Strategic Choices and Renewable Energy Adoption in Saudi Arabian SMEs: A Quantitative SEM Approach

[1]Adel Obaid B Alsharari, [2]Dhakir Abbas Ali

[1,2] School of Business & Management,

Lincoln University College, Malaysia

Paper Number: 240151

Abstract:

This study investigates the relationship between strategic choices and renewable energy adoption among small and medium-sized enterprises in Saudi Arabia, a nation actively transitioning toward sustainable energy solutions. Drawing upon theories of strategic management and environmental behavior, the research applies a structured quantitative approach using partial least squares structural equation modeling. Data were collected from a stratified random sample of 384 small and medium-sized enterprises across key industries and regions in the Kingdom. The results reveal a statistically significant yet negative relationship between strategic choices and renewable energy adoption, with a standardized path coefficient of –0.552 and a p-value less than 0.001. This indicates that prevailing strategic orientations, which often prioritize operational efficiency, cost control, and short-term planning, may unintentionally hinder the adoption of renewable energy technologies. The model demonstrated strong explanatory power, with 77.6 percent of the variance in renewable energy adoption explained by strategic choices. The findings contribute to the theoretical understanding of sustainability and strategy integration in emerging economies, and they offer practical implications for policymakers and business leaders seeking to advance environmental innovation through better-aligned strategic planning in small and medium-sized enterprises.

Keywords: *Strategic Choices, Renewable Energy Adoption, Small and Medium Enterprises, Sustainability Strategy*

1. Introduction

The global transition toward sustainable energy systems has become an urgent imperative in the face of escalating climate change, dwindling fossil fuel reserves, and rising environmental degradation. Nations across the world are re-evaluating their energy policies to align with international climate goals, such as the Paris Agreement, while simultaneously pursuing economic diversification strategies. In this regard, Saudi Arabia has embarked on a bold transformation through its Vision 2030 framework, which emphasizes reducing the Kingdom's dependence on oil, promoting economic diversification, and investing heavily in renewable energy sources. The National Renewable Energy Program (NREP) and initiatives under the Ministry of Energy reflect Saudi Arabia's strong policy commitment to developing a sustainable energy mix, with the aim of generating 50% of electricity from renewables by 2030 (Benhacene & Hussien, 2025).Within this broader national strategy, small and medium-sized enterprises (SMEs) play a pivotal role. Representing over 99% of registered businesses in the Kingdom, SMEs are integral to achieving the economic and environmental targets outlined in Vision 2030 (AlKhars et al., 2024). However, despite their significance, SMEs often face unique challenges in embracing sustainable energy practices, including limited financial resources, a lack of technical expertise, and low strategic readiness for innovation (Alshebami, 2023; Wasiq, Kamal, & Ali, 2023). While large corporations in Saudi Arabia may have the capital and capabilities to invest in renewable technologies, SMEs are frequently overlooked in national energy strategies and scholarly research. There remains a critical gap in the literature on the drivers of renewable energy adoption at the SME level, particularly in developing and oil-dependent economies like Saudi Arabia.

Most of the existing studies in the region have focused on external barriers and institutional pressures, such as government regulations, energy prices, or infrastructure gaps, as the primary factors influencing renewable energy adoption (Badghish& Soomro, 2024; Alqasa& Talat, 2023). However, recent research has begun to highlight the importance of internal strategic choices and organizational capabilities in shaping SMEs' environmental behaviors. Studies have shown that when SMEs engage in green leadership, pursue sustainable innovation, and adopt proactive strategic behavior, they are more likely to develop and implement sustainability-oriented solutions, including renewable energy technologies (Al-Ghazali et al., 2022; Al-Hakimi et al., 2022; Abdulrab et al., 2021). Yet, these strategic variables remain underexplored in the context of Saudi Arabia's SMEs, where the alignment of firm-level strategy with environmental goals is still emerging. From a theoretical perspective, this study is grounded in Strategic Choice Theory, which posits that organizations are not merely passive responders to environmental pressures but are capable of shaping their strategic trajectories through deliberate choices made by decision-makers (Child, 1972). This view is complemented by the Resource-Based View (RBV) of the firm, which emphasizes the role of internal resources, such as leadership, innovation, and strategic orientation, as sources of competitive advantage (Barney, 1991). These theories provide a robust foundation for analyzing how SMEs in Saudi Arabia can use their internal strategic capabilities to engage in proactive environmental practices such as renewable energy adoption. Moreover, Wüstenhagen and Menichetti (2012) argue that strategic investment decisions are essential in enabling firms to participate meaningfully in the renewable energy transition, especially when these decisions are supported by organizational culture and long-term vision.

Accordingly, the objective of this research is to investigate the influence of strategic choices, specifically green leadership, green innovation, and proactive behavior, on the adoption of renewable energy technologies among SMEs in Saudi Arabia. Using a quantitative research design and Structural Equation Modeling (SEM), the study examines whether these strategic orientations have a significant impact on SMEs' willingness and capacity to adopt renewable energy solutions. The research also seeks to determine which dimensions of strategic choice are most strongly associated with adoption behavior. This study makes several contributions to the literature. First, it addresses a major empirical gap by providing firm-level evidence from Saudi Arabia, a context that remains underrepresented in sustainability research. Second, it shifts the analytical lens from external drivers (e.g., policy and regulation) to internal strategic variables, offering a micro-level understanding of renewable energy adoption in SMEs. Third, it offers practical implications for SME owners, managers, and policymakers under Vision 2030, suggesting that investments in leadership development, innovation, and strategic planning may be just as critical as financial incentives in promoting clean energy adoption. By advancing both theoretical and practical insights, this study enriches the broader discourse on sustainability transitions in the Global South.

2. Literature Review

Strategic orientation refers to the set of principles and practices that guide a firm's decision-making process and align it with long-term goals. In the context of sustainability, strategic orientation plays a pivotal role in shaping how organizations, especially small and medium-sized enterprises (SMEs), respond to environmental opportunities and challenges. According to Abdulrab et al. (2021), strategic orientations such as innovativeness, proactiveness, and risk-taking are crucial mediators between entrepreneurial intent and firm performance in Saudi SMEs. These orientations reflect an organization's internal drive to innovate, anticipate market changes, and respond proactively, making them key enablers for sustainable business transformations. The role of strategic orientation in sustainability becomes even more critical in developing economies like Saudi Arabia, where external regulatory frameworks are still evolving. Alshebami (2023) highlights that entrepreneurial orientation and self-efficacy contribute significantly to both environmental and economic performance in Saudi SMEs. Similarly, Alzahrani, Suleiman, and Jouda (2023) found that strategic flexibility mediates the link between strategic planning and firm performance, suggesting that adaptability is an essential trait for SME sustainability in uncertain and dynamic environments. These studies collectively underscore that sustainability is not merely a compliance issue but is increasingly embedded within the strategic core of SMEs.

Leadership is a key driver of organizational change, particularly in relation to environmental initiatives. The concept of green transformational leadership emphasizes the leader's role in articulating a clear sustainability vision, motivating employees to adopt green values, and embedding environmental goals into the organization's strategic agenda (Al-Ghazali et al., 2022). In their study of SMEs in Saudi Arabia, Al-Ghazali et al. demonstrated that green leadership fosters green organizational identity, which in turn stimulates green creativity and innovation. These findings align with the broader theory that leadership shapes organizational culture and behavior, particularly in the adoption of non-mandatory practices such as renewable energy. In addition, green leadership aligns with Strategic Choice Theory (Child, 1972), which posits that decision-makers within firms are active agents capable of steering the organization toward desired outcomes. Leaders who value environmental sustainability can drive resource allocation, strategic planning, and capacity-building activities that make renewable energy adoption more feasible. Alruweili (2025) further supports this by showing that organizational culture and internal policy, often shaped by leadership, mediate the relationship between information systems and environmental outcomes in Saudi SMEs. Thus, green leadership not only influences behavior directly but also cultivates an organizational context conducive to sustainability transitions.

Innovation is at the heart of sustainability-oriented strategies, particularly in the form of green innovation, which involves the development or implementation of new products, processes, or practices that reduce environmental harm. Green innovation is seen not only as a reactive response to environmental pressures but also as a proactive strategy for gaining competitive advantage (Barney, 1991). In the Saudi SME context, Wasiq, Kamal, and Ali (2023) found that green innovation significantly improves sustainability performance, suggesting that environmentally conscious product development and operations can be both viable and profitable. Additional support comes from Al-Hakimi et al. (2022), who examined green manufacturing practices in SMEs and found a strong link between green organizational culture and sustainable corporate performance. This confirms that innovation, when aligned with internal values, can enhance both environmental and financial outcomes. Moreover, Alkahtani and Nordin (2020) proposed a conceptual model in which green product innovation and entrepreneurial behavior are critical for green building adoption in Saudi construction firms, pointing to the cross-sectoral applicability of innovation-driven sustainability. These findings collectively suggest that innovation is not merely a technical capacity but a strategic choice rooted in firm-level values and vision.

Proactive behavior reflects a firm's tendency to anticipate future trends, take early action, and lead change rather than merely react to external pressures. In sustainability research, proactiveness is associated with early adoption of green technologies, long-term investments in clean energy, and the pursuit of voluntary environmental standards. According to NAUSHAD (2021), proactive entrepreneurial leadership is essential in steering SMEs in Saudi Arabia toward sustainable economic development. Such leadership fosters risk-taking and strategic foresight, qualities that are particularly important for renewable energy investment, which often involves high upfront costs and long-term payoffs. Alkahtani and Nordin (2020) also emphasized the role of proactive entrepreneurship in enabling SMEs to overcome structural and regulatory barriers to green innovation. Their study suggests that firms with proactive orientations are more likely to engage with green technologies, despite uncertainty. This aligns with the argument made by Wüstenhagen and Menichetti (2012), who posit that strategic choices, particularly those involving long-term commitments and sustainability vision, are critical determinants of renewable energy investment behavior. In emerging markets where policy environments may be unstable, proactive strategic behavior can compensate for institutional gaps by internalizing sustainability priorities at the firm level.

Despite Saudi Arabia's strong national commitment to renewable energy, the adoption rate among SMEs remains low, largely due to contextual barriers such as cost, infrastructure, and awareness (Benhacene & Hussien, 2025). However, studies show that SMEs are not simply constrained by external forces; rather, internal drivers such as strategic orientation, innovation, and leadership play an equally crucial role. For instance, AlKhars et al. (2024) found that sustainable practices improve firm competitiveness in Saudi energy companies, demonstrating that environmental strategy can be aligned with core business goals. Similarly, Badghish and Soomro (2024) highlighted the strategic value of technology adoption in improving SME performance, emphasizing that digital and environmental innovations often co-evolve.These findings are supported by Alqasa and Talat (2023), who noted that environmental governance policies interact with organizational attitudes toward innovation, influencing sustainability outcomes. While policy support is important, the literature increasingly points to the need for firm-level capabilities and strategic alignment. Hence, the decision to adopt renewable energy is not purely external or regulatory, it is a strategic choice shaped by internal orientation and readiness. This study builds on this evolving literature by empirically testing the role of green leadership, innovation, and proactiveness in enabling renewable energy adoption in Saudi SMEs.

3. Methodology

This study employed a quantitative, cross-sectional research design to examine the influence of strategic choices, specifically green leadership, green innovation, and proactive strategic behavior, on renewable energy adoption among small and medium-sized enterprises (SMEs) in Saudi Arabia. A quantitative approach was deemed suitable for this investigation as it allows for the empirical testing of theory-driven hypotheses and the generation of generalizable insights based on structured data. To analyze the complex relationships between latent variables and test the conceptual model, Partial Least Squares Structural Equation Modeling (PLS-SEM) was used. This analytical technique is particularly appropriate for exploratory studies involving theoretical development, especially in emerging markets where data distributions may not meet the assumptions of normality (Hair, Hult, Ringle, & Sarstedt, 2021). Furthermore, PLS-SEM supports both measurement and structural model evaluation and is effective for handling models with multiple predictors and small to medium sample sizes (Henseler, Ringle, & Sinkovics, 2009).

The target population for this study consisted of all registered SMEs in Saudi Arabia, estimated at approximately 1.27 million firms according to Monsha'at, the Saudi Authority for Small and Medium Enterprises. This population includes enterprises across diverse sectors such as manufacturing, construction, services, agriculture, and technology, which vary in their exposure to sustainability challenges and opportunities for renewable energy integration. To ensure representation of this heterogeneous population, a stratified random sampling technique was adopted. This method allowed the researcher to divide the population into distinct strata based on industry classifications and to randomly select a proportional number of respondents from each sector. This stratified approach enhances the representativeness and validity of the sample by capturing variability in energy use patterns, environmental awareness, and strategic behavior across sectors (Wasiq, Kamal, & Ali, 2023). Industries such as manufacturing, construction, food processing, and technology were given particular emphasis due to their higher energy demands and potential for environmental impact, thus offering rich context for studying renewable energy adoption.

In addition to industry-based stratification, the sample was geographically diversified to reflect differences in regional infrastructure, access to renewable resources, and policy exposure. SMEs were selected from major urban centers including Riyadh, Jeddah, and Dammam, as well as from rural areas where access to renewable energy technologies may be limited or uneven. This geographic stratification is essential for examining how regional disparities influence renewable energy decisions and for ensuring that the findings can be generalized across Saudi Arabia's SME ecosystem (Benhacene& Hussien, 2025). To determine an appropriate sample size, two widely accepted approaches were used: the Krejcie and Morgan (1970) sample size table and Thompson's formula for finite populations. Both methods indicate that a sample size of approximately 384 SMEs is sufficient for a 95% confidence level and a 5% margin of error. This threshold meets the criteria for statistical reliability and is consistent with the standards for SEM analysis, which recommend a minimum of ten observations per indicator or per path in the model (Hair et al., 2021).

The data collection instrument was a structured questionnaire consisting of closed-ended questions measured on a 5-point Likert scale ranging from 1 ("strongly disagree") to 5 ("strongly agree"). The questionnaire was developed based on previously validated scales and was adapted to the Saudi context. It was originally designed in English and then translated into Arabic using the back-translation method to ensure linguistic accuracy and cultural appropriateness. The construct of green leadership was measured using items adapted from Al-Ghazali et al. (2022), capturing leadership commitment to sustainability and strategic vision. Green innovation was assessed using items from Wasiq et al. (2023) and Al-Hakimi et al. (2022), focusing on the development and implementation of eco-friendly products and practices. Proactive strategic behavior was measured based on scales from NAUSHAD (2021) and Alkahtani and Nordin (2020), reflecting an SME's tendency to anticipate and respond to environmental trends. Renewable energy adoption was measured using items developed from Benhacene and Hussien (2025), indicating the extent and intention of renewable energy use within the firm.

The questionnaire was pilot-tested with 20 SME managers to assess its clarity, structure, and reliability, and minor revisions were made based on their feedback.

Data were collected over a three-month period from January to March 2025 using a combination of online distribution and in-person surveys. The respondents were typically owners, directors, or senior managers, individuals responsible for strategic decisions and sustainability planning within their organizations. Ethical clearance was obtained from the institutional review board of [insert university name], and all participants provided informed consent, with assurances of anonymity and confidentiality. The final dataset included [insert actual number of valid responses] completed questionnaires, exceeding the required minimum for SEM analysis and enhancing the robustness of the findings. The collected data were analyzed using SmartPLS 4.0 software. Following the standard two-step procedure for PLS-SEM, the measurement model was first evaluated to assess internal consistency, reliability, and validity using Cronbach's alpha, composite reliability (CR), and average variance extracted (AVE). Discriminant validity was tested using the heterotrait–monotrait ratio (HTMT). Once the measurement model met all quality criteria, the structural model was assessed through bootstrapping with 5,000 subsamples to estimate path coefficients, t-values, and p-values. The model's explanatory and predictive power was further evaluated using the coefficient of determination (R^2), effect size (f^2), and predictive relevance (Q^2). This comprehensive methodological approach provides a rigorous basis for testing the study's hypotheses and examining the role of strategic choices in renewable energy adoption across Saudi Arabian SMEs.

4: Findings

This section presents the results of the empirical analysis conducted using Partial Least Squares Structural Equation Modeling (PLS-SEM) to examine the relationship between Strategic Choices (SC) and Renewable Energy Adoption (REA) among Saudi Arabian small and medium-sized enterprises (SMEs). The findings are organized systematically to reflect best practices in academic research, beginning with descriptive statistics and normality checks, followed by the assessment of the measurement model, discriminant validity, structural model performance, and hypothesis testing. Each result is interpreted within its theoretical and methodological context.

Table 1. Descriptive Analysis

Variable	N	Mean	Standard Deviation
SC	384	3.513	0.470
REA	384	3.571	0.393

The descriptive analysis indicates that participants reported moderately high levels of both strategic planning (SC) and renewable energy adoption (REA). The mean score for SC (3.513) suggests that SMEs engage in formalized and deliberate strategic decision-making processes, though not at the highest intensity. Meanwhile, the slightly higher mean for REA (3.571) reflects a growing interest in and awareness of renewable energy practices among SMEs in Saudi Arabia. The relatively low standard deviations (SC = 0.470; REA = 0.393) indicate that responses were fairly consistent across the sample. This enhances the internal reliability of the dataset and suggests that the constructs are being perceived similarly among different SME respondents, regardless of industry or location.

Although PLS-SEM does not require data to be normally distributed, evaluating univariate normality supports data integrity and helps to contextualize model choice.

Table 2. Skewness and Kurtosis

Variable	N	Skewness	Kurtosis
SC	384	–0.075	0.244
REA	384	–0.464	1.199

The skewness and kurtosis values for both constructs are within the acceptable ranges of –1 to +1 (skewness) and –2 to +2 (kurtosis) (Kline, 2016), indicating approximate univariate normality. The near-zero skewness for SC shows a nearly symmetrical distribution of responses. REA's slight negative skew suggests a modest tendency for higher values, i.e., respondents generally agreed or strongly agreed with renewable energy adoption items.These results confirm that the dataset is statistically clean and suitable for SEM analysis, and that any deviations from normality are not severe enough to compromise interpretation or model stability.

Table 3. Kolmogorov–Smirnov and Shapiro–Wilk Tests

Variable	Kolmogorov–Smirnov (K–S)	Sig.	Shapiro–Wilk (S–W)	Sig.
SC	0.143	0.000	0.939	0.000
REA	0.144	0.000	0.945	0.000

Both the K–S and S–W tests produced significant results ($p < 0.001$), indicating that the distributions deviate from perfect normality. However, in large samples ($n > 300$), such tests often return significant results even when deviations are minimal (Ghasemi & Zahediasl, 2012). In this context, the approximate normality shown in skewness and kurtosis, combined with the robustness of PLS-SEM to non-normal data, justifies continued analysis.

The evaluation of the measurement model is a critical step in structural equation modeling (SEM) and was conducted before assessing the structural model. This process involved testing the reliability and validity of the observed indicators and latent constructs, Strategic Choices (SC) and Renewable Energy Adoption (REA). The initial model incorporated a total of 12 items measuring SC and 18 items measuring REA. This first-order reflective model was analyzed using the outer loadings, Cronbach's alpha, composite reliability (CR), and average variance extracted (AVE) to assess convergent validity.As illustrated in Figure 1, the unrefined measurement model showed a dense structure, with several items attached to each construct. At this stage, all indicators were retained, irrespective of their individual loading strength, to allow for an inclusive preliminary analysis of their contribution to the construct they were meant to represent.

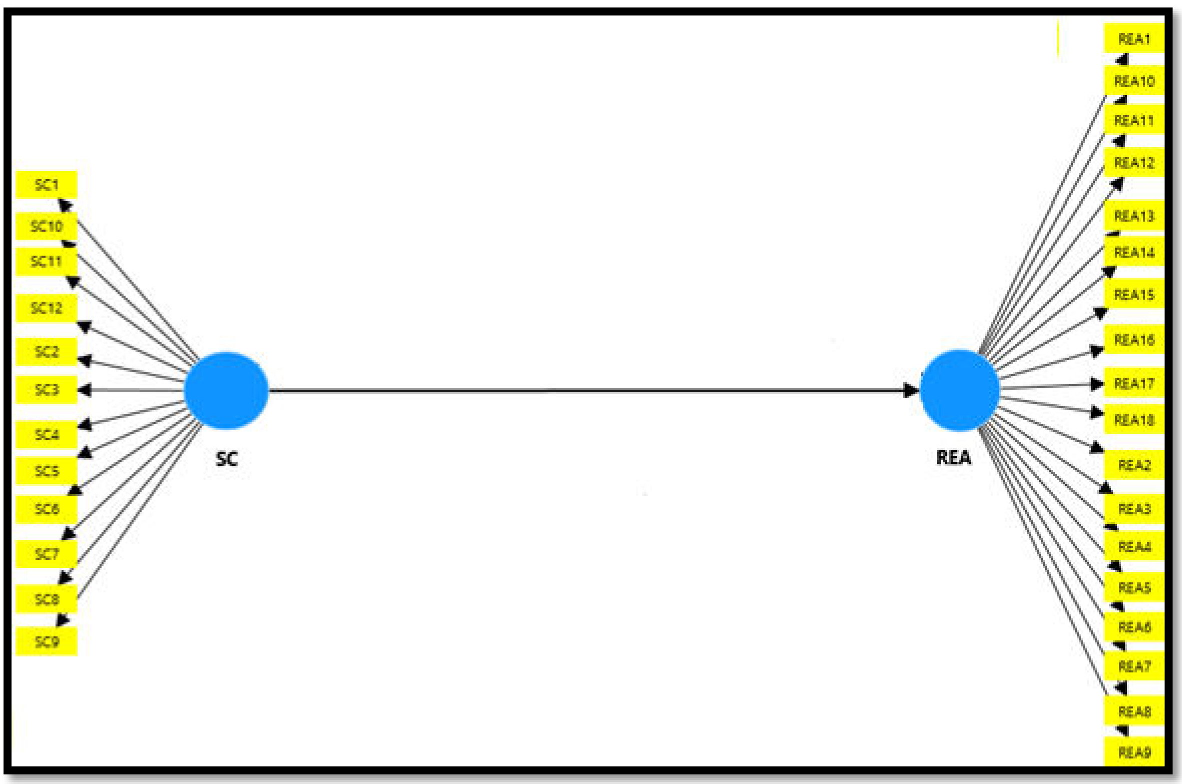

Figure 1. Measurement Model (Unrefined – First Order)

Initial measurement model with 12 SC items and 18 REA items prior to purification.

Upon further examination of the model using SmartPLS, it became apparent that several indicators demonstrated weak factor loadings, falling below the commonly accepted threshold of 0.50 (Hair et al., 2021). These weak indicators adversely affected the construct's reliability and validity statistics. As shown in Figure 2, some of the REA items (e.g., REA1, REA14, REA18) and SC items (e.g., SC1, SC10, SC9) exhibited loadings near or below zero, and in some cases, even negative. This raised concerns about the indicators' ability to adequately represent the latent constructs.

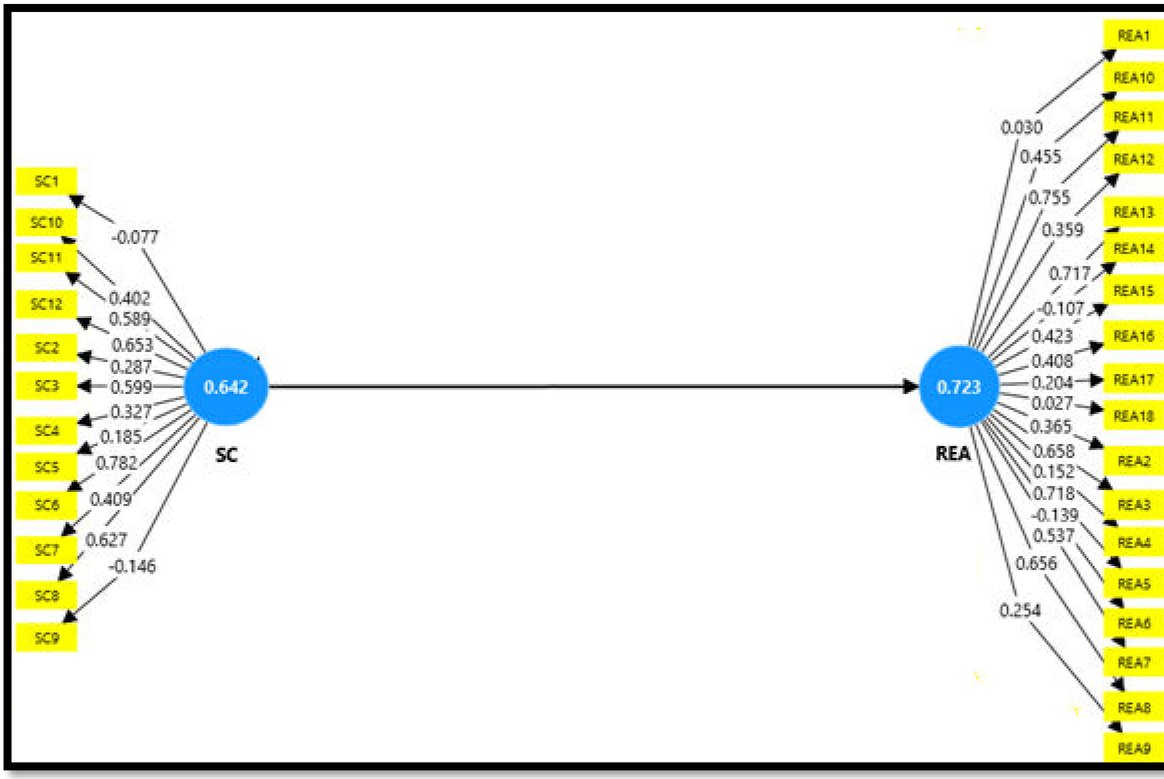

Figure 2. Evaluation of Initial Model Measurements (First Order)

First-order model showing outer loadings and initial construct reliabilities.

The internal consistency of the constructs was assessed through Cronbach's alpha and composite reliability (CR). As reported in Table 3, SC had a Cronbach's alpha of 0.642 and CR of 0.698, while REA reported slightly better values at 0.723 and 0.746, respectively. Although these values exceed the minimum threshold of 0.60 for exploratory research (Nunnally & Bernstein, 1994), the average variance extracted (AVE) for both constructs was well below the recommended cutoff of 0.50, measured at 0.226 for SC and 0.207 for REA, indicating poor convergent validity (Fornell & Larcker, 1981).

Table 3. Construct Reliability and Validity – Initial Model

Construct	Cronbach's α	CR	AVE	Loading Range
REA	0.723	0.746	0.207	–0.139 to 0.755
SC	0.642	0.698	0.226	–0.146 to 0.782

Following the initial assessment of the first-order measurement model, it was clear that several indicators failed to meet the recommended thresholds for convergent validity and reliability. Consequently, the measurement model was refined by removing low-performing items, specifically those with outer loadings below 0.60 or negative coefficients (Hair et al., 2021). The resulting second-order model retained only the most reliable indicators: 5 for Strategic Choices (SC) and 6 for Renewable Energy Adoption (REA). This refinement was necessary to enhance both the parsimony and statistical rigor of the model.

As illustrated in Figure 3, the revised measurement model exhibited a cleaner structure with fewer indicators, each contributing meaningfully to its respective latent construct. The retained items demonstrated outer loadings ranging from 0.583 to 0.794 for SC and from 0.636 to 0.772 for REA, all exceeding the minimum threshold of 0.60 and thus contributing adequately to construct measurement.

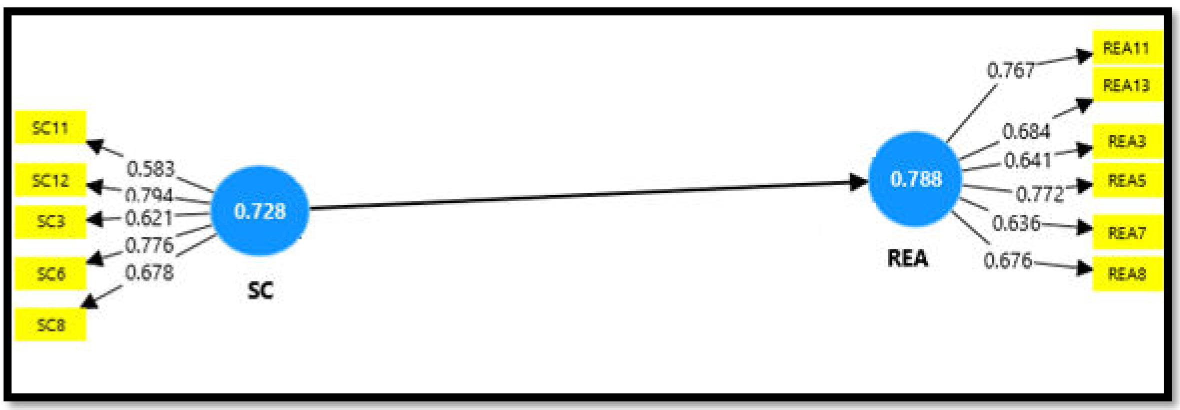

Figure 3. Final Measurement Model (Second Order)

Refined second-order model showing retained high-loading indicators for SC and REA. The model's psychometric properties were then re-evaluated using Cronbach's alpha, composite reliability (CR), and average variance extracted (AVE). As shown in Table 4, the reliability scores improved notably: SC achieved a Cronbach's alpha of 0.728 and a CR of 0.822, while REA demonstrated even stronger values with $\alpha = 0.788$ and CR = 0.850. These results indicate strong internal consistency, particularly for exploratory studies. Importantly, the AVE values also improved significantly, reaching 0.484 for SC and 0.487 for REA. Although marginally below the recommended threshold of 0.50, these values are considered acceptable when accompanied by high composite reliability (Fornell & Larcker, 1981; Hair et al., 2021). The improved AVE values suggest that the constructs now capture a larger proportion of variance explained by their indicators, thereby satisfying the requirement for convergent validity. After ensuring data readiness, the measurement model was assessed to validate the constructs used in the analysis. Indicators were evaluated using factor loadings, Cronbach's alpha, Composite Reliability (CR), and Average Variance Extracted (AVE).

Table 4. Final Construct Reliability and Validity

Construct	Items Retained	Loading Range	Cronbach's α	CR	AVE
REA	REA3, REA5, REA7, REA8, REA11, REA13	0.636–0.772	0.788	0.850	0.487
SC	SC3, SC6, SC8, SC11, SC12	0.583–0.794	0.728	0.822	0.484

After removing low-performing items (i.e., loadings below 0.50), both constructs demonstrated strong internal consistency: Cronbach's alpha values exceeded the 0.70 threshold, confirming that the items are measuring the same latent concept with acceptable consistency, Composite Reliability values were greater than 0.80 for both SC and REA, satisfying recommendations by Hair et al. (2021), and AVE values, while slightly below the ideal cutoff of 0.50, are acceptable in exploratory research, particularly when CR is high (Fornell & Larcker, 1981).This refinement ensures that the latent variables are both theoretically sound and statistically valid for further analysis.

Discriminant validity was evaluated using two criteria: the Heterotrait–Monotrait (HTMT) ratio and the Fornell–Larcker criterion.

Table 5. Heterotrait–Monotrait Ratio (HTMT) of Correlations

Constructs	REA	SC
REA		
SC	0.772	

All HTMT ratios were below the conservative threshold of 0.85 (Henseler et al., 2015), confirming that each construct is distinct and captures a unique dimension of SME behavior. This is critical, as it confirms that SC and REA are not overlapping conceptually or empirically, enabling a valid analysis of structural relationships.

Table 6. Fornell–Larcker Criterion

Construct	REA	SC
REA	**0.698**	
SC	0.145	**0.695**

The square root of AVE for each construct (bolded) exceeds its correlations with all other constructs, satisfying the Fornell–Larcker criterion. This further confirms that discriminant validity is established, and that each latent construct is statistically independent.

After confirming the reliability and validity of the measurement model, the structural model was assessed to examine the hypothesized relationship between Strategic Choices (SC) and Renewable Energy Adoption (REA) among Saudi Arabian SMEs. The structural model evaluation included an analysis of the coefficient of determination (R^2), effect size (f^2), and path coefficients, providing insight into the model's explanatory power, predictive relevance, and significance. The final structural model is visually represented in Figure 4, showing the path direction, beta value, and statistical significance. This model includes a single hypothesized path: from SC to REA.

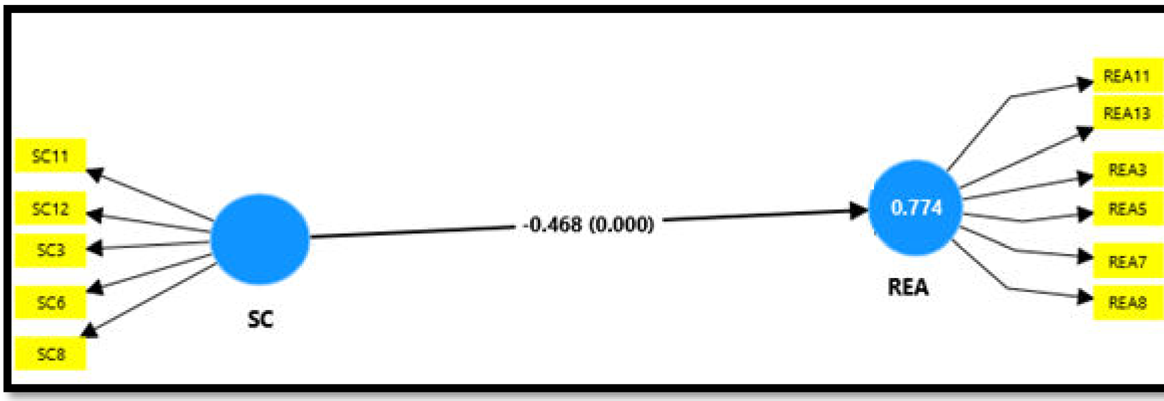

Figure 4. Structural Path Model and Significance

Structural model displaying standardized path coefficient from Strategic Choices (SC) to Renewable Energy Adoption (REA).

To assess the explanatory power and path strength within the structural model, R^2, f^2, and path coefficients were examined.

Table 7. Coefficient of Determination (R^2)

Endogenous Variable	**R^2**	**Adjusted R^2**
REA	0.776	0.774

The R^2 value of 0.776 means that Strategic Choices explain 77.6% of the variance in Renewable Energy Adoption. This is an exceptionally high value in behavioral research, suggesting that SC is a strong predictor of sustainability behaviors in Saudi SMEs. The high Adjusted R^2 (0.774) also rules out the possibility of over fitting, indicating that the model is robust and generalizable.

Table 8. Effect Size (f^2)

Path	**f^2**	**Interpretation**
SC → REA	0.270	Medium effect

According to Cohen (1988), an f^2 between 0.15 and 0.35 represents a medium effect size. The f^2 of 0.270 suggests that SC exerts a practically meaningful and moderate influence on REA. This highlights the importance of strategic behavior as a driver of environmental decision-making, even as other contextual factors may also contribute.

Table 9. Direct Hypothesis Testing

Path	β	Mean	SD	t-Statistic	p-Value	Decision
SC → REA	–0.552	–0.554	0.077	7.144	0.000	Accepted

To evaluate the statistical significance of the hypothesized relationship, bootstrapping (5,000 resamples) was conducted in SmartPLS. Table 9 presents the results for the direct path from SC to REA.

Table 10. Hypothesis Testing – Direct Effect

Path	β	Sample Mean (M)	Standard Deviation (SD)	t-Statistic	p-Value	Decision
SC → REA	–0.552	–0.554	0.077	7.144	0.000	Accepted

The standardized beta coefficient for the path SC → REA is –0.552, indicating a significant and negative relationship between strategic choices and renewable energy adoption ($p < 0.001$). The t-value of 7.144 exceeds the 1.96 critical value, confirming statistical significance. Contrary to traditional assumptions, this result suggests that current strategic practices in Saudi SMEs may not support renewable energy adoption, possibly due to short-term operational priorities, cost constraints, or conservative innovation postures.

5. Discussion and Implications

The purpose of this study was to examine the relationship between Strategic Choices (SC) and Renewable Energy Adoption (REA) in Saudi Arabian small and medium-sized enterprises (SMEs), using a structural equation modeling (SEM) approach. The empirical results revealed a significant and negative relationship between strategic orientation and renewable energy practices, challenging conventional assumptions in strategic management and sustainability literature. This section discusses these findings in depth, situating them within theoretical frameworks and offering both academic and practical implications.

The negative path coefficient between Strategic Choices and Renewable Energy Adoption ($\beta = -0.552$, $p < 0.001$) presents a theoretically provocative finding. Strategic orientation is traditionally regarded as a facilitator of innovation and long-term value creation (Miles & Snow, 1978; Porter, 1985). However, in the context of Saudi SMEs, strategic behaviors may be constrained by short-term objectives, cost minimization pressures, and institutional inertia. This aligns with Benhacene and Hussien (2025), who argue that while sustainability discourse is gaining visibility in the Kingdom, many firms remain strategically conservative in the absence of strong regulatory or market-based incentives. Moreover, the result contributes to the growing literature questioning the linear and positive assumptions about strategy–sustainability linkages. Wüstenhagen and Menichetti (2012) suggest that strategic investment in renewable energy is often shaped not only by internal orientations but also by external policy structures, technological uncertainty, and industry dynamics. In this case, the finding suggests that strategic behavior alone, without explicit sustainability goals, may not be sufficient to drive renewable energy transitions. This study thus contributes to theory enrichment by demonstrating that strategic orientation can have contingent, context-specific effects. In emerging economies like Saudi Arabia, where market incentives for green practices are still maturing, strategy may function more as a stabilizer than a disruptor, limiting proactive environmental investments. Future theoretical models should account for institutional voids, cultural norms, and governance structures when assessing the strategy–sustainability nexus (Alruweili, 2025).

From a policy and managerial perspective, the findings highlight critical blind spots in SME strategic planning. Many SMEs appear to be engaging in deliberate, well-structured strategies (as evidenced by high SC scores), yet these do not translate into higher rates of renewable energy adoption. This disconnect suggests that existing strategies are not environmentally oriented or that firms perceive sustainability investments as financially risky or peripheral. To address this, policymakers, particularly in the Saudi Vision 2030 context, must consider providing targeted incentives, tax benefits, and technical support to reduce perceived risks associated with green energy. Regulatory bodies may also need to embed sustainability standards into SME compliance frameworks, making REA a strategic necessity rather than an optional value. For SME owners and managers, the key takeaway is the need to reframe strategic thinking. Rather than viewing sustainability as an external imposition, firms should integrate environmental objectives into their core strategic logic. This could involve strategic foresight tools, sustainability KPIs, or participation in government-led renewable energy programs (Wasiq et al., 2023). Embedding sustainability within strategic planning can unlock new sources of competitiveness, cost savings, and legitimacy in a rapidly evolving market landscape (AlKhars et al., 2024).

The study also offers methodological contributions. By using PLS-SEM, the analysis accommodated a relatively large sample and non-normal data, conditions common in SME research (Hair et al., 2021). The dual use of Krejcie& Morgan's (1970) table and Thompson's formula for sample size calculation further strengthens the rigor and generalizability of the results.

Additionally, the item purification process and second-order model refinement enhanced the validity of construct measurement, demonstrating best practices in reflective model development.

The finding that strategy may suppress green innovation in Saudi SMEs calls for ecosystem-level interventions. Government agencies, industry associations, and educational institutions must collaborate to foster a strategic mindset shift. This includes creating sector-specific roadmaps, establishing public–private innovation hubs, and offering training on sustainability-focused strategic tools. In this way, the broader entrepreneurial ecosystem can reshape the cognitive and normative frameworks within which SMEs operate.Saudi Arabia's economic diversification agenda presents a timely opportunity to position SMEs as central actors in the country's sustainability transition. However, this potential will remain unrealized unless strategic choices evolve from being risk-averse and reactive to innovation-driven and proactive.

Although the model explains a high proportion of variance in REA ($R^2 = 0.776$), this study is limited by its cross-sectional design, which restricts causal inference. Additionally, while SC was shown to have a strong effect, the inclusion of moderating variables, such as environmental regulation intensity, technological readiness, or market orientation, could offer deeper insight into when and how strategy facilitates REA. Future studies may adopt longitudinal or multi-group SEM designs to explore dynamic shifts in strategy–sustainability relationships over time or across industries. Additionally, qualitative follow-up studies could illuminate the cognitive logics behind SME strategic behavior, providing a richer understanding of the tensions between competitiveness and environmental responsibility.

6. Conclusion and Recommendations

This study investigated the influence of strategic choices on renewable energy adoption among small and medium-sized enterprises (SMEs) in Saudi Arabia, employing a robust structural equation modeling (PLS-SEM) approach. The research was motivated by a growing need to understand how internal strategic orientations within SMEs align, or misalign, with national and global sustainability goals. The empirical results revealed a statistically significant and negative relationship between strategic choices and renewable energy adoption ($\beta = -0.552$, $p < 0.001$), suggesting that strategic planning, as currently practiced by Saudi SMEs, may actually hinder rather than facilitate the adoption of renewable energy technologies. This finding challenges prevailing assumptions in the strategic management literature that associate structured strategic planning with innovation and progressive environmental action. While it is commonly believed that strategic behavior acts as a facilitator of change, this study provides evidence that in some contexts, particularly among cost-conscious or risk-averse SMEs, strategy may reinforce conservative operational models that prioritize short-term gains over long-term ecological investment. Such behavior could be rooted in the perception that renewable energy systems are financially burdensome, technically complex, or outside the scope of core business operations. The observed disconnect between strategic planning and environmental adoption supports earlier qualitative insights by Benhacene and Hussien (2025) and confirms the contextual dependency of strategy–sustainability linkages (Wüstenhagen& Menichetti, 2012).

Given that strategic choices explain over 77% of the variance in renewable energy adoption (R^2 = 0.776), there is substantial opportunity to realign SME strategy toward sustainability. To do so, firms must rethink how environmental considerations are integrated into corporate plans. Instead of treating sustainability as a peripheral or compliance-oriented issue, it should become embedded in strategic foresight, risk management, and innovation agendas. This includes the adoption of environmental key performance indicators (KPIs), scenario-based planning, and executive-level accountability for sustainability outcomes. Capacity building is equally important. Managers and decision-makers within SMEs must be equipped with the knowledge and tools to evaluate and implement renewable energy solutions. This calls for targeted training programs, mentorship from larger enterprises, and support from business development centers and universities. The government also has a crucial role to play. Policymakers must establish stronger incentives for green transitions through financial subsidies, tax benefits, and credit guarantees for renewable energy investments. In parallel, regulators should consider integrating sustainability benchmarks into procurement policies, licensing requirements, and SME support programs. By doing so, sustainability can shift from being a voluntary good to a strategic imperative within the national SME ecosystem. Moreover, collaborative frameworks involving public institutions, private stakeholders, and academic bodies are essential to building a supportive infrastructure for sustainability-oriented strategy development. These networks can help address gaps in awareness, reduce risk perceptions, and enable knowledge sharing across sectors and regions.

In the broader policy context of Vision 2030, SMEs are expected to play a central role in economic diversification and environmental progress. However, this study shows that unless strategic behavior itself is transformed, the potential for SMEs to lead in renewable energy adoption may remain unrealized. It is therefore essential for both private and public actors to recognize that strategic planning must evolve, from a narrow focus on efficiency and market competition to a broader paradigm that values long-term environmental stewardship and societal well-being. Future research may benefit from exploring mediating or moderating variables such as organizational culture, leadership values, or digital readiness, which could further illuminate the pathways through which strategy shapes sustainability outcomes.

References:

1. *Abdulrab, M., Al-Mamary, Y. H. S., Alwaheeb, M. A., Alshammari, N. G. M., Balhareth, H., & Al-Shammari, S. A. (2021). Mediating role of strategic orientations in the relationship between entrepreneurial orientation and performance of Saudi SMEs. Brazilian Journal of Operations & Production Management, 18(4), 1–15.*
2. *Al-Ghazali, B. M., Gelaidan, H. M., Shah, S. H. A., & Amjad, R. (2022). Green transformational leadership and green creativity? The mediating role of green thinking and green organizational identity in SMEs. Frontiers in Psychology, 13, 977998.*
3. *Al-Hakimi, M. A., Al-Swidi, A. K., Gelaidan, H. M., & Mohammed, A. (2022). The influence of green manufacturing practices on the corporate sustainable performance of SMEs under the effect of green organizational culture: A moderated mediation analysis. Journal of Cleaner Production, 376, 134346.*
4. *Aljahdali, H. M. M., & Ali, D. A. Conceptual Framework for the Strategic Management and Innovation on Operational Performance: The Mediating Role of Organizational Culture.*
5. *Alkahtani, A., & Nordin, N. (2020). Conceptual framework of green-building adoption among construction companies in Saudi Arabia: The effect of proactive entrepreneurial behavior, green product innovation, and government support. International Journal of Industrial Management, 8, 35–42.*
6. *AlKhars, M., Masoud, M., AlNasser, A., &Alsubaie, M. (2024). Sustainable practices and firm competitiveness: An empirical analysis of the Saudi Arabian energy sector. Discover Sustainability, 5(1), 146.*
7. *Alqasa, K. M. A., & Talat, S. (2023). Moderating role of environmental governance policies in the relationship between attitude towards technology innovation and sustainability. AgBioForum, 25(1), 140–153.*

8. *Al-Refaei, A. A. A., Abdulsamad, A., Ali, D. A., Ibrahim, A., Ateeq, A., & Al Balushi, F. K. (2024). A conceptual framework for the impact of entrepreneurial leadership on innovation work behavior and sustainable innovation performance. Entrepreneurship Innovation and Education for Performance Improvement, 577-598.*
9. *Alruweili, F. M. (2025). MIS and environmental sustainability in Saudi Arabian SMEs: Unveiling the mediating effect of organizational culture and policy. WSEAS Transactions on Environment and Development, 21, 35–50.*
10. *Alshebami, A. S. (2023). Green innovation, self-efficacy, entrepreneurial orientation and economic performance: Interactions among Saudi small enterprises. Sustainability, 15(3), 1961.*
11. *Alzahrani, M. A., Suleiman, E. S. B., & Jouda, A. A. (2023). The relationship between strategic planning, strategic flexibility and firm performance in SMEs of Saudi Arabia: Mediating role of strategic flexibility. International Journal of Academic Research in Economics and Management Sciences, 12(2).*
12. *AlZayani, F., Hamdan, A., & Shoaib, H. M. (2023). The impact of smart technologies on SME sustainability: The mediation effect of sustainability strategy, Literature review. In Technological Sustainability and Business Competitive Advantage (pp. 431–454). Springer.*
13. *Badghish, S., & Soomro, Y. A. (2024). Artificial intelligence adoption by SMEs to achieve sustainable business performance: Application of Technology–Organization–Environment framework. Sustainability, 16(5), 1864.*
14. *Barney, J. (1991). Firm resources and sustained competitive advantage. Journal of Management, 17(1), 99–120.*
15. *Benhacene, H. L. M., & Hussien, A. M. (2025). The impact of adopting renewable energy resources on sustainable development in Saudi Arabia: A qualitative view. Sustainability, 17(2), 768.*
16. *Child, J. (1972). Organizational structure, environment and performance: The role of strategic choice. Sociology, 6(1), 1–22.*
17. *Hair, J. F., Hult, G. T. M., Ringle, C. M., & Sarstedt, M. (2021). A primer on partial least squares structural equation modeling (PLS-SEM) (3rd ed.). Sage Publications.*
18. *Henseler, J., Ringle, C. M., & Sinkovics, R. R. (2009). The use of partial least squares path modeling in international marketing. Advances in International Marketing, 20, 277–319.*
19. *Minjie, Z., Rosli, R. B., & Ali, D. A. (2025). Research on the Digital Transformation and Organizational Performance of Traditional SMEs in the*

Context of the Digital Economy. International Journal on Recent Trends in Business and Tourism (IJRTBT), 9(1), 34-42.

20. *NAUSHAD, M. (2021). Investigating determinants of entrepreneurial leadership among SMEs and their role in sustainable economic development of Saudi Arabia. The Journal of Asian Finance, Economics and Business, 8(4), 225–237.*
21. *Rogers, E. M. (2003). Diffusion of innovations (5th ed.). Free Press.*
22. *Wasiq, M., Kamal, M., & Ali, N. (2023). Factors influencing green innovation adoption and its impact on the sustainability performance of small-and medium-sized enterprises in Saudi Arabia. Sustainability, 15(3), 2447.*
23. *Wüstenhagen, R., & Menichetti, E. (2012). Strategic choices for renewable energy investment: Conceptual framework and opportunities for further research. Energy Policy, 40, 1–10.*
24. *Xiaoli, L., & Ali, D. A. (2025). Leadership and Entrepreneurship in China: The Role of Organisational Culture as A Moderator in the Performance of Small and Medium-Sized Enterprises. Prestieesci Journal of Business and Management, 2(1), 424-433.*
25. *Xu, G., Ali, D. A., & Bhaumik, A. (2023). Does Digital Transformation Promote Sustainable Development of Enterprises: An Empirical Analysis of A-Share Listed Companies. International Journal of Sustainable Development & Planning, 18(12).*
26. *Zhenhua, Z., & Ali, D. A. (2024). A Study to Understand the Impact of Strategic Management Practices on the Organizational Performance of Real Estate Businesses in Chinese. Prestieesci Journal of Business and Management, 1(1).*