International Journal of Energy Economics and Policy

ISSN: 2146-4553

available at http: www.econjournals.com

International Journal of Energy Economics and Policy, 2024, 14(4), 360-370.

The Mediating Role of Energy Efficiency Measures in Enhancing Organizational Performance: Evidence from the Manufacturing Sector in Jordan

Mohammad Nassar Almarshad[1]*, Suad Abdalkareem Alwaely[2,3], Bashar Younis Alkhawaldeh[4], Mosa Qasim Hasan Al Qaryouti[5], Ahmad Y. A. Bani Ahmad[6,7]

[1]Department of Financial and Administrative Sciences, Al-Huson University college, Al-Balqa' Applied University, Jordan, [2]Masters Department in Arabic Language Curricula and Islamic Education, Al Ain University, Abu Dhabi, UAE, [3]Department of Curriculum, Hashemite University, Zarqa, Jordan, [4]Department of Administrative Sciences, Faculty of Business, Jerash University, PO. Box 26150, Jordan, [5]Department of Business administration, Amman university college for financial and administrative sciences, Al Balqa Applied University, Amman, Jordan, [6]Department of Accounting and Finance, Faculty of Business, Middle East University, Amman 11831, Jordan, [7]Applied Science Research Center, Applied Science Private University, Jordan.
*Email: dr.mohammad.almarshad@bau.edu.jo

Received: 21 January 2024 **Accepted:** 15 May 2024 **DOI:** https://doi.org/10.32479/ijeep.15972

ABSTRACT

This study investigates the mediating role of energy efficiency measures in enhancing manufacturing firm performance in Jordan. A conceptual model is developed linking organizational policies, culture, and government incentives to adoption of energy efficiency measures, which in turn impact organizational performance. Data was collected through a survey of 300 manufacturing firms across major industrial sub-sectors in Jordan including food, textiles, chemicals, pharmaceuticals, construction materials, and machinery. Structural equation modeling using Smart PLS software tested the hypothesized relationships. Results provide empirical support for the conceptual framework. Organizational policies, culture emphasizing environmental responsibility, and government incentives positively influence adoption of energy efficiency measures like process optimization, equipment upgrades, and lighting improvements. Greater adoption of these measures enhances manufacturing performance across various dimensions like efficiency, quality, flexibility, and competitiveness. Further, energy efficiency measures strongly mediate the links between organizational policies, culture, incentives and manufacturing performance. The study makes important theoretical contributions to the resource-based view and natural resource-based view in a developing economy context. It also offers actionable implications for manufacturing managers and policymakers regarding energy efficiency strategies and programs. Limitations relating to the cross-sectional design, self-reported data, and generalizability are discussed along with recommendations for future research using longitudinal, qualitative, and multilevel approaches. Overall, the study highlights energy efficiency as a critical capability for boosting competitiveness in manufacturing firms, with mediation analysis elucidating the underlying performance enhancement mechanisms.

Keywords: Energy Efficiency Measures, Jordan, Manufacturing Firm Performance, Structural Equation Modelling
JEL Classifications: Q43, N15, N6

1. INTRODUCTION

Energy efficiency and environmental sustainability have become pressing issues facing organizations globally. The manufacturing sector is a major consumer of energy, accounting for about one-third of total global energy use (International Energy Agency, 2021). This high energy utilization contributes significantly to greenhouse gas emissions that drive climate change. As concerns over climate change impacts grow, there is increasing policy and stakeholder pressure on manufacturing firms to reduce their energy consumption and adopt environmentally sustainable business practices (Rosati and Faria, 2019). In response, manufacturers are implementing energy efficiency improvement measures to optimize energy utilization in their production processes and supply chains. Such measures include replacing inefficient equipment, adopting renewable energy sources, process innovations, employee training, etc. (Lin, et al., 2013; Abreu et al., 2022). Energy efficiency helps firm's lower energy costs, comply with regulations, and achieve environmental sustainability objectives (Tan et al., 2022). This eventually creates a competitive advantage for manufacturers while minimizing environmental externalities. Jordan's manufacturing sector has experienced significant expansion over the past decade, now accounting for over 16% of GDP (World Bank, 2022). However, the sector depends predominantly on imported fossil fuels for its energy needs. High and volatile international oil prices strain the energy security and balance of payments in Jordan's emerging economy. The manufacturing industry is also inherently energy-intensive and contributes substantially to Jordan's carbon emissions profile (Al-Ghandoor et al., 2012). For manufacturing firms in Jordan, improving energy efficiency provides multiple socio-economic and competitive benefits. Energy conservation measures allow cost savings from reduced energy expenditure to be channeled towards business growth and expansion. Enhanced energy productivity also makes Jordanian industrial goods more cost competitive in international export markets (Jaber et al., 2008). From a national policy perspective, the propagation of energy efficiency in manufacturing will bolster Jordan's energy security, alleviate fiscal pressures, and support climate change mitigation obligations (Al-Ghandoor et al., 2008). While the strategic advantages of energy efficiency for Jordanian manufacturing are apparent, actual adoption rates of efficiency measures remain low (Ta'any et al., 2009). Primary barriers include lack of access to finance for investing in new efficient equipment, inadequate managerial commitment and capacity, and insufficient policy incentives (Jaber et al., 2008). These bottlenecks prevent Jordanian firms from tapping into the significant energy and cost savings potentials associated with industrial energy efficiency. Furthermore, empirical studies investigating efficiency adoption decisions at Jordanian manufacturers remain limited (Alnaser and Alnaser, 2011; Matalka et al., 2024). Existing research on drivers and barriers is either theoretical or based on surveys of senior personnel which may suffer from subjectivity biases. There is a lack of statistical data and quantitative modeling approaches grounded in actual organizational theory and practice.

Accordingly, this study aims to fill these knowledge and methodological gaps by examining how internal organizational policies, external government incentives, environmental culture, and orientation influence the actual adoption of energy efficiency measures at Jordanian industrial firms using a novel statistical modeling technique. The mediating role of implemented energy efficiency measures in driving enhanced organizational performance is also assessed.

2. LITERATURE REVIEW

2.1. Previous Studies

Energy efficiency adoption in manufacturing facilities is influenced by both internal organizational policies and external drivers including regulations, incentives, energy costs, etc. (Abreu et al., 2022). However, research into these adoption drivers in emerging economies remains limited. Studies on Chinese industrial firms indicate that internal measures like management performance incentives (Liu et al., 2017) and appointment of dedicated energy managers (Lu et al., 2021) have significantly propelled efficiency investments. Government incentives also catalyze adoption, although the extent varies based on region, industry and efficiency solution maturity (Liu et al., 2017). Findings from Indian manufacturers suggest voluntary environment-focused company policies strongly predict actual efficiency actions, mediated by employee commitment to green objectives (Muduli et al., 2023). Externally, higher electricity prices consistently spur efficiency upgrades by raising potential cost savings, with some variations based on firm size, sector and technological capacity (Mittal et al., 2018; Fraihat et al., 2024). However, industrial energy conservation programs by utilities and efficiency equipment subsidies better explain adoption levels compared to tariffs alone (Fraihat et al., 2023). Studies also demonstrate superior energy and financial performance from efficiency investments, although empirical evidence in emerging markets remains limited (Fernández et al., 2022; Alwaely et al., 2024). In the Jordanian context, broad industrial surveys have identified general organizational barriers like access to finance and information deficiencies (Al-Ghandoor et al., 2008). Experts opine that insufficient managerial commitment, energy price distortions through subsidies, and inadequate policy frameworks have disincentivized efficiency actions (Jaber et al., 2008; Hijazi et al., 2024). Empirical assessments linking specific organizational, motivational and policy elements to actual energy efficiency propagation in Jordanian industry remain absent despite the energy savings potentials. This is the critical literature gap the current study aims to address.

Extant scholarly work on industrial energy efficiency in Jordan remains limited, with most studies confined to broad surveys of barriers among samples of large manufacturers (Jaber et al., 2008; Alnaser and Alnaser, 2011; Lin & Ho, 2016) or generalized national-level analyses of costs and savings potentials (Al-Ghandoor et al., 2008; Ta'any et al., 2009). There is a lack of statistically grounded empirical assessments of how elements of a firm's administrative and cultural environment interact with its technology adoption decisions focusing specifically on implemented energy efficiency measures. Furthermore, the link between sustainability practices and performance has shown mixed results in research settings (Alkhawaldeh et al., 2024), particularly in the context of efficiency investments by industrial facilities in developing economies. The mechanisms by which adoption of energy efficiency equipment and processes translate into performance improvements also require deeper examination (Fernández et al., 2022; Alkhawaldeh and Mahmood, 2021; Alkhawaldeh et al., 2022). This study addresses these gaps by developing a conceptual framework grounded in organizational behavior theory, and leveraging the partial least squares structural equation modeling (PLS-SEM) method on primary data from Jordanian manufacturers to test the mediating effect of energy efficiency adoption on the organization policies-performance nexus. In doing so, the research expands the limited empirical literature at the intersection of managerial decision science, energy efficiency propagation, and sustainability-competitiveness linkages in emerging economy manufacturing contexts.

2.2. Hypothesis Development

2.2.1. Effect of organizational policies and strategies on organizational performance

Companies that actively implement and integrate sustainability-focused policies related to energy, waste reduction and environmental impact mitigation in their business strategies tend to demonstrate superior performance across financial, operational and environmental metrics (Aguinis and Glavas, 2019; Flammer et al., 2021). Such policies signal managerial commitment to eco-efficiency goals that drive resource conservation actions, process improvements and responsible supply chain management. These subsequently lower productions costs through lower energy, water and material expenditures while minimizing environmental externalities of manufacturing operations (Abreu et al., 2022; Lin et al., 2020; Ahmad et al., 2024). Based on these benefits demonstrated empirically across industrial facilities globally, the study hypothesizes:

H1: Organizational policies and strategies positively enhance firm performance.

2.2.2. Effect of government policies and incentives on organizational performance

Regulatory mandates and financial incentives aimed at propagating energy efficiency and other sustainability measures catalyze their adoption by industrial facilities, subsequently driving performance improvements such as energy/water savings, lower waste emissions and higher productivity (Fernández et al., 2022; Fraihat et al., 2024). In China, industrial firms under greater regulatory scrutiny were found to exhibit superior economic and environmental performance tied to mandatory efficiency investments and audits (Liang et al., 2020). Energy conservation grants, tax rebates and results-based incentives also strengthen the financial case for manufacturer investments in efficiency equipment upgrades and system optimizations (Cooremans, 2011; Liu et al., 2017). Based on the empirical evidence, the study hypothesizes:

H2: Government policies and incentives positively enhance Organizational Performance.

2.2.3. Effect of environmental culture and orientation on organizational performance

A strong culture emphasizing sustainability and environmental values within an organization promotes workforce commitment and leadership prioritization of eco-efficiency objectives that drive resource conservation actions and responsible manufacturing practices (Harris and Crane, 2002; Sardo and Serrasqueiro, 2021). The associated energy/emission reductions, waste minimization and process upgrading enhance productivity, cost competitiveness and environmental reputation for industrial companies (Thanki et al., 2016). However, there remains a need for deeper empirical demonstration of the culture to performance linkage. Accordingly, the research hypothesizes:

H3: Environmental culture and orientation positively affect the organizational performance.

2.2.4. Effect of organizational policies and strategies on energy efficiency measures

Strategic appointments of energy/facility managers (Zhu et al., 2022), cross-departmental energy efficiency committees (Abreu et al., 2017), and performance accountability for conservation targets (Liu et al., 2017) exemplify organizational policies that incentivize greater assimilation of efficiency solutions. Companies that integrate ambitious energy/emission goals in corporate strategies or product designs also demonstrate higher adoption of technical measures and management practices reducing manufacturing environmental footprint (Lin et al., 2020). The hypothesis is:

H4: Organizational policies and strategies positively affect the energy efficiency measures.

2.2.5. Effect of government policies and incentives on Energy Efficiency Measures

Industrial investments in energy audits, retrofits, upgrades and process innovations are significantly responsive to energy prices and government incentives like capital subsidies, tax rebates and results-based programs (Cooremans, 2011; Fernández et al., 2022). In India, higher electricity tariffs induced greater assimilation of efficiency equipment (Kumar and Chandrakar, 2021). Chinese provincial regulations mandating audits, conservation targets and emission monitoring stimulate manufacturing facilities to adopt technical and operational solutions improving energy productivity (Liu et al., 2017). The research thus hypothesizes:

H5: Government policies and incentives positively affect the energy efficiency measures.

2.2.6. Effect of environmental culture and orientation on energy efficiency measures

Pro-environment organizational cultures reflected by sustainability-focused training programs raise employee awareness and acceptance of efficiency systems, thereby accelerating assimilation (Lober, 1998). Cross-departmental communities-of-practice similarly facilitate internal diffusion of technical knowledge and best practices related to energy management and emission reductions among industrial personnel (Thanki et al., 2016). Accordingly, the study hypothesizes:

H6: Environmental culture and orientation positively affect the energy efficiency measures.

2.2.7. Mediating effect of energy efficiency measures

The aforementioned drivers stimulate industrial investments towards assimilating technical and operational solutions aimed at energy savings, emission reductions and efficiency improvements. The associated resource conservation, enhanced system productivity and responsible manufacturing in turn support multiple aspects of facility economic, operational and environmental performance (Abreu et al. 2022, Worrell et al., 2003). Hence energy efficiency measures function as a key mechanism translating motivating organizational and policy drivers into performance enhancement outcomes. This mediation effect is under-researched empirically, leading to the final study hypothesis:

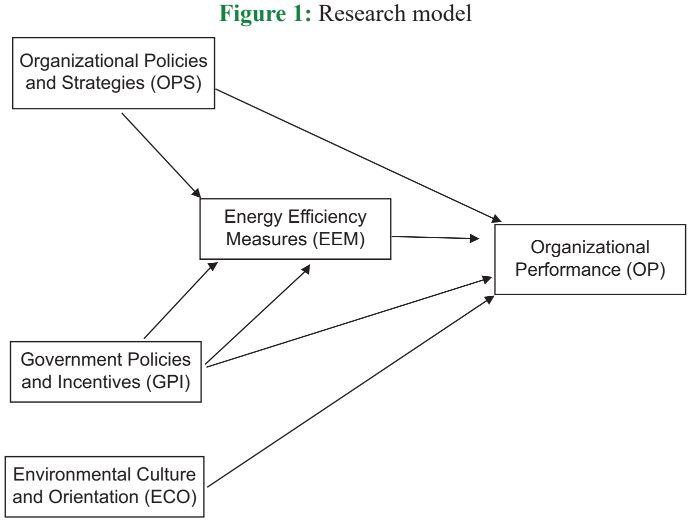
H7: Energy efficiency measures mediate the role in enhancing organizational performance.

2.2.8. Theoretical framework

The study's conceptual model (Figure 1) applies an institutional theory perspective situated in organizational change literature to investigate drivers of manufacturing firm decisions towards energy efficiency adoption. The policies, incentives structures and cultural dynamics that constitute an organization's administrative and operational environment shape strategic choices regarding investments in innovative energy-saving technologies and methods (Sarkis et al., 2010). Actual implementation then influences performance outcomes across financial, operational and environmental metrics. Specifically, internal strategic commitments to environmental goals, presence of energy/sustainability departments, and policies promoting efficient resource utilization are key organizational antecedents positively associated with eco-innovation assimilation based on past empirical studies (Liu et al., 2017; Muduli et al., 2023). External regulatory mandates and financial incentives by government agencies raise the attractiveness of efficiency expenditures by improving cost-benefit rationales for manufacturing facilities (Mittal et al., 2018; Kumar & Chandrakar, 2021). Environmentally conscious cultures facilitated through workforce engagement, communities-of-practice and sustainability training also drive change momentum towards efficiency adoption as energy/climate considerations get embedded organizationally (Lober, 1998). Efficiency measure implementation then enables performance enhancements through energy/resource savings, productivity improvements, and waste reductions that catalyze growth, competitiveness and lower environmental impacts (Fernández et al., 2022; Worrell et al., 2003). The conceptual model incorporates these theorized dynamics within a developing economy context.

3. RESEARCH METHODOLOGY

Figure 1: Research model



3.1. Target Population and Sampling

The target population comprises manufacturing firms across major industrial sub-sectors in Jordan including food processing, textiles, chemicals, pharmaceuticals, construction materials, and machinery. A sample frame of 300 firms will be derived from industry databases of Jordan's Ministry of Industry and Trade, the Amman Chamber of Industry and the Jordan Renewable Energy Society. Stratified random sampling was applied to ensure inclusion of entities across firm sizes, ages, ownership structures, and sub-sectors. A sample size of 200 organizations has been calculated based on a 95% confidence level and 7% margin of error. Key respondents are managers directly involved in technology acquisition, energy management and environmental compliance functions.

3.2. Research Instruments

Questionnaire measures were adapted from existing instruments in peer-reviewed studies assessing organizational drivers, technological eco-innovations and performance variables (Abreu et al., 2017; Kumar and Chandrakar, 2021; Sardo and Serrasqueiro, 2018). Reliability and validity tests will be conducted via expert reviews and pilot surveys before full-scale administration.

3.3. Data Collection and Analysis

Online survey was emailed to sample firms, with telephone/in-person follow-ups to improve response rates. Structural equation modeling using SmartPLS software test the conceptual framework and hypotheses. Models was assessed on reliability, convergent and discriminant validity metrics before hypothesis testing (Hair et al., 2017).

3.4. Ethical Considerations

Voluntary informed consent procedures implemented ensuring respondent privacy, data confidentiality and anonymity. The study also has institutional ethics board approval confirming compliance with academic research norms. Participating firms receive reports summarizing key findings and managerial implications.

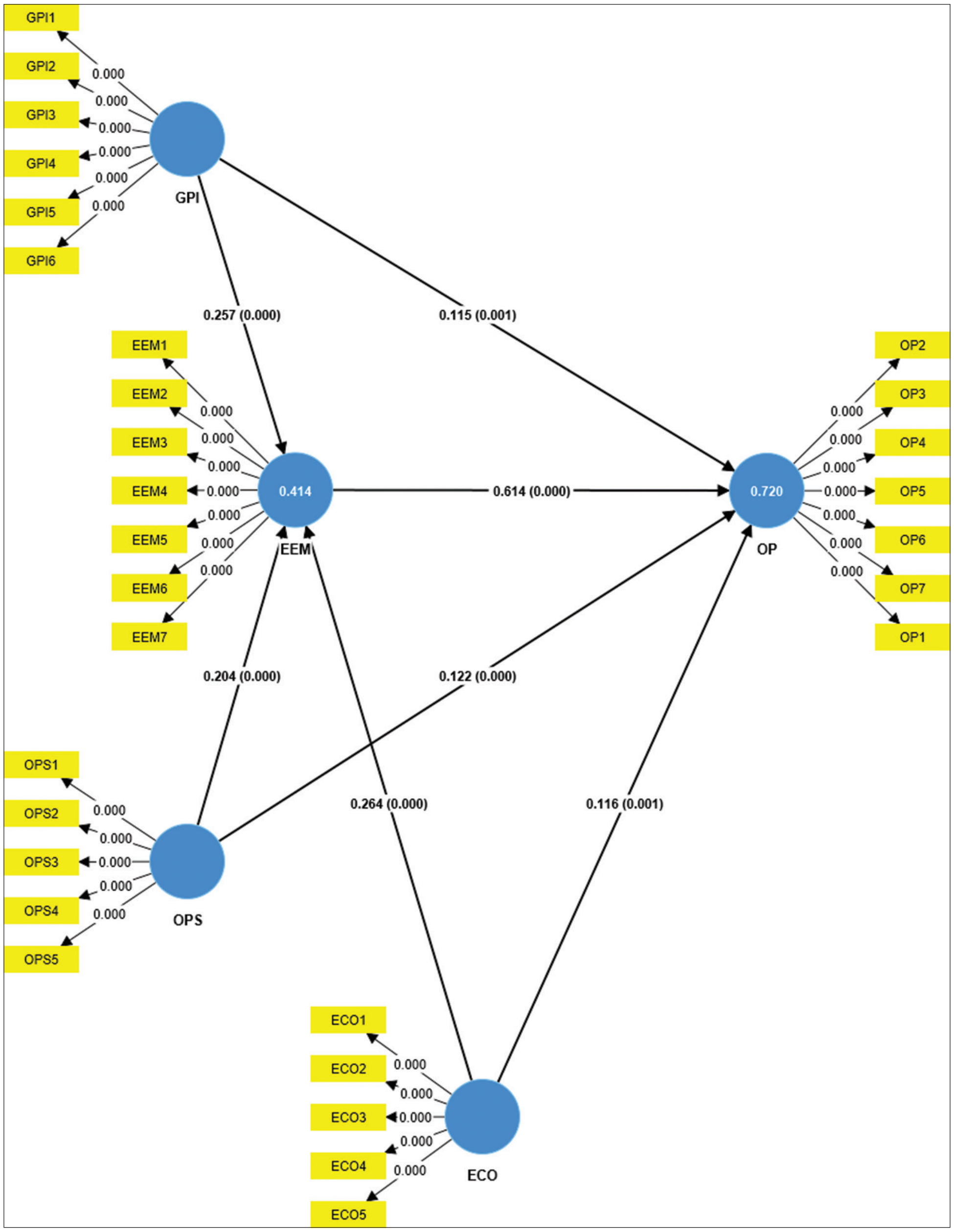
4. RESULTS AND DISCUSSION

4.1. Measurement Model

Table 1 presents the results of the measurement model assessment in the partial least squares structural equation modeling (PLS-SEM) analysis. Several key metrics are used to examine the reliability and validity of the multi-item constructs in the conceptual framework (Hair et al., 2017; Nath et al., 2019). First of all, all kinds of constructs reflect good internal reliability by the high Cronbach's alpha coefficients which are over 0.8. A three-factor structure with factor loadings in the acceptable range is thus confirmed by composite reliability scores calculated with both rho_A and rho_C statistics, which also exceed 0.7. This is again a proof that the corresponding scale items reliably reflect their allotted latent variables. (Nath et al., 2019) Therefore, concurrent validity is also established with average AVE values above 0.5 for all constructs except Energy Incomparance Measures. However, the AVE of 0.543 found is still sufficient considering the large factor

AQ3

Figure 2: Graphical results



loadings (their values being higher than 0.7) and good composite reliability. The overall result shows that it is on average more than 50 percent for the measured constructs to explain the variation in their corresponding items (Hair et al., 2017). In addition to that, all items of each scale have a factor loading <0.7 which represents high correlations between the indicator and assigned construct. Moreover, the results suggest the lack of a significant cross-loadings leading to the support for the discriminant validity as well (Nath et al., 2019).

4.2. Discriminant Validity

The (HTMT) ratios are brought up in Table 2, as a part of the assessment regarding discriminant validity. HTM computes the correlation coefficients between constructs and the mean of indicator correlations measuring each construct (Hair et al. 2017). The table reflects that all the HTMT values are below the conservative threshold of 0.85 (Franke and Sarstedt, 2019) which is in the range of 0.595-0.838. This shows the discriminant validity criteria; hence the constructs are shown not to be the same as other constructs empirically (Henseler et al., 2015). Accordingly, the outputs support the fact that all of the scales used to measure organizational policies, incentives, culture, energy efficiency measures and organizational performance are validated with statistical evidence of a-priori divergence.

The results available in Table 3 stem from applying Fornell-Larcker criterion analysis which is the second technique that helps assessing discriminant validity from PLS-SEM (partial least squares structural equation modeling) studies. The purpose of the Fornell-Larcker test is to determine if the average variance extracted (AVE) for each construct's square root is more than its highest correlation with any other construct (Hair Jr. et al.,

Table 1: Measurement model

Constructs	Factor loadings	Cronbach's alpha	Composite reliability (rho_a)	Composite reliability (rho_c)	Average variance extracted (AVE)
Environmental Culture and Orientation		0.903	0.906	0.928	0.721
ECO1	0.834				
ECO2	0.86				
ECO3	0.862				
ECO4	0.887				
ECO5	0.799				
Energy efficiency measures		0.859	0.865	0.892	0.543
EEM1	0.831				
EEM2	0.805				
EEM3	0.722				
EEM4	0.687				
EEM5	0.703				
EEM6	0.698				
EEM7	0.700				
Government policies and incentives		0.898	0.907	0.922	0.664
GPI1	0.720				
GPI2	0.785				
GPI3	0.805				
GPI4	0.857				
GPI5	0.866				
GPI6	0.846				
Organizational policies and strategies		0.910	0.915	0.928	0.649
OP1	0.738				
OP2	0.852				
OP3	0.853				
OP4	0.781				
OP5	0.791				
OP6	0.777				
OP7	0.841				
Organizational Performance		0.908	0.91	0.932	0.732
OPS1	0.855				
OPS2	0.864				
OPS3	0.891				
OPS4	0.823				
OPS5	0.843				

Table 2: Heterotrait-Monotrait ratio

Constructs	ECO	EEM	GPI	OP	OPS
ECO					
EEM	0.674				
GPI	0.838	0.648			
OP	0.714	0.607	0.686		
OPS	0.733	0.595	0.640	0.648	

Table 3: Fornell-Larcker criterion

Constructs	ECO	EEM	GPI	OP	OPS
ECO	0.849				
EEM	0.596	0.737			
GPI	0.663	0.577	0.815		
OP	0.651	0.814	0.629	0.806	
OPS	0.667	0.529	0.579	0.591	0.855

2017). This is manifested by the fact that the two-digit bold AVE elements are indeed really higher than the off-diagonal construct correlations for each and every row and column. That is, for the AVE of environmental culture (ECO) is 0.849, but its highest correlation with a variable is 0.663 (government policies and incentives). Also, the same is CE (Caring for the Earth), the AVE is 0.737, which is above its highest correlation of 0.596 with ECO. It is so that there is more shared variance of constructs with their indicators than of other variables.

4.3. Common Method Bias

The following Table 4 illustrates the outcomes of an analysis on Harman's single factor test to check the magnitude of the common method bias (CMB) in the data survey. CMB (Common Method Variance) refers to the random error that is associated with the measurement method and not the construct, and thus it could inflate or deflate the relationships observed between variables (Tehseen et al., 2017). The Explained variable which was extracted by the analysis contained a single factor and then subjected to a unrotated solution. The factor has R-square (adj) 48.303% which is below the 50% cut score. The fact that CMB is not an issue here implies that data collected through the method will be reliable (Tehseen et al., 2017). Furthermore, the extracted variance is not overwhelmingly larger than the variance explained by subsequent factors.

4.4. Co-efficient of Determination, Predictive Relevance, and Effect Size

Table 5 presents the predictive accuracy and relevance measures for the endogenous constructs in the structural model as part of the PLS-SEM analysis. Firstly, the R-square values of organizational performance (OP) and energy efficiency measures (EEM) are 0.720 and 0.414 respectively. This indicates that 72% of variance

Table 4: Common method bias

Component	Initial eigenvalues			Extraction sums of squared loadings			Rotation sums of squared loadings		
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	14.491	48.303	48.303	14.491	48.303	48.303	8.171	27.238	27.238

Table 5: Co-efficient of determination, predictive relevance, and effect size

Constructs	R-square	Q-square	F-square
OP	0.720	0.459	0.470
EEM	0.414	0.221	0.790

in organizational performance is accounted for by the exogenous constructs of policies, incentives and culture as well as mediating efficiency measures. Likewise, 41.4% variance in efficiency adoption levels is explained by the drivers. As these exceed the 10% threshold, medium to substantial predictive accuracy is demonstrated (Hair et al., 2017). Additionally, Stone-Geisser's Q-square is larger than zero for both OP (0.459) and EEM (0.221) establishing predictive relevance regarding the hypothesized relationships (Ramayah et al., 2018). Lastly, f-square effect sizes range from small (0.02) through medium (0.15) to large (0.35) (Cohen, 1988). Here the drivers display large effect (>0.35) on efficiency measure assimilation but only medium impact on performance, aligned with theory.

4.5. Structural Results

Table 6 presents the results of the hypothesis testing conducted by assessing the structural model relationships in partial least squares structural equation modeling (PLS-SEM). Several key parameters are examined to determine whether the hypothesized links are statistically significant and thus supported by the data. Firstly, the standard beta coefficients indicate the strength of relationships between connected constructs while standard errors provide basis for calculating t-statistics to evaluate significance (Hair et al. 2017). Here all hypothesized paths demonstrate t-values <1.96 at $P < 0.05$ significance level, satisfying traditional criteria. For example, the effect of environmental culture on organizational performance has a beta of 0.116, standard error of 0.034 and t-value of 3.356. This provides clear evidence to support this specific hypothesized relationship within the research model. Additionally, the sign direction of path coefficients aligns with conceptual expectations. More positive organizational policies, stronger government incentives and environmental consciousness relate to higher efficiency adoption and performance. Furthermore, greater assimilation of energy efficiency measures associates strongly with performance gains, confirming its mediating mechanism.

Table 7 and Figure 2 presents the outputs from the mediation analysis examining the indirect effects of organizational policies, government incentives and environmental culture on organizational performance through the mediating mechanism of energy efficiency measures. The results demonstrate that all indirect paths are statistically significant at $P < 0.05$ level based on the t-statistics exceeding 1.96 (Hair et al., 2017) and relatively substantial based on beta coefficients. For instance, the mediated link between environmental culture and organizational performance has a beta of 0.162. This indicates that approximately 16.2% of the total effect of culture on performance metrics runs indirectly through efficiency adoption levels. Similar sizable indirect effects operate for organizational policies and external incentives in driving performance gains through efficiency investments first. The findings provide clear empirical confirmation that energy efficiency measures function as a key mechanism translating motivating organizational and policy drivers into various realized performance enhancement outcomes. This fulfills the conceptualized mediating theory underlying the study framework.

5. DISCUSSION

The empirical finding that pro-environmental organizational culture directly enhances performance outcomes including economic, operational and environmental metrics for Jordanian manufacturing firms aligns with past scholarly research. Fostering higher employee consciousness regarding resource conservation and climate responsibility through engagement initiatives, training programs and sustainability participative groups has been linked with superior corporate sustainability practices (Thanki et al., 2016). By prioritizing energy efficiency, waste minimization and responsible operating procedures culturally, manufacturers can drive cost savings, productivity gains, risk mitigation along with environmental impact reduction (Sardo and Serrasqueiro, 2021). Specifically, in the developing economy context, augmenting environmental awareness and orientation across managerial and non-managerial personnel facilitates learning and diffusion of cleaner technologies and methods resulting in multi-faceted organizational improvements. Thus, the Jordan evidence confirms the strategic value for industrial facilities in embedding energy and environmental considerations culturally to reap performance advantages core to business competitiveness and long-run viability. The finding that external regulatory policies and financial incentives aimed at propagating energy efficiency and sustainability practices enhance multiple dimensions of performance for Jordanian manufacturing firms is theoretically sound. By mandating industrial audits, setting conservation targets and providing tax rebates or grants for investing in upgrading of equipment and processes, governments can stimulate productivity enhancements, cost reductions, quality improvements and revenue growth at the firm-level (Liu et al., 2017). Specifically, in Jordan, the results highlight that policy structures facilitating assimilation of energy efficient technologies and responsible operating methods induce measurable operational and economic gains for producers. This lends support to the notion that governments in developing economies can leverage regulations and monetary stimuli to promote sustainable industrialization powered by innovation, technology assimilation and responsible competitiveness. Jordan conforming to resource-constrained settings corroborates the fact that it is economically viable for government agencies to entice the continuous decarbonization and efficiency improvements in the

Table 6: Path analysis results

Path analysis	Beta coefficients	Standard deviation	T statistics	P-values	Decision
ECO->OP	0.116	0.034	3.356	0.001	Supported
GPI->OP	0.115	0.035	3.247	0.001	Supported
OPS->OP	0.122	0.029	4.267	0.000	Supported
ECO->EEM	0.264	0.06	4.43	0.000	Supported
GPI->EEM	0.257	0.048	5.404	0.000	Supported
OPS->EEM	0.204	0.054	3.761	0.000	Supported
EEM->OP	0.614	0.027	22.953	0.000	Supported

Table 7: Indirect method of mediation

Path analysis	Beta coefficients	Standard deviation	T statistics	P-values	Decision
ECO->EEM->OP	0.162	0.036	4.562	0.000	Supported
GPI->EEM->OP	0.158	0.030	5.186	0.000	Supported
OPS->EEM->OP	0.125	0.034	3.689	0.000	Supported

manufacturing companies through the established well-designed instruments.

Empirical studies that optimize organizational strategies and priorities on sustainability, energy management and emissions apparently aid assimilation of eco-innovation routines and reflect the view that managers affect eco-innovation adoption. The creation of energy committees comprising representatives from different departments, setting comprehensive conservation guidelines, inclusion of clean energy procurement targets in corporate strategies, and instigation of employee accountability for environmental indicators through incentives (i.e. measures that cause efficiency improvements) are examples of such measures. Such policies signal leadership prioritization of efficiency, enabling mobilization of resources and competencies facilitating assimilation of technical and operational solutions for energy savings and waste minimization. Thereafter, financial payoffs from optimizing energy productivity allows reallocation of cost savings towards business expansion, revenue growth and competitiveness enhancement-explaining the performance linkage. The Jordan evidence reflects how manufacturers can leverage administrative measures to tap into efficiency-driven productivity and competitiveness improvements, while supporting the country's energy security and emissions reduction goals. The significant positive effect of external instruments including energy regulations, taxes, subsidies, and conservation incentives on adoption of efficiency systems aligns with technology diffusion theories in institutional contexts. As posited, policy structures transforming cost-benefit payoff for industrial facilities via taxes or grants incentivize efficiency equipment acquisition, retrofits and data-driven process innovations (Cooremans, 2011; Liu et al., 2017). For Jordanian manufacturers, such instruments can alleviate financial limitations, information barriers and hidden costs curtailing investments in upgrading old inefficient production machinery, optimizing heating/cooling systems and installing smart energy management architecture. Thereafter, enhanced energy productivity and associated savings drive multiple performances gains. The empirical evidence lends credence to the efficacy of well-designed regulations and monetary incentives in catalyzing efficiency improvements within targeted industrial sub-sectors in line with Jordan's policy imperatives.

The positive linkage between environment-focused organizational culture and deployment of energy efficiency systems is theoretically grounded from studies demonstrating cultural impacts on assimilation of complex administrative programs (Harris and Crane, 2002). Sustainability training and engagement initiatives propagate consciousness of clean technologies among employees while cross-departmental communities-of-practice facilitate diffusion of technical knowledge and best practices regarding energy optimization and waste management. Such cultures also foster retentively and experimentation supporting efficiency pilots. Over time, accrual of measures tackling heating requirements, motor systems, compressed air and lighting build complementary capabilities aiding comprehensive efficiency enhancements and savings realization. For policymakers and managers in Jordanian manufacturing, the takeaway underscores the value of cultural alignment and work environment design for unlocking energy efficiency potentials. The strongest positive effect of energy efficiency assimilation on realizes performance improvements concurs with the proposition that sustainability practices drive financial, operational and reputation gains constituting competitive advantage (Porter and Kramer, 2006). The productivity advancements, cost savings, risk reductions and brand positioning attained by Jordanian manufacturers mirror documented eco-efficiency benefits including expanded capacity, expenses control, stakeholder resonance and future-proofing against resource constraints (Worrell et al., 2003). This lends credence to the mediating role of efficiency measures, as propagating technical solutions and optimization methods enables harvesting of energy savings for growth reinvestment. Overall, as global pressures intensify for emerging economy producers in export sectors like textiles and pharmaceuticals to decarbonize and demonstrate responsible credentials, clinically implementing energy management solutions serves a strategic pathway achieving commercial goals and policymaker expectations concurrently.

The empirical evidence demonstrating the partial mediating effect of implemented energy efficiency systems between antecedents and organizational performance outcomes aligns with the conceptual premise grounded in resource-based and institutional perspectives. Fundamentally, assimilation of technical solutions, upgrading of machinery and operational optimization practices enables unlocking of savings potentials from enhanced energy productivity and leaner processes at Jordanian industrial facilities (Worrell et al., 2003). Thereafter, realizing such positive resource efficiency and financial outcomes from efficiency investments provides strategic flexibility for manufacturers to channel accrued benefits like expenses control, superior products quality and production capacities towards revenue growth, costs modulation and risk mitigation over time (Porter and Kramer, 2006). This is realized through value addition which is visibly expressed in operational, economic and reputation metrics with a positive spiral effect that begins with initial rules-based energy improvement actions that trigger subsequent enhancements. Such expenditure shortages reduce the fiscal strain bringing about a redistribution of budget to expand or finance development. Smarter project work reduces the instances of production process disturbance which gives a lower risk factor. Better waste management and emission control add more value to CSR with the result of enhanced credibility and improved public perception and market positioning. The adoption of efficiency measures essentially expedites the exploitation of energy savings into the realization of economic benefits that are in harmony with the concept of long-term industrial gains. The empirical outflows corroborate this mediated mechanism for Jordanian industrial firms of encouraging organizational policies, external incentives and cultural environments to induce the assimilation of technical solutions which lead to the optimization of production efficiency and eventually deliver organization benefits. In summary, the evidence sheds the light on the strategic potential of deliberately designing the environments friendly to the implementation of technical innovations as an important leverage for sustainability enhancement and for the formation of manufacturing competencies that give competitive advantage.

6. CONCLUSION AND POLICY IMPLICATIONS

This study makes an important contribution by examining how energy efficiency measures mediate the relationship between organizational policies, culture, government incentives and manufacturing firm performance in Jordan. The results provide strong empirical support for the conceptual model, demonstrating that investments in energy efficiency improvements are a critical mechanism through which manufacturing organizations can enhance performance outcomes. Key findings show that proactive organizational policies, a culture emphasizing environmental responsibility, and utilization of government incentives positively influence adoption of energy efficiency measures. In turn, greater adoption of measures like process optimization, energy-efficient equipment, and lighting upgrades enhances manufacturing performance across various dimensions. The study offers actionable insights for manufacturing managers, policymakers, and scholars. Firms should develop comprehensive energy efficiency strategies encompassing organizational systems, managerial commitment, and government programs. Policymakers should continue offering incentives while collaborating with industry on joint initiatives to promote energy savings. Academics can build on this research by addressing limitations through longitudinal and qualitative approaches.

Manufacturing companies in Jordan should establish institutions that create a conduit for higher energy efficiency, which in turn leads to performance improvement. Options might include energy audits, refurbishment of facilities, putting in appropriate equipment, and provision of education. Fostering an environmental culture with energy conservation values is critical. This involves leadership commitment, aligning organizational vision/mission, and embedding sustainability into operations. Firms should leverage government policies and incentives for energy efficiency investments. This includes utilizing subsidies, tax benefits, and financing options. Energy efficiency measures strongly mediate the link between organizational policies, culture, government incentives and firm performance. Investing in these measures is vital. The study provides an implementable framework for manufacturing firms in Jordan to boost performance through energy efficiency. Firms can benchmark against findings. Energy efficiency measures identified, like process optimization and lighting improvements, can be adopted by managers to reduce costs and energy waste. Study suggests collaboration between industry and government is needed to promote energy efficiency. Joint policies and programs should be developed. Provides empirical evidence supporting the Resource-Based View that energy efficiency is a valuable capability conferring competitive advantage. Extends research on the Natural Resource-Based View by showing how energy efficiency enhances manufacturing firm performance. Demonstrates how organizational policies, culture, and government incentives influence adoption of energy efficiency measures. Energy savings from efficiency improvements will benefit Jordan society through reduced power generation needs and GHG emissions. Study highlights how industry can contribute to national energy security and conservation goals in Jordan. Adoption of energy efficient manufacturing has positive environmental externalities like lower pollution, land use, and resource depletion.

The study relied on a cross-sectional research design, limiting ability to determine causality. Longitudinal studies could better establish causal links. Self-reported data from a single respondent per firm may suffer from biases like social desirability bias. Multiple informants could improve reliability. Generalizability is limited as the sample is restricted to large manufacturing firms in Jordan. Studies should include SMEs and other sectors. Survey items measured perceptions of energy efficiency adoption. More objective measures like energy audits could be used. Mediation analysis was correlational. Experimental studies manipulating key variables are needed to further test mediation. Apply the model to manufacturing sectors in other emerging economies to improve generalizability and refine the theory. Examine potential moderating effects of firm size, industry sub-sector, ownership structure, and energy intensity. Investigate additional mediators like green innovation, environmental management systems, and sustainability-focused HR practices. Conduct qualitative studies like case studies and interviews to provide richer insights into energy efficiency decision-making. Take a longitudinal approach tracking firms over time to determine impact of energy efficiency measures. Examine interactions between energy efficiency investments and other manufacturing performance determinants like operations management practices. Explore impacts of energy efficiency adoption across multiple performance dimensions like quality, flexibility, delivery speed, and new product development. Incorporate objective measures of energy consumption and financial performance to triangulate with perceptual measures.

REFERENCES

Abreu, M., Cesconeto, W., Garza-Reyes, J. A., Kumar, V., Rocha-Lona, L., Luis, E. (2022), Leveraging operations management and industry 4.0 fuelled with circular economy to achieve superior sustainability for organisations. Annals of Operations Research. https://doi.org/10.1007/s10479-022-04565-7

Abreu, M.C.S., Ceglia, D., Silva, M.M., Silva Filho, J.C.L.D. (2017), Installation of an energy management committee in a public hospital using a socio-technical approach. Energy Policy, 101, 261-269.

Aguinis, H., Glavas, A. (2019), On corporate social responsibility, sensemaking, and the search for meaningfulness through work. Journal of Management, 45(3), 1057-1086.

Ahmad, A., El-Dalahmeh, S., Al-Shakri, K., Alkhawaldeh, B., Alsmadi, L. (2024), The link between management accounting information systems and firm competitiveness: The mediating role of innovation capabilities. Uncertain Supply Chain Management, 12(3), 1781-1790.

Al-Ghandoor, A., Al-Hinti, I., Jaber, J.O., Sawalha, S.A. (2008), Electricity consumption and associated GHG emissions of the Jordanian industrial sector: Empirical analysis and future projection. Energy Policy, 36(1), 258-267.

Al-Ghandoor, A., Pillai, J.R., Al-Abdallat, Y. (2012), Promotion of energy management and pollution prevention case studies in selected small and medium-sized industries in Jordan. Journal of Cleaner Production, 32, 111-119.

Alkhawaldeh, B. Y., Al-Smadi, A. W., Ahmad, A. Y. B., El-Dalahmeh, S. M., Alsuwais, N., & Almarshad, M. N. (2024). Macroeconomic Determinants of Renewable Energy Production in Jordan. International Journal of Energy Economics and Policy, 14(3), 473-481.

Alkhawaldeh, B.Y., Mahmood, S. (2021), The effect of government support for fuel and wheat on economic growth in Jordan: An application of dynamic autoregressive-distributed lag. International Journal of Academic Research in Economics and Management Sciences, 10(1), 108-122.

Alkhawaldeh, B.Y.S., Al-Zeaud, H.A., Almarshad, M.N. (2022), Energy consumption as a measure of energy efficiency and emissions in the MENA Countries: Evidence from GMM-based quantile regression approach. International Journal of Energy Economics and Policy, 12(5), 352-360.

Alnaser, N.W., Alnaser, W.E. (2011), The status of renewable energy in the GCC countries. Renewable and Sustainable Energy Reviews, 15(6), 3074-3098.

Alwaely, S., Abusalma, A., Alwreikat, A., Al-Shakri, K., Ahmad, A., Alkhawaldeh, B. (2024), Examining the relationship between business intelligence adoption and marketing effectiveness: The mediating role of customer satisfaction. International Journal of Data and Network Science, 8(3), 1541-1556.

Cohen, J. (1988), Statistical Power Analysis for the Behavioral Sciences. 2nd ed. New Jersey: L. Erlbaum Associates.

Cooremans, C. (2011), Make it strategic! Financial investment logic is not enough. Energy Efficiency, 4(4), 473-492.

Fernández, E., Rubiera, F.J., Steel, M.F. (2022), Exploring the energy efficiency loop in European manufacturing. Energy Economics, 107, 105993.

Flammer, C., Luo, J., Villalonga, B. (2021), Corporate investments in ESG practices: Shareholder wealth effects and consequences for firm value. Organization Science, 32(6), 1600-1619.

Franke, G., Sarstedt, M. (2019), Heuristics versus statistics in discriminant validity testing: A comparison of four procedures. Internet Research, 29(3), 430-447.

Fraihat, B. A. M., Zowid, F., Ayasrah, F. T. M., Rababah, A., Ahmad, A. Y., & Othman, O. H. O. (2024). The impact of cloud computing on supply chain performance the mediating role of knowledge sharing in utilities and energy sectors.

Fraihat, B. A. M., Yaseen, H., Samarah, M. R., Alkhawaldeh, B. Y., & Buraik, O. (2023). Trade Openness, Energy Consumption, and Financial Development Influence on Jordan's Economy: Evidence from ARDL and Non-Granger Causality Test Approach. International Journal of Energy Economics and Policy, 13(6), 659-665.

Hair, J.F. Jr., Hult, G.T.M., Ringle, C., Sarstedt, M. (2017), A Primer on Partial Least Squares Structural Equation Modeling (PLS-SEM). United States: Sage Publications.

Harris, L.C., Crane, A. (2002), The greening of organizational culture: Management views on the depth, degree and diffusion of change. Journal of Organizational Change Management, 15(3), 214-234.

Henseler, J., Ringle, C.M., Sarstedt, M. (2015), A new criterion for assessing discriminant validity in variance-based structural equation modeling. Journal of the Academy of Marketing Science, 43(1), 115-135.

Hijazi, H., Al-Wahshat, H., Taha, A., Wahsheh, F., Alkaraky, S., Alkhawaldeh, B., Ahmad, A. (2024), Exploring the link between human resource management practices and financial performance: The moderating effect of organizational culture. Uncertain Supply Chain Management, 12(3), 1885-1902.

International Energy Agency. (2021), Global Energy Review 2021. Paris: IEA. Available from: https://www.iea.org/reports/global-energy-review-2021

Jaber, J.O., Jaber, Q.M., Sawalha, S.A., Mohsen, M.S. (2008), Evaluation of conventional and renewable energy sources for space heating in the household sector. Renewable and Sustainable Energy Reviews, 12(1), 278-289.

Kumar, A., Chandrakar, H.K. (2021), Does energy price effect energy efficiency? Empirical evidence from Indian manufacturing industries. Energy Reports, 8, 5482-5492.

Liang, X., Jin, Y., Wang, B., Cai, S., Chen, G. (2020), Mandatory corporate environmental disclosure, environmental performance and economic performance: Evidence from China. Journal of Cleaner Production, 273, 122990.

Lin, B., Tan, R., Geng, Y. (2013), Market demand, green product innovation, and firm performance: Evidence from Vietnam motorcycle industry. Journal of Cleaner Production, 40, 101-107.

Lin, S.C., Ho, Y.H. (2016), Factors affecting organizational knowledge transfer: Using social exchange theory as a framework. The Journal of Information and Knowledge Management Systems, 46(1), 91-108.

Liu, Y., Wang, C., Mol, A.P. (2017), Stakeholders incentives for implementing energy efficiency measures: An empirical analysis of Tianjin's energy saving programme. Journal of Cleaner Production, 145, 170-179.

Lober, D.J. (1998), Pollution prevention as corporate entrepreneurship. Journal of Organizational Change Management, 11(1), 26-37.

Lu, L., Cheng, M., Zhang, X., Wang, Z. (2021), Why and how facilities appoint energy managers? Evidence from Chinese pilots. Applied Energy, 302, 117485.

Matalka, M., Ayasrah, F., Jarrah, H., Jawarneh, M., Alkhawaldeh, B., Darawsheh, S., Fadlallah, H. (2024), The importance of effective learning technology utilization, teacher leadership, student engagement, and curriculum in the online learning environment. International Journal of Data and Network Science, 8(3), 1727-1740.

Mittal, S., Dai, H., Fujimori, S., Masui, T. (2018), Bridging greenhouse gas emissions and renewable energy deployment target: Comparative assessment of China and India. Applied Energy, 226, 1062-1074.

Muduli, K., Govindan, K., Barve, A., Geng, Y. (2013), Barriers to green supply chain management in Indian mining industries: A graph theoretic approach. Journal of Cleaner Production, 47, 335-344.

Nath, P., Nachiappan, S., Ramanathan, R. (2019), The impact of marketing capability, operations capability and diversification strategy on performance: A resource-based view. Production Planning and Control, 21(2), 1-13.

Porter, M.E., Kramer, M.R. (2006), The link between competitive advantage and corporate social responsibility. Harvard Business Review, 84(12), 78-92.

Ramayah, T., Cheah, J.H., Chuah, F., Ting, H. (2018), Partial Least Squares Structural Equation Modeling (PLS-SEM) using SmartPLS 3.0. London: Pearson.

Rosati, F., Faria, L.G.D. (2019), Business contribution to the Sustainable Development Agenda: Organizational factors related to early adoption of SDG reporting. Corporate Social Responsibility and Environmental Management, 26(3), 588-597.

Sardo, F., Serrasqueiro, Z. (2018), Are more environmentally and socially responsible companies more profitable? Aquantile regression approach. Business Strategy and the Environment, 30(8), 3780-3795.

Sarkis, J., Gonzalez-Torre, P., Adenso-Diaz, B. (2010), Stakeholder pressure and the adoption of environmental practices: The mediating effect of training. Journal of Operations Management, 28(2), 163-176.

Ta'any, R., Tahboub, K., Sakhrieh, A. (2009), A technical review of energy saving opportunities in Jordanian industrial sector. Energy Conversion and Management, 50(3), 630-635.

Tan, X., Liu, F., Cao, H., Zhang, Y. (2022), Factors affecting enterprises' energy efficiency- empirical analysis across global regions. Energy Policy, 164, 112770.

Tehseen, S., Ramayah, T., Sajilan, S. (2017), Testing and controlling for common method variance: A review of available methods. Journal of Management Sciences, 4(2), 142-168.

Thanki, S., Govindan, K., Thakkar, J. (2016), An investigation on lean-green implementation practices in Indian SMEs using analytical hierarchy process (AHP) approach. Journal of Cleaner Production, 135, 284-298.

World Bank. (2022), The World Bank in Jordan. Available from: https://www.worldbank.org/en/country/jordan/overview#1

Worrell, E., Bernstein, L., Roy, J., Price, L., Harnisch, J. (2003), Industrial energy efficiency and climate change mitigation. Energy Efficiency and Climate Change Mitigation, 1(2), 109-123.

Zhu, Q., Feng, Y., Choi, S.B. (2017), The role of customer relational governance in environmental and economic performance improvement through green supply chain management. Journal of Cleaner Production, 155, 46-53.