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Analyzing Key Drivers for Sustainable Energy Development in Saudi Arabia: A DEMATEL Methodology Perspective

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Abstract

In the ever-evolving landscape of sustainable business practices, Corporate Social Responsibility (CSR) has emerged as an essential component within the energy sector, permeating every facet of its operations. Despite extensive studies on CSR-related strategies, there exists a notable gap in understanding the Critical Success Factors (CSFs) at a regional level. Consequently, this research focuses on Saudi Arabia, the world's largest energy consumer, as a pivotal hub for analyzing the specific CSFs of corporate social responsibility within the energy sector. This study conducts a comprehensive literature review to gather CSFs, subsequently validated and assessed by experts and industrial managers based in Saudi Arabia. Employing the 'Decision Making Trial and Evaluation Laboratory' (DEMATEL) method, the research analyzes and visually represents the most influential CSFs for promoting CSR. The findings underscore the significance of Saudi energy companies prioritizing key success factors, categorizing them into cause-and-effect groups. Notably, this research marks the pioneering effort to scrutinize CSFs relevant to the energy sector on a regional scale. It provides initial insights into the strategic process of CSR implementation, presenting a decision framework aimed at aiding managers in the Saudi energy sector to establish a robust foothold in CSR implementation. The findings of this study contribute unique perspectives to energy consumption, offering actionable strategies for industry leaders navigating the dynamic landscape of sustainable energy practices.

Keywords
Corporate Social Responsibility (CSR), Critical Success Factors (CSFs), Decision Making Trial and Evaluation Laboratory (DEMATEL), Multiple Criteria Decision Analysis (MCDA) and Sustainable Energy.

1. Introduction

The global shift towards sustainability in corporate activities, driven by the United Nations' sustainable development goals, is evident in the Saudi Arabian energy sector. Stakeholders are pressuring companies to adopt eco-friendly practices, particularly as the sector faces challenges related to oil dependency, resource depletion, and environmental concerns. This study focuses on Critical Success Factors (CSFs) in Corporate Social Responsibility (CSR) implementation within the Saudi Arabian energy sector. It introduces the innovative DEMATEL method to identify and analyse the causal relationships among CSFs. The methodology involves a four-step process: identifying CSFs through literature and expert validation, developing a research model, and applying the DEMATEL method for analysis. The study's contributions are threefold: firstly, it fills a gap in existing literature by exploring the causal links between CSFs and CSR implementation in the Saudi Arabian energy sector. Secondly, the research introduces the DEMATEL method as a novel approach, providing visual insights into interrelationships and aiding industrial managers in prioritizing key success factors. Lastly, the study holds contextual and industrial significance by offering a comprehensive evaluation of CSFs in the energy sector, providing valuable insights for shaping CSR strategies and informing policy decisions towards sustainable development.

1.1 Objectives
The objective of this study is to examine and establish a framework for prioritizing CSFs required for the effective implementation of CSR within the Saudi Arabian energy sector. The study places a specific focus on understanding the causal relationships among these CSFs, especially within the context of an industry undergoing rapid industrial and urban development, with oil as its primary energy source.

2. Literature Review
The examination of CSR) encompasses diverse interpretations, associating CSR with social, economic, and environmental sustainability. Over recent decades, businesses have increasingly acknowledged CSR as a strategic approach. The pioneer of CSR, Howard Bowen, introduced the CSR strategy in 1930 (K. Pactwa and J. Wo´zniak 2020). Since the inception of CSR, different studies have expanded upon the concept from a range of application areas and varying perspectives. For example, Nave and Ferreira (A. Nave and J. Ferreira 2019) recognized the implementation of CSR strategies by major global corporations across their organizational structures, utilizing dedicated resources. In their study, Zhu, Zou (Q. Zhu, F. Zou and P. Zhang 2019) identified how distinct dimensions of CSR can assist Small and Medium Enterprises (SMEs) in cultivating an innovative culture and enhancing environmental performance through community engagement. CSR has gained traction in recent decades, extending across various sectors. It is defined as self-regulation within business activities, covering socially and environmentally responsible practices such as green energy usage, Iyer and Jarvis (G.R. Iyer, L. Jarvis 2019), for example, investigated CSR issues within the framework of the hospitality industry. By reviewing CSR and employer branding literature, Carlini, Grace (J. Carlini 2019) underscored how organizations could excel across various CSR dimensions. Sustainable production, and ethical emissions reduction**.** Studies have examined the risks and benefits of CSR adoption, exploring its role in fostering investor trust and delving into diplomatic and political facets. Research has also focused on fundamental CSR concepts like critical success factors, impediments, motivators, and pressures. For instance, obstacles like cognitive dissonance in the gaming industry and motivators in Indian family businesses have been studied**.** The exploration of (CSR) within various industry sectors, particularly the energy sector, reveals its significant impact, given the pronounced social presence of energy companies. Numerous studies in the energy sector focus on CSR-related concerns, linking CSR implementation to public image and reputation**.** Corporate Social Responsibility has gained increasing significance in Saudi Arabia as the Kingdom endeavours to achieve its socio-economic goals outlined in Vision 2030. This literature review explores the key dimensions, challenges, and initiatives of CSR in Saudi Arabia and is supported by references to seminal research and key publications. The Saudi government actively supports CSR initiatives, with regulatory bodies and policies that encourage and facilitate responsible business practices. The Saudi Arabian General Investment Authority (SAGIA) provides guidelines and incentives for businesses to incorporate CSR into their operations. Regulatory reforms are also aimed at simplifying business processes and encouraging CSR adoption. Challenges include ensuring the effectiveness, measurability, and transparency of CSR initiatives, as well as addressing the expectations of an increasingly socially conscious consumer base. However, CSR also presents significant opportunities for businesses to enhance their brand reputation, build trust, and contribute to the social and economic progress of Saudi Arabia. Decision analysis proves its worth when addressing complex problems involving numerous stakeholders, criteria, and goals. CSR is an organizational approach with multifaceted elements that demand specific approaches and tools for management. Hence, researchers employed a range of multi criteria decision analysis (MCDA) methods to tackle CSR challenges.

3. Methods
The methods section outlines the steps to be taken to explore a research issue and the justification for employing particular procedures or techniques for the identification, selection, and analysis of information aimed at comprehending the problem. Furthermore, it will detail all the software and methodologies to be utilized in this research, provide reasons for their selection, and elucidate the anticipated outcomes following the application of these software and methodologies.

Decision-making trial and evaluation laboratory tools are designed to tackle such intricate issues, and DEMATEL stands out as an excellent choice. This methodology aids decision-makers in prioritizing the steps in the CSR implementation process and provides a means to assess and gauge respondents' subjective judgments, DEMATEL primarily serves to assess the strength of the impact and the cause-and-effect relationships among the direct and indirect variables within a complex system through matrix calculations. Furthermore, DEMATEL is better suited for an expert survey rather than a general public survey. Therefore, given this appropriateness, DEMATEL is employed to assess CSFs of CSR implementation in Saudi Arabia's energy sector. DEMATEL was originally introduced by the Geneva Research Centre of the Battelle Memorial Institute in 1971. This approach visualizes intricate structural and causal relationships using matrices or directed graphs and can transform the cause-and-effect relationships of criteria into a unique structural model, thus elucidating the fundamental causes of issues and outlining strategies for addressing core problems (A. Gabus, E. Fontela 1973). The calculation steps and structure of DEMATEL have been compiled and are outlined in Figure 1.

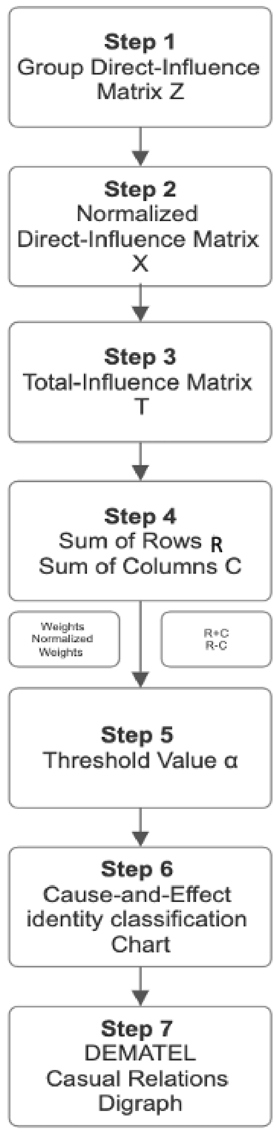

Figure 1. DEMATEL Steps and Structure Flowchart

Step 1: Compute the Group Direct-Influence Matrix Z by examining the connections among n factors, denoted as F = {F1, F2, . . ., Fn}. A panel of l experts assesses the associations between these factors within an experts' decision group, labelled as E = {E1, E2, . . ., El}. The experts are tasked with expressing the direct impact of factor Fi on factor Fj using the numerical scale outlined in Table 1.

Table 1. Comparison Integer Scale of the DEMATEL Method

Integer Scale	Definition
0	No influence
1	Low influence
2	Medium influence
3	High influence
4	Very high influence

The specific direct-influence matrix $Z_k = [z_{ij}^k]_{n\times n}$, signifies the assessment of each expert from $E_k$on E_l regarding the impact of factor $F_i$on F_j Subsequently, the collective opinions of all participating experts (l experts in total) are consolidated into a group direct-influence matrix denoted as $Z = [z_{ij}]_{n\times n}$, This group matrix is determined through the utilization of Equation (1).

$$Z_{ij} = \frac{1}{l}\sum_{k=1}^{1} z_{ij}^{k} \qquad i.j = 1,2,\dots,n \qquad (1)$$

Step 2: Calculate the Normalized Direct-Influence Matrix X by utilizing the group direct-influence matrix Z, which was computed in Step 1. This normalized direct-influence matrix $X = [x_{ij}]_{n\times n}$ is obtained through the application of Equations (2) and (3). Where all elements in X conform with $0 \le x_{ij} \le 1, 0 \le \sum_{j=1}^{n} x_{ij} \le 1$, and at least one i such that $\sum_{j=1}^{n} z_{ij} \le s$.

$$X = \frac{Z}{s} \qquad (2)$$

$$s = \max\left(max_{1\le i\le n}\sum_{j=1}^{n} z_{ij}, max_{1\le i\le n}\sum_{j=1}^{n} z_{ij},\right) \qquad (3)$$

Step 3: Calculate the Total-Influence Matrix T by utilizing the normalized direct-influence matrix X, which was determined in Step 2. The computation of the total-influence matrix $T = [T_{ij}]_{n\times n}$is accomplished through the application of Equation (4).

$$T = X + X + \dots + X^{h} = X(I - X)^{-1} \quad when, h \to \infty \qquad (4)$$

Where 'I' is the identity matrix.

Step 4: Compute the summation of rows and columns utilizing the Total-Influence Matrix T, which was determined in Step 3. This is achieved by determining vectors R and C, representing the total of rows and columns in matrix T, respectively, through the application of Equations (5) and (6).

$$R = [r_i]_{n\times 1} = \left[\sum_{i=1}^{n} t_{ij}\right]_{n\times 1} \qquad (5)$$

$$C = [c_i]_{n\times 1} = \left[\sum_{i=1}^{n} t_{ij}\right]_{1\times n}^{T} \qquad (6)$$

Where,

r_i: the summation of the ith row in matrix T signifies the effects originating from factor F_i and impacting other factors.

c_j: the summation of the jth column in matrix T signifies the effect that factor F_i is receiving from other factors.

Following this, for $i = j$ and i, j {1, 2, . . ., n}, the vectors on the horizontal axis (R + C), known as "Prominence," and on the vertical axis (R - C), known as "Relation," are computed. The value of (R + C) (i.e., Prominence) signifies the level of significance of factors within the system. A higher (R + C) value indicates a stronger relationship with other factors, while a lower (R + C) value indicates a weaker relationship with other factors. On the other hand, the (R - C) (i.e., Relation) reveals the type of relationship between factors in terms of their contribution effects. If the (ri - ci) value is positive, it designates factor F_i as a "dispatcher" factor, classifying it as a causal factor as it influences other factors within the system. Conversely, if the (ri - ci) value is negative, factor F_i is identified as a "receiver" factor, categorized as an effect factor since other factors influence it within the system. Subsequently, by applying Equation (7), the relative importance of each factor is determined by calculating the weight ω_j for each factor using its Prominence and Relation (R + C and R - C, respectively). These computed weights are then normalized using Equation (8) and ranked accordingly.

$$\omega_j = \sqrt{(r_j + c_j)^2 + (r_j - c_j)^2} \quad (7)$$
$$\omega_j = \frac{\omega_j}{\sum_{j=1}^{n} \omega_j} \quad (8)$$

Step 5: Establish the threshold value denoted as α for the purpose of distinguishing between insignificant and substantial influences within the factor relationships in matrix T. Influence values within matrix T that are less than the value of "a" are categorized as insignificant, while influence values equal to or greater than "a" are considered as strong effects. The Cause-and-Effect Identity Classification Chart and the DEMATEL Causal Relations Digraph are created exclusively using strong influences. Typically, the value of "a" is determined by decision-makers to encompass all relevant factors in the system, and this threshold value can be adjusted until a satisfactory Cause-and-Effect Identity Classification Chart and DEMATEL Causal Relations Digraph are achieved. However, in this study, the threshold value α is computed using Equation (9) by taking the average of all elements in matrix T through Equation (7).

$$\alpha = \frac{\sum_{i=1}^{n} \sum_{j=1}^{n} [t_{ij}]}{n^2} \quad (9)$$

Step 6: Generate the Cause-and-Effect Identity Classification Chart by utilizing the cause-and-effect identity classification of the factors. This chart is constructed based on the total-influence matrix T calculated in Step 3, along with the summed rows and columns from Step 4, which are mapped in a chart format as (R + C, R - C). The chart is established in accordance with the threshold value determined in Step 5.

Step 7: Create the DEMATEL Causal Relations Digraph by using the Cause-and-Effect Identity Classification Chart and the specified threshold value "a." This digraph illustrates the cause-and-effect relationships among the factors within the system, offering valuable insights for decision-making in the subject matter.

4. Data Collection

In the pursuit of sustainable energy solutions, the Kingdom of Saudi Arabia stands at a critical juncture. As the nation seeks to diversify its energy portfolio and reduce its environmental footprint, the identification and prioritization of critical success factors are essential. The DEMATEL approach offers a structured methodology for understanding the interrelationships between these factors and, ultimately, for determining the most influential drivers of success. More details about the steps can be seen in Figure 2.

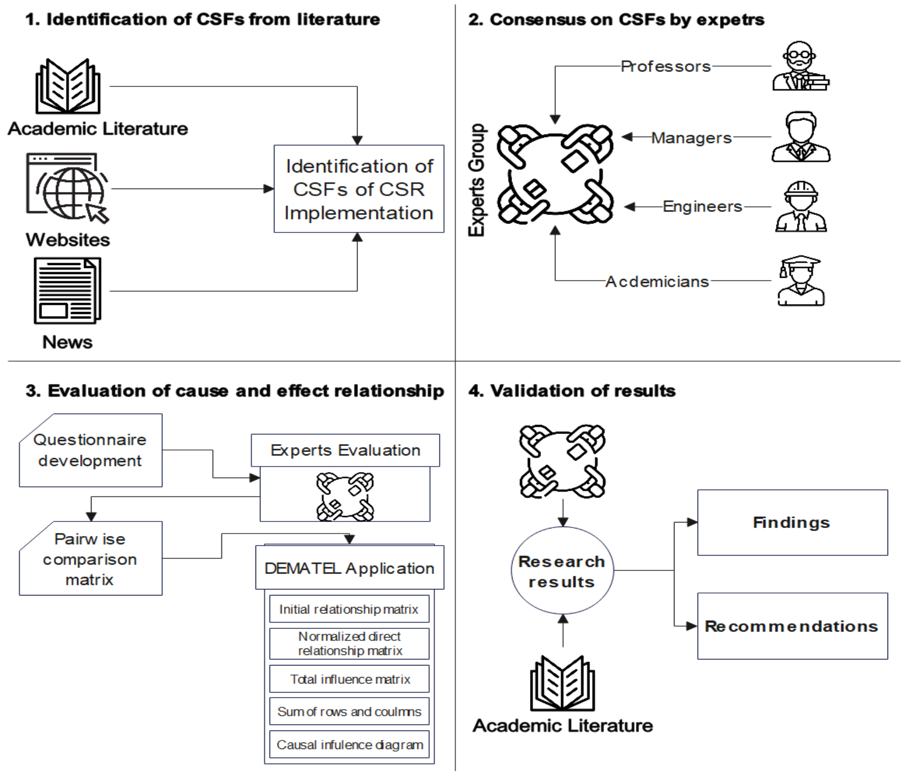

Figure 2. The Proposed Framework of Study

Data is gathered from different sources and from multiple steps: **Step 1:** Identifying Critical Success Factors for CSR Implementation: In the initial phase, a comprehensive literature review was conducted to gather pertinent information. This review involved the use of various keywords such as "critical success factors", "key enablers", "drivers", "CSR", "Sustainable development", and "DEMATEL". Multiple databases, including Web of Science, Science Direct, and google scholar were meticulously searched to pinpoint any research gaps in previously published studies. Following this review, a total of 16 critical success factors were identified that are relevant to energy sector as shown in Table 2.

Table 2. A List of Common CSFs for the Implementation of CSR in the Energy Sector

Factor number	Factor	References
F1	Government support	(K. Govindan, 2018)
F2	Societal support	(E. Santoyo 2014)
F3	Customer involvement and pressure	(M. Tyagi & P. Kumar 2018)
F4	Environment protection system	(Zhu et al., 2019)
F5	Training and development of human resource	(Moon, Jeremy 2007)
F6	Information and communication technology	(T. Jamasb & T. Thakur 2018)
F7	Organizational capability and resources	(D.-S. Chang 2015)
F8	Green practices for procurement	(Choi et al., 2019)
F9	Top management support	(M. Tyagi, P. Kumar 2018)
F10	Economic benefits	(A. Nave, J. Ferreira 2019)
F11	Sustainability-based organizational culture	A. Gabus, E. Fontela 1973
F12	Atmosphere for innovation	(Mazzola, E, & Perrone, G 2015)
F13	Assessing sustainable performance and benefits	(Mazzola et al., 2015)
F14	Support from external stakeholders	(Choi et al., 2019)
F15	Improve human rights, ethical, legal, safety, and wellness	(G.R. Iyer & L. Jarvis 2019)
F16	Integrating Corporate Social Responsibility into functional areas	(J. Carlini 2019)

Step 2: Establishing Agreement on the Applicability of CSFs in the Saudi Arabian Energy Sector: In the second phase, critical success factors were presented to a panel of field experts. This panel comprised high-level managers, university professors, and academic practitioners, carefully selected using non-probability sampling techniques, specifically snowball sampling and judgmental sampling. Aligning with the interests and perspectives of major stakeholders as shown in Table 3. The aim was to assess the acceptability and validate the identified CSFs within the Saudi Arabian energy sector.

Table 3. The Field of Expert's Table

No. of Experts	Expert	Qualification	Years of experience
2	Professors	Ph.Ds	20-30
2	Managers	Masters & Ph.Ds	5-6
2	Engineers	Masters	3-9
2	Sr. Managers	Masters & Ph.Ds	10-15
2	Academicians	Post-Doc	3-5

Evaluated using a five-point Likert scale (ranging from 0 to 4) to measure importance, where 0 indicates no influence, and 4 signifies very high influence. Correspondence via email was employed to contact field experts, resulting in responses from a total of 10 experts. Following the pairwise comparison of CSFs, the data underwent further analysis within the DEMATEL framework.

Step 3: Results Verification:
In the third stage, the results acquired are revalidated through a comprehensive review of existing literature. Furthermore, they are subjected to in-depth discussions with field experts to obtain valuable insights regarding CSFs for implementing CSR in the energy sector. The valuable suggestions and recommendations provided by these experts concerning CSR implementation's critical success factors are elaborated upon in detail within the results and discussion section.

5. Results and Discussion

5.1 Numerical Results

To Establish Cause-and-Effect Relationships Using the DEMATEL Approach the following steps are taken:

1. **Computation of the Initial Relationship Matrix 'A':** The initial relationship matrix for the criteria is constructed based on input from industrial managers and experts. This matrix is created using Equation (1) and is presented in Table 4.

Table 4. Initial Relationship Matrix 'A' For Criteria

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	Total
1	0	2	3	4	0	0	0	0	3	3	3	0	0	3	4	4	29
2		0	4	3	2	4	0	0	3	4	2	2	2	2	2	1	31
3			0	0	2	0	0	0	0	3	3	0	3	3	4	0	18
4				0	0	2	0	0	0	3	3	0	3	3	4	4	22
5					0	2	2	2	2	3	3	0	2	2	1	0	19
6						0	0	0	0	4	0	2	2	3	4	0	15
7							0	0	2	4	3	0	3	3	0	4	19
8								0	2	4	3	0	3	3	4	0	19
9									0	3	4	3	4	3	3	0	20
10										0	2	2	2	3	4	4	17
11											0	3	4	4	4	4	19
12												0	4	3	4	0	11
13													0	4	3	4	11
14														0	4	4	8
15															0	4	4
16																0	
Total	0	2	7	7	4	8	2	2	12	31	26	12	32	39	45	33	

2. **Computation of the Normalized Direct Relationship Matrix:** Equations (2) and (3) are utilized to normalize the initial relationship matrix, resulting in the formation of the direct-relationship matrix 'D' as demonstrated in Table 5.

Table 5. Normalized Direct Relationship Matrix

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
1	0	0.04	0.066	0.089	0	0	0	0	0.06	0.06	0.06	0	0	0.06	0.08	0.08
2		0	0.089	0.067	0.04	0.089	0	0	0.06	0.08	0.04	0.04	0.04	0.04	0.04	0.02
3			0	0	0.04	0	0	0	0	0.06	0.06	0	0.06	0.06	0.08	0
4				0	0	0.04	0	0	0	0.06	0.06	0	0.06	0.06	0.08	0.08
5					0	0.04	0.04	0.04	0.04	0.06	0.06	0	0.04	0.04	0.02	0
6						0	0	0	0	0.08	0	0.04	0.04	0.06	0.08	0
7							0	0	0.04	0.08	0.06	0	0.06	0.06	0.00	0.08
8								0	0.04	0.08	0.06	0	0.06	0.06	0.08	0
9									0	0.06	0.08	0.06	0.08	0.06	0.0	0
10											0.04	0.04	0.04	0.06	0.08	0.08
11											0	0.06	0.08	0.08	0.09	0.08
12												0	0.08	0.06	0.08	0
13													0	0.08	0.06	0.08
14														0	0.08	0.08
15																0.08
16																0

3. **Computation of the Total Influence Matrix 'T':** Equation (4) is applied to derive the total influence matrix 'T' from the normalized direct relationship matrix 'D', the Total Influence Matrix shows the mutual causal relationships between the various factors or criteria under consideration. This matrix aids in understanding the factors' cause and-effect relationships, as well as the degree and direction of influence they have on one another as shown in Table 6.

Table 6. Total Influence Matrix 'T'

	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**
1	0.00	0.04	0.07	0.09	0.01	0.01	0.00	0.00	0.07	0.09	0.09	0.02	0.03	0.10	0.14	0.14
2		0.00	0.09	0.07	0.05	0.09	0.00	0.00	0.07	0.12	0.07	0.06	0.09	0.09	0.11	0.07
3			0.00	0.00	0.04	0.00	0.00	0.00	0.00	0.07	0.07	0.01	0.08	0.09	0.12	0.04
4				0.00	0.00	0.04	0.00	0.00	0.00	0.07	0.07	0.01	0.08	0.09	0.12	0.13
5					0.00	0.04	0.04	0.04	0.05	0.08	0.08	0.01	0.07	0.08	0.06	0.04
6						0.00	0.00	0.00	0.00	0.09	0.00	0.05	0.05	0.08	0.11	0.03
7							0.00	0.00	0.04	0.09	0.08	0.01	0.08	0.09	0.03	0.12
8								0.00	0.04	0.09	0.08	0.01	0.08	0.09	0.12	0.04
9									0.00	0.07	0.09	0.08	0.11	0.09	0.10	0.04
10									0.00	0.00	0.04	0.05	0.05	0.08	0.11	0.11
11										0.00	0.00	0.07	0.10	0.10	0.11	0.12
12											0.00	0.00	0.09	0.08	0.10	0.02
13												0.00	0.00	0.09	0.08	0.10
14													0.00	0.00	0.09	0.10
15														0.00	0.00	0.09
16															0.00	0.00

4. **Calculation of Sum of Rows and Columns:** Equations (5) and (6) are employed to calculate the sums of rows and columns from the total influence matrix 'T'. These sums are represented as vectors 'R' and 'D,' respectively. The outcomes are presented in Table 7, these outcomes are used to determine whether the factor is cause or effect.

Table 7. Sum of Rows and Columns for Matrix ‘T’

F	**D**	**R**	**D-R**	**D+R**
1	0.90	0.00	0.90	0.90
2	0.98	0.04	0.93	1.02
3	0.53	0.16	0.37	0.69
4	0.61	0.16	0.45	0.77
5	0.60	0.10	0.50	0.70
6	0.42	0.19	0.22	0.61
7	0.55	0.05	0.50	0.60
8	0.56	0.05	0.51	0.61
9	0.58	0.28	0.30	0.86
10	0.44	0.77	-0.32	1.21
11	0.49	0.67	-0.18	1.16
12	0.29	0.37	-0.09	0.66
13	0.27	0.91	-0.64	1.17
14	0.19	1.15	-0.96	1.33
15	0.09	1.40	-1.31	1.48
16	0.00	1.19	-1.19	1.19

The results of the data set (D-R) values have been used to categorize 16 CSFs into cause-and-effect groups as illustrated in Table 8.

Table 8. DEMATEL Results

F	D-R	D+R	Type
1	0.898	0.898	Cause
2	0.932	1.021	Cause
3	0.368	0.687	Cause
4	0.449	0.766	Cause
5	0.502	0.698	Cause
6	0.225	0.611	Cause
7	0.501	0.599	Cause
8	0.509	0.607	Cause
9	0.301	0.857	Cause
10	-0.320	1.209	Effect
11	-0.183	1.162	Effect
12	-0.086	0.663	Effect
13	-0.639	1.172	Effect
14	-0.963	1.334	Effect
15	-1.307	1.485	Effect
16	-1.187	1.187	Effect

5.2 Graphical Results

This study aims to fill a knowledge gap in research about effectively implementing CSR in the Saudi energy sector by identifying essential success factors towards implementation. "Societal support (F2)" has the greatest (D-R) value among the whole cause group as shown in Figure 3.

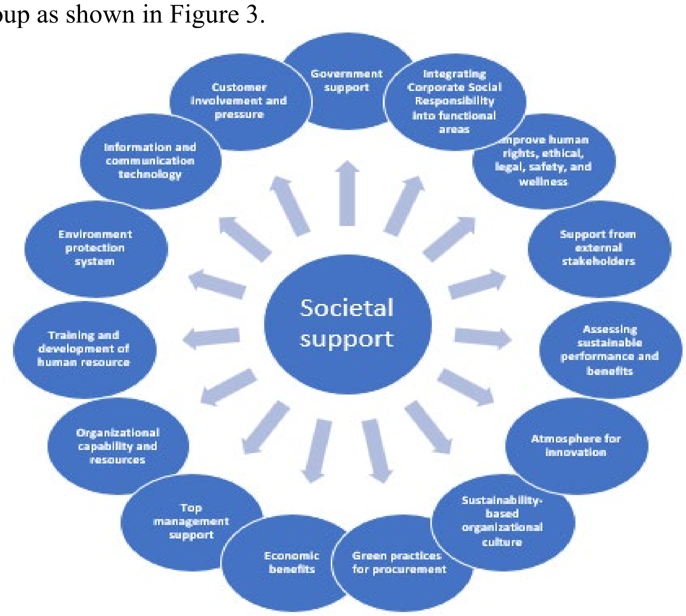

Figure 3. Influence Diagram of Societal Support on all other factors

Which indicates that it has the highest influence on the entire system, societal support can significantly impact the CSFs in the Saudi energy sector. A strong focus on building and maintaining positive relationships with local communities, addressing environmental concerns, and aligning with societal values and expectations is crucial for the sector's success and long-term sustainability.

Establishing the Causal Influence Diagram: The final phase involves creating a causal influence diagram, which serves as the concluding step in the DEMATEL model's application. This diagram aids decision-makers in identifying the most influential factor among the selected CSFs. In Figure 4, the X-axis depicts the values of D + R, while the Y-axis represents the values of D - R, as illustrated in Figure 4.

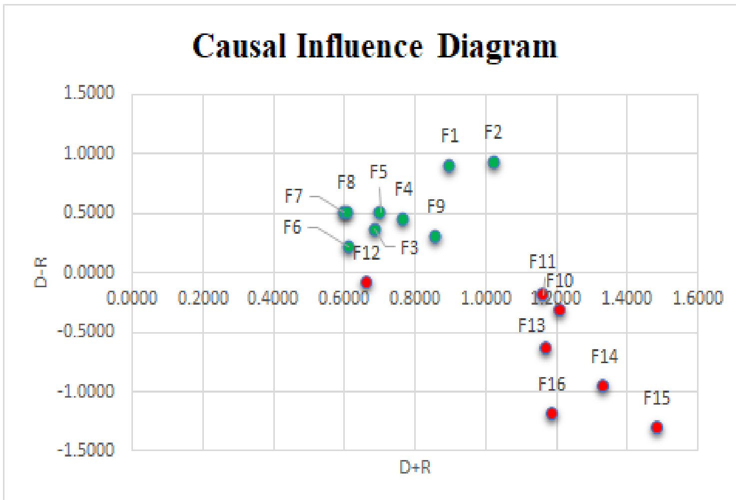

Figure 4. Causal Influential Diagram for CSR Criteria

5.3 Proposed Improvements

This study has significant promise for enhancing sustainability and CSR plans in the Saudi Arabian energy sector and serves as a model for research in other locations and industries. Engagement with stakeholders: Reinforce collaboration with governmental entities, society, and customers to enhance support for CSR initiatives. Leveraging technology: Continue to make use of information and communication technology to enhance data analysis, reporting, and the communication of sustainability efforts. Dynamic analysis: Investigate the evolving relationships between the identified factors, employing methodologies beyond DEMATEL to comprehend how these relationships change over time and impact CSR implementation. Comprehensive training program: Develop and implement thorough training and development initiatives for the workforce, focusing on ethical standards, safety, and wellness. Resource allocation: Ensure that organizational capabilities and resources are dedicated to CSR initiatives, enabling the sustainable implementation of green procurement practices and corporate responsibility. Top management commitment: Develop unwavering commitment from top management, nurturing a corporate culture that backs CSR and sustainability. Strong leadership at the highest levels is crucial in steering CSR initiatives throughout the organization.

6. Conclusion

The implementation of CSR in the energy sector in Saudi Arabia is a crucial step towards aligning the industry with global sustainability standards and contributing to the nation's development. It is evident that CSR initiatives are gaining momentum in the sector, with several companies embracing responsible business practices. These efforts have the potential to benefit both the industry and the broader Saudi Arabian society by addressing environmental concerns, enhancing stakeholder relations, and fostering long-term sustainability. The study's unique contribution is its emphasis on identifying and prioritizing CSFs for effective CSR implementation using the DEMATEL method. By doing so, it not only fills a significant research gap but also provides practical insights for energy managers and policymakers. Furthermore, the DEMATEL approach's methodological contribution simplifies complex interrelationships and provides a visual understanding on the causal and consequential influences of CSFs. This tool enables energy sector industrial managers to make informed decisions by identifying and prioritizing the most important success factors, allowing them to focus on what truly matters for CSR implementation. The most influential factors are found to be societal support, government backing, and green procurement practices. Societal support emphasizes the importance of developing positive relationships with local communities and addressing environmental issues. Government assistance emphasizes the importance of collaboration between the government and industry. Green procurement practices promote environmental responsibility and sustainability. Each of these factors plays a unique role in driving change over time and influencing critical success factors. Societal support creates awareness and demand for sustainable energy solutions. The public's understanding of the environmental and economic benefits of clean energy encourages individuals to support and engage in sustainable practices. Government backing is essential for establishing a conducive policy framework. Green procurement practices create a significant market demand for sustainable products and services. This demand, in turn, encourages businesses to adopt sustainable practices to remain competitive in procurement processes. It can also influence the entire supply chain, companies that want to secure government contracts or meet the demands of environmentally conscious consumers are more likely to adopt sustainable energy practices in their operations. This includes setting renewable energy targets, providing incentives, and creating regulations that favor sustainable energy development. Collaboration and innovation are critical for successful CSR implementation in the energy sector. These findings highlight the importance of societal, governmental, and environmental factors in developing CSR strategies for long-term industry success. This study not only improves the understanding of the critical role of CSR in the Saudi energy sector, but it also provides industry leaders with useful tools for driving meaningful change. It is an important step toward a more sustainable and responsible future in a vital and dynamic industry. However, challenges persist, such as the need for more comprehensive regulatory frameworks, improved transparency, and a stronger culture of sustainability within the sector. While significant progress has been made, continuous commitment and innovation are essential for sustained CSR success.

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Biographies

Ammar Y. Alqahtani, PhD, is an associate professor of Industrial Engineering at King Abdulaziz University in Jeddah, Saudi Arabia. He received his BS degree with first honors from the Industrial Engineering Department of King Abdulaziz University, Jeddah, Saudi Arabia, in May 2008. Being awarded with a full scholarship by the King Abdulaziz University (KAU), he received his MS degree in Industrial Engineering from Cullen College of Engineering, University of Houston. In September 2012, he started his PhD studies in Industrial Engineering at Northeastern University, Boston, Massachusetts. He received his PhD degree in 2017. He has been employed as a faculty member by King Abdulaziz University since December 2008. His research interests are in the areas of environmentally conscious manufacturing, product recovery, reverse logistics, closed-loop supply chains (CLSC), sustainable operations and sustainability, simulation and statistical analysis and modeling with applications in CLSC and multiple life-cycle products. He has published two books, titled *Warranty and Preventive Maintenance for Remanufactured Products Modeling & Analysis* and *Responsible Manufacturing Issues Pertaining to Sustainability*. He has coauthored several technical papers published in edited books, journals and international conference proceedings. At Northeastern University, he won the Alfred J. Ferretti research award. He also received the 33rd Quality.

Sultan J. Enani was born in Jeddah, Saudi Arabia, on the 15th of October 2000. Goal and detail-oriented senior industrial engineering student who constantly seeks improvement in his skills and education. Eager to increase knowledge and skills to reach a high level of professionalism. Successful at managing multiple priorities with a positive attitude. Outstanding communication, problem-solving, and analytical skills. During the whole industrial engineering journey, he has recalled his knowledge from the courses and beyond to apply it to organizations to assist them in better functioning.

Albaraa R. Gazzaz, hailing from Jeddah, Saudi Arabia, entered the world on June 10, 2001. As a senior Industrial Engineering student, he expresses a meticulous and goal-driven approach. His dedication revolves around constant self-improvement, aiming for a heightened level of professionalism through the acquisition of knowledge and skills. Proficient in managing multiple priorities while maintaining a positive outlook, Albaraa stands out for his exceptional communication, problem-solving, and analytical abilities. Albaraa's interest and passion for Industrial Engineering reflects his dedication to understanding and improving the intricate dynamics of operations and assuring its quality. In addition to his academic pursuits, Albaraa has further enhanced his skill set by completing courses in Excel and Power BI. This proficiency in data analysis tools complements his Industrial Engineering background, showcasing a versatile approach to problem-solving. Throughout his journey, he has adeptly drawn upon his wealth of knowledge, extending beyond formal coursework, to contribute effectively to organizational efficiency and functionality.

Bader A. Alalshaik on September 30, 2001, he was born in Jeddah, Saudi Arabia. Senior industrial engineering student who strives for continuous growth in his abilities and knowledge. Eager to expand knowledge and abilities in order to achieve a high degree of professionalism. Successfully handling multiple priorities while maintaining a cheerful mood. Excellent communication, problem-solving, and analytical abilities. Throughout his industrial engineering path, he has retained his knowledge from the courses and beyond to apply to firms to help them work better.

Majed M. Fallata was born on January 1, 2001, in Jeddah, Saudi Arabia. Senior industrial engineering student pursuing constant improvement in his abilities and knowledge. Willing to increase knowledge and abilities in order to acquire a high level of professionalism. Managing numerous priorities successfully while remaining pleasant. Outstanding communication, problem-solving, and analytical skills. Throughout his industrial engineering career, he has applied what he has learned in the classroom and beyond to help businesses run more efficiently.