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Impact of Transformational leadership Dimensions on environmental Performance of Small and medium Enterprises in Yemen .

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Keywords

1. small and medium enterprises
2. transformational leadership
3. environmental performance

Abstract:

Sustainability has evolved from being an optional consideration to a mandatory requisite, particularly in light of the excessive exploitation of natural resources by developed nations in pursuit of profitability. This overconsumption has necessitated a shift towards sustainable practices, often prioritized through lean manufacturing, which is closely tied to profitability. However, this shift presents significant challenges for small and medium enterprises (SMEs), especially in developing countries, where the adoption of essential capabilities such as effective leadership is critical to addressing these issues. This study explores the relationship between transformational leadership and the environmental performance (EP) of manufacturing SMEs in Yemen, adopting a multidimensional approach. Data were gathered from 199 managers and owners of SMEs through a structured survey questionnaire, and the analysis was conducted using structural equation modeling. The findings, derived using PLS 4.0, reveal a positive and significant influence of individual consideration on EP, while other dimensions of transformational leadership—charisma, inspirational motivation, and intellectual stimulation—do not exhibit a significant effect on EP. These results provide actionable recommendations for stakeholders aiming to enhance the environmental performance of SMEs through targeted leadership strategies

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اثر أبعاد القيادة التحويلية على الأداء البيئي للمنشآت الصناعية الصغيرة والمتوسطة في الجمهورية اليمنية

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الكلمات المفتاحية

1. المؤسسات الصغيرة والمتوسطة
2. القيادة التحويلية
3. الأداء البيئي

الملخص:

لقد تحولت الاستدامة من كونها اعتباراً اختيارياً إلى حتمية إلزامية، خاصة في ظل الاستغلال المفرط للموارد الطبيعية من قبل الدول المتقدمة سعياً لتحقيق الربحية. وقد استلزم هذا الاستهلاك المفرط التحول نحو الممارسات المستدامة، والتي غالبًا ما يتم تحديد أولوياتها من خلال التصنيع الخالي من الهدر للموارد الطبيعية، حيث يرتبط حاليا ارتباطًا وثيقًا بالربحية مع ارتفاع نسبه الوعي بأهمية الاستدامة. ومع ذلك، فإن هذا التحول يمثل تحديات كبيرة للمؤسسات الصغيرة والمتوسطة، وخاصة في البلدان النامية، إذ يعد اعتماد القدرات الأساسية مثل القيادة الفعالة أمرًا بالغ الأهمية لمعالجة هذه القضايا.

تسعى هذه الدراسة إلى محاولة اكتشاف العلاقة بين القيادة التحويلية والأداء البيئي للمؤسسات الصغيرة والمتوسطة الصناعية في اليمن، وذلك باعتماد نهج متعدد الأبعاد. حيث تم جمع البيانات من عدد 199 منشاءه صغيرة ومتوسطة من خلال استبيان مسح منظم، وتم إجراء التحليل باستخدام نمذجة المعادلة الهيكلية. تكشف لنتائج التحليل المنبثقة باستخدام PLS 4.0، عن تأثير إيجابي ذو دلاله إحصائية للاعتبارات الفردية على الأداء البيئي ، في حين أن الأبعاد الأخرى للقيادة التحويلية – الكاريزما، والتحفيز الإلهامي، وكذلك التحفيز الفكري – لا تظهر تأثيرًا ذو دلالة إحصائية على الأداء البيئي. توفر هذه النتائج توصيات قابلة للتنفيذ لأصحاب المصلحة الذين يهدفون إلى تعزيز الأداء البيئي للشركات الصغيرة والمتوسطة من خلال تبني استراتيجيات القيادة المناسبة

1. Introduction

Small and medium-sized enterprises (SMEs) play a significant role in the economic growth of both developing and developed countries, contributing to sustainable development goals by generating job prospects, fostering sustainable industrial development, and reducing income inequalities in developing countries [1]. SMEs are becoming one of the main instruments driving a country's economic, political, financial, and social growth and are a primary component in reducing poverty in developing countries[2]. SMEs account for approximately 90% of global businesses and employment. They contribute nearly 40% of national income in developing economies. According to World Bank estimates, around 600 million jobs will be required by 2030 to address the growing global workforce, prompting many governments to prioritize SME development [3].

SMEs in Yemen lack financial, logistic, and strategic capabilities, as well as a qualified workforce. Therefore, stakeholders must prioritize SMEs as they are considered the foundation of the national economy [1]. Regarding sustainable performance, SMEs demonstrate poor contributions to this area [4]. Despite the tendency of SMEs in developing countries to focus on financial performance, the increasing global demand for lean manufacturing presents significant challenges. SMEs must develop strategies and prepare adequately with various internal capacities, such as enhancing leadership capabilities, improving employee knowledge of lean practices, and increasing environmental performance. Sustainable business performance has become a global requirement due to recent economic crises, and green measures are seen as a leading solution [5].

Transformational leadership (TL) has been extensively studied for its impact on various organizational outcomes. TL is positively associated with profitability and growth in SMEs [6]. However, financial outcomes often receive more attention than environmental or social outcomes. Few studies explore how TL drives sustainability in SMEs. While TL's focus on ethical practices and long-term vision aligns with sustainability goals, its impact on environmental outcomes remains underexplored [7]. For example, Begum et al. (2020) [2] highlight that TL fosters sustainable innovation and organizational learning, critical for SMEs balancing financial performance with social and environmental goals. Nonetheless, this study focuses more on innovation than on direct environmental outcomes. Prior research also emphasizes the importance of environmental management and sustainable development [8]. Increasingly, organizations adopt Green Human Resource Management (GHRM) practices to promote a green society through implementing green workplaces and achieving environmental goals.

Several studies, including Burawat (2019), Zhao and Huang (2022), Lin (2022), and Chen and Chang (2023),[10][5][11][12] have explored TL's effects on lean manufacturing and its direct association with sustainable business performance. However, findings indicate differing results based on structural models, such as variations between automotive and non-automotive companies and organizations that have implemented lean programs for fewer than five years compared to those with longer durations[10]. This underscores the need for further research to test TL's impact on environmental performance. Gaps in the literature highlight the need to investigate TL's role in SMEs' sustainability in under-represented regions, particularly the Middle East, Africa, and South Asia. For instance, existing studies largely focus on regions like Vietnam (Pham et al., 2023[13]) and China, where sustainability awareness is relatively advanced. Comparative research examining cultural and regional influences on the relationship between TL and environmental outcomes is crucial.

Additionally, the study by Xiaomei Sun, et al (2022)[14], indicated that Environmental issues represent one of the most pressing challenges faced globally, with significant implications for both developed and developing nations and these challenges not only affect ecosystems but also hinder sustainable economic and social development, particularly in less-developed regions. In this context, examining the relationship between transformational leadership and environmental

performance has emerged as a nascent yet promising area of research, as this area remains underexplored and requires extensive scholarly attention to develop robust theoretical frameworks and actionable insights.

1.1 Problem Statement

Existing literature predominantly explores the impact of transformational leadership (TL) on SMEs' financial and economic performance, often utilizing a one-dimensional construct of TL. This narrow focus has resulted in a research gap, particularly concerning the multidimensional impacts of TL on SMEs' environmental performance. To the best knowledge of the authors, no studies have investigated the relationship between TL dimensions and environmental performance in Yemen, where SMEs are pivotal to economic growth but face significant resource constraints. While financial performance is well-documented, limited research examines the simultaneous influence of TL on environmental and social outcomes, especially within resource-constrained SMEs. Moreover, interdisciplinary approaches integrating TL with environmental sciences or green technology adoption remain underexplored, emphasizing the need for studies that address dimensions such as intellectual stimulation and individualized consideration [15].

Most studies conceptualize TL as a holistic construct, overlooking the distinct contributions of its dimensions, such as intellectual stimulation or inspirational motivation, to sustainable performance aspects like environmental innovation or social responsibility. Furthermore, research on TL primarily focuses on developed economies, neglecting SMEs in developing nations like Yemen, where regulatory, cultural, and institutional contexts significantly differ. For instance, studies in Pakistan and sub-Saharan Africa highlight unique challenges SMEs face in aligning leadership practices with sustainability goals[16]. Globally, the push for sustainable performance in international trade is intensifying, driven by climate change and resource scarcity. Manufacturers are under pressure to adopt lean and green manufacturing strategies to enhance sustainability while ensuring profitability and market competitiveness [17][18]. Yemeni SMEs, however, lag behind in these areas due to significant economic, social, and institutional challenges. war-induced displacement, a low labor force participation rate (36.3%), and disrupted social services have further exacerbated the lack of managerial skills and strategic capabilities in SMEs [19][3].

To address these challenges and theoretical gaps, this study investigates the multidimensional impact of TL on the environmental performance of Yemeni manufacturing SMEs. Specifically, it seeks to determine how TL dimensions—charisma, inspirational motivation, intellectual stimulation, and individualized consideration— affect SMEs' environmental performance. The study aims to answer the following questions:

Does charisma impact the environmental performance of small and medium enterprises in Yemen?

Does inspirational motivation impact the environmental performance of small and medium enterprises in Yemen?

What is the impact of individualized consideration on the environmental performance of small and medium enterprises in Yemen?

Does intellectual stimulation impact the environmental performance of small and medium enterprises in Yemen?

1.2 Objectives of the Study

The primary objective of this study is to examine the effects of transformational leadership dimensions—namely charisma, inspirational motivation, intellectual stimulation, and individualized consideration— on the environmental performance of small and medium enterprises (SMEs) in Yemen. This research seeks to address the gaps highlighted by the study. Xiaomei Sun, et al (2022) 14] in their study emphasize the need for more exploration of TL impact on environmental Performance, as it is a new field of research to be explored Systematically.

2. Theoretical Concepts and Literature Review

2.1 Definitions of Terms

2.1.1 SMEs in Yemen:

Small and medium enterprises (SMEs) are defined differently across various international contexts. For the purpose of this study, the definition established by SMEDA (2016) [20] is adopted, which relies on two main criteria: the number of employees and the level of assets, as detailed in Table (12). In Yemen, SMEs are classified based on Ministerial Decree No. 631 of 2009, which categorizes establishments into large size, medium, small, and smaller enterprises. This classification is determined using two criteria: the number of workers and the amount of capital. Specifically, small enterprises are defined as those employing up to nine workers and having a capital between $5,000 and $100,000. Medium-sized enterprises, on the other hand, are characterized by a workforce of up to fifty employees and capital ranging from more than $100,000 to less than $500,000.
This standardized framework facilitates the identification and categorization of SMEs within Yemen's economic landscape, enabling targeted research and policy development tailored to their unique characteristics and challenges.

Table number (1): Division of Enterprises in Yemen According to Size

Statement	Smaller establishments	Small establishments	Medium establishments	Large Establishments
Capital ($)*	5000 >	5000 – 100,000	100,000-500,000 >	500,000 <
Number of workers	1-3	4-9	10-50	50<

Source: Ministry of Industry and Trade (2015), Manual of small, medium-sized, and micro-projects: German Agency for International Cooperation (GIZ), June, Yemen, Sana'a.
Note: *In 2009, 1$ was worth YR 200.

2.1.2 Transformational Leadership

Transformational leadership theory has become a significant focus in management research [21]. Initially conceptualized by Burns (1978)[22] and later expanded by Bass (1985)[23], this theory emphasizes the role of leaders in transforming followers' perspectives, motivating them to embrace organizational goals as their own. Such leadership inspires employees to transcend personal interests and work towards collective objectives (Bass, 2006)[24]. The theory is structured around four core dimensions: (1) idealized influence (charisma), (2) inspirational motivation, (3) intellectual stimulation, and (4) individualized consideration.

2.1.2.1 Charisma: Charismatic leaders are defined as those capable of altering followers' world views to inspire genuine change [25].
Accordingly, Charisma could be defined as one of the SMEs leader's abilities to world view of the followers and leading a real change of the firm towards the sustainability of success.

2.1.2.2 Inspirational Motivation: Bass (1985)[23] identified inspirational motivation as the ability of leaders to articulate high expectations, utilize symbols to unify efforts, and convey significant goals in accessible ways.
Bass (1985, 1990) also defined inspirational motivation as something that reflects leaders' interest in communicating high expectations, using symbols to focus efforts and expressing important purposes in simple ways.

Accordingly, It is the outcomes of one of the leader's capacities, that reflects the voice the thoughts of the SMEs leaders in an easy ways to strongly direct the followers.

2.1.2.3 Intellectual Stimulation: Intellectual stimulation involves fostering intelligence, rational thinking, and creative problem-solving among followers (Bass, 1985)[23].

Accordingly, It could be defined as the outcomes of one of the SMEs leader's capacities that; is effectively uncover the followers' intellectual self abilities to overcomes work obstacles.

2.1.2.4 Individualized Consideration: This dimension reflects leaders' commitment to coaching, personalized guidance, and treating employees as unique individuals [23].

Accordingly, It could be defined as SMEs' leaders' interest in coaching and advising, personal attention and treating each employee individually to make him feel how important he is to the firm with concerning simultaneously about their needs.

2.1.2.5 Environmental Performance is the outcome of a firm's strategic activities that manage (or not) its impact on the natural environment (Walls et al., 2011)[26].

Akanmu et al., (2020)[46] defined environmental sustainable performance as the concerned about the reduction of harmful materials, hazardous consumption, usage of resources, and efficient energy.

Accordingly, Environmental sustainable performance could be defined as the SMEs concerned about the reduction of harmful materials, hazardous consumption, usage of resources, and efficient energy, with ensuring the best natural resource consuming practices to attain sustainability.

3. Research Framework and Hypotheses Development

3.1 Theoretical Foundation

The integration of Resource-Based Theory (RBT) with Transformational Leadership practices provides valuable insights into improving the environmental performance of SMEs, as demonstrated in prior research [27][28]. RBT underscores the strategic utilization of organizational resources to gain competitive advantages, including environmental sustainability. Transformational leadership complements the RBT by mobilizing human capital and fostering innovation towards sustainable outcomes [29]. For example, green transformational leadership mediates the relationship between corporate social responsibility (CSR) practices and environmental performance, aligning resource utilization with sustainability goals [30].

In conclusion, the synergy between RBT and transformational leadership enhances green innovation and resource optimization, offering a robust framework for addressing environmental challenges in SMEs.

3.2 Hypotheses Development

Existing literature underscores the significant role of transformational leadership in enhancing environmental performance. For instance, Pham et al. (2023) [13] demonstrated that green transformational leadership (GTL) positively influences environmental performance in Vietnamese SMEs through its mediating effects on green human resource management (GHRM) and green innovation (GI). Similarly, Chen and Chang (2023)[12] highlighted the importance of green mindfulness and employee engagement, revealing that GTL fosters a sustainability-focused organizational culture, thereby improving environmental outcomes. Robertson and Barling (2017)[31] further established that environmentally specific transformational leadership and general transformational leadership are distinct but interrelated constructs, both contributing positively to environmental performance.

Moreover, Hanif et al. (2023)[28] found that GTL significantly impacts corporate environmental performance both directly and indirectly via green process innovation. Survey-based research in China corroborates these findings, demonstrating that transformational leadership inspires environmental behavior at both individual and organizational levels [32]. Additionally, Riva et al. (2021)[33] identified green knowledge and GTL as critical drivers of green creativity, which in turn enhances environmental performance. Peng et al. (2021)[34] observed that team pro-environmental behaviors are positively influenced by environmentally specific transformational leadership through mediators like pro-environmental goal clarity and harmonious passion.

Furthermore, research by Farrukh et al. (2022)[35] suggested that developing green transformational leadership traits in supervisors promotes green employee behaviors. Similarly, Chen et al. (2014)[36] demonstrated that GTL

positively impacts green performance, both directly and indirectly, through green mindfulness and self-efficacy. Finally, Niazi et al. (2023)[29] emphasized that GTL moderates the relationship between GHRM and green corporate social responsibility, reinforcing its role as a strategic enabler of environmental performance.

Based on these insights, the following hypotheses are proposed:
H1: Charisma has a positive influence on environmental performance.
H2: Inspirational motivation has a positive influence on environmental performance.
H3: Individualized consideration has a positive influence on environmental performance.
H4: Intellectual stimulation behavior has a positive influence on environmental performance.

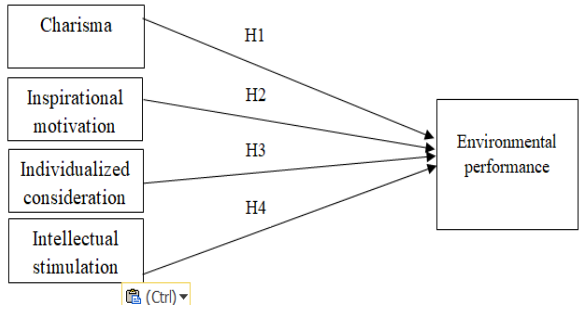

Figure 1. Research model

4. Methodology

4.1 population and sampling

This study aims to examine how the dimensions of transformational leadership—Charisma, Inspirational motivation, Intellectual stimulation, and Individualized consideration—affect the environmental performance of manufacturing SMEs. A quantitative research approach was applied, with random sampling across the target population of manufacturing SMEs in Yemen.
Based on Roscoe's (1975)[47] guideline, which suggests that an appropriate sample size for robust research ranges between 30 and 500, the data for this study were collected using a stratified random sampling technique. The sample was drawn from the database of the General Unit of SMEs within the Ministry of Commerce and Industry. The study focused on manufacturing SMEs operating in the cities of Thamar, Sana'a, Taiz, Alhodadah, Amran, Lahj and Al-Bayda. The inclusion criteria encompassed nutritional manufacturing SMEs, such as those involved in the production of bottled water, tomato products, and juices. Additionally, industrial manufacturing SMEs engaged in fields such as the forming and fabrication of iron, wood, aluminum, tiles, and concrete blocks were included. The sample also incorporated SMEs specializing in the formulation and crafting of precious metals, including gold and silver.

Table number (2) Profile of the responding manufacturing SMEs.

Items	Category	N	%
Position	Owner and Manger 105		52.76
	Manger	94	47.23
location	alamaneh	79	39.69
	Sana'a	6	3.015
	Taize	28	14.070
	Ebb	28	14.070
	Thamar	12	6.030
	Alhodaida	27	13.56
	Lahje	3	1,50
	Shabwah	6	3.015
	Albaida	8	4.020
	Less than 5 years	58	

Length of work experience in retail industry			29.14
	From 5 years to 10	72	36.18
	From 10 to less than 15	55	27.63
	More than 15 years	14	7.035
Qualification	High school and less	112	46.23
	University Degree	83	51.75
	Master degree	4	2.010
Field of Manufacturing	Food and Feed manufacturing	37	18.59
	Metal forming and manufacturing	24	12.06
	Wood forming and manufacturing	10	5.025
	Aluminum forming and manufacturing	38	19.95
	Tiles, and concrete blocks	27	13.56
	Clothes designing and manufacturing	13	6.53
	Ballistic and detergent manufacturing	22	11.05
	precious metals Formulation and crafting (gold and silver).	28	14.07

Table number (2) Results of Skewness and Kurtosis for Normality Test.

4.2 Data Collection

The primary data collection tool was a questionnaire distributed through various means, including electronic platforms (e.g., WhatsApp) and in-person delivery. The sampling approach employed was convenience sampling, targeting SME owners and managers involved in transformational leadership (TL) practices and environmental performance. Questionnaires were completed by SME owners and managers, distributed physically and digitally. PLS-SEM was employed for data analysis using 5,000 bootstrapped subsamples[39]. Data were gathered on a six-point Likert scale, from 1 (strongly disagree) to 6 (strongly agree), avoiding a neutral midpoint to minimize respondent bias. Out of the 400 distributed questionnaires, 199 valid responses were retained after eliminating incomplete entries. The questionnaire items were derived from established scales in prior research.

4.3 Measurement

Transformational leadership was measured using the Multifactor Leadership Questionnaire (MLQ) (Bass & Avolio, 1994)[37], and environmental performance was assessed using scales adopted from Abdul-Rashid et al. (2016)[38]. To ensure clarity and relevance, a pilot study with 20 participants was conducted, followed by reliability analysis to confirm the internal consistency of the scales.

4.4 Data Analysis

The study employed Partial Least Squares Structural Equation Modeling (PLS-SEM) using Smart PLS 4 to test the proposed hypotheses. Smart PLS 4 is widely used for its user-friendly interface and compatibility with modern assessment techniques (Riva et al., 2021; Zhao & Huang, 2022)[33][5]. PLS-SEM is advantageous due to its minimal requirements for sample size and data normality compared to AMOS [40].

4.4.1 Assumption of Normality

The assumption of normality is crucial in statistical analyses, as it ensures that the data follows a symmetrical distribution characterized

by a bell-shaped curve, where the highest frequency of scores occurs at the center, with progressively smaller frequencies toward the extremes (Pallant, 2005)[48].

Skewness measures the symmetry of a distribution. If the distribution extends disproportionately toward either the right or left tail, it is considered skewed. Negative skewness reflects the presence of more substantial values, whereas positive skewness indicates a predominance of smaller values. Skewness values between -1 and +1 are considered excellent, while values within the range of -2 to +2 are generally acceptable. Values outside this range suggest significant deviations from normality (Hair et al., 2022, p. 66)[49]. In this study, the skewness value lies between -1 and +1, indicating an excellent level of normality.

Kurtosis assesses the shape of the distribution in terms of its peakedness or flatness relative to a normal distribution. Positive kurtosis signifies a distribution that is more peaked, whereas negative kurtosis indicates a flatter distribution. According to Hair et al. (2010) and Byrne (2010)[50][51], data is considered normal if skewness values are within the range of -2 to +2 and kurtosis values fall between -7 and +7. Based on these criteria, the data in this study is deemed to follow a normal distribution. For further details, see Table 3

Variables	Excess kurtosis	Skewness	p value
Charisma	1.535	-0.989	0.000
Inspirational	4.360	-1.982	0.000
Individualized	3.217	1.376	0.000
Intellectual	1.975	-1.131	0.000
EP	-0.120	-0.668	0.000

4. Result

Following a two-step process, the study evaluated the outer (measurement) model for validity and reliability and then test the hypotheses by using regression technique in pls 4.

5.1 Measurement Model Assessment

The measurement model was assessed for convergent validity using factor loadings, composite reliability (CR), average variance extracted (AVE) and Cronbach's Alpha. All factor loadings exceeded the threshold of 0.50, except for two items—ENV3 and Inspirational4—which were removed to improve AVE values. Composite reliability for all constructs exceeded the minimum threshold of 0.60, and AVE values surpassed 0.50, ensuring the robustness of the measurement model (Hair et al., 2016)[42]

While one item, Charisma3, had a factor loading close to 0.50, it was retained based on Hair's (2022)[41] recommendation, as overall AVE values remained acceptable. Cronbach's alpha is widely regarded as a measure of internal consistency, with values between 0.60 and 0.70 generally considered to indicate an acceptable level of reliability, particularly in exploratory research (Diamantopoulos, Sarstedt, Fuchs, Wilczynski, & Kaiser, 2012). Values between 0.70 and 0.90 are typically interpreted as ranging from satisfactory to good, whereas values exceeding 0.90—especially those above 0.95—may suggest redundancy among items rather than an optimal level of reliability. Previous studies have acknowledged that Cronbach's alpha values below 0.70 and above this threshold can still be deemed acceptable, depending on the context and purpose of the study (Hair et al., 2006; Aron & Aron, 1999; Griethuijsen et al., 2014). As shown in Table 4, the Cronbach's alpha values in this study ranged from 0.619 to 0.850, while composite reliability statistics ranged from 0.755 to 0.896. Both measures exceed the commonly accepted reliability thresholds, indicating the internal consistency and reliability of the instrument used (Hair et al., 2021).

Table 4 Measurement Model Analysis.

Construct	Items	Outer loadings	CR (rho_c)	AVE	Cronbach's Alpha
Charisma	Charisma1	0.983	0.755	0.531	0.685
	Charisma2	0.657			
	Charisma3	0.443			
Inspirational	Inspirational1	0.877	0.896	0.685	0.850
	Inspirational2	0.811			
	Inspirational3	0.889			
	Inspirational4	0.724			
Individualized	Individualized1	0.563	0.824	0.618	0.719
	Individualized2	0.907			
	Individualized3	0.846			
Intellectual	Intellectual1	0.700	0.793	0.563	0.619
	Intellectual2	0.837			
	Intellectual3	0.706			
Environmental performance	EP1	0.549	0.823	0.617	0.691
	EP2	0.880			
	EP4	0.881			

Note. CR= composite reliability; AVE = average variance extracted; EP = Environmental performance.

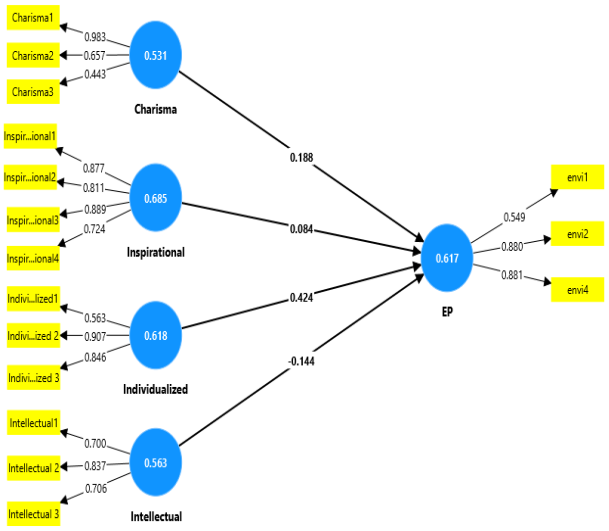

Figure 2 measurement model

Discriminant validity is the fourth step in assessing the extent to which a construct is empirically distinct from other constructs within a structural model (Hair et al., 2022)[41]. The Heterotrait-Monotrait Ratio (HTMT), as shown in Table 5, demonstrates validated discriminant validity based on the findings. According to Henseler et al. (2015)[43], HTMT values should not exceed the threshold of 0.90. The results in this study confirm that the HTMT values are below this threshold, thus supporting the establishment of discriminant validity.

Table 5. Discriminant Validity- Heterotrait-Monotrait Ratio (HTMT)

	Charisma	EP	Individualized	Inspirational	Intellectual
Charisma					
EP	0.242				
Individualized	0.403	0.518			
Inspirational	0.628	0.300	0.495		
Intellectual	0.570	0.219	0.631	0.687	

The Fornell-Larcker Criterion further supports discriminant validity. According to Fornell and Larcker (1981)[44], discriminant validity is established when the square root of the Average Variance Extracted (AVE) for a construct is greater than its correlation with other constructs. In this study, the square root of the AVE (presented in bold and italics) for each construct exceeds its correlations with other constructs (Table 6), providing robust evidence for discriminant validity.

Table 6. Discriminant Validity- Fornell & Larcker criterion.

	Charisma	EP	Individualized	Inspirational	Intellectual
Charisma	0.729				
EP	0.283	0.786			
Individualized	0.271	0.448	0.786		
Inspirational	0.420	0.266	0.415	0.828	
Intellectual	0.380	0.153	0.431	0.506	0.750

Cross-loadings were also analyzed to ensure that each item loads more strongly on its respective construct than on any other constructs in the model. As shown in Table 7, the factor loadings of items are significantly higher on their respective parent constructs than on other constructs. This evaluation confirms the establishment of discriminant validity through cross-loading analysis.

.Table 7. Discriminant Validity- cross-loading .

	Charisma	Inspirational	Individualized	Intellectual	EP
Charisma1	0.983	0.368	0.260	0.369	0.312
Charisma2	0.657	0.398	0.181	0.209	0.059
Charisma3	0.443	0.392	0.173	0.289	0.033
Inspirational1	0.438	0.877	0.329	0.459	0.277
Inspirational2	0.308	0.811	0.365	0.451	0.143
Inspirational3	0.331	0.889	0.399	0.388	0.263
Inspirational4	0.279	0.724	0.280	0.416	0.126
Individualized1	0.303	0.144	0.563	0.194	0.103
Individualized 2	0.205	0.259	0.907	0.313	0.457
Individualized 3	0.238	0.528	0.846	0.480	0.356
Intellectual1	0.332	0.311	0.374	0.700	0.102
Intellectual 2	0.247	0.484	0.299	0.837	0.143
Intellectual 3	0.308	0.311	0.321	0.706	0.089
EP1	0.107	0.088	0.174	0.033	0.549
EP2	0.227	0.245	0.407	0.165	0.880
EP4	0.290	0.249	0.413	0.129	0.881

Note. EP =Environmental performance.

By considering the HTMT ratio, the Fornell-Larcker criterion, and cross-loading evaluations, this study provides comprehensive support for the discriminant validity of the constructs under investigation, as evidenced by the results presented in Tables 5,6 and 7.

Before estimating the structural model, multicollinearity was assessed using Variance Inflation Factor (VIF) values, adhering to the recommended maximum threshold of 5 (Hair et al., 2012)[45]. As shown in Table 8, all VIF values were below this threshold

Table 8. VIF

	VIF
Charisma1	1.413
Charisma2	1.509
Charisma3	1.225
Inspirational1	2.423
Inspirational2	2.275

Inspirational3	2.691
Inspirational4	1.995
Individualized1	1.270
Individualized 2	1.574
Individualized 3	1.537
Intellectual1	1.177
Intellectual 2	1.263
Intellectual 3	1.253
envi1	1.169
envi2	1.719
envi4	1.627

Note. VIF = variance inflation factor.

confirming the absence of multicollinearity among the variables. Additionally, the model's explanatory power was evaluated through the Q^2 value, which, as indicated in Table 9, was found to be greater than zero. This result demonstrates that the model possesses adequate predictive quality, aligning with the recommendations of Hair et al. (2012)[45].

Table 9. Q^2 value

	Q^2predict	RMSE	MAE
EP	0.195	0.910	0.692

5.2. Partial Least Squares (PLS) regression assessment

The structural model assessment was conducted for SMEs to test the hypotheses after verifying the reliability of the model and evaluating the measurement model. Multi regression method in PLS4 were used to analyze the collected data to determine whether the hypotheses were supported or rejected. Linear regression is a key statistical method for predicting a dependent variable based on one or more independent variables. Multiple regression analysis, as described by Hair et al. (2018)[55][56][57], Backhaus et al. (2021), and Sarstedt & Mooi (2019), enhances prediction accuracy by weighting independent variables appropriately. Smart-PLS facilitates both single and multiple regression modeling, offering estimations with or without intercepts and providing standardized and unstandardized regression coefficients, making it a valuable tool for researchers in predictive analysis. Therefore; effects of transformational leadership (TL) dimensions were estimated using multiple regression technique in Smart-PLS 4.

5.2.1 Unstandardized Coefficients

This regression analysis examines the influence of leadership attributes on Environmental Performance (EP). The results indicate that **individualized attention (0.380)** has the most substantial positive effect, suggesting that leaders who provide personalized support significantly enhance EP. **Charisma (0.129)** and **inspirational qualities (0.118)** also exhibit positive effects on EP; however, their statistical significance should be verified using p-values. In contrast, **intellectual stimulation (-0.098)** negatively impacts EP, implying that a leadership approach emphasizing critical thinking and problem-solving may not directly contribute to improved environmental outcomes and could have unintended adverse effects. The **intercept (-0.000)** indicates that when all independent variables are zero, the predicted EP is effectively zero. While the intercept itself holds limited interpretative value, it is relevant within the overall regression model. These findings align with previous research, which highlights the role of transformational leadership—particularly individualized attention—in fostering positive organizational and environmental outcomes. However, further statistical analysis, including hypothesis testing and confidence intervals, is necessary to confirm the significance and robustness of these relationships. See table 13.

Table 13.Unstandardized Coefficients

	EP
Charisms	0.129
Individualized	0.380
Inspirational	0.118
Intellectual	-0.098
Intercept	-0.000

5.2.2 R-Square and Adjusted R-Square

The R-Square as shown is table 14 is (0.208). This indicates that approximately 20.8% of the variability in Environmental Performance (EP) can be explained by the independent variables (Charisma, Individualized Attention, Inspirational, and Intellectual). While this is a moderate effect size, it suggests that there are

other factors not included in the model that also influence EP. See table 10.

5.2.3 Durbin-Watson Test.

Durbin-Watson Test was employed to test Independence as it shows in table 10 that Durbin-Watson value of 1.742 suggests that there is no significant autocorrelation in the residuals, meeting the independence assumption.see also figure 4

Table 10. R- square and Durbin-Watson value.

	EP
R-square	0.208
R-square adjusted	0.192
Durbin-Watson test	1.742

5.2.4 Multicollinearity

As shown in table 11 All VIF values are well below 11, indicating no multicollinearity issues. The VIF values for model predictors are as follows:

Table 11. VIF values.

	VIF
Charisms	1.257
Individualized	1.244
Inspirational	1.421
Intellectual	1.387

5.2.5 F-Statistic

The F-Statistic quite high. This indicates that the regression model is a good fit for the data. P-Value: The p-value associated with the F-statistic is 0.000, which is less than the common significance level of 0.05. The F-statistic is 12.769 with a p-value of 0.000, indicating that the regression model is significant overall. This means that your set of independent variables collectively explain a significant portion of the variability in the dependent variable (environmental Performance. See Table. 12

Table. 12. Summery ANOVA

	Sum square	**df**	**Mean square**	**F**	**P value**
Total	199.000	198	0.000	0.000	0.000
Error	157.527	194	0.812	0.000	0.000
Regression	41.473	4	10.368	12.769	0.000

5.2.6 Hypotheses result.

According to Table 13 and figure 3**Charisma**, **Inspirational**, and **Intellectual** attributes are not significantly predicting EP (Employee Performance), as their p-values are greater than 0.05, indicating that the relationship is not statistically significant.

Individualized attention is significantly predicting EP, with a p-value less than 0.05 and a confidence interval that does not include zero, indicating a statistically significant and positive relationship.

Table 13Regression Model Analysis.

Hypotheses	Relationship		**standardized coefficients**	**SE**	**T value**	**P value**	**2.5 %**	**97.5 %**	Decision
H1	Charisma -> EP		0.129	0.072	1.802	0.073	-0.012	0.270	NOT Supported
H2	Inspirational -> EP		0.118	0.076	1.545	0.124	-0.033	0.268	NOT Supported
H3	Individualized -> EP		0.380	0.071	5.340	0.000	0.240	0.521	Supported
H4	Intellectual -> EP		-0.098	0.075	1.309	0.192	-0.247	0.050	NOT Supported
Intercept			0.000	0.064	0.000	1.000	-0.126	0.126	

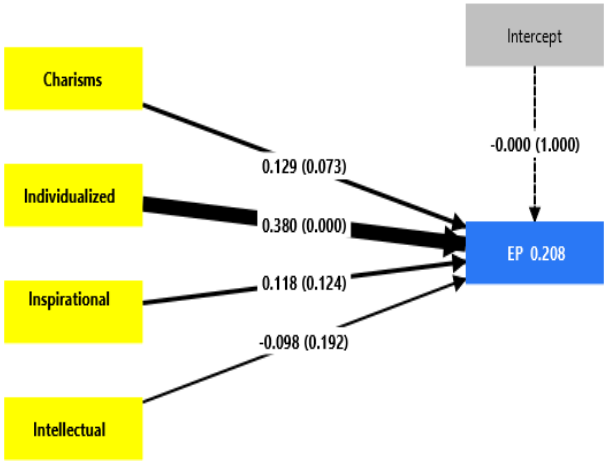

Figure 3 hypothesis testing (regression method).

6. Discussion

This study examines the impact of transformational leadership (TL) dimensions on environmental performance (EP). Our analysis reinforces prior research suggesting that transformational leadership positively influences EP, particularly by exploring the impact of individual TL dimensions on EP, which has been underexplored in previous studies. The findings demonstrate that each TL exerts a unique influence on EP, either directly or indirectly. While prior studies (e.g., Pham et al., 2023; Chen & Chang, 2023; Robertson & Barling, 2017; Hanif et al., 2023; Asghar et al., 2022; Riva et al., 2021; Chen et al., 2014)[13][12][31][28][32][33][36]
consistently report a positive relationship between TL and EP, other studies, such as Younis and Hussain (2023)[27], found no significant moderating role of Green Transformational Leadership in the relationship between Green Human Resource Management (GHRM) and Psychological Green Climate. However, Younis and Hussain confirmed that GHRM significantly affects EP in the healthcare sector, mediated by Psychological Green Climate.
The findings also align with studies showing that TL impacts employees, which in turn enhances EP (Peng et al., 2021; Farrukh et al., 2022)[34][35]. Notably, the present study highlights that individualized consideration—a TL dimension—has the strongest impact on improving EP, consistent with Robertson and Barling (2017)[31]. Their findings reveal that individualized consideration and moral modeling indirectly influence organizational citizenship behavior for the environment (OCBE) via psychological ownership, with individualized consideration having a stronger effect. These results emphasize the importance of addressing individual employee needs to drive EP improvements. Transformational leaders practicing individualized consideration pay close attention to the needs and potential of each employee. This personalized approach enhances employee engagement and commitment to sustainability initiatives. Leaders who provide individualized support create a nurturing environment that fosters the development of pro-environmental behaviors and practices (Ren et al., 2024)[15]. he Impact of Transformational Leadership Dimensions on Environmental Performance in Manufacturing SMEs
The results of this study indicate that certain dimensions of transformational leadership (TL), namely charisma, inspirational motivation, and intellectual stimulation, do not have a statistically significant impact on the Environmental Performance (EP) of manufacturing SMEs, as outlined in the study's objectives and presented in Table 8. The low t-values associated with these dimensions further support this finding. A possible explanation for this outcome is that in SMEs, particularly those operating in developing economies with financial constraints, charismatic leaders tend to prioritize achieving financial goals over environmental considerations. Their efforts are directed primarily towards ensuring profitability and business sustainability, which may inadvertently divert attention away from environmental objectives.
Similarly, inspirational leaders, while effective in motivating employees, may communicate organizational priorities in a simplified manner, emphasizing financial success over

sustainability initiatives. Consequently, employees may not perceive environmental performance as a critical goal. Furthermore, in economically strained contexts, intellectually stimulating leaders often focus on enhancing employees' cognitive capabilities to optimize financial outcomes. As they themselves face financial pressures, they may prioritize immediate economic gains over long-term environmental sustainability, leading to the neglect of environmental performance.

On the other hand, the analysis highlights that Individualized Attention is the most influential factor when examined independently. The standardized coefficient for Individualized Attention (H3) is 0.380, with a highly significant p-value of 0.000, indicating a strong positive relationship with EP. This suggests that personalized leadership approaches, such as providing direct support and considering individual employee needs, play a crucial role in fostering environmental performance.

Despite the insignificant impact of individual TL dimensions such as charisma, inspirational motivation, and intellectual stimulation, the collective analysis suggests that a combination of leadership traits can create a synergy effect, where different dimensions complement each other to enhance environmental performance. This implies that while no single leadership trait may be a definitive predictor of EP, the integration of various TL dimensions could yield more substantial environmental outcomes.

Summary of Hypothesis Testing:

Charisma (H1): Not supported (Standardized coefficient = 0.129, p-value = 0.073) → While a positive relationship exists, it is not statistically significant, suggesting that charisma alone does not strongly predict EP.

Inspirational Motivation (H2): Not supported (Standardized coefficient = 0.118, p-value = 0.124) → Similar to charisma, inspirational motivation does not significantly contribute to EP.

Individualized Attention (H3): Supported (Standardized coefficient = 0.380, p-value = 0.000) → A significant and strong positive predictor of EP, highlighting the importance of personalized leadership.

Intellectual Stimulation (H4): Not supported (Standardized coefficient = -0.098, p-value = 0.192) → The negative but insignificant effect suggests that intellectual stimulation alone does not enhance EP.

These findings reinforce the notion that leadership effectiveness in driving environmental performance may depend on a combination of transformational leadership traits rather than any single dimension alone.

6.1. Theoretical Contribution

This study makes significant theoretical contributions. First, it investigates the impact of TL dimensions on EP, which, to the authors' knowledge, has not been studied comprehensively, particularly in the context of Yemen. Second, this research adds to the existing literature by providing empirical evidence on the role of TL in developing nations. Lastly, it addresses the gap in prior studies by practically examining the TL-EP relationship, offering insights for advancing the understanding of TL's influence on EP.

6.2. Practical Implications and Recommendations

The findings provide actionable recommendations for leaders and managers to leverage TL to improve EP in SMEs. Fostering transformational leadership capabilities can enhance both sustainability and profitability, aligning with global trends toward sustainable and lean manufacturing practices. Additionally, policymakers and governmental agencies are encouraged to design strategies that support SMEs, recognizing their crucial role in bolstering national economic sustainability.

6.3. Limitations and Future Directions

This study, like others, has limitations. First, the data were collected from SMEs in selected regions of Yemen; future research should expand to cover broader geographical areas, including other cities in Yemen. Second, the study should be replicated under different and more stable environmental conditions. Third, the current focus on manufacturing SMEs

should be broadened to include service-oriented SMEs to generalize the findings. Finally, future studies are encouraged to explore alternative theories and measurements to further enrich understanding in this domain.

6.4 Conclusion

The prioritization of profitability over sustainability by manufacturing firms, particularly in developed countries, has adversely affected global sustainable development. This growing concern has drawn worldwide attention, leading to increased pressure on manufacturing firms, including small and medium enterprises (SMEs), to align with sustainable development goals. Transformational leadership (TL) emerges as a critical internal organizational resource with significant potential to enhance a firm's environmental performance. However, the impact of individual TL dimensions on environmental performance remains underexplored, as much of the existing literature focuses on their collective influence. This oversight has created a theoretical gap in TL research, particularly regarding its role in promoting sustainable practices within SMEs. Furthermore, limited studies have specifically examined the distinct effects of TL dimensions on SMEs' environmental performance (EP). The findings of this study emphasize the need for further research to bridge this gap and expand TL literature in the context of firms pursuing sustainable performance. Future research could replicate these studies in stable environments across multiple cities within the country to ensure broader applicability. Additionally, incorporating moderating and mediating factors, alongside diverse methodologies, is recommended to deepen the understanding of how TL dimensions influence EP within SMEs operating in a sustainability-focused framework.

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