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Research paper

Driving Sustainability: How Regulatory Pressure, Leadership and Uncertainty Shape EMA Adoption in Oman's Manufacturing Sector

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Abstract

This paper examines the factors that lead to the adoption of EMA (EMAAD) in the manufacturing industry in Oman, with the three main drivers of EMAAD as Regulatory Pressure (RP), Top Management Commitment (TMC), and Environmental Uncertainty (EUC) Based on a quantitative study of responses from 200 managers across industries. The findings show that RP has a potent effect since companies orient their business activities towards ever-stricter environmental laws. TMC was also shown to be important, indicating that organisations with greater leadership support for sustainability initiatives were more likely to adopt EMA. The research provides a rich database on how external forces manifest alongside internal organisational forces, leading to environmental management accounting and development (EMAAD), both theoretically through Institutional Theory and Contingency Theory and empirically through manufacturing companies and policymakers. The study contributes to the broader knowledge of sustainability practice in emerging economies by shedding more light on the significance of regulatory frameworks and leadership commitment to sustainability initiatives.

Keywords: *Organisational Regulatory Pressure; Organisational Management Commitment and Support; Environmental Uncertainty; Environmental Management Accounting Adoption; Manufacturing Sector.*

1. Introduction

1.1. Background of the study

EMA has attracted significant management and academic interest over the last few years due to its potential to combine environmental stewardship with operational efficiency. As a strategic tool, EMA can help organisations determine, quantify, and allocate environmental costs, evaluate the costs of environmental policy, and oversee the link between environmental and financial performance. Its structure allows effective decision-making and the development of sustainable activities, which have helped it improve organisational performance and sustainability (Sousa et al., 2019; Sinnaiah et al., 2023). The manufacturing sector is a core area where EMA can be used, especially as companies face overwhelming sustainability and compliance requirements. Since manufacturing activities are resource-intensive and environmentally significant, EMA provides an organised mechanism to capture, monitor, and offset associated environmental expenditures (Zatini et al., 2025). In this context, the EMAAD system enables companies to meet regulatory requirements, improve resource management, reduce waste, and improve stakeholder trust. In Oman, the EMAAD's relevance has become more pronounced amid the diversification of the national economy and changing regulatory structures. Oman (among the rest of the GCC economies) is advancing the concept of sustainable industrialisation and eco-friendly responsibility; however, the implementation of EMA in Oman's manufacturing sector is underdeveloped. Customers and environmental Non-Governmental Organisations are exerting greater pressure on local manufacturers to adopt more sustainable business models, clearly demonstrating the need for already mature EMAAD frameworks (Amir et al., 2025;Khan et al., 2025;Kadir et al., 2024;Javed et al 2025).
This study explores the key drivers of EMAAD in the manufacturing industry in Oman; a specific focus is put on RP, TMC and EUC. The results advance the current discussion on sustainability and environmental management in the region and provide practitioners with evidence-based information to promote widespread EMAAD embracement and enhance environmental performance.

1.2. Problem statement

EMA has attracted greater scholarly attention because it has the potential to improve environmental stewardship in manufacturing organisations. However, there remain critical barriers to its more widespread adoption in Oman's manufacturing industry. The most prominent of these barriers is the lack of knowledge regarding the proper utilisation of EMA in most aspects. Most Omani manufacturers continue to use traditional cost accounting systems that do not reveal the true nature of environmental costs or their impact on profitability. The shift to an EMA platform is also viewed as a challenging financial endeavour, especially hard on small- and medium-sized enterprises, which are the majority in Oman's manufacturing sector (Al Qubtan & Gan, 2020).
Additionally, the existing regulatory framework in Oman does not provide clear incentives or guidelines for implementing EMA, and enforcement and monitoring measures are not fully developed. These regulatory gaps deter firms' desire to mainstream EMA. Also, there have been limited empirical studies on EMA adoption in Oman, and as a result, there is a significant lack of research on influencing factors such as RP, TMC, and EUC. Therefore, the general concept of how these forces influence EMAAD in the Omani manufacturing industry cannot be fully comprehended.

2. Literature Review

2.1. Environmental management accounting

EMA is the systematic gathering, processing, and utilisation of both financial and non-financial data to manage environmental performance, reduce environmental spending and promote sustainability practices throughout organisations. EMA helps identify environmental costs correctly, utilise resources rationally, and make better sustainability-related decisions. The main pillars of EMA are environmental cost management, eco-efficiency analysis and the smooth integration of environmental data with the financial accounting systems. EMA is a critical component in the manufacturing industry. It strengthens business by improving tracking efficiency, reducing waste, and introducing effective resource utilisation, which could directly contribute to the formulation of sustainability objectives. The cost transparency EMA provides enables organisations to analyse environmental costs embedded in their activities, products, and processes, thereby supporting better resource allocation and risk management. This openness also enhances compliance, as companies can expect audits and demonstrate compliance with environmental regulations more efficiently.
EMA reduces ecological footprints, increases operational efficiency, and promotes cost savings by identifying waste-reduction and resource-optimisation opportunities. In addition, it prepares manufacturers to comply with changing environmental requirements, a necessity in the wake of increased regulatory scrutiny. Sustainable long-term development and maintenance of relationships with stakeholders, especially customers, investors, and regulatory authorities, are also reinforced by including environmental information in general business plans.
Conclusively, EMA's ability to streamline environmental and financial performance management makes it a powerful tool for simultaneously achieving sustainability, financial efficiency, and regulatory compliance in manufacturing operations. With increasing external pressures on firms to improve environmental performance, EMAAD has emerged as an essential strategy for balancing profitability and environmental responsibility.

2.2. Theoretical background

Some of the most influential theoretical frameworks have informed the EMAAD's theoretical underpinnings. The Institutional Theory provides one of the main explanatory tools for interpreting the effects of external regulatory factors on organisational behaviour. In this view, organisations are known to embrace new practices and norms as guidelines to ensure compliance with statutory requirements, social expectations, and industry standards (De Colle et al., 2014). In the EMA context, RPs take the form of legal requirements and normative pressures, such as industry standards and professional expectations, that push firms toward EMA to gain compliance and organisational legitimacy (Alnaim & Metwally, 2024). This theoretical framework explains the influence of outside forces- RP and norms of society that foster the diffusion of EMA in the manufacturing industry of Oman.
Complementary to this, Contingency Theory suggests that EMAAD is not consistently present across companies; it depends on or varies with environmental factors in each company, such as market volatility, regulatory changes, and EUC. Companies facing elevated uncertainty prefer to implement EMA as a forward-looking approach to achieve greater flexibility, reduced risk, and long-term sustainability (Donaldson, 2001). By implementing EMA, companies can personalise decision-making and resource allocation in response to external pressures, thereby becoming more resistant to unstable environmental factors (Altalhi et al., 2023).

2.3. RP and EMAAD

RP is a determining factor of EMAAD in the Oman manufacturing sector. There is evidence that the regulatory environment is changing, with a larger emphasis on environmental performance and sustainability. Despite the presence of regulatory tools, their uneven application would have a minimal impact on organisational behaviour (Altalhi et al., 2023). Regulatory regimes/coercion: This is a strong factor, as it provides firms with an incentive to adopt EMA to avoid government sanctions. Empirical observations indicate that business entities subject to government-imposed environmental standards and regulations are more likely to adopt EMA to avoid sanctions and maintain compliance (Niap, 2024) . Moreover, these regulations can spur environmental innovation, and companies begin to use EMA as a tool for sustainable growth and cost savings (Zatini et al., 2025).
In addition to coercive forces, normative forces promote EMAAD. Pressure is placed on firms to adopt EMA in line with industry standards, certifications, and sustainability frameworks such as ISO 14001. Moreover, peer pressure and industry leadership can create common expectations for the EMAAD, thereby accelerating its diffusion (Wilkins & Emik, 2021). As a result, Omani manufacturers might be forced to consider adopting EMA to keep abreast of social and technical standards and retain competitiveness in the industry. Given these dynamics, the following hypothesis is proposed:
H1: RP has a positive effect on EMAAD in Oman's manufacturing sector, driven by coercive and normative isomorphism.

2.4. TMC and EMAAD

A sound TMC has been generally recognised as a game-changer in achieving EMAAD. The commitment of top leadership to environmental sustainability is of utmost importance in motivating change within the organisation and in allocating resources to sustainability measures. Using the Resource-Based View (RBV) model, organisations with strong leadership and a positive organisational culture are better prepared to adopt EMA effectively. The availability of financial and human resources is usually a central determinant of EMAAD, and it is the obligation of top management to allocate these resources in line with the firm's sustainability goals (Ariffin al., 2024; Javed et al., 2024;Javed & Husain, 2024). Empirical evidence indicates that organisational sustainability is more likely when top management is aware of its importance and integrates it into the organisation's strategic goals. Besides, the managerial commitment guarantees the required systems, training, and tools to be adopted, thus developing a corporate culture that appreciates sustainability and environmental performance, consequently leading all employees of the different hierarchical levels to conform to the company-set environmental goals (Wilkins & Emik, 2021; Cambra-Fierro & Ruiz-Benítez, 2011; Messikh, 2023). Thus, the following hypothesis is proposed:
H2: TMC has a positive influence on EMAAD in Oman's manufacturing sector, ensuring resource allocation and fostering a culture of sustainability.

2.5. EUC and EMAAD

EUC is a significant external factor that influences the EMAAD process. Contingency Theory assumes that organisations operating in conditions of uncertainty tend to engage in practices such as EMA to reduce risks, improve decision-making, and increase performance (Donaldson, 2001). EUC, in whatever form it comes, i.e., in the form of fluctuating market conditions, changing regulatory and regulatory frameworks, developing new environmental challenges, etc., pressurises the firms to make adaptations and develop strategies that would ensure a high level of flexibility and control. EMA ensures environmental costs and risks are addressed by integrating them into the financial decision-making process, which has the advantage of eliminating decision-making uncertainty and maintaining stable, compliant (Gunarathne et al., 2023).
Empirical studies indicate that companies in industries with high EUC levels use proactive strategies, such as EMA, more frequently to reduce risk and promote sustainability (Liu et al., 2021). In the manufacturing sector, where in a dynamic environment, factors like resource availability, regulatory changes, and changing market requirements are more or less unpredictable, EMA helps companies to make more accurate forecasts and carry out strategic planning and management of environmental implications in an effective manner to have a better long-term sustainability and reduced vulnerability to environmental risk(Javed & Al-Mulali 2025;Rafique et al., 2025) . Thus, the following hypothesis is proposed:
H3: EUC positively influences EMAAD in Oman's manufacturing sector as firms seek to mitigate risks and enhance operational performance.

2.6. Conceptual framework

This diagram explains the causal relationships among the independent variables RP, TMC, and EUC, and the dependent variable EMAAD. RP, TMC, and EUC contribute incrementally to EMAAD, and there is the possibility of a network of moderating or mediating effects among the three.

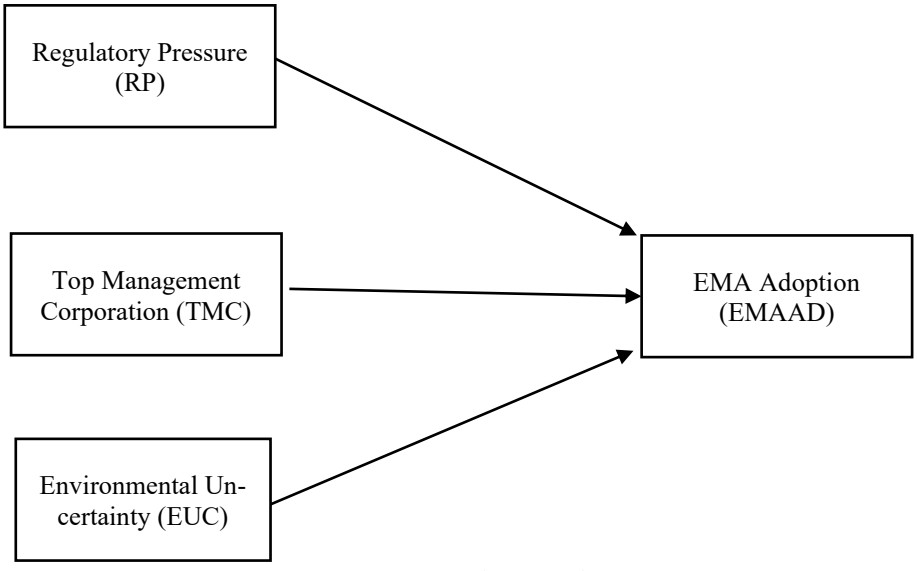

Fig. 1: Conceptual Framework.

2.7. Summary of the literature review

Study	Year	Variables	Findings
Zhang & Zhao	2023	RP, EMAAD,	RP drives EMAAD through coercive and normative isomorphism.
Hedrick et al.	2022	TMC, EMAAD,	TMC is crucial for allocating resources and fostering EMAAD
(Hasan et al., 2024) Boeske, 2023	2023 and 2024	EUC, EMAAD,	EUC increases the likelihood of EMAAD in environments characterised by uncertainty.
Liu et al.	2021	RP, EMAAD,	RP, combined with normative isomorphism, enhances the EMAAD in manufacturing firms.

Gupta & Sharma	2021	TMC, EMAAD,	Leadership commitment to sustainability accelerates the EMAAD.
Pereira et al.	2020	Environmental Cost Management, EMAAD,	EMA provides greater transparency in environmental cost management, thereby improving sustainability.
Juma	2022	EMAAD, Manufacturing Sector	The lack of awareness and resource limitations hinder the EMAAD in Oman's manufacturing sector.
Bennett & James	2023	EMA, Sustainability	EMA facilitates organisational sustainability and regulatory compliance in the manufacturing industry.
Zhang & Zhao	2023	RP, EMAAD,	Coercive isomorphism and environmental regulations are primary drivers of EMAAD.
(Hasan et al., 2024) Boeske, 2023	2023 and 2024	EMAAD, Regulatory Framework	Inconsistent regulatory enforcement limits EMAAD in Oman's manufacturing sector.

3. Methodology

3.1. Research design

The current research employs a quantitative research design, which is often used to develop relationships among variables and test hypotheses in a formal, systematic way (Creswell, 2021). The selected design enables a data-based analysis of the relationships between RP, TMC, and EUC with the EMAAD construct. The causal effect of the independent variables on the dependent variable is the focal concern.
The data obtained through a structured survey, an appropriate method for collecting quantitative data from large samples of respondents, increases the external validity of the study for the general population of the manufacturing industry (Sekaran & Bougie, 2020). Surveys are also suitable to this question since they allow gathering relevant information regarding the experiences of decision-makers with RPs, TMC, and EUC in a systematic way and also allow such respondents to provide a structured opportunity to express their opinion regarding EMAAD, thus facilitating collecting both the relevant data needed and an amount which could be used in later statistical analysis speedily and comprehensively (Bryman & Bell, 2015).
The data were analysed using both descriptive and inferential statistical methods to establish the strength of relationships between the primary constructs. The given methodological approach aligns with accepted practice in EMAAD research and helps identify the key drivers of EMAAD in Oman's manufacturing industry (Zhang & Zhao, 2023).

3.2. Population and sample

The current study examines managerial decision-making styles among managers working in manufacturing firms in Oman. In particular, the study focuses on managers who have both the power to decide and familiarity with the structure of environmental management actions and environmental management audits (EMAA). According to Hasan et al., 2024 and Boeske, 2023, such a group is pivotal, as it comprises top-level executives, department directors, and heads who are either directly or indirectly involved in, and/or aware of, their organisations' environmental policies and sustainability initiatives.
A purposive sampling approach will be used to compose the sample. Purposive sampling enables the selection of participants who are especially expert in EMAA and provides optimal representativeness of organisational opinions (Bryman & Bell, 2015). The resultant sample comprises around 200 managers across various manufacturing industries, including chemicals, electronics, and textiles, thereby creating diversity within the sampled industry typologies. The selected n of 200 managers provides sufficient statistical power and meets the minimum thresholds for Structural Equation Modelling, a statistical method regularly used in recent research of this nature (Hair et al., 2021).

3.3. Variables and measurements

It analyses how RP, TMC, EUC, and EMAAD levels are related to one another. Each construct used was based on existing scales and was thus modified to fit the manufacturing sector in Oman. RP measures the extent to which external regulations constrain or facilitate EMAAD processes. Zhang and Zhao (2023) and Gupta and Sharma (2021) provided six items. The TMC instrument assesses the level of commitment to environmental sustainability and EMA practice by the TMC and its investments. It is possible to define six items based on Pereira et al. (2020) and Liu et al. (2021). EUC reflects the organisation's concern over market fluctuations, regulatory uncertainty, and environmental setbacks. The scale comprised six items based on Pereira et al. (2020) and Liu et al. (2021). The performance dimension, EMAAD, measures the extent to which EMA has been operationalised within the organisation. Seven variables were extracted from Gupta and Sharma (2021) and Liu et al. (2021).
The 5-point Likert scale (1 = strongly disagree, 5 = strongly agree) was used to assess each construct, with respondents indicating their level of agreement or disagreement with each statement. The format provides an accurate measure of attitudes and perceptions, thus enabling rigorous statistical analysis. The choice of all items was based on recent EMA, RP, TMC and EUC studies to maximise construct validity and reliability. The EMAAD scale is based on existing frameworks and has been adjusted for the Omani manufacturing industry, resulting in high reliability and validity indicators (Zhang and Zhao, 2023).

3.4. Data collection methods

The data collection method for this study was a survey questionnaire, administered to a sample of 200 managers in Oman's manufacturing sector. The survey consists of 5-point Likert-scale questions, enabling quantitative analysis of respondents' attitudes and behaviours regarding EMAAD. The questionnaire is divided into the following sections: Demographic Information: This section collects basic information about the participants, including age, gender, position, and years of experience within the company. RP: Questions assess the RPs influencing the EMAAD. TMC: This section focuses on top management's commitment to sustainability and EMA. EUC: This part captures perceptions of external uncertainty and its role in decision-making regarding environmental practices. The survey was distributed electronically to enhance reach and minimise logistical constraints. Online survey platforms, such as Google Forms, facilitate distribution and data collection. Participants were invited via email, accompanied by a cover letter outlining the study's purpose, to ensure transparency and encourage participation. A pilot study was conducted with a small sample of managers to refine the survey and address any issues before the full distribution.

3.5. Data analysis techniques

In the current research, SPSS was combined with SmartPLS to perform descriptive and inferential statistical analyses. In the descriptive dimension, SPSS was used to generate measures, including means, standard deviations, and frequency distributions, and to summarise the survey responses. The key analytical procedure in the software tool SmartPLS, which enables Partial Least Squares SEM, is Structural Equation Modelling (Hair et al., 2021; Javed & Husain, 2024; Javed, 2023; Javed et al., 2023; Rababah et al., 2022; Husain et al., 2021). SEM was particularly well-suited to testing multiple independent variables on a single dependent variable by virtue of its ability to handle more complex patterns of relationships among variables. Such a model-based method was used to evaluate the causal associations between RP, TMC, EUC, and EMAAD, allowing exploration of direct and indirect effects and overall model fit.

3.6. Ethical considerations

Ensuring ethical integrity is paramount in this research. The study adheres to ethical guidelines. Participants were provided with a detailed information sheet explaining the study's purpose, procedures, and their right to withdraw at any time. Informed consent was obtained electronically before participation. All survey responses are anonymised, and personal information is kept confidential. Participants' identities will not be disclosed in the final report, ensuring privacy throughout the research process. All responses are stored securely and are only accessible to the research team.

4. Demographic Analysis of Respondents

In the first step, the respondents' demographic characteristics were analysed to understand the composition of the sample. The following demographic information was collected from the survey:

Table 1: Demographic Information

Demographic Variable	Category	Frequency	Percentage
Age	18-30 years	30	15%
	31-40 years	60	30%
	41-50 years	70	35%
	51+ years	40	20%
Gender	Male	150	75%
	Female	50	25%
Position	Senior Manager	80	40%
	Department Head	90	45%
	Director	30	15%
Industry Type	Chemical Manufacturing	50	25%
	Electronics Manufacturing	60	30%
	Textile Manufacturing	40	20%
	Other (e.g., Machinery)	50	25%
Years of Experience	Less than 1 year	10	5%
	1-3 years	40	20%
	4-6 years	60	30%
	More than 6 years	90	45%

SPSS Output: Frequency Distribution.

In Table 1, the sample is predominantly middle-aged (31-50 years), suggesting that most respondents have substantial industry experience and leadership roles. There is a notable gender imbalance in this sample, with a higher proportion of males in managerial roles in Oman's manufacturing sector. It may reflect industry trends or organisational structures that favour male representation in leadership. The majority of respondents hold mid-level management positions, which are key to EMAAD's decision-making process. The sample comprises a diverse mix of both senior and middle management, providing valuable insights into the perspectives of those responsible for implementing environmental strategies. The sample is well distributed across several manufacturing industries, with the highest representation in Electronics and Chemical Manufacturing. This diversity allows for broader insights into EMAAD across various manufacturing sectors in Oman. The sample is highly experienced, with 45% of respondents having over 6 years of experience. This is important for understanding the perspective of established managers who have likely encountered both regulatory changes and sustainability initiatives, making their opinions on EMAAD particularly insightful.

4.1. Descriptive statistics

Descriptive statistics are used to summarise the data and present a clear overview of the key variables. It includes calculating the mean, standard deviation, and other relevant summary statistics for the independent and dependent variables.

Table 2: Descriptive Statistics

Variables	Mean	Standard Deviation	Min	Max
RP	3.85	0.72	2	5
TMC	4.12	0.58	3	5
EUC	3.74	0.65	2	5
EMAAD	4.05	0.61	3	5

SPSS Output: Descriptive Statistics.

The descriptive statistics in Table 2 show that respondents generally perceive RP (mean = 3.85) as moderate to high, indicating a significant influence from environmental regulations. TMC (mean = 4.12) is viewed positively, with low variability, suggesting strong support for environmental initiatives in the organisations. EUC (mean = 3.74) is perceived as moderate, with some respondents reporting greater impact from external factors, such as market volatility and regulatory changes. EMAAD (mean = 4.05) is also rated positively, indicating that

many organisations have implemented EMA practices, although there is some variability in the extent to which they have done so. Overall, the results highlight that RPs and strong leadership commitment are key drivers of EMAAD, while EUC also plays a significant role.

4.2. Reliability analysis

Reliability analysis was conducted to assess the internal consistency of the scales used in this study. A Cronbach's Alpha greater than 0.70 is generally considered acceptable for reliability.

Table 3: Reliability Analysis

Variables	Number of Items	Cronbach's Alpha
RP	6	0.85
TMC	6	0.82
EUC	6	0.79
EMAAD	7	0.87

SPSS Output: Reliability Statistics (Cronbach's Alpha).

Table 3 above shows that the Cronbach's Alpha for RP is 0.85, indicating excellent internal consistency. The items used to measure RP are highly reliable and cohesive. The Cronbach's Alpha for TMC is 0.82, indicating that the measurement scale is reliable and internally consistent. The items used to measure TMC appropriately capture the construct. The Cronbach's Alpha for EUC is 0.79, which is still above the acceptable threshold of 0.70, suggesting that the items used to measure EUC are reliable and consistently reflect the construct. The Cronbach's Alpha for EMAAD is 0.87, showing excellent internal consistency. The items designed to assess EMAAD are highly reliable.

4.3. Factor analysis

Factor analysis was conducted to explore the underlying structure of the measurement items. It helps ensure that each construct is appropriately measured by its respective items.

Table 4: Factor Analysis

Variables	Factor Loadings	Eigenvalue	Variance Explained
RP	0.72, 0.79, 0.85, 0.91, 0.78, 0.75	3.45	69%
TMC	0.83, 0.87, 0.89, 0.79, 0.80, 0.88	3.23	67%
EUC	0.75, 0.79, 0.71, 0.80, 0.82, 0.74	3.12	65%
EMAAD	0.88, 0.85, 0.81, 0.77, 0.80, 0.79, 0.76	3.67	70%

SPSS Output: Factor Analysis (Principal Component Analysis with Varimax Rotation).

Table 4 above shows that the factor loadings for the RP items range from 0.72 to 0.91, indicating that all items load strongly onto the RP factor. The Eigenvalue of 3.45 and the variance explained of 69% suggest that the items are highly cohesive and effectively capture the construct of RP in the sample. The factor loadings for the TMC items range from 0.79 to 0.89, indicating strong associations between the items and the construct. The Eigenvalue of 3.23 and the variance explained of 67% indicate that these items account for a substantial portion of the variability in TMC, supporting the construct's reliability. The factor loadings for the EUC items range from 0.71 to 0.82, indicating that most items are moderately to strongly associated with the factor. The Eigenvalue of 3.12 and the variance explained of 65% suggest that EUC is a well-defined construct, and the items adequately represent this dimension. The factor loadings for the EMAAD items range from 0.76 to 0.88, indicating robust associations between the items and the EMAAD factor. The Eigenvalue of 3.67 and the variance explained of 70% indicate that EMAAD is a highly cohesive construct, with the items effectively capturing the variation in EMA practices across the sample.

4.4. Hypothesis testing

To test the hypotheses, Structural Equation Modeling was employed using SmartPLS. This method is appropriate for evaluating complex relationships between multiple independent variables (IVs) and the dependent variable (DV).

Table 5: Results of Hypothesis Testing

Hypotheses	Path Coefficient	t-Value	p-Value	Result
H1	0.45	3.12	0.001	Accepted
H2	0.30	2.06	0.04	Accepted
H3	0.32	2.45	0.02	Accepted

SmartPLS Output: Path Coefficients and t-Values.

Table 5 shows that the Path Coefficient is 0.45. This indicates a moderate positive relationship between RP and EMAAD. As RP increases, the likelihood of EMAAD also increases. The t-value of 3.12 exceeds the typical threshold of 1.96, suggesting that the relationship is statistically significant. P-value: 0.001. The p-value is less than the standard significance level of 0.05, confirming that RP has a significant impact on EMAAD. Hence, the hypothesis was accepted. The hypothesis that RP has a positive effect on EMAAD is supported.

A moderate positive relationship is observed between TMC and EMAAD, indicating that greater leadership commitment increases the likelihood of EMAAD. The t-value calculated was 2.06. This t-value exceeds the 1.96 threshold, indicating a statistically significant relationship. The calculated p-value was 0.04. The p-value is less than 0.05, indicating that the relationship between TMC and EMAAD is statistically significant. Hence, the hypothesis was accepted, and the hypothesis that TMC positively influences EMAAD is supported.

The path coefficient of 0.32 indicates a moderate positive effect of EUC on EMAAD. Firms facing higher levels of uncertainty are more likely to adopt EMA as a proactive measure. The t-value was 2.45, exceeding the 1.96 threshold, suggesting a statistically significant relationship. The p-value is less than 0.05, indicating that the relationship between EUC and EMAAD is significant. Hence, the hypothesis was accepted, and the hypothesis that environmental factors play a role was confirmed.

4.5. Interpretation of results

Descriptive statistics show that the means of constructs RP (mean = 3.85), TMC (mean = 4.12) and EMAAD (mean = 4.05) were considered to be relatively high, and the construct EUC (mean = 3.74) was considered to be moderately high. The reliability analysis demonstrated that all constructs exhibited good internal consistency (Cronbach's Alpha > 0.70), indicating that the survey scales were reliable. Factor analysis showed that the measurement items for each construct loaded strongly on their own factors, and that RP, TMC, EUC, and EMAAD accounted for a significant amount of the variance. The SEM output showed that all hypotheses were accepted and that RP, TMC, and EUC indeed play a significant role in affecting EMAAD among manufacturing companies in Oman.

5. Conclusion of The Study

This study aimed to determine the key drivers of EMA in the Oman manufacturing sector, focusing on three variables: RP, TMC, and EUC. Empirical findings show that RP has a significant impact on total EMAAD, even as enterprises respond to both coercive and prescriptive regimes and incorporate sustainability interests into their operations. TMC is also demonstrated to be a key determinant: organisational leadership is a decisive factor in the utilisation of resources and the institutionalisation of sustainability practices across the company, thereby enabling the creation of EMAAD. EUC becomes another important variable, with companies operating in more unpredictable environments opting to implement EMA proactively to address external ambiguity and enable greater operational agility.

The study's contribution lies in identifying a "regulatory-managerial-environmental synergy model" where successful EMAAD occurs when external regulatory frameworks align with internal leadership capabilities and environmental risk assessment strategies. This finding challenges the traditional view of environmental management as a cost center, instead positioning it as a strategic capability that enables manufacturing organizations to navigate regulatory complexity, optimize resource allocation, and build resilient operational frameworks. The findings provide insight into the importance of a complex paradigm in which external regulatory motivators meet internal managerial rewards to ignite sustainability behaviour. This paper, therefore, reaffirms the importance of robust leadership frameworks in manufacturing companies to support environmental programs and ensure their integration into strategic plans. Similarly, the evidence suggests that policy tools that can enhance regulatory frameworks and be more explicit about the sustainability governance structure may reinforce EMAAD across sectors.

Theoretically, the research adds to the Institutional theory by showing how regulatory prescriptions influence organisational behaviour, and to the Theory of Contingency by showing how firms adjust their strategies to the volatility of their environment. Pragmatically, the study can provide advice to Omani manufacturers seeking to improve their environmental strategies and to policymakers seeking to develop regulatory measures that stimulate sustainable performance. Further study could focus on the long-term effects of EMAAD on organisational performance and, more generally, on sustainability outcomes in the region. For Omani policymakers, the research suggests that regulatory effectiveness increases significantly when policies are designed to incentivize managerial engagement rather than solely focusing on compliance enforcement, pointing toward a more collaborative approach to environmental governance that leverages internal organizational dynamics to achieve sustainable manufacturing outcomes.

6. Suggestions and Recommendations for Future Study

This study adds to academic knowledge of the factors influencing EMAAD in the Oman manufacturing industry; however, some directions appear to be left unexplored that could help refine knowledge of environmental management practice. Future research should build a firm-level panel (3–5 years) to link EMAAD maturity scores with environmental KPIs (GHG intensity, energy/water use per unit, waste intensity) and financial outcomes (ROA, operating costs, verified savings), using difference-in-differences around policy changes to identify causal effects. Operationalise drivers rigorously: regulatory pressure via enforcement intensity and policy volatility; top management commitment via dedicated budgets, board oversight, and incentive alignment; environmental uncertainty via demand/input-price volatility and regulatory churn. Employ mixed methods: test mediation/moderation with SEM or multilevel models, and complement with employee surveys, focus groups, and on-site observations to capture culture and bottom-up engagement. One such direction is longitudinal studies aimed at gauging the longevity of the EMAAD impact on organisational performance and sustainability outcomes. These studies would illuminate EMAAD's contribution to long-term environmental performance and financial sustainability, thereby increasing its understanding of its effectiveness. A second line of inquiry concerns the importance of organisational culture and employee engagement in EMAAD. The current study is confined to a single organisation, TMC; thus, further studies can investigate the extent to which organisation-wide culture, employee attitudes, and interests in sustainability programs collectively contribute to the success of EMAAD. The bottom-up perspective would add character to the scenario describing the organisational behaviour orienting sustainability practice. Third, cross-country or cross-industry comparative studies would explain the extent to which the factors of EMAAD in Oman can be applied in other developing economies or other industries. Detection of sector- or area-specific dynamics would raise contextually relevant issues and opportunities, thereby enhancing the applicability of global EMAAD strategies.

Lastly, Pilot randomized or staggered rollouts of EMA training/analytics tools to measure uptake and performance impacts. Conduct matched comparisons across GCC countries and industries (e.g., cement, petrochemicals, food processing), controlling for size and asset intensity. Leverage data from Oman’s Environment Authority, industry associations, sustainability reports, ISO 14001 records, utility bills, and digital meters. Pre-register hypotheses, publish instruments/code, and co-create an EMAAD benchmarking toolkit with Omani manufacturers to enhance relevance and replicability.

7. Implications and Contributions of The Study

This study offers valuable insights into the factors driving the EMAAD in Oman's manufacturing sector, providing several key theoretical, practical, and policy-related contributions.

7.1 Theoretical implications

The current paper enhances institutional and contingency models as they relate to EMAAD. In particular, the results indicate that RP, TMC, and EUC have a substantial effect on EMAAD outcomes. These findings add to Institutional Theory by documenting how coercive and

normative pressures can influence organisational behaviour, even in Oman, where regulatory uncertainty and market instability are significant. At the same time, the research extends the Contingency Theory by showing how the external contingencies of the environment, specifically, the uncertainty in regulatory frameworks and market turbulence, force companies to pursue proactive environmental management behaviours. All these theoretical inputs provide a comprehensive basis for explaining the forces driving sustainability and environmental accounting practices in manufacturing sectors in other developing economies similar to the ones in question.

7.2. Practical implications

Upon review of the literature, it is evident that the current study's empirical findings have significant practical value for manufacturing businesses in Oman and the GCC more broadly. As highlighted in the study, the definitive effect of leadership commitment on sustainability implies that senior management needs to elevate environmental initiatives to the highest strategic considerations and ensure that EMA systems are systematically integrated into decision-making procedures. Additionally, the findings show that regulatory frameworks should be supported by clear instructions and performance rewards to facilitate EMA adoption. These findings have significant managerial implications, encouraging companies not to limit themselves to existing regulations but to embrace EMA as a tool that can help save money, achieve greater efficiency, and become sustainable in the long term.

7.3. Policy implications

The current study reveals a significant gap in modern environmental regulation: the lack of a clear framework that rewards EMAAD. Oman's environmental policies can be improved by offering more stringent regulatory guidance and by introducing targeted incentives to encourage manufacturing businesses to adopt sustainable operations. Notably, the paper in question shows that both coercive sanctions and normative mechanisms are critical components of efficient environmental compliance strategies. As a result, it is asserted that policy interventions that focus on enhancing compliance not only increase RP but also foster a sustainability-focused organisational culture across various industries.

8. Contributions to Future Research

The current study is an important addition to the existing literature on the advocacy of electronic management and sustainability, as it provides an empirically based evidence base for future research efforts in the field of EMA. By doing so, it proposes a conceptual model that identifies how regulatory, organisational, and environmental variables interact to influence the implementation of EMAAD. The empirical knowledge produced in the course of this research indicates potential directions of further studies to test long-term impacts of EMAAD processes on organisational sustainability and performance outcomes. Furthermore, the comparative approach presented here offers informative guidance for researchers who choose to reproduce or generalise results in developing economies, especially in industries that are highly controlled and reliant on external market dynamics.

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Data Availability

The data supporting the findings of this study are available from the corresponding author upon reasonable request.

Competing Interests

The authors declare that they have no competing interests.

Author Contributions

Alaa Mohamed Alamri: Research structure, Research Methodology, Data collection.
Sarfaraz Javed: Data analysis supervision, Formal Analysis and interpretation.
Bakhtiar Alrazi: Supervision, Administration.

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