware of the principles of cost accounting**	**I understand how engineering data can be integrated into cost accounting**	**My company is currently integrating engineering data into cost accounting practices**	**There are established practices for accurately tracking and identifying the actual costs of environmental cleanup in my department**	**Integrating engineering data into accounting would improve the accuracy of environmental cleanup cost calculations**	**I believe this integration would help in making better-informed decisions regarding environmental costs**
Position	**Pearson Correlation**	1	-.136	.029	-.043	.077	.083	.027	.041	-.048
	Sig. (2-tailed)		.176	.773	.669	.447	.414	.789	.686	.634

	N	100	100	100	100	100	100	100	100	100
Department	**Pearson Correlation**	-.136	1	-.050	.008	.142	-.152	-.150	.063	.094
	Sig. (2-tailed)	.176		.624	.933	.160	.131	.137	.532	.350
	N	100	100	100	100	100	100	100	100	100
Years of Experience in the Oil Industry	**Pearson Correlation**	.029	-.050	1	-.027	-.035	.087	.088	-.105	-.125
	Sig. (2-tailed)	.773	.624		.792	.732	.389	.383	.297	.215
	N	100	100	100	100	100	100	100	100	100
I am aware of the principles of cost accounting	**Pearson Correlation**	-.043	.008	-.027	1	.139	-.051	.024	.062	.032
	Sig. (2-tailed)	.669	.933	.792		.168	.617	.809	.540	.750
	N	100	100	100	100	100	100	100	100	100
I understand how engineering data can be integrated into cost accounting	**Pearson Correlation**	.077	.142	-.035	.139	1	.056	.084	-.113	-.241*
	Sig. (2-tailed)	.447	.160	.732	.168		.581	.407	.262	.016
	N	100	100	100	100	100	100	100	100	100
My company is currently integrating engineering data into cost accounting practices	**Pearson Correlation**	.083	-.152	.087	-.051	.056	1	.007	.066	-.052
	Sig. (2-tailed)	.414	.131	.389	.617	.581		.943	.513	.605
	N	100	100	100	100	100	100	100	100	100
There are established practices for accurately tracking and identifying the actual costs of environmental cleanup in my department	**Pearson Correlation**	.027	-.150	.088	.024	.084	.007	1	-.086	.023
	Sig. (2-tailed)	.789	.137	.383	.809	.407	.943		.395	.822
	N	100	100	100	100	100	100	100	100	100
Integrating engineering data into accounting would improve the	**Pearson Correlation**	.041	.063	-.105	.062	-.113	.066	-.086	1	.089
	Sig. (2-tailed)	.686	.532	.297	.540	.262	.513	.395		.379
	N	100	100	100	100	100	100	100	100	100

accuracy of environmental cleanup cost calculations										
I believe this integration would help in making better-informed decisions regarding environmental costs	**Pearson Correlation**	-.048	.094	-.125	.032	-.241*	-.052	.023	.089	1
	Sig. (2-tailed)	.634	.350	.215	.750	.016	.605	.822	.379	
	N	100	100	100	100	100	100	100	100	100

*. Correlation is significant at the 0.05 level (2-tailed).

Other correlations, such as the ones between department, position, and years of experience with various measures, show no significant relationships, implying that demographic and positional differences do not significantly influence perceptions and practices regarding sustainable accounting within the context of this dataset. The overall lack of significant correlations might indicate the need for a more nuanced approach to understanding how these factors interact or suggest that other non-measured variables could be influencing these relationships.

Regression Analysis

The regression analysis assesses the influence of demographic variables (Position, Department, Years of Experience in the Oil Industry) on the belief that integrating engineering data into accounting would improve environmental sustainability.

Table 1: Model Summary

Model Summary				
Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.131[a]	.017	-.014	1.381
a. Predictors: (Constant), Years of Experience in the Oil Industry, Position, Department				

The results indicate poor model fit, with an R-squared value of only 0.017, suggesting that only 1.7% of the variance in the dependent variable can be explained by these predictors. The adjusted R-squared value is negative (-0.014), which often occurs when the R-squared is low and the model includes multiple predictors. This indicates that the model does not improve prediction accuracy compared to a model without predictors.

Table 3: ANOVA

ANOVA[a]						
Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	3.204	3	1.068	.560	.643[b]
	Residual	182.986	96	1.906		
	Total	186.190	99			

a. Dependent Variable: Integrating engineering data into cost accounting would improve accuracy of environmental cleanup cost calculation
b. Predictors: (Constant), Years of Experience in the Oil Industry, Position, Department

The variance analysis table 3 indicates that the regression model is not statistically significant ($F(3, 96) = 0.560$, $p = 0.643$), suggesting that the variables (position, department, and years of experience) collectively do not significantly predict the perceived benefit of integrating engineering data into cost accounting

Table 2: Coefficients

Coefficients						
Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	3.044	.572		5.319	.000
	Position	.060	.117	.053	.518	.606
	Department	.079	.124	.065	.639	.525
	Years of Experience in the Oil Industry	-.125	.122	-.104	-1.023	.309
a. Dependent Variable: Integrating engineering data into cost accounting would improve Accuracy of environmental cleanup cost calculation						

The individual coefficients for each predictor show no substantial effects. The coefficients indicate minimal impact on sustainability improvement beliefs, with no p-values approaching significance. This suggests demographic factors within this sample do not strongly influence perceptions regarding integration's impact on environmental cleanup cost accounting accuracy (Orazalin & Mahmoud, 2018). This implies other, unmodeled factors may be more crucial in explaining these attitudes.

5-2 Qualitative Analysis

Theme 1: Awareness and Understanding of Environmental Cleanup Costs

The analysis reveals the need to increase awareness and knowledge of sustainable practices across various professional capacities. For example, a manager deeply involved in operational oversight emphasized the importance of accurately estimating environmental cleanup costs, indicating strategic alignment with long-term organizational goals: "Yes, I have a good understanding of cost accounting in estimating environmental cleanup costs. It is essential for our long-term goals" (Participant 3). A cost accountant, whose role requires close integration between engineering data and environmental cleanup cost estimation practices (Participant 2), confidently stated: "I understand it well; integrating engineering data with the reports prepared on it is a crucial part of my job" (Participant 1). Such statements indicate a fundamental level of awareness and highlight the use of this knowledge in improving their work and operational and strategic planning within the company (Cooper et al., 2020).

Theme 2: Engineering Accounting Practices

This theme focuses on the practices and procedures of the oil company regarding engineering data and cost accounting. Some practices involve initiating such changes, while others focus on whether these changes will be effective. An environmental engineer highlighted the operational reality, saying: "Yes, our company effectively integrates engineering data with cost accounting" (Participant 2). The extent of procedure development varies, as another engineer pointed out the need for more comprehensive frameworks: "We have basic procedures, but they could be more comprehensive" (Participant 2). These findings illustrate the innovative integration and areas of improvement achieved in current practices; this indicates that there is still room for

enhancement and innovation to maximize the potential of this integration (O'Dwyer et al., 2019).

Theme 3: Impact on Environmental Cleanup Strategies and Decision-Making

The third theme focuses on the impacts of integrating engineering data into environmental cost accounting and reporting for environmental sustainability. All participants agreed that this integration has a positive impact on sustainability practices. An operations manager noted that "integrating this data definitely helps enhance our environmental sustainability efforts" (Participant 3). The role of integration in promoting better-informed decision-making was also emphasized, with the same manager highlighting its strategic importance: "It is critical. It allows us to allocate resources more effectively and pursue sustainability goals with greater vision" (Participant 3). These reflections indicate that integration positively enhances environmental and financial governance at the company level (Pizzi et al., 2021).

4. Discussion

The study aimed to identify the impacts of integrating engineering specialization into accounting to enhance the development of environmental cost accounting and clarify environmental impact reporting. Therefore, the quantitative and qualitative data provided a better perspective on these research questions (Rentizelas et al., 2020). The quantitative analysis showed a weak and insignificant relationship in correlation and regression tests between the implementation of engineering data and practices and financial factors in the organization. The regression analysis primarily resulted in a weak R-squared value, indicating that the perceived benefits of this integration are not determined by demographic factors such as position, department, and experience in the organization. This means that although there is some measurement and understanding of these practices in organizations, they are not considered sufficient by the demographics in this study. The hypothesis that engineering insights lead to a significant improvement in the accuracy of environmental cost accounting cannot be strongly confirmed (Schroeder et al., 2022).

Through the interviews, there are indications of a more positive qualitative outlook, as illustrated by the following themes. Finally, participants mentioned that they believe this integration provides accurate and reliable information that helps management make informed decisions regarding environmental investments and cleanup strategies. The theme "Impact on Sustainability and Decision-Making" particularly embraced the fact that integrating engineering data helps enhance decision-making and improve the impacts of environmental cleanup strategies. Participants also acknowledged the importance of integrated data for providing better visibility and accountability, addressing the second research question about the role of engineering accounting (Song et al., 2019). While the quantitative evidence is relatively weak, the qualitative results suggest a perceived value among professionals that the integration of engineering accounting and cost accounting can help accurately determine the actual costs of environmental cleanup, enabling companies to better allocate resources and improve their operational efficiency in reducing waste. These aspects may not necessarily be quickly measured in the current structure of Iraqi oil companies or may be influenced by other unknown variables.

5. Conclusion

The research was conducted to improve decision-making processes in oil companies by analyzing costs and benefits and identifying the most economically viable environmental investments and cleanup strategies. The implementation of engineering knowledge on how to account for environmental costs and report on them has an impact within the oil industry. The quantitative results revealed a minimal statistical relationship between demographic factors and the perceived effectiveness of integration. Participants expressed positivity about the integration, stating that it provides accurate and reliable information that helps management make informed decisions regarding the best environmental investments and cleanup strategies. This highlights the issue that while integration is indeed desirable, its measurable effectiveness may not necessarily be revealed through simple demographic factors, as integration is a somewhat multifaceted process that must be implemented in practice and within the company's environment.

Based on the insights gathered, several recommendations can be made for oil companies aiming to enhance their environmental and accounting practices:

1. Companies need to acquire better-integrated systems that can link engineering data with cost accounting. This would also help achieve better accuracy in the process of allocating environmental costs and increase corporate responsibility for the environmental impacts they produce (Qian et al., 2021).
2. The integration of engineering accounting and cost accounting in Iraqi oil companies can have a significant impact on improving the accuracy of environmental cleanup cost estimation.
3. It may also be beneficial to design and offer training programs to qualify accountants and environmental engineers to use integrated accounting models for application.
4. Integration processes should be periodically reviewed, and improvements made as necessary to address new challenges or adopt new technologies.

Implementing these recommendations may ensure better integration of engineering results into cost accounting frameworks, enabling oil companies to improve decision-making processes by analyzing costs and benefits and identifying the most economically viable environmental investments and cleanup strategies. This would enhance environmental sustainability efforts and accountability in ensuring compliance with local and international environmental standards, reducing legal and financial risks regarding environmental investments and cleanup strategies.

Future Research Agenda in Integrating Engineering Accounting and Cost Accounting

1. Explore and Develop Accounting Models Combine engineering accounting and cost accounting to improve the accuracy of environmental cost estimation.
2. Collect and Analyze Environmental Data From oil companies to identify environmental impacts and associated costs, helping to determine the economic feasibility of environmental projects.
3. Study and Evaluate Social Impacts Of implementing an integrated accounting system on local communities and oil companies.

REFERENCES

1. Almagtome, A. H., Al-Yasiri, A. J., Ali, R. S., Kadhim, H. L., & Heider, N. B. (2020). Circular economy initiatives through energy accounting and sustainable energy performance under integrated reporting framework. International Journal of Mathematical, Engineering and Management Sciences, 5(6), 1032.
2. Alnoor, A., Chew, X., Khaw, K. W., Muhsen, Y. R., & Sadaa, A. M. (2024). Benchmarking of circular economy behaviors for Iraqi energy companies based on engagement modes with green technology and environmental, social, and governance rating. Environmental Science and Pollution Research, 31(4), 5762-5783.
3. Alshehhi, A., Nobanee, H., & Khare, N. (2018). The impact of sustainability practices on corporate financial performance: Literature trends and future research potential. Sustainability, 10(2), 494.

4. Andersen, A. D., & Gulbrandsen, M. (2020). The innovation and industry dynamics of technology phase-out in sustainability transitions: Insights from diversifying petroleum technology suppliers in Norway. Energy Research & Social Science, 64, 101447.
5. Bridge, G., Özkaynak, B., & Turhan, E. (2018). Energy infrastructure and the fate of the nation: Introduction to special issue. Energy research & social science, 41, 1-11.
6. Cuckston, T. (2018). Making accounting for biodiversity research a force for conservation. Social and Environmental Accountability Journal, 38(3), 218-226.
7. Ebaid, I. E. S. (2022). Sustainability and accounting education: perspectives of undergraduate accounting students in Saudi Arabia. Journal of Applied Research in Higher Education, 14(4), 1371-1393.
8. Fethi, S., & Rahuma, A. (2020). The impact of eco-innovation on CO2 emission reductions: Evidence from selected petroleum companies. Structural Change and Economic Dynamics, 53, 108-115.
9. Haque, F., & Ntim, C. G. (2018). Environmental policy, sustainable development, governance mechanisms, and environmental performance. Business Strategy and the Environment, 27(3), 415-435.
10. Ibrahim, Y. M., Hami, N., & Othman, S. N. (2019). Integrating sustainable maintenance into sustainable manufacturing practices and its relationship with sustainability performance: A conceptual framework. International journal of energy economics and policy, 9(4), 30-39.
11. Joanne L. Tingey-Holyoak, Roger L. Burritt, and John D. Pisaniello، 2013", Integration of Macro and Micro Sustainability Issues: The Need for 'Engineering Accounting'" International Federation for Information Processing. IFIP AICT 413, pp. 500–507, 2013.
12. Kamble, S. S., Gunasekaran, A., & Gawankar, S. A. (2018). Sustainable Industry 4.0 framework: A systematic literature review identifying the current trends and future perspectives. Process safety and environmental protection, 117, 408-425.
13. Karlsson-Vinkhuyzen, S.I., Jollands, N., Staudt, L.)2012), Global Governance for Sustainable Energy: The Contribution of a Global Public Goods Approach. Ecological Economics 83,11–18.
14. Kober, T., Schiffer, H. W., Densing, M., & Panos, E. (2020). Global energy perspectives to 2060–WEC's World Energy Scenarios 2019. Energy Strategy Reviews, 31, 100523.
15. Mohammed, Iman Shakir, INTEGRATING ENGINEERING AND SUSTAINABLE ACCOUNTING TO ACHIEVE ENVIRONMENTAL SUSTAINABILITY: AN APPLIED STUDY OF IRAQI OIL COMPANIES, World Economics & Finance Bulletin (WEFB), Vol. 39, October, 2024.p. 167-175, Available Online at: https://www.scholarexpress.net.
16. Ngwakwe, C.C.: Rethinking the Accounting Stance on Sustainable Development. Sustainable Development 20, 28–41 (2012).
17. O'Dwyer, E., Pan, I., Acha, S., & Shah, N. (2019). Smart energy systems for sustainable smart cities: Current developments, trends and future directions. Applied energy, 237, 581-597.
18. Olson, E. G. (2021). Environmental disclosures in the oil industry under new regulations. Energy Policy, 148, 111916. https://doi.org/10.1016/j.enpol.2020.111916
19. Orazalin, N., & Mahmood, M. (2018). Economic, environmental, and social performance indicators of sustainability reporting: Evidence from the Russian oil and gas industry. Energy policy, 121, 70-79.
20. Pizzi, S., Moggi, S., Caputo, F., & Rosato, P. (2021). Social media as stakeholder engagement tool: CSR communication failure in the oil and gas sector. Corporate Social Responsibility and Environmental Management, 28(2), 849-859.
21. Qian, W., Tilt, C., & Belal, A. (2021). Social and environmental accounting in developing countries: contextual challenges and insights. Accounting, Auditing & Accountability Journal, 34(5), 1021-1050.
22. Rentizelas, A., de Sousa Jabbour, A. B. L., Al Balushi, A. D., & Tuni, A. (2020). Social sustainability in the oil and gas industry: institutional pressure and the management of sustainable supply chains. Annals of Operations Research, 290, 279-300.
23. Schroeder, R. G., Clark, M. W., & Cathey, J. M. (2022). Financial accounting theory and analysis: text and cases. John Wiley & Sons.
24. Song, M., Fisher, R., & Kwoh, Y. (2019). Technological challenges of green innovation and sustainable resource management with large scale data. Technological Forecasting and Social Change, 144, 361-368.