Managerial Perspectives on Renewable Energy Deployment for Carbon Mitigation during the Russia-Ukraine War

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***Abstract*—Carbon mitigation plays a pivotal role in advancing the circular economy, particularly during the Russia-Ukraine war when energy security and sustainability have become critical concerns. This study applies a fuzzy Decision-Making Trial and Evaluation Laboratory (DEMATEL) approach to investigate optimal strategies for corporate carbon mitigation. The model identifies interdependent feedback relationships among key criteria and their causal linkages. The dimension of "renewable technology" is assessed through five criteria: material reuse, energy circulation, toxin reduction, reverse logistics, and green innovation. Data were collected from ten senior managers. Twenty-one criteria were derived by aggregating their evaluations. A dimension-based fuzzy total-influence matrix was then constructed, and a causality diagram was developed to capture the directional influences among dimensions. The results reveal that the "government incentives and penalties" dimension serves primarily as a causal driver, influencing other dimensions while being weakly influenced in return. The fuzzy DEMATEL-based Analytic Network Process (DANP) further indicates that "renewable technology" exerts the greatest influence on corporate carbon mitigation. Within this dimension, "green innovation," "energy circulation," and "material reuse" are identified as the most critical criteria. The findings highlight the importance of fostering renewable energy and green technologies in Taiwan's export-oriented economy to align with international sustainability standards and strengthen trade competitiveness.**

***Keywords*—renewable energy; carbon mitigation; circular economy; Environmental, Social, and Governance (ESG); Russia-Ukraine War**

I. Introduction

The Russia-Ukraine war is impacting the international energy market, prompting business executives to assess the importance of renewable energy in manufacturing and production as key to their operations. Carbon mitigation plays a pivotal role in advancing the circular economy, particularly during the Russia-Ukraine War when energy security and sustainability have become critical concerns. This study applies a fuzzy Decision-Making Trial and Evaluation Laboratory (DEMATEL) approach to investigate optimal strategies for corporate carbon mitigation. Uvarova *et al.* [1] indicate that technologies related to reducing energy consumption, reuse, resource recycling, and reverse logistics drive carbon mitigation in enterprises. Price *et al.* [2] explore that developing clean energy and efficient power generation technologies is essential to balance economic growth with environmental protection. Mossali *et al.* [3] mention that lithium-ion battery production has continued to increase in recent years due to their widespread application in advanced technology devices and electric and hybrid vehicles. To promote sustainable material utilization, the recycling and processing of waste lithium batteries is an indispensable part of the circular economy. Additionally, Bertino *et al.* [4] also propose alternatives to traditional demolition methods for recycling construction raw materials. This approach reduces the substantial waste generated during demolition, reuses building materials, and minimizes impacts on urban environments. Material reuse constitutes a key element in the technical feasibility of carbon mitigation. For these reasons, renewable energy is critical to carbon mitigation, particularly during the Russia-Ukraine War when energy sustainability has become a major concern. The motivation of this study is to investigate the role of renewable energy in corporate carbon mitigation from a managerial perspective amid the Russia-Ukraine War.

Yang *et al.* [5] proposed that the DEMATEL method identifies the interdependent feedback relationships as well as the causal linkages between decision-making factors. The purpose of this study is to identify which dimension most significantly influences corporate carbon mitigation. Twenty-one criteria were obtained. Four key dimensions—Environmental, Social, and Governance (ESG), government incentives and penalties, renewable technology, and operational management are proposed in this research. This study considers the interests and resources of the company that are mutually exclusive among the twenty-one criteria. To overcome the disadvantage of semantic error, this study refers to Mahad *et al.* [6], who use the fuzzy approach, so fuzzy DEMATEL is used in our study. Finally, the fuzzy DEMATEL-based Analytic Network Process (DANP) ranks the criteria importance for the company's priority consideration. Li *et al.* [7] propose that corporations have to take social responsibilities and conduct environmental protection. Because senior managers decide whether a company is socially responsible, senior managers are qualified as experts.

Russia is the second-largest oil and natural gas exporter, so the Russia-Ukraine war has severely affected the energy market. Zhang *et al.* [8] indicated that the Russia-Ukraine war caused the West Texas Intermediate (WTI) crude oil prices to increase by 52.33%, and the Brent crude oil price to rise by 56.33%. Zhang *et al.* [9] further found the impact of the Russia-Ukraine on the renewable energy trades among the Belt and Road Initiative countries. To avoid the energy shortage drawbacks of the Russia-Ukraine conflicts, prior research addresses the necessity to state the corporate manager's decisions about renewable energy feasibility, so this study collected questionnaires from ten senior managers for analysis. Our paper contains five sections. Section II illustrates the literature review. Section III denotes the method. Section IV denotes the results and discussion. Finally, we make conclusions in Section V.

II. LITERATURE REVIEW

Renewable literature indicates that technologies related to reducing energy consumption, reuse, resource recycling, and reverse logistics drive carbon mitigation in enterprises [1]. The global consensus that fossil fuel-based power generation increases greenhouse gas emissions, emphasizing that developing clean energy and efficient power generation technologies is essential to balance economic growth with environmental protection [2]. To promote sustainable material utilization, the recycling and processing of waste lithium batteries is an indispensable part of the circular economy [3]. Material reuse constitutes a key element in the technical feasibility of carbon mitigation [4]. Li *et al.* [7] propose that corporations have to take social responsibilities such as environmental protection. The development of renewable energy is influenced by management, government, corporate renewable energy R&D, corporate profits, ESG, and the Russo-Ukrainian War [8–10]. The academic field investigates how senior managers make decisions of the corporate decarbonization [11]. Nadel and Saves [12] emphasize corporate governance and ecological investments in French industry. Prior literature emphasizes the important roles of senior managers in renewable energy technological utilization.

III. MATERIALS AND METHODS

In this study, ten senior managers participated in our research by completing questionnaires in 2025 amid the Russia-Ukraine war. Linguistic terms are 9-scales in this research: absolutely strongly low, very strongly low, strongly low, low, just equal, high, strongly high, very strongly high, absolutely strongly high. Following steps are conducted:

Step 1: Triangular fuzzy numbers direct-influence data.

This study constructs direct-influence matrix of the triangular fuzzy number $D = [d_{I,j}] = [(d^L_{I,j}, d^M_{I,j}, d^U_{I,j})] = (D^L, D^M, D^U)$, where the lower limit matrix D^L, the middle matrix D^M, and the upper limit matrix D^U. Because we have 21 criteria, the criterion-level matrix D is 21 × 21.

Step 2: The criteria-based total-influence matrix *P*.

The maximum values of the sum of the criteria of rows and columns as Eq. (1)

$$S = \min\left\{\frac{1}{\max\limits_i \sum_{j=1}^{21} \tilde{d}_{i,j}}, \frac{1}{\max\limits_j \sum_{i=1}^{21} \tilde{d}_{i,j}}\right\} \tag{1}$$

Then, normalized matrix *N* is calculated through multiplying the direct-influence matrix *D* by matrix *S*. Total-influence matrix *P* for the criteria is denoted in Eq. (2):

$$P = N(I - N)^{-1} \tag{2}$$

Step 3: Computing criteria-based causal impact and total impact

$V_i = \sum_{j=1}^{21} p_{i,j}$ and $Z_i = \sum_{j=1}^{21} p_{j,i}$ of matrix *P* are computed. The *V* value represents the extent to which a criterion directly affects other criteria, while the *Z* value indicates the extent to which a criterion is directly affected by others.

Step 4: The dimension correlation

The means of the criteria $t_{i,j}$ for each dimension in matrix *P* is computed through the dimension-based total-influence matrix *T* as Eq. (3).

$$\mathrm{T} = \begin{bmatrix} \mathrm{t}_{1,1} & \cdots & \mathrm{t}_{1,4} \\ \vdots & \ddots & \vdots \\ \mathrm{t}_{4,1} & \cdots & \mathrm{t}_{4,4} \end{bmatrix}_{4\times 4} \tag{3}$$

The sum of the rows $Q_i = \sum_{j=1}^{4} t_{i,j}$ and the sum of columns $R_i = \sum_{j=1}^{4} t_{j,i}$ of the dimension-based total-influence matrix T are expressed.

Step 5: Dimension causality diagram.

In the dimension causality diagram, the *Y*-axis plots (Q − R), representing how much a dimension influences others, and the *X*-axis plots (Q + R), showing the total degree of mutual influence between a dimension and the others.

Step 6: Ranking the criteria importance using DANP.

This study follows Chiu *et al.* [13] to use the fuzzy DANP method to calculate the mutual influence and dependence relationship between each criterion.

IV. RESULT AND DISCUSSION

A. Criteria-Based Total Direct-Influence Matrix

To overcome the disadvantage of semantic error, this study refers to Mahad *et al.* [6], who use the fuzzy approach, so fuzzy DEMATEL is used in our study. Table 1 shows the dimension-based fuzzy total-influence matrix obtained by the middle value of the manager questionnaire investigation under the fuzzy framework. The upper, middle and lower value of the linguistic terms of the 9-scales: absolutely strongly low, very strongly low, strongly low, low, just equal, high, strongly high, very strongly high, absolutely strongly high are (1/9,1/9,1/8), (1/8,1/7,1/6), (1/6,1/5,1/4), (1/4,1/3,1/2), (1,1,1), (2,3,4), (4,5,6), (6,7,8), and (8,9,9), respectively. Table 1 denotes the criteria middle value of total direct-influence matrix under the fuzzy framework.

Table 1. Criteria middle value of total direct-influence matrix under the fuzzy framework

Criteria	C_1	C_2	C_3	C_4	C_5	C_6	C_7	C_8	C_9	C_{10}	C_{11}	C_{12}	C_{13}	C_{14}	C_{15}	C_{16}	C_{17}	C_{18}	C_{19}	C_{20}	C_{21}
C_1	0.120	0.170	0.176	0.173	0.201	0.170	0.173	0.163	0.128	0.178	0.108	0.120	0.129	0.123	0.140	0.136	0.172	0.157	0.112	0.088	0.166
C_2	0.193	0.158	0.209	0.200	0.242	0.195	0.202	0.183	0.146	0.215	0.134	0.156	0.167	0.165	0.181	0.165	0.204	0.201	0.124	0.088	0.186
C_3	0.195	0.210	0.141	0.210	0.235	0.195	0.202	0.189	0.140	0.211	0.128	0.146	0.153	0.148	0.170	0.155	0.213	0.199	0.124	0.088	0.178
C_4	0.175	0.182	0.173	0.144	0.213	0.174	0.180	0.163	0.147	0.187	0.129	0.152	0.150	0.150	0.168	0.152	0.187	0.179	0.108	0.078	0.161
C_5	0.205	0.218	0.200	0.211	0.174	0.213	0.216	0.186	0.146	0.216	0.129	0.156	0.158	0.153	0.178	0.166	0.206	0.189	0.117	0.083	0.182
C_6	0.185	0.204	0.187	0.212	0.227	0.176	0.232	0.196	0.162	0.248	0.150	0.180	0.189	0.165	0.191	0.191	0.241	0.239	0.144	0.081	0.180
C_7	0.187	0.209	0.185	0.211	0.229	0.221	0.184	0.201	0.166	0.250	0.152	0.189	0.192	0.168	0.192	0.200	0.243	0.241	0.145	0.082	0.182

C_8	0.194	0.221	0.202	0.229	0.228	0.236	0.237	0.176	0.176	0.264	0.165	0.196	0.210	0.177	0.202	0.211	0.258	0.252	0.151	0.092	0.196
C_9	0.154	0.160	0.146	0.177	0.178	0.178	0.175	0.162	0.103	0.183	0.119	0.134	0.138	0.134	0.146	0.140	0.186	0.181	0.109	0.071	0.141
C_{10}	0.207	0.231	0.210	0.237	0.254	0.254	0.259	0.244	0.191	0.217	0.177	0.208	0.217	0.187	0.214	0.218	0.270	0.262	0.163	0.102	0.213
C_{11}	0.213	0.236	0.207	0.236	0.259	0.264	0.275	0.242	0.192	0.287	0.143	0.223	0.232	0.205	0.229	0.216	0.261	0.264	0.161	0.125	0.220
C_{12}	0.191	0.219	0.189	0.221	0.245	0.238	0.257	0.216	0.180	0.264	0.173	0.156	0.211	0.195	0.221	0.211	0.248	0.248	0.152	0.088	0.193
C_{13}	0.215	0.246	0.223	0.259	0.265	0.273	0.288	0.264	0.208	0.292	0.202	0.237	0.186	0.234	0.256	0.252	0.287	0.289	0.164	0.103	0.216
C_{14}	0.187	0.211	0.189	0.222	0.236	0.210	0.220	0.197	0.146	0.232	0.157	0.197	0.201	0.135	0.205	0.185	0.219	0.216	0.126	0.083	0.172
C_{15}	0.202	0.233	0.206	0.244	0.253	0.242	0.256	0.211	0.179	0.266	0.179	0.219	0.219	0.201	0.169	0.200	0.252	0.248	0.146	0.089	0.193
C_{16}	0.207	0.222	0.207	0.246	0.255	0.253	0.260	0.260	0.194	0.271	0.173	0.214	0.225	0.190	0.219	0.170	0.265	0.266	0.150	0.096	0.213
C_{17}	0.176	0.207	0.197	0.204	0.225	0.223	0.230	0.205	0.174	0.246	0.141	0.159	0.163	0.145	0.168	0.165	0.179	0.224	0.140	0.099	0.182
C_{18}	0.185	0.217	0.196	0.224	0.238	0.249	0.257	0.230	0.188	0.265	0.171	0.192	0.201	0.176	0.195	0.209	0.263	0.194	0.157	0.093	0.192
C_{19}	0.113	0.130	0.119	0.127	0.141	0.132	0.135	0.126	0.100	0.148	0.090	0.103	0.104	0.095	0.107	0.105	0.147	0.135	0.067	0.066	0.123
C_{20}	0.099	0.102	0.084	0.093	0.106	0.091	0.095	0.088	0.073	0.103	0.066	0.076	0.078	0.071	0.079	0.078	0.107	0.094	0.073	0.035	0.114
C_{21}	0.192	0.203	0.167	0.188	0.216	0.183	0.190	0.173	0.146	0.199	0.128	0.143	0.147	0.139	0.160	0.145	0.205	0.188	0.134	0.112	0.131

B. Dimension-Based Total-Influence Matrix

Table 2 displays the upper, middle, lower, and average values for our proposed dimensions. The upper, middle, and lower values are listed in parentheses. From the senior managers' questionnaires, the influence of "government incentives and penalties" on "operation management", "renewable technology", and "environmental, social, and governance" is 0.2248, 0.2379, and 0.1917, respectively. "Government incentives and penalties" in the dimension-based total-influence matrix have the strongest influence on other dimensions. From the senior managers' questionnaires, the impact of "renewable technology" on "operation management", "government incentives and penalties", and "environmental, social, and governance" is 0.2025, 0.1784, and 0.1770, respectively. "Renewable Technology" in the dimension-based total-influence matrix has the second strongest influence on other dimensions. This suggests that advancing the circular economy has become a critical concern, particularly during the Russia-Ukraine war.

Table 2. Average dimension upper, middle, and lower value of the total-influence matrix

Dimensions	D_1	D_2	D_3	D_4
Operation Management (D_1)	0.1892 (0.169,0.189,0.209)	0.1808 (0.162,0.181,0.2)	0.1488 (0.13,0.149,0.168)	0.1517 (0.133,0.152,0.17)
Renewable Technology (D_2)	0.2025 (0.181,0.203,0.223)	0.2037 (0.187,0.204,0.22)	0.1784 (0.161,0.179,0.195)	0.1770 (0.161,0.177,0.193)
Government Incentives and Penalties (D_3)	0.2248 (0.201,0.225,0.248)	0.2379 (0.221,0.238,0.255)	0.2011 (0.183,0.201,0.219)	0.1917 (0.174,0.192,0.209)
Environmental, Social, and Governance (ESG) (D_4)	0.166 (0.145,0.166,0.187)	0.17 (0.152,0.17,0.187)	0.1333 (0.116,0.133,0.151)	0.1381 (0.122,0.138,0.155)

Fig. 1 depicted the dimension causality diagram. The positive value 0.1938 on the Y-axis indicates that renewable technology depends on the push of the "governmental incentives and penalties" dimension. Senior managers make efforts to develop renewable energy due to the governmental policies. The arrows of "government incentives and penalties" are all pointing to other dimensions. Fig. 1 implies that among all the dimensions, the government incentives and penalties only unilaterally affect the other dimensions, while other dimensions have minor effect on governmental incentives and penalties. Politically advancing the circular economy has become a critical concern, particularly during the Russia–Ukraine war.

C. Criteria-Based Total-Influence Matrix

Table 3 lists criteria-based causal impact and total impact. The fuzzy DEMATEL-based average row value of "green innovation (C_{10})," "energy circulation (C_7)," and "material reuse (C_6)" are 4.5368, 4.0307 and 3.9791. It further indicates that "renewable technology" exerts the second greatest influence on corporate carbon mitigation. Within this dimension, "green innovation", "energy circulation", and "material reuse" are identified as the most critical criteria. The findings highlight the importance of fostering renewable energy and green technologies in Taiwan's export-oriented economy to align with international sustainability standards and strengthen trade competitiveness

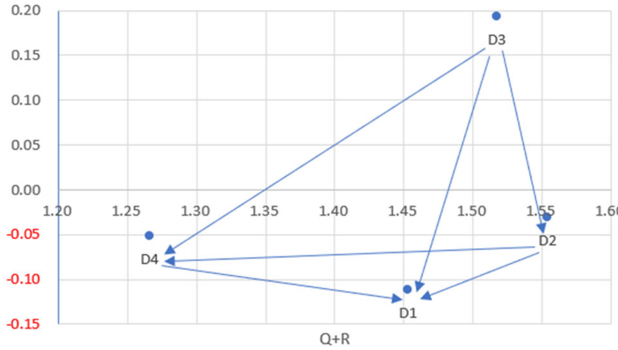

Fig. 1. Dimension causality diagram.

Table 3. Criteria-based causal impact and total impact

Dimensions	Criteria	*V*	*Z*	*V+Z*	*V-Z*
Operation Management (D_1)	C_1	3.106 (2.727,3.111,3.48)	3.7984 (3.339,3.804,4.253)	6.9044 (6.066,6.914,7.733)	−0.6924 (−0.611,−0.693,−0.773)
	C_2	3.7137 (3.285,3.718,4.138)	4.1886 (3.75,4.192,4.624)	7.9022 (7.034,7.91,8.762)	−0.4749 (−0.465,−0.474,−0.486)
	C_3	3.6317 (3.242,3.635,4.017)	3.8118 (3.386,3.815,4.234)	7.4435 (6.629,7.451,8.251)	-0.1801 (−0.144,−0.18,−0.216)
	C_4	3.3541 (2.903,3.359,3.801)	4.2683 (3.817,4.273,4.714)	7.6224 (6.72,7.632,8.515)	-0.9142 (−0.915,−0.914,−0.914)
	C_5	3.7017 (3.313,3.705,4.086)	4.6189 (4.125,4.625,5.106)	8.3205 (7.438,8.331,9.193)	−0.9172 (−0.811,−0.92,−1.02)
Renewable Technology (D_2)	C_6	3.9791 (3.621,3.982,4.334)	4.3705 (3.975,4.373,4.764)	8.3496 (7.596,8.355,9.098)	−0.3914 (−0.353,−0.392,−0.429)
	C_7	4.0307 (3.661,4.033,4.397)	4.5245 (4.166,4.527,4.881)	8.5551 (7.827,8.56,9.278)	-0.4938 (-0.504,-0.494,-0.484)
	C_8	4.2709 (3.886,4.274,4.652)	4.0781 (3.717,4.081,4.436)	8.3491 (7.604,8.355,9.088)	0.1928 (0.169,0.193,0.217)
	C_9	3.115 (2.734,3.119,3.492)	3.2833 (2.866,3.288,3.696)	6.3983 (5.6,6.407,7.188)	−0.1683 (−0.132,−0.169,−0.204)
	C_{10}	4.5368 (4.187,4.539,4.885)	4.7416 (4.423,4.743,5.059)	9.2784 (8.61,9.282,9.944)	−0.2048 (−0.236,−0.204,−0.174)
Government Incentives and Penalties (D_3)	C_{11}	4.6922 (4.268,4.696,5.113)	3.0127 (2.616,3.017,3.405)	7.7049 (6.884,7.713,8.518)	1.6795 (1.652,1.678,1.708)
	C_{12}	4.3167 (3.902,4.32,4.728)	3.5572 (3.186,3.56,3.926)	7.8739 (7.088,7.88,8.654)	0.7595 (0.716,0.76,0.802)
	C_{13}	4.9579 (4.585,4.96,5.329)	3.6693 (3.291,3.672,4.045)	8.6273 (7.876,8.632,9.374)	1.2886 (1.294,1.288,1.284)
	C_{14}	3.9453 (3.505,3.95,4.381)	3.3581 (2.94,3.363,3.772)	7.3034 (6.445,7.313,8.153)	0.5872 (0.566,0.587,0.609)
	C_{15}	4.4049 (4.029,4.408,4.778)	3.7899 (3.456,3.793,4.121)	8.1949 (7.485,8.2,8.899)	0.615 (0.573,0.615,0.657)
	C_{16}	4.5556 (4.183,4.557,4.927)	3.6709 (3.32,3.672,4.02)	8.2264 (7.503,8.229,8.947)	0.8847 (0.863,0.884,0.907)
Environmental, Social, and Governance (ESG) (D_4)	C_{17}	3.851 (3.495,3.853,4.205)	4.6137 (4.23,4.616,4.995)	8.4647 (7.725,8.469,9.199)	−0.7627 (−0.735,−0.763,−0.79)
	C_{18}	4.2901 (3.879,4.293,4.698)	4.4654 (4.088,4.467,4.841)	8.7555 (7.968,8.76,9.539)	−0.1753 (−0.209,−0.174,−0.143)
	C_{19}	2.4139 (2.023,2.419,2.8)	2.765 (2.367,2.769,3.159)	5.1789 (4.39,5.188,5.959)	−0.3511 (−0.343,−0.35,−0.36)
	C_{20}	1.8061 (1.509,1.809,2.1)	1.84 (1.595,1.842,2.084)	3.6462 (3.104,3.651,4.184)	−0.0339 (−0.085,−0.033,0.016)
	C_{21}	3.4899 (3.038,3.495,3.936)	3.7369 (3.327,3.741,4.142)	7.2268 (6.366,7.237,8.078)	−0.247 (−0.289,−0.246,−0.206)

The *(V-Z)* value of “green innovation (C_{10}),” “energy circulation (C_7),” and “material reuse (C_6)” are −0.2048, −0.3914 and −0.4938, while the *(V+Z)* value of “green innovation (C_{10}),” “energy circulation (C_7),” and “material reuse (C_6)” are 9.2784, 8.3496 and 8.5551. The renewable energy technologies, “green innovation (C_{10}),” “energy circulation (C_7),” and “material reuse (C_6),” should be driven by operational profits, regulatory support, and ESG policies so that their *(V-Z)* value is negative. However, their impact on other criteria is high as well, so the sum value is over eight.

Table 4 shows the DANP results. It indicates that global weights are 0.272, 0.274, 0.228, and 0.227 for operational management, renewable technology, government incentives and penalties, and ESG, respectively. The fuzzy DEMATEL-based Analytic Network Process (DANP) suggests that “renewable technology” exerts the greatest influence on corporate carbon mitigation. Within this dimension, “green innovation”, “energy circulation”, and “material reuse” are identified as the most critical criteria. The findings highlight the importance of fostering renewable energy and green technologies in Taiwan’s export-oriented economy to align with international sustainability standards and strengthen trade competitiveness. In addition, environmental regulation, carbon tax on international trade, and pollution penalty are the critical criteria within this dimension of government incentives and penalties, with the third strongest influence. Avoiding carbon trading in international trade is the initial focus, followed by government punishments and environmental regulations to mitigate the associated expenses. Our findings suggest that Taiwan's export-driven economy benefits from participating in carbon trading with trading partners to facilitate export transactions. On the other hand, senior managers believe that social donation (C_{19}) and friendly workplace (C_{20}) criteria in ESG dimension (D_4) are unrelated to the carbon mitigations. Therefore, their local weights are only 0.158 and 0.106, which rank behind other criteria.

Table 4. Ranking results of DANP

Dimensions	Criteria	Global Weight (1)	Sum of Global Weight (2)	Local Weight (1)/(2)
Operations Management (D_1)	C_1	0.050	**0.272**	0.184
	C_2	0.055		0.202
	C_3	0.050		0.184
	C_4	0.056		0.205
	C_5	0.061		0.224
Renewable Technology (D_2)	C_6	0.057	**0.274**	0.208
	C_7	0.059		0.215
	C_8	0.053		0.194
	C_9	0.043		0.156
	C_{10}	0.062		0.226
Government Incentives and Penalties (D_3)	C_{11}	0.033	**0.228**	0.143
	C_{12}	0.038		0.168
	C_{13}	0.040		0.174
	C_{14}	0.036		0.159
	C_{15}	0.041		0.180
	C_{16}	0.040		0.175
Environmental, Social, and Governance (ESG) (D_4)	C_{17}	0.060	**0.227**	0.264
	C_{18}	0.058		0.255
	C_{19}	0.036		0.158
	C_{20}	0.024		0.106
	C_{21}	0.049		0.216

V. Conclusion

Carbon mitigation is pivotal to the circular economy. This study employs fuzzy mathematics within a DEMATEL to explore optimal strategies for green innovation. The DEMATEL method identifies the interdependent feedback relationships among four key dimensions—ESG, government incentives and penalties, renewable technology, and operational management—as well as the causal linkages between these dimensions. This analysis identifies the dimension that most significantly influences corporate green innovation. This study collected questionnaires from ten senior managers for analysis. The results of the dimension causality diagram illustrate that the arrows of "government Incentives and Penalties" are all pointing to other dimensions, implying that among all the dimensions, the government incentives and penalties only unilaterally affect the other dimensions. DANP approaches further indicate that "renewable technology" exerts the greatest influence on corporate carbon mitigation. Within this dimension, "green innovation", "energy circulation", and "material reuse" are identified as the most critical criteria. The findings highlight the importance of fostering renewable energy and green technologies in Taiwan's export-oriented economy to align with international sustainability standards and strengthen trade competitiveness. The contribution of this study confirms that senior managers believe that renewable energy technology is the key to corporate carbon mitigation, especially during the Russia-Ukraine war, where the supply of oil energy is unstable. However, the cost of a renewable technology breakthrough is high, and government incentives and penalties are the key to motivating senior managers to commit to carbon mitigation. On the other hand, senior managers believe that social donation and friendly workplace criteria in ESG dimension are unrelated to environmental protection. Therefore, DANP ranks them behind other criteria.

Conflict of Interest

The authors declare no conflict of interest.

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