MIS and Environmental Sustainability in Saudi Arabian SMEs: Unveiling the Mediating Effect of Organizational Culture and Policy

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Abstract: - This research aims to explore the role played by management information systems (MIS) in increasing environmentally sustainable practices among SMEs in Saudi Arabia. The first research question is to establish how MIS impact and use can promote environmental Sustainability, and the second is to establish the mediating role of organizational policy culture in MIS impact and use for ecological Sustainability. The methodology employs a quantitative approach, concentrating on the structural equation modeling (SEM) tool, and it utilizes primary data from 180 leaders in Saudi Arabian SMEs. We developed the survey instrument based on existing scale questions and conceptual frameworks and conducted reliability and validity assessments. The research has yielded significant findings. Firstly, SMS and UAP in MIS significantly correlate with the use of environmentally sustainable practices, and higher levels of these practices positively influence system maintenance, support, user adoption, and proficiency in the management information system. These findings stress the need to support the MIS system and user proficiency in appropriately utilizing MIS for Sustainability. Second, the research identifies that the moderating factors of organizational policy and culture play a significant role in MIS utilization and environmental Sustainability. This has implications for the view that the overarching organizational environment greatly enhances or hinders MIS's operational effectiveness in encouraging sustainable practices. These results are possible academic contributions and the application of store choice methods. The study offers a comprehensive perspective on the practical and proper management of MIS in SMEs, which can foster environmental Sustainability and align with Saudi Arabia's Vision 2030.

Key-Words: - Management Information Systems (MIS), Environmental Sustainability, Small and Medium Enterprises (SMEs), Organizational Policy and Culture, System Maintenance and Support (SMS), User Adoption and Proficiency (UAP), Structural Equation Modeling (SEM), Sustainable Practices, Saudi Arabia.

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1 Introduction

Arabia is on the edge of a watershed in its development paradigm—from an oil economy aimed at transforming it to an economically sustainable one, per the country's Vision 2030. However, this shift puts SMEs in an awkward position, which acknowledges that SMEs hold significant capacity for economic growth and employment growth. However, the debate about managing and incorporating environmentally sustainable activities in business activities is not a simple process, [1], [2].

This paper aims to identify and discuss MIS integration in SMEs as a feasible measure to obtain helpful information and insights from tools and data necessary for decision-making processes, enhancing operations, and the optimal utilization of resources. However, by recognizing that MIS affects environmental Sustainability in a limited manner, its examination identifies organizational factors such as the polarity of policy and culture through which they predicate the use of MIS for Environmental Sustainability, [3], [4], [5].

This technological role in driving environmental consciousness and sustainable development is now more crucial, especially in light of the present Saudi Arabia Vision 2030, which seeks to map out an environment-friendly future. This position holds that MIS can stand well in lobbying for environmentally friendly practices in the burgeoning SME environment. This reflected the feeling experienced globally in terms of pollution and other calamities related to environmental degradation as citizens

demanded sustainable governance from governments, [6], [7].

The following strategy concerning Management Information Systems in SMEs is thus deemed to constitute a solution. Thus, MIS can provide the way and the information to make decisions and change organizations to utilize available resources better. However, these systems cannot be preserved or sustained in the environment just by a system of existence. To sum up, the density of the grounds is shifted right towards pro for plumbing because it is much more dependent upon the environmental policy and the culture relevant to the organization concerned in the matter. Following the theoretical framework developed by [8]. Certain modifications can be made to provide a solution for SMEs' management information systems. MIS can provide excellent practice and important decision-making information, help solve the functioning process and show how resources are best used. Nevertheless, the effectiveness of such systems or their applicability to further the promotion of Sustainability of the environment is not only in the technology. However, this happens more through the organizational context, particularly the policy culture nexus, [9].

The third piece of evidence is that experience suggests that managerial policy and culture are vital to properly utilizing MIS and correctly using MIS for Sustainability. The culture aligns people with the change and gives them the right attitude towards sustaining change. That is equally crucial for SMEs in Saudi Arabia because when they seek to align themselves with actualizing the goals of the country's vision for sustainable development, it is helpful for them to understand this. The challenges suggested and highlighted by [10] are that even though Mezirow's theory was a good way of transforming the perspective of adults, this theory has possible challenges.

Technology as a tool in instilling awareness about environmental conservation has become central, particularly to Saudi Arabia, as the country seeks to embrace environmental conservation in line with the country’s Vision 2030 program. Technologically sophisticated MIS is highly instrumental, especially in the present era of green businesses. It especially applies to SMEs where the broad concept of 'green' or environmentally sustainable practices is nascent. This has a similar implication to what is currently being observed in other countries, where the public and governments are calling for Sustainability because of disasters brought about by pollution and manufactured activities resulting in a negative effect on the ecological system, as noted by [11]. Similarly, the past few decades have observed cultural shifts toward friendly environmental actions, including green entrepreneurship, which asks for the incorporation of MIS for the sustainable outlook of SMEs, as mentioned by [12].

The infusion of mis into SMEs to implement environmentally sustainable practices echoes the call for education for employment in Saudi Arabia, specifically for sustainability-minded commitment, green economy performance, and future job readiness, as posited by_HASHMI ETAAL_. This implies that embracing high technology, as depicted by the implementation of MIS, positively impacts the stewardship of the environment and other economic and education change measures for better environmental stewardship and the overall sustainable development of Rwanda. Such a study needs to better the authorities' understanding of illness preventability, [13].

2 Problem Formulation

A gap exists in understanding how MIS implementation and utilization impact environmentally sustainable practices within Saudi SMEs. While MIS has the potential to enhance decision-making, resource efficiency, and operational effectiveness, its role in specifically driving environmental Sustainability still needs to be explored. Besides, the influence of internal organizational elements, especially policy and culture, on the successful implementation of MIS in sustainability schemes needs more investigation. In this regard, internal factors are critical as they can significantly mediate between implementing the MIS and sustainable outcomes.

Consequently, this research tried to tackle these shortcomings by going deeper into the role of MIS in environmentally sustainable practices among SMEs in Saudi Arabia. It also looked at the mediating effect of organizational policy and culture on this relationship. First, the study sheds light on the strategic utilization of MIS for Sustainability from an environment-related perspective within the unique context of Saudi SMEs. Understanding such a role of mediating organizational factors should guide SMEs to create an enabling environment for effectively utilizing MIS.

This paper is, therefore, tailored to examine how MIS can help develop environmentally sustainable practices in SMEs in Saudi Arabia with specific reference to the intermediary role of organizational policy and culture. This research is essential as it

bridges the gap between adopting technology and meeting the sustainability agenda in a crucial sector of the Saudi Arabian economy. It arises from a research motivation with questions such as those intending to comprehend whether implementing MIS influences sustainable practices in SMEs and, if it does, how organizational factors like policy and culture could mediate such a relationship. In particular, this paper seeks to measure MIS's impact on Sustainability, test the moderating influence of organizational factors, and derive practical insights to help an SME incorporate MIS for enhanced Sustainability. The value of this study is in giving practical advice to business leaders, guiding policies with data-driven methods, contributing to the discussion in academia about technology and Sustainability, and achieving societal goals through sustainable development. This research directly responds to these needs and meets some Vision 2030 ideals in Saudi Arabia. Its suggested model application for technology and sustainability integration might resonate well beyond the Saudi context.

3 Literature Review and Hypothesis

The role of MIS in supporting the cause of environmentally sustainable practices must be considered. MIS helps resolve issues such as fragmented management, inconsistent standards, and usability challenges when dealing with extensive data on energy, [14], [15]. Only through this can the energy ecosystem be built, integrating data service modes and enforcing a "one chessboard" data resource mechanism, and then MIS will realize resource intensification, efficient operation, and concurrent business and technical development under environmental Sustainability, [16]. Lastly, the various types of ICT that MIS can use to help us spread information about sustainable development will be identified. By combining modern scientific knowledge with traditional wisdom and involving people whose lives depend very much on nature in the policy dialogues, MIS may offer a way to find potential solutions to sustainable development, [17]. In implementing the MIS, environmentally friendly practices, together with the organizational policies and culture, will affect the performance of enterprises in terms of sustainability, [18]. The inclusion of MIS improves the implementation and application of environmentally sustainable practices. For instance, the outcome of ecologically sound practices is improved sustainability performance, [19]. Organizational culture is essential for greening practices and outcomes. A solid organizational culture supporting quality improvement for greening results in positive sustainability outcomes.

On the other hand, the study reports that organizational policies and business strategy are significant drivers of sustainability performance, [20], [21]. Precisely defined vision, values, and culture regarding sustainability and people management practices will make positive sustainability outcomes less likely to be achieved in the firms. Therefore, effective implementation and application of the MIS, environmentally sustainable practices, supportive organizational policy, and culture are the primary drivers for sustainability performance in enterprises.

3.1 MIS Implementation and Utilization

3.1.1 Data Quality and Management (DQM)

Data quality is at the epicenter of decision-making and Sustainability. Reliability in health data—relating to health status and its enhancement in service delivery—is crucial in ensuring consistent evidence, [22]. To better believe in the accuracy of their data, companies have to put it in place for informed decision-making. Procedures aimed at assessing and confirming data quality are likely to help reach this target, [23]. The following have been classified as some of the barriers to effective data use in education: increased sensitivity and understanding that is required, data quality issues, and a focus more on data transparency than data used to support decision-making, [24]. Data Quality Management (DQM) has to be applied to preserve data quality and ensure accuracy in information delivery for decision-making, [25]. This research postulates the following hypothesis:

- HP1: Data Quality and Management (DQM) positively influences Environmentally Sustainable Practices (ESP).

3.1.2 Functionality and Features (FF)

The critical roles of Management Information Systems (MIS) that enable environmental Sustainability include involving people with environmental information in developing care and disturbing relationships with climatic effects. In addition to this, MIS encourages ecosystem health and protection through a sustainable environmental management and information system, [26]. Additionally, MIS aids in assessing organizational impacts and instigating shifts in production and consumption behaviors towards more conscientious and dedicated market engagements with the environment, [27]. MIS also oversees and manages

the environment, establishing connections with governmental policies, research endeavors, international collaborations, and technology transfers, [28]. This study offers the following hypothesis:

- HP2: The functionality and features (FF) of Management Information Systems positively impact Environmentally Sustainable Practices (ESP).

3.1.3 System Integration and Compatibility (SIC)

System integration is an essential component in enhancing the productivity of Management Information Systems (MIS), [29], [30]. The same case applies to small- and medium-sized establishments in Vietnam, not to mention the impact of the input on the efficiency of MIS among organizational traits, [31]. More excellent reported factors associated with enhancing the MIS's effectiveness include the manager's competency, user participation, and information quality, [32]. On the other hand, the level of management commitment does not significantly impact the improvement in effectiveness at MIS, as in [33]. This further provides the following hypothesis:

- HP3: System Integration and Compatibility (SIC) positively impacts adopting Environmentally Sustainable Practices (ESP).

3.1.4 System Maintenance and Support (SMS)

System maintenance and support are vital to the continued effectiveness of MIS. The strength of the maintenance support systems lies in their ability to identify equipment for which there is a call for maintenance close by, reorganize data by proximity and maintenance status, and relay the information, [34]. This is important because these strategies are critical in system maintenance implementation for optimum system performance, availability, and cost-effectiveness, allowing system longevity and robustness, [35]. Maintenance support procedures involve recording defect data, developing corrective actions, and issuing step-by-step instructions for practical maintenance work. Maintenance support systems provide maintenance workers with relevant information to support their tasks and use databases, camera-based image capture, position/orientation estimation, object recognition, and augmented reality displays, [36]. MIS can follow best practices and ensure that the systems are designed to be as low maintenance as possible to have long-term effectiveness without depending on production support teams, [37]. This research proposes the following hypothesis:

- HP4: System Maintenance and Support (SMS) significantly enhances Environmentally Sustainable Practices (ESP).

3.1.5 User Adoption and Proficiency (UAP)

The scholarly literature about user adoption models and training effectiveness within Management Information Systems (MIS) contexts elucidates several crucial discoveries. The Technology Acceptance Model (TAM) and Unified Theory of Acceptance and Use of Technology (UTAUT) frameworks illustrate how to predict user acceptance of technology like employee-used HRIS, [38]. These models have the potential to be substantially upgraded by integrating technological attributes, user satisfaction, and organizational factors, [39]. Secondly, user contentment is a fundamental aspect of the triumph of information systems, [40]. Thirdly, most educators participating in a distinct Learning Management System (LMS) training initiative acknowledged the LMS as beneficial, user-friendly, easy to grasp, and gratifying. Furthermore, elements delineated in various theories and models can anticipate the extent of user approval towards novel technologies, [41]. This research proposes the following hypothesis:

- HP5: User Adoption and Proficiency (UAP) in Management Information Systems positively correlate with implementing Environmentally Sustainable Practices (ESP).

3.2 Environmentally Sustainable Practices (ESP)

The employment of information systems (IS) for the advancement of Sustainability poses various advantages and challenges. The capabilities of IS, encompassing personnel, administrative functions, infrastructure, and information management, have the potential to enhance a company's sustainable competitive edge and overall survival, [42]. Moreover, using IS can support various objectives across different sustainability levels, delivering tangible and anticipated advantages for environmental Sustainability, [43]. IS could help preserve and use resources, but energy and resource consumption could harm the environment, [44]. Thus, to understand IS's role in Sustainability, technology adoption predictors, task-technology interactions, implementation challenges, knowledge gaps, system longevity, and lasting effects must be examined, [45]. Communicating Sustainability effectively is also essential, as unregulated economic activities driven solely by profit and market share can have severe and irreversible environmental consequences, [46].

Using information systems to promote Sustainability in Saudi Arabia has several benefits and challenges. The benefits include improved organizational Sustainability, enhanced financial, social, and cultural well-being of organizations and their communities, and increased user satisfaction with information systems, [47]. Additionally, the knowledge economy, driven by digital technologies, positively impacts sustainable development in Saudi Arabia, particularly regarding adopting information and communication technology (ICT), [48]. Furthermore, the construction industry uses Building Information Modelling (BIM) to achieve sustainability development goals, such as efficient data sharing, life cycle cost optimization, and energy efficiency, [49]. Moreover, adopting environmental, social, and governance (ESG) reporting practices promotes corporate investment efficiency and Sustainability in Saudi Arabian firms, [50]. However, there are challenges, such as the need for further research to identify predictors of organizational sustainability success, shortcomings in the knowledge economy beyond ICT adoption, and increased awareness and utilization of BIM capabilities among engineers and project managers, [51].

3.3 Organizational Policy and Culture (OPC) as a Mediating Variable

Organizational culture and policies make a notable impact on the connection between Management Information Systems (MIS) and environmentally sustainable practices (ESP), as brought to light by [52]. The inquiry by [53] hints that a durable organizational culture focusing on environmental matters can encourage incorporating environmentally sound practices within organizations. According to [54], the implementation of total quality management practices (TQMPs) enhances the relationship between green practices (GPs) and sustainability performance (SP). [55], note that environmental transformational leadership (ETL) can shape environmental, organizational citizenship behavior (EOCB) and organizational sustainable performance (SP). The interaction between ETL and EOCB is moderated by employee work passion, subsequently influencing SP through EOCB. Company culture, managerial attitudes, and environmental pressure improve environmental sustainability performance, but social responsibility does not. Organizational culture and policies are crucial to implementing environmentally sustainable practices and improving sustainability performance. This research proposes the following hypothesizes:

- HP6: The influence of Data Quality and Management (DQM) on Environmentally Sustainable Practices (ESP) is mediated by Organizational Policy and Culture (OPC).
- HP7: Organizational Policy and Culture (OPC) mediates the relationship between the functionality and features (FF) of Management Information Systems and Environmentally Sustainable Practices (ESP).
- HP8: The effect of System Integration and Compatibility (SIC) on Environmentally Sustainable Practices (ESP) is mediated through Organizational Policy and Culture (OPC).
- HP9: Organizational Policy and Culture (OPC) partially mediates the impact of System Maintenance and Support (SMS) on Environmentally Sustainable Practices (ESP).
- HP10: The relationship between User Adoption and Proficiency (UAP) in Management Information Systems and Environmentally Sustainable Practices (ESP) is mediated by Organizational Policy and Culture (OPC).

3.4 Gaps in Literature

SMEs have yet to investigate using management information systems (MIS) to improve sustainability due to the cost of implementation and customization. SMEs need source constraints, limiting their capacity to effectively embrace and utilize advanced MIS tools for sustainable practices. There is a notable necessity for research concentrated on formulating MIS solutions that are economical and adaptable to align with SMEs' specific operational structures. The literature also requires in-depth studies on how MIS affects SME sustainability, as outlined in the research framework depicted in Figure 1 (Appendix).

4 Methodology

The primary purpose of this research is to determine how the Management Information Systems in Saudi Arabia can contribute to improving SMEs' environmentally sustainable practices. The top management of 186 SMEs was selected as a sample. All respondents were chosen because they were all involved with MIS, and their companies had a policy on protecting the environment; hence, they helped provide crucial information given that their role is central in the decision-making process related to technological implementations and sustainability initiatives.

A structured questionnaire was the key instrument used to collect data for this study. This questionnaire had been carefully designed due to a

comprehensive review of the relevant literature and previous studies on the area. The formulation of questions and content was inspired by the findings and methodologies of past studies, so the questions are not only relevant but robust in themselves.

The questionnaire was subjected to a complete review process, and the same was put under consideration to guarantee its validity. Management Information Systems experts and other environmental sustainability experts were consulted on whether the questions were relevant, clear, and sufficient in their overall perception of the research objectives. Their input helped in tweaking questions that would see the achievement of the research objectives.

The final questionnaire had sections that addressed various aspects of SMEs' contribution to MIS toward Sustainability in the environment. The areas covered include system integration, user acceptance, functionality, data accuracy, system upkeep, and organization policies and culture.

The questionnaires were then mailed to the identified respondents, SME leaders in all regions of the Kingdom of Saudi Arabia. They were distributed electronically and on paper to improve response rates and convenience for those taking part. Guaranteed confidentiality of all responses and a briefing on the study's objectives went a long way toward raising the response rate and, consequently, the quality of information that would be gathered.

The application of statistical techniques to test hypotheses from the collected data with the questionnaires led to a conclusion and determination of how MIS helps improve environmentally sustainable practices in Saudi Arabian SMEs.

5 Results

We assessed the Model's fit by examining its convergent validity and reliability. Item loadings and average variance extracted (AVE) values had to exceed 0.50 for convergent validity. We used Cronbach's alpha and rho A; both were expected to exceed 0.70 for reliability. Figure 2 (Appendix), 'Output loading of factors', showed factor loadings and AVEs comfortably exceeded 0.70, [56].

An overview of the reliability and convergent validity of the constructs within the research is provided in Table 1 (Appendix). The review of Data Quality and Management, Functionality and Features, System Integration and Compatibility, System Maintenance and Support, User Adoption and Proficiency, Environmentally Sustainable Practices, and Organizational Policy and Culture is summarized based on several parts, as indicated below. The respective parts are highly associated with loadings that are higher than 0.70. The results show high reliability, as all constructs' values of Cronbach's Alpha and rho_A are above 0.70, proving their internal consistency. AVE is higher than 0.50; thus, it indicates acceptable convergent validity. It shows that the constructs have the potential to explain a large part of the variance of response that was supposed by the hypotheses of the study. Table 1 and Figure 2, in Appendix, provide sufficient evidence that underlies the fact that the used constructs in this study have high reliability and validity. These high values of Cronbach's Alpha, rho_A, and AVE across all the constructs strengthen the robustness of the measurement model and increase the credibility of the instruments used in this study. There is a need for such solid methodological grounding to ensure the study's precision and trustworthiness because of the intricate relationships among MIS implementation, environmental sustainability practices, and organizational factors within the context of Saudi Arabia.

Table 2 (Appendix) elaborates on the analysis of the convergent and discriminant validity of the research constructs. Discriminant validity is demonstrated using the two indices, namely, the HTMT Ratio and the Fornell-Larcker criterion, [57], [58]. This section on the HTMT ratio is a new criterion for discriminant validity, which compares heterotrait correlations and monotrait average correlations among different pairs of constructs. Table 2 (Appendix) shows ratios for different construct pairs. This means the constructs are different, and they measure different concepts, hence demonstrating good discriminant validity: Data Quality and Management (DQM), Environmentally Sustainable Practices (ESP), Functionality and Features (FF), Organizational Policy and Culture (OPC), System Integration and Compatibility (SIC), System Maintenance and Support (SMS), User Adoption and Proficiency (UAP).

On the other hand, the Fornell-Larcker criterion compares the square root of each construct's Average Variance Extracted (AVE) with the correlations between that construct and all others. For sound discriminant validity, the square root of AVE for each construct should exceed its correlations with any other construct. In the table, this is evident as the diagonal elements (representing the square root of AVE for each construct) are more significant than the off-diagonal elements in the corresponding rows and columns. This compliance with the Fornell-Larcker criterion

reinforces that each construct is uniquely measured and not merely a reflection of another variable.

Overall, the evidence from Table 2 (Appendix) underscores the solid validity of the discriminant constructs in the study. The HTMT Ratio and the Fornell-Larcker criterion affirm that the constructs are distinct and measure unique concepts. This robust level of discriminant validity, in conjunction with previously established convergent validity, lends substantial credibility to the measurement model of the study.

Table 3 (Appendix) in this study provides an insightful analysis of the structural fit of this study model, focusing on the relationships and impacts of various variables. It encompasses R-Square, Adjusted, Variance Explained, Explanatory Power, and the F2 effect size.

For Environmentally Sustainable Practices (ESP) and Organizational Policy and Culture (OPC), both R-Square and Adjusted R-Square values are presented, revealing high explanatory power. ESP shows an R-Square of 0.794 and an Adjusted R-Square of 0.790, while OPC exhibits an R-Square of 0.699 and an Adjusted R-Square of 0.694. These high values signify that a significant proportion of the variance in ESP and OPC is explained by the predictors in this Model, indicating a solid fit and high predictive power.

In terms of the Variance Explained, as reflected in the F2 values, the impact of the independent variables on the dependent variable is assessed. Data Quality and Management (DQM) has an F2 value of 0.084, suggesting a small effect size. In contrast, Functionality and Features (FF) stands out with a high F2 value of 1.825, indicating a significant impact on the variable dependent. System Integration and Compatibility (SIC) has an F2 value of 0.041, System Maintenance and Support (SMS) has 0.057, and User Adoption and Proficiency (UAP) has 0.033, all of which imply relatively small effects.

Overall, the results from Table 3 (Appendix) suggest that the structural Model of the study is robust, especially in explaining Environmentally Sustainable Practices and Organizational Policy and Culture. The high R-Square values for these variables underscore the Model's effectiveness in accounting for a significant portion of their variance. The varying F2 values for different predictors provide insights into their impacts, with FF notably demonstrating a significant effect.

Table 4 (Appendix) in this study presents the goodness-of-fit results for the saturated and estimated models, providing critical insights into how well the proposed Model fits the observed data. The table includes several fit indices, each offering a different perspective on the Model's performance.

The Standardized Root Mean Square Residual (SRMR), a measure of the difference between observed and predicted correlations, shows values of 0.082 for the saturated Model and a slightly higher 0.087 for the estimated Model. These values are marginally above the ideal threshold of 0.08, suggesting a reasonable fit, though not perfect.

Regarding the Unweighted Least Squares Discrepancy (D_ULS) and the Geodesic Discrepancy (D_G), which both assess Model fit, the estimated Model displays higher values (2.294 for D_ULS and 0.961 for D_G) compared to the saturated Model. This increase is expected as the saturated Model represents an ideal scenario. While these higher values indicate a less-than-perfect fit, they do not necessarily imply a poor model, especially if the increase is insignificant.

The Chi-Square statistic, which evaluates the difference between expected and observed covariance matrices, is notably high for both models, with the estimated Model registering a value of 1590.052. However, the utility of the Chi-Square statistic can be limited in complex models or those with large sample sizes, where it tends to be overly sensitive.

Lastly, the Normed Fit Index (NFI) provides a comparative fit measure between the estimated and baseline null models. The values of 0.776 for the saturated Model and 0.756 for the estimated Model are below the commonly recommended threshold of 0.90. This suggests that, according to the NFI, the model fit could be better. Table 5 (Appendix) in this study provides a detailed summary of hypothesis testing, encompassing direct and indirect effects within the research framework. These hypotheses are rigorously evaluated using standard beta coefficients, t-values, and p-values, and decisions are made on whether to accept or reject each hypothesis based on these statistical measures. For a visual representation of these relationships and their respective hypotheses, refer to Figure 3 (Appendix), 'Structural Model (hypotheses testing),' which illustrates the connections and directional influences among the variables in the Model, [59].

5.1 Direct Effects Analysis

Table 5 (Appendix) begins with the direct effects of independent variables on Environmentally Sustainable Practices.

HP1, HP2, and HP3 examine how DQM, FF, and SIC directly affect ESP. Results for these hypotheses suggest a need for a more significant direct impact. HP1 (DQM -> ESP), HP2 (FF ->

ESP), and HP3 (SIC -> ESP) have p-values of 0.248, 0.838, and 0.651, respectively, exceeding the 0.05 significance level. This rejects these hypotheses, suggesting that DQM, FF, and SIC do not directly affect ESP in this study.

Hypotheses HP4 and HP5 examine how SMS and UAP directly affect ESP. These hypotheses differ from others. HP4 (SMS -> ESP) and HP5 (UAP -> ESP) are accepted with 0.000 and 0.030 p-values. SMS and UAP have a statistically significant direct effect on ESP, highlighting their importance in environmental Sustainability.

Indirect Effects Analysis

The second part of the table examines indirect effects, mainly how Organizational Policy and Culture (OPC) mediates independent variable-ESP relationships.

The mediation effect of OPC on DQM/SIC and ESP is tested in hypotheses HP6 and HP8. Both hypotheses are supported by 0.000 and 0.020 p-values, indicating complete mediation. Because OPC fully mediates the effect of DQM and SIC on ESP, organizational policies and culture are crucial to turning these aspects of MIS into sustainable practices.

Hypotheses HP9 and HP10 examine OPC's mediation of SMS/UAP-ESP relationships. Support for both hypotheses (p-values of 0.006 and 0.008) suggests partial mediation. SMS and UAP directly affect ESP, but OPC partially channels their effect, reinforcing the multifaceted impact of organizational dynamics on sustainable practices.

P-value = 0.121 for Hypothesis HP7 (FF -> OPC -> ESP), indicating that OPC does not mediate the relationship between FF and ESP. This suggests that organizational policy and culture do not affect FF's effect on ESP.

6 Discussion

The literature stresses the importance of management information systems (MIS) in promoting environmental Sustainability. These systems address the issues of fragmented management and inconsistent standards in energy big data, [60], [61]. MIS improves resource intensification, efficiency, and business and technological growth while promoting environmental Sustainability by unifying data service modes and advocating a "one chessboard" data resource mechanism, [62]. MIS also spreads sustainable development information through ICTs, bridging modern scientific knowledge with traditional insights and bringing policy dialogues closer to nature, [63].

A study on MIS implementation and utilization in environmental Sustainability proposes five hypotheses (HP1-HP5) addressing various aspects of MIS use in sustainable practices.

HP1 (Data Quality and Management (DQM): Data quality informs sustainable practice decision-making. In healthcare, data accuracy and timeliness are essential for service delivery decisions, [64].

HP2 (Functionality and Features (FF): This hypothesis suggests that MIS functionalities, such as user engagement with environmental data and support for sustainable environmental management, improve environmentally sustainable practices. MIS supports ecosystem health and sustainable market interactions, [65].

System Integration and Compatibility (SIC): HP3 hypothesizes that sustainable practices necessitate effective system integration. SMEs in Vietnam found that organizational characteristics affect MIS effectiveness, [66].

HP4 (System Maintenance and Support (SMS): Maintenance and support are essential to the long-

term effectiveness of MIS and sustainable practices, [67].

HP5 (User Adoption and Proficiency (UAP): MIS user adoption and proficiency positively correlate with sustainable practices. This supports the efficacy of TAM and UTAUT in technology adoption, [68].

Information systems (IS) play a dual role in Sustainability, as highlighted in the literature review on environmentally sustainable practices (ESP). IS capabilities help companies maintain a competitive edge and survive. However, we must manage IS's environmental impact, including energy consumption, [69]. Given its long-term sustainability effects, the review emphasizes the need for a balanced approach to technology use.

MIS implementation and environmental Sustainability depend on organizational culture and policies (HP6–HP10). A supportive organizational culture that values environmental concerns boosts sustainable practices. Green policies and quality improvement are essential for sustainability, [70].

The literature on cost-effective MIS implementation and customization for SMEs needs to be improved. Due to their limited budgets and resources, SMEs need affordable, scalable MIS solutions, [71]. The impact of MIS measurement on SME sustainability performance is also understudied, providing fertile ground for future research.

As discussed in this extensive literature review and hypothesis testing, MIS is essential to environmentally related sustainable practices within

SMEs. Sustainability performance is improved when MIS is effectively employed, thus functioning with sound organizational policies and a sustainable culture. Still, the difficulty of SMEs implementing MIS economically, effectively, and successfully is a focus that justifies further research. This research aims to contribute to the debate on information systems and organizational strategy about Sustainability for the scaling-up development of cost-effective MIS solutions and robust methods for measuring Sustainability.

7 Conclusion

This study focused on the contribution of management information systems to improving environmental Sustainability in Saudi Arabian SMEs. Practical MIS sustainability lies in proper data management, system functioning, integration, and user proficiency. The significant findings highlight that high-quality data management is critical in informed decision-making for Sustainability. Organizationally, MIS is functional and integrative in helping organizations manage and monitor their environmental impacts toward Sustainability.

The study also highlighted the importance of system maintenance, support, and user proficiency. It illustrated that skillful users with well-supported systems help implement and maintain sustainable practices. The study has shown that organizational policy and culture mediate MIS implementation and sustainable practices; environmentally conscious cultures and supportive policies make Sustainability work better.

The findings will guide SME practitioners in integrating MIS into their sustainability strategies. The key to maximizing the MIS sustainability benefits includes data quality, system functionality, and user training. This study investigates the understudied area of MIS implementation for environmental Sustainability in SMEs. We add system integration, maintenance, and organizational culture to the MIS effectiveness theory.

The study's focus on Saudi Arabian SMEs may limit its generalizability. We could expand this study to include larger corporations or different locations to confirm and extend our findings. Further investigation could address the identified cost-effectiveness gap in MIS implementation for SMEs.

This study shows that SMEs seeking environmental Sustainability need MIS. Effective MIS implementation, supported by a supportive organizational culture and robust policies, can improve SMEs' environmental and operational Sustainability.

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During the preparation of this work, the author used QuillBot to improve the readability and language of the manuscript. After using these tools, the author reviewed and edited the content as needed and take full responsibility for the content of the publication.

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APPENDIX

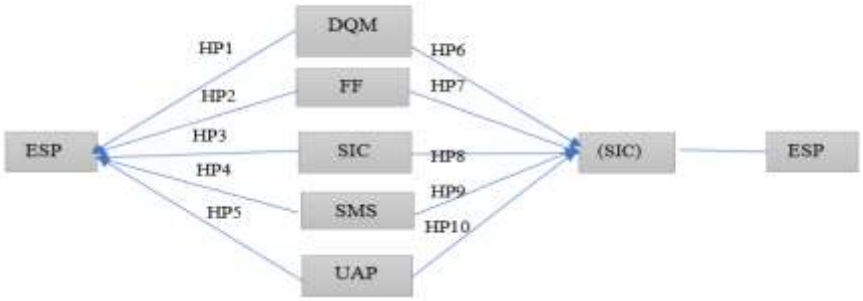

Fig. 1: The research framework

Note: System Integration and Compatibility (SIC), User Adoption and Proficiency (UAP), Functionality and Features (FF), Data Quality and Management (DQM), System Maintenance and Support (SMS), Environmentally Sustainable Practice (ESP), Organizational Policy and Culture (OPC)

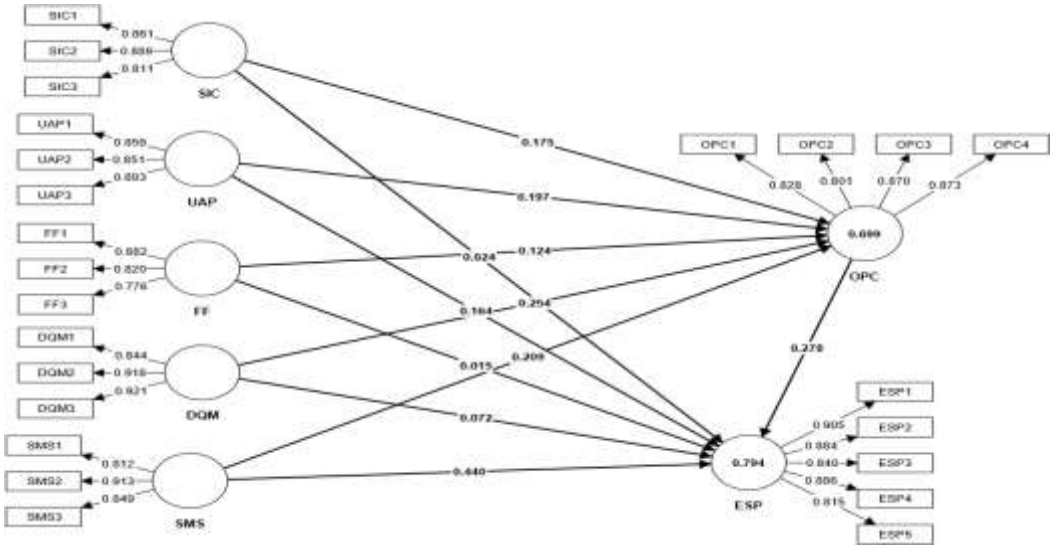

Fig. 2: Output loading of factors

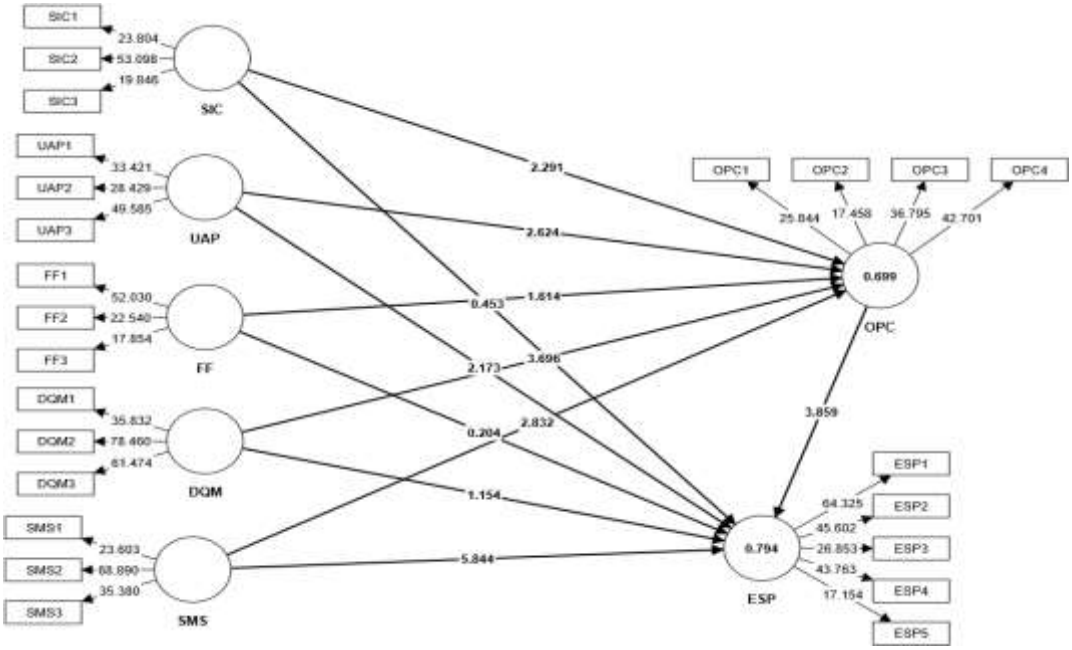

Fig. 3: Structural Model (hypotheses testing)

Table 1. The reliability and convergent validity of constructs

Constructs	Items	Loadings (>0.70)	Cronbach's Alpha (>0.70)	rho_A	Average Variance Extracted (AVE) (>0.50)
Data Quality and Management (DQM)	DQM1	0.844	0.874	0.874	0.800
	DQM2	0.918			
	DQM3	0.921			
Functionality and Features (FF)	FF1	0.882	0.768	0.780	0.684
	FF2	0.820			
	FF3	0.776			
System Integration and Compatibility (SIC)	SIC1	0.861	0.814	0.818	0.730
	SIC2	0.889			
	SIC3	0.811			
System Maintenance and Support (SMS)	SMS1	0.812	0.821	0.821	0.737
	SMS2	0.913			
	SMS3	0.849			
User Adoption and Proficiency (UAP)	UAP1	0.859	0.836	0.841	0.753
	UAP2	0.851			
	UAP3	0.893			
Environmentally Sustainable Practices (ESP)	ESP1	0.905	0.917	0.920	0.751
	ESP2	0.884			
	ESP3	0.840			
	ESP4	0.886			
	ESP5	0.815			
Organizational Policy and Culture (OPC)	OPC1	0.828	0.864	0.866	0.712
	OPC2	0.801			
	OPC3	0.870			
	OPC4	0.873			

Table 2. Convergent and discriminant validity

	Discriminant validity (HTMT Ratio)**							Discriminant validity (Fornell-Larcker criterion) *						
	DQM	ESP	FF	OPC	SIC	SMS	UAP	DQM	ESP	FF	OPC	SIC	SMS	UAP
DQM								0.894						
ESP	0.785							0.702	0.866					
FF	0.830	0.870						0.765	0.736	0.827				
OPC	0.836	0.898	0.811					0.725	0.804	0.746	0.844			
SIC	0.696	0.802	0.869	0.831				0.587	0.695	0.684	0.698	0.854		
SMS	0.790	0.959	0.876	0.865	0.837			0.669	0.835	0.701	0.730	0.686	0.859	
UAP	0.785	0.875	0.854	0.878	0.893	0.868		0.674	0.769	0.823	0.751	0.737	0.723	0.868

Note: Using the Fornell-Larcker criterion, bold values are accepted when they exceed row and column values. A HTMT Ratio < 0.85 is valid.

Table 3. Criteria for the study model structural fit

VARIABLES	R-SQUARE	R-SQUARE ADJUSTED	VARIANCE EXPLAINED	EXPLANATORY POWER F2
ESP	0.794	0.790	High	/
OPC	0.699	0.694	High	/
DQM	/	/	/	0.084
FF	/	/	/	1.825
SIC	/	/	/	0.041
SMS	/	/	/	0.057
UAP	/	/	/	0.033

Table 4. *Results of GOODNESS-OF-FIT*

	SATURATED MODEL	ESTIMATED MODEL
SRMR	0.082	0.087
D_ULS	1.157	2.294
D_G	0.834	0.961
CHI-SQUARE	1460.460	1590.052
NFI	0.776	0.756

Table 5. Summary of hypotheses testing

Relationships		Std beta	t value	P values	Decision
Direct effects					
HP1	DQM -> ESP	0.072	1.154	0.248	Hypothesis Rejected*
HP2	FF -> ESP	0.015	0.204	0.838	Hypothesis Rejected*
HP3	SIC -> ESP	0.024	0.453	0.651	Hypothesis Rejected*
HP4	SMS -> ESP	0.440	5.844	0.000	Hypothesis Accepted**
HP5	UAP -> ESP	0.164	2.173	0.030	Hypothesis Accepted*
Indirect Effects					
HP6	DQM -> OPC -> ESP	0.206	3.795	0.000	Full mediation
HP7	FF -> OPC -> ESP	0.095	1.552	0.121	No mediation
HP8	SIC -> OPC -> ESP	0.141	2.328	0.020	Full mediation
HP9	SMS -> OPC -> ESP	0.170	2.735	0.006	Partial mediation
HP10	UAP -> OPC -> ESP	0.160	2.634	0.008	Partial mediation

Contribution of Individual Authors to the Creation of a Scientific Article (Ghostwriting Policy)

As the sole author, I was responsible for all aspects of the research and manuscript preparation.

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Conflict of Interest

The author has no conflicts of interest to declare.