International Journal of Scientific Research and Engineering Development-– Volume 9 Issue 4, July – August 2026
Available at www.ijsred.com

RESEARCH ARTICLE OPEN ACCESS

Impact of The Integration of Large Data Analyses (Big Data) and Environmental Management Accounting Methods in Promoting Sustainable Competitive Advantage: Intermediate Role of Sound Risk Management

Hadier Jassim Al-Hasnawi
College of Administration and Economics, University of Babylon ،Iraq
bus684.haider.jasem@uobabylon.edu.iq

----------**********----------

Abstract:

The business sector is undergoing rapid shifts imposed by subsequent technological developments and environmental and economic challenges, requiring organizations to adopt modern management and accounting tools that enhance performance efficiency and ensure sustainability. Petroleum institutions are among the most responsive sectors in view of their extensive nature of activity and its environmental and societal impacts, requiring the development of their systems to support governance and sustainability requirements.

In this context, research aims to measure the impact of the integration of large data analyses (Big Data Analytics) and environmental management accounting methods (EMA) in promoting sustainable competitive advantage, while testing the intermediate role of risk management (Agile Risk Management). To achieve the objectives of the research, the analytical metadata was adopted through a field study in a series of formations and services of the Ministry of Oil. This study draws its importance from providing an analytical framework that helps decision makers in the oil sector to invest large data and environmental accounting applications to deal with risks with high flexibility and achieve sustainable competitive advantage.

Keywords — **big data, big data analyses, environmental management accounting, sustainable competitive advantage, oil sector**

----------**********----------

I. INTRODUCTION

Accelerated changes in the contemporary business environment — the digital revolution and increasing environmental challenges have imposed on organizations to reshape their strategies and working methods to consolidate more sustainable practices. In this regard, the oil sector is at the heart of these shifts, owing to its complexity in operations, its intensity of resource consumption and wide environmental impacts; this makes it an urgent requirement to adhere to governance and environmental sustainability standards and to develop accounting and management information systems capable of absorbing these variables.

Traditional management accounting techniques are no longer sufficient to provide management with the information necessary to deal with a volatile and uncertain environment. In this sense, the integration of large data analyses (Big Data Analytics) and environmental management accounting methods (EMA) emerges as a modern strategic pillar. While large data analyses contribute to the treatment of large quantities of structural and non-structural data very quickly, environmental management accounting provides the regulatory framework for tracking and costing environmental impacts and the exploitation of resources, allowing decision makers a comprehensive vision that enhances performance

efficiency and contributes to building a sustainable competitive advantage.

However, taking full advantage of this integration requires effective use of increasing environmental and operational uncertainties and risks, and here highlights the role of risk management (Agile Risk Management) as a medium- and transformative variable. Distinguish risk management allows oil institutions to respond quickly and resiliently to changes, predict risks and mitigate their effects in a dynamic manner based on persistent data flows, ensuring the protection of resources and the sustainability of competitive advantage.

Accordingly, the study highlights the impact of the integration of large data analyses and environmental management accounting methods in achieving sustainable competitive advantage, while demonstrating the intermediate role of risk management, through the field application of a sample of the Ministry of Oil configurations and services.

II.RESEARCH METHODOLOGY

A. Problem of research (Research Problem)

At present, oil institutions are facing increasing pressure to comply with the requirements of sustainability and environmental governance in the context of accelerated volatility and digital transformations. Despite the increasing reliance on modern technology, however, there is a practical and theoretical gap in the ability of these institutions to effectively integrate large data analyses (BDA) and environmental management accounting (EMA) and their use in strategic decision-making.

The central issue of research is reflected in the following question:

Does the integration of large data analyses and environmental management accounting methods contribute to the promotion of sustainable competitive advantage in the services of the Ministry of Oil, and what is the nature and extent of the median role played by risk management in this relationship?

B. Importance of research (Research Importance)

The importance of research is illustrated by two fundamentals:

- The theoretical (academic) importance lies in the provision of a modern knowledge and integration framework that links modern data systems (Big Data) and environmental accounting measurement (EMA) as independent integrated variables, managing risk as an intermediate variable and their impact on achieving sustainable competitive advantage; thus contributing to the enrichment of the Arab Library in the areas of management accounting, risk management and sustainability.
- Practical (applicable): A practical guide and procedural recommendations are made for officials and decision makers in the Ministry of Oil; to develop their digital and accounting infrastructure; and to exploit large data flows in managing environmental and operational risks with the highest degree of flexibility (Agility), thereby enhancing optimal use of resources and achieving sustainable competitive excellence for the enterprise.

C. Research objectives (Research Obje) ctives)

The research seeks to achieve the following objectives:

1. Field diagnosis of the level of application and integration of large data analysis and environmental management accounting, as well as the good risk management practices of the Ministry of Oil.
2. Measuring the nature and strength of correlative relationships and the direct impact of the integration between massive data analyses and environmental management accounting in achieving sustainable competitive advantage.
3. Examine and explore the intermediate role (partial/clear) of risk management in interpreting the mechanism for transferring the impact of this accounting/digital integration to promoting sustainable competitive advantage.
4. Formulate a set of operational recommendations and proposals based on

field results to support digital and environmental transformation in the oil sector.

D. Research Hyp hypothesis othesis

Based on the problem of research, its objectives and the model adopted, the main hypothesis of research is formulated as follows:

Key hypothesis: " There is a morally significant (statistical) impact on the integration of massive data analyses and environmental management accounting methods in promoting sustainable competitive advantage in the Ministry of Oil, and this impact is enhanced through the intermediate role of sound risk management " .

E. Methodology and tools used thodology

- Research curriculum: The analytical Descriptive Analytical Approach is adopted to suit the subject of the study, where theoretical data are collected and the phenomenon is described, thus analysing field data and testing assumptions.
- Research Society: The research community is composed of administrative, accounting, financial and technical leaders and department heads in the departments and formations of the Ministry of Oil, and a random sample is withdrawn for field study.
- Data-collection tool: reliance on questionnaire (Questionnaire) as a major tool for collecting field data, developed by the lekert scale, as well as supporting personal interviews.
- Statistical analysis methods: use of the statistical package (SPSS) and modelling programmes with structural equivalents (AMOS/SmartPLS) to measure honesty and persistence (Cronbach 's Alpha), test linkages, direct and indirect impact (mediation).

THE THEORETICAL FRAMEWORK

RESEARCH I: BIG DATA ANALYSIS AND ENVIRONMENTAL MANAGEMENT ACCOUNTING

First: Big data analyses (Big Data Analytics)

Large data analyses are one of the most important modern techniques, enabling organizations to process and analyse large and diverse amounts of data quickly and efficiently. It has five main characteristics: size, speed, diversity, credibility and value, which contribute to supporting strategic decisions, improving operational efficiency and enhancing competitive advantage. (Agustia, 2025)

II: ENVIRONMENTAL MANAGEMENT ACCOUNTING METHODS (ENVIRONMENTAL MANAGEMENT ACCOUNTING)

Environmental management accounting is a strategic tool for integrating environmental considerations into management decisions, including environmental costing, performance measurement, sustainability reporting and green investment assessment. Its application contributes to improving financial and environmental performance and enhancing the competitiveness of organizations. (Alabi et al., 2024)

III. INTEGRATION OF LARGE DATA ANALYSES WITH ENVIRONMENTAL MANAGEMENT ACCOUNTING

The integration of large data analyses with environmental management accounting is a recent trend aimed at enhancing the effectiveness of environmental accounting practices through the use of advanced analysis capabilities. This integration contributes to: (Aliyev, 2024)

1. Accurate and comprehensive data on environmental costs and performance.
2. Analysis of complex relationships between environmental and financial variables.
3. Support strategic decision-making on sustainability.
4. Improve the accuracy of financial and environmental forecasts.
5. Promoting transparency and environmental disclosure.

Research indicates that organizations that integrate large data analyses with their accounting practices achieve better sustainability and have greater adaptability to environmental and regulatory variables. (Hoyos-Vallejo, 2025)

RESEARCH II: DISTINGUISH RISK MANAGEMENT

I: THE CONCEPT OF RISK MANAGEMENT

Rough risk management is a new approach based on flexibility, adaptation and rapid response to variables, through ongoing risk assessment, enhanced cooperation and participation, and integrated risk management into day-to-day operations. It is based on the principles of adaptation, continuous updating and early surveillance of future risks. Mellal, 2023

II: RISING RISK MANAGEMENT DIMENSIONS

1. Rational risk identification: use of flexible techniques to identify potential risks, such as brainstorming, scenario analysis and use of risk-adjusted Canaban panels.
2. Sharing risk assessment: recurrent risk assessment using tools such as risk burning schemes (Risk Burndown Charts) to track risk management efforts. (bird, 2020)
3. Bridging risk response: developing flexible response plans that can be quickly adjusted when new risks emerge.
4. Bridging control: ongoing risk control and periodic updating of the risk register. (Tanchangya et al., 2025)

RESEARCH III: SUSTAINABLE COMPETITIVE ADVANTAGE

I. THE CONCEPT OF SUSTAINABLE COMPETITIVE ADVANTAGE

Sustainable competitive advantage is defined as the ability of the Organization to achieve and maintain its long-term outperformance for competitors by adopting balanced strategies and practices that take into account economic, environmental and social dimensions. The concept of competitive advantage has evolved from focusing only on financial aspects to a broader perspective that includes sustainability. (Wang Wang, 2024) Order (Hashimi, 2021)

Recent research suggests that a sustainable competitive advantage requires integration between green and digital capacities, where these capacities work together to enhance organizational performance under increasing environmental and regulatory pressures. (Nguyen et al., 2024)

II: DIMENSIONS OF SUSTAINABLE COMPETITIVE ADVANTAGE

1. Economic dimension: improving profitability, reducing costs, increasing market share, improving operational efficiency.
2. Environmental dimension: reducing emissions, rationalizing resource consumption, compliance with environmental standards, improving environmental reputation.
3. Social dimension: improving working relationships, enhancing social responsibility, increasing client and community satisfaction. (Zhang et al., 2025)

RESEARCH IV: METHODOLOGY AND APPLICATION

I. RESEARCH METHODOLOGY AND FIELD DESIGN

The research was based on the analytical descriptive approach to the relevance of the nature and objectives of the study, which allows for measurement of the level of field practices, diagnosis of the nature of relationships and impact among the variables of the study (digital accounting integration, risk management, sustainable competitive advantage) and testing of the main hypothesis.

- Research society: The research community represents all administrative leaders, financial specialists, accountants, risk management officials and data analysts in the formations and services of the Ministry of Oil.
- Research sample: Purposive Sampling has been adopted to reach the most familiar groups with the subject matter of the study; 200 identifications have been distributed, and (175) statistical analysis has been retrieved, with a very acceptable response rate of 87.5%.

II: RESEARCH TOOL AND DEMOGRAPHIC CHARACTERISTICS

The resolution (Questionnaire) was adopted as a major tool for data collection, designed according to the lekert scale. Table I shows the frequency distribution and percentages of search sample personnel:

TABLE I
Repetition distribution and percentages of research sample by demographic characteristics (N = 175)

Percentage (%)	Repeat.	Category	The variable.
61.7%	108	Male	**Sex**
38.3%	67	Female	
16.0%.	28	Less than 30 years	**Age**
45.1%	79.	30 - 40 years	
27.4%	48	41.	
11.4%	20	Over 50 years	
17.7%	31	Diploma.	**Scientific qualifications**
56.0%.	98.	B.A.	
20.0%.	35.	Master.	
6.3%	11	Doctor.	
13.7%	24	Less than 5 years	**Years of service**
35.4%	62	5 - 10 years	
29.1%	51	11-15 years	
21.7%	38	Over 15 years	
18.3%	32	Director/Head of Section	**Functional title**
33.1%	58	Chief Division/Unit	
29.7%	52	Finance Officer/Accounter	
18.9%	33	Data analyst/risk officer	

Analysis of demographic characteristics:

- Sex: The results show that the majority of samples are male (61.7%), which is consistent with the operational and field nature of the oil sector.
- Age and years of experience: the largest age group (30 - 40 years) is concentrated by 45.1% and is integrated with practical experience ranging from 5 - 10 years) by 35.4%; this indicates that there are young owners and their personnel have sufficient field experience to accommodate modern techniques and risk management.
- Scientific and functional qualifications: The results revealed that 82.3 per cent of the sample members were university, primary and senior (Bachelor ' s, Master ' s, Ph.D.) and belonged to administrative, accounting and artistic leadership; this added high accuracy and objectivity to the responses in the resolution.

III. STATUS OF THE RESEARCH MEASURES (ALPHA KRONBACH COEFFICIENT)

To measure the internal consistency of the study tool, the α kronbach coefficient (Cronbach 's Alpha) has been calculated for the dimensions and variables of research, and the results are explained in table II:

TABLE II
values of alpha kronbach coefficients for study variables

Level of persistence	Alpha kronbach coefficient	Number of paragraphs	Changing/dimensional
Very high.	0.873	Three.	**Integration of data analysis with environmental accounting (independent variable)**
Very high.	0.915	Three.	**Distinguish risk management (intermediate variable)**
Very high.	0.908	10	**Sustainable competitive advantage (changer)**
Very high.	0.932	16	**The tool as a whole**

Analysis of results: all AK values exceeded the statistically and academically accepted ratio (0.70); values ranged from (0.873) to (0.915), and the tool was stable as a whole (0.932). This proves that the resolution enjoys a very high degree of internal consistency and competence for evidentiary analysis and presumptive testing.

IV. DESCRIPTIVE STATISTICS OF RESEARCH VARIABLES

Descriptive analysis includes calculating the calculation of the mathematics and the standard deviations of the recognition and application of the research variables in the research service:

TABLE III
calculation averages of standard deviations of major variables

Estimated level	Standard deviation	Average	The variable.
High	0.76.	3.72	**Integration of data analysis and environmental accounting**
High	0.74	3.81	**Distinguish risk management**
High	0.79.	3.73	**Sustainable competitive**

			advantage

Analysis of metadata:

- The integration variant between large data analyses and environmental accounting methods was an average of 3.72 and a standard deviation (0.76), which is an (high); this indicates a good understanding of the importance of mega-data integration with environmental indicators, with opportunities to develop the environmental accounting aspect to match technological development.
- The critical risk management variant obtained the highest accounting average (3.81) and standard deviation (0.74), reflecting the interest of the management of the Service in the flexible and rapid response to operational and environmental risks.
- The variable of sustainable competitive advantage achieved an average of 3.73 and a standard deviation (0.79), which illustrates the firm ' s vigorous pursuit of sustainability and improved reputation and resource efficiency.

V. MAIN HYPOTHESIS TEST AND COURSE TEST (PATH ANALYSIS)

To test the validity of the main hypothesis of research, which states:

There is a morally significant impact of the integration of large data analyses and environmental management accounting methods in enhancing the sustainable competitive advantage of the Ministry of Oil, through the intermediate role of sound risk management

The path analysis (Path Analysis) and the structural equation model were used to compare the direct impact of the model before and after the introduction of the intermediate variable, as shown in table IV:

Table IV
Results of a downsizing analysis and intermediate role testing (Path Coefficients)

Model Path	Standardized	Significance	Statistical
	Regression Coefficient (β)	Level (Sig.)	Result
Integration →Competitive Advantage (Direct Effect Without Mediator)	0.681	0.000	Highly Significant
Integration →Competitive Advantage (Direct Effect With Mediator)	0.312	0.003	Significant
Integration →Agile Risk Management (Path a)	0.708	0.000	Significant
Agile Risk Management →Competitive Advantage (Path b)	0.486	0.000	Significant
Integration →Competitive Advantage (Indirect Effect via Mediator)	0.344	0.000	Significant
Total Effect	0.656	0.000	Significant

Interpretation of the results of the test of the main hypothesis:

1. Preliminary direct impact: The results showed a strong and statistically significant direct impact of the integration of large data analyses with environmental management accounting in achieving sustainable competitive advantage before the introduction of the intermediary (β = 0.681, Sig = 0.000).
2. Impact of the independent variable on the intermediary: integration has a direct and substantive impact on supporting good risk management practices (β = 0.708, Sig = 0.000); this means that data analyses and environmental measurement provide high-speed and accurate inputs to risk management.
3. Impact of the intermediary variable on the subordinate: The results showed that risk management has a direct and moral impact on promoting sustainable competitive advantage (β = 0.486, Sig = 0.000).
4. Mediation Test:When a variable (price risk management) is introduced as an

intermediate variable in the model, the value of the direct impact factor for integration on the competitive advantage decreased from (0.681) to (0.312), but remained moral (Sig = 0.003 < 0.05). At the same time, a statistically significant indirect impact (0.344) and a significant level (Sig = 0.000) has been achieved.

5. Statistical decision:

As the direct impact has remained intact, along with an indirect moral impact across the intermediary variable, this statistically proves that risk management plays a part-time intermediate role (Partial Mediation) in enhancing the impact of integration between large data analyses and environmental management accounting on the sustainable competitive advantage.

Based on these findings, the main hypothesis of the search is fully accepted.

I. CONCLUSIONS

Based on the results of the statistical analysis and the test of the main hypothesis on the practical side, the following conclusions were reached:

1. Field findings have shown that the level of integration between large data analyses and environmental management accounting methods, good risk management practices and sustainable competitive advantage is high in the Department of Oil, reflecting the availability of floor and institutional desire for digital transformation and adherence to environmental standards.
2. The results of the path analysis confirmed the validity and acceptance of the main comprehensive research hypothesis; there has been a demonstrable impact of the integration of large data analyses and environmental management accounting methods in promoting sustainable competitive advantage, while emphasizing the direct and indirect impact of the model.
3. Analyses have shown that risk management plays the role of micro-mediation (Partial Mediation) in the model; its introduction as an intermediate variable has enhanced interpretative power and transformed part of the direct impact of digital/accountering integration into an indirect moral impact (β = 0.344); thus emphasizing that flexible and rapid response to risks is an essential mechanism for translating environmental data into a competitive advantage.
4. A strong and direct impact of the integration of data analysis and environmental accounting on good risk management (β = 0.708); this indicates that the provision of soft flows and large data enhances the efficiency of prediction and responsiveness to environmental and operational risks.
5. Results have shown that the sustainable competitive advantage of the oil sector is no longer based solely on traditional financial performance, but is closely linked to the ability to integrate environmental indicators into the accounting system and to benefit from large data techniques to reduce waste and commit to environmental governance.

II: RECOMMENDATIONS

The need for a comprehensive automated link between large data analysis platforms (BDA) and EMS (EMA) at the Ministry of Oil to ensure that environmental impacts, emission costs and resource consumption are effectively addressed and tracked to support strategic decision-making.

1. Agile Frameworks are built within the risk management units of oil formations by relying on predictive data analyses to deal proactively with environmental, cyber and operational risks and replacing routine traditional methods with rapid and flexible response mechanisms.
2. Specialized and intensive training programmes for accountants, finances and risk management officials of the Ministry of Oil to integrate digital skills (such as data analysis) with environmental management accounting and sustainability concepts.
3. Formulation and application of an integrated performance measurement system (Balan) ced Scorecard links environmental and financial indicators to

risk response mechanisms; to pursue sustainable competitive advantage and ensure compliance with domestic and international environmental legislation.

4. Review and update the procedural manuals and accounting regulations in the oil sector that require formations and companies to investigate, measure and disclose environmental costs and obligations using modern technical applications.

REFERENCES

1. Agustia, D. 2025. Innovation, environmental management accounting, future performance: Evidence in Indonesia. Universitas Airlangga, Surabaya.
2. Alabi, O., Balogun, O., Airemen, S., Fasina, A. 2024. Big data analytics and corporate social responsibility performance in the oil and gas industry. American Journal of Operations Management and Information Systems, 9(4), 45-62.
3. Aliyev, A. S. 2024. Managing projects in uncertainty: Risk stra tegies, digital solutions, and economic resilience. TIM Journal, (4), 173-183.
4. Hoyos-Vallejo, C. A. 2025. Navigating uncertainty: Agility, data, and sustainability as drivers of business resilience. PhilPapers.
5. Mellal, A. 2023. The role of big data analytics in improving environmental management accounting practices. Journal of Accounting and Marketing, 12(3), 1-8.
6. Tanchangya, T., Siddiqi, K. O., Dhar, B. K., Rahman, J., Islam, N., Das, S. 2025. Leveraging green capabilities and digital accounting under ESG pressure: Strategic insights from an emerging market's global value chains. Thunderbird International Business Review, 67(2), 1-22.
7. Wang, J., Wang, Y. 2024. The impact of environmental management accounting on sustainable competitive advantage: The mediating role of green innovation and the moderating role of big data analytics capabilities. Journal of Cleaner Production, 434, 140-158.
8. Nguyen, T. H., Tran, P. Q., Le, M. T. 2024. Big data analytics capability, environmental management accounting, and sustainable firm performance: Evidence from manufa cturing enterprises. Sustainability, 16(8), 3412.
9. Zhang, L., Li, X., Chen, Y. 2025. Digital transformation, environmental management accounting, and sustainable competitive advantage: The moderating role of big data analytics capability. Business Strategy and the Environment, 34(2), 1125–1143.
10. Al-Otaibi, Fahad Mutlaq. 2023. Sustainable competitive advantage under digital transformation: An applied study on the oil sector. Middle East Journal of Management, Dubai, Vol. (10), No. (2), pp. 155-188.
11. Al-Ghamdi, Ali Hassan. 2022. The role of environmental management accounting in enhancing environmental and financial performance. Arab Journal of Management, Cairo, Vol. 42, No. (4), pp. 199-225.
12. Al-Mutairi, Bandar Nasser. (2020). The reality of adopting big data analytics in Iraqi government institutions. Rafidain Development Journal, Mosul, Vol. 42, No. 137, pp. 150-175.
13. Al-Hashimi, Abdullah Ali. (2021). Evaluation of risk managem ent practices and their impact on the continuity of service organizations. University of Baghdad Journal of Admini strative Sciences, Baghdad, Vol. 32, No. 125, pp. 34.56.
14. Al-Saidi, Fadel Abbas. 2023. Big data analytics as a tool to enhance the effe ctiveness of internal control. Journal of Accounting Sciences, University of Mosul, Vol. (15), No. (2), pp. 77.104.

