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Structure Optimization of Academic Disciplines for Universities Featuring Energy under the Roadmap towards Carbon Neutrality: Results from a Hybrid Fuzzy-Based Method

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Abstract: The goal of carbon neutrality is an extensive and profound economic and social change, which will have far-reaching impacts on industrial structure, energy structure, and social consumption structure. Energy sectors will face in-depth adjustment, and it is essential to optimize major structures consequently due to the foresight of talent training. This research first employs Strengths, Weaknesses, Opportunities, and Threats (SWOT) analysis, Analytic Network Process (ANP), and the weighted fuzzy Technique for Order Performance by Similarity to Ideal Solutions (TOPSIS) to formulate and analyze the structure optimization of academic disciplines, and finally, the universities featuring mining are taken as an example to verify the feasibility of the method. Results reveal that the integration of ANP, SWOT, and the fuzzy TOPSIS evaluation method is able to qualify the assessment for academic discipline optimization. The specialty structure optimization results should focus on clean, intelligent, and sustainable development of the coal industry. The first priority is to increase relevant research on sustainable development of the mining industry, with a priority value of 0.0435. The modern coal chemistry and intelligent coal mining are also highly valued as the options for achieving carbon neutrality. Adding natural gas-related majors is underestimated as the least recognized priority, with a priority value of 0.0133. Suggestions and implications are provided for structure optimization of academic disciplines in universities featuring energy.

Keywords: carbon neutrality; universities featuring energy; structure optimization; SWOT; ANP; fuzzy TOPSIS

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1. Introduction

With the proposal of a carbon neutralization goal, the low-carbon development mode will accelerate energy system transitions, and the energy industry will be significantly affected by this clean transformation. As of the end of 2021, more than 130 countries have incorporated carbon neutrality commitments into their national climate strategies to advance a zero-carbon future [1]. In 2020, China has announced that it will strive to peak carbon dioxide emissions before 2030 and achieve carbon neutrality before 2060. This vision will promote the development of a green and low-carbon energy system, and increase the proportion of non-fossil energy in energy supply [2]. With the changes of energy structure, the coal and petroleum industry, thermal power industry, and non-metallic minerals sector are facing new requirements for technological innovation and talent training. In 2021, the Ministry of Education of China issued the "Carbon Neutral Science and Technology Innovation Action Plan for Colleges", to improve scientific and technological support and talent cultivation. The universities have the mission of actively responding to climate change through research, education, technological innovations, and should play a major role in talents cultivation and transformative research. It is urgent and indispensable for the universities featuring energy to cultivate talents with technological innovation and high-quality management ability, and those who promote the transformation and development of coal, oil and gas, non-energy minerals and so on.

The universities with a distinctive characteristic in the energy field refer to universities that focus on energy-related disciplines and support the development of energy industry by cultivating high-end talents and developing advanced energy technology, including China University of Mining and Technology, Colorado School of Mines, China University of petroleum, and Heriot-Watt University, etc. The majors of the universities featuring energy are relatively centralized on disciplines behind the carbon emissions. The pace of engineering disciplines construction and talent training cannot keep up with the needs of industrial transformation under the goal of carbon neutrality. It is urgent to carry out the research on the disciplines structure optimization for these universities featuring energy serving for the targets of carbon peak and carbon neutrality. The optimization on the specialty structure and training system will be beneficial for energy transition and industrial transition through an educated workforce cultivation by universities.

The discipline optimization and strategic planning for university have become the focus of numerous researchers because of industrial structure adjustment. Taking Yangtze University College of Engineering and Technology as an example, Liu did a specific analysis on the core elements of how to carry out structural adjustment and development by using the method of qualitative analysis [3]. Dyson analyzed the strategic development of the University of Warwick using SWOT (strengths (S), weaknesses (W), opportunities (O), and threats (T)) analysis [4]. Syed Hammad et al. evaluated the opportunities and challenges for sustainable development of universities in Industry 4.0 using SWOT and the analytic hierarchy process (AHP), and concluded that effective financial planning, skilled staff, increased industrial partnerships, and advanced infrastructure are fundamental requirements for universities [5]. Through the SWOT method, Lu analyzed the opportunities and challenges faced by the specialty construction of Five-year Higher Vocational Colleges in Xuzhou, and put forward the optimization strategies of major setting innovation, curriculum system innovation, and Industry–University–Research cooperation [6]. The above studies are absent in quantitative analysis of strategic ranking and systematic evaluation model of specialty structure optimization. Therefore, this study is to optimize major structure of the universities featuring energy by constructing a decision evaluation model, so as to achieve sustainable development of universities with energy characteristics and meet the talent and technical needs for the realization of carbon neutrality.

The contributions of this study are as follows. First, due to the importance of discipline optimization in the universities featuring energy, the selection of the optimization strategies is a critical and complex decision-making problem. This study proposes a comprehensive hybrid evaluation model using SWOT analysis, Analytic Network Process (ANP) process, and weighted fuzzy Technique for Order Performance by Similarity to Ideal Solution (TOPSIS) to solve the decision-making problem of disciplines optimization in the universities featuring energy. Second, the coal industry is the major contributor to China's carbon emissions, and it will be inevitable for coal industry adjustment to reduce coal use and to achieve clean coal consumption gradually. The talent training and technological innovation of the universities featuring mining cannot match the requirements of mining industry development. Therefore, this study takes the universities featuring mining as a case study and systematically analyzes the structure optimization of academic disciplines from the aspects of talent training, major adjustment, and curriculum system construction under the goals of carbon neutrality and carbon peak. What should be emphasized is the feasibility of the proposed analytic framework and methodology in determining the major optimization of universities or faculties featuring in all energy field under the goal of carbon neutrality.

The rest of this study is organized as follows. Section 2 firstly explained the fundamentals about SWOT, ANP, and fuzzy TOPSIS, and then presented the proposed integrated methodology. The structure optimization of academic disciplines is discussed in Section 3 by taking the universities featuring mining as the research object. The sensitivity analysis is shown in Section 4. Finally, the conclusions of this study are given in Section 5.

2. Methodologies

2.1. Research Framework

Figure 1 is the integrated framework of the research. With the background of discipline structure optimization, this research puts forward an integrated hybrid evaluation model using SWOT, ANP, and the fuzzy TOPSIS method to analyze the structure optimization of academic disciplines in the universities featuring energy. Firstly, SWOT analysis is employed to identify strengths, weaknesses, opportunities, and threats from internal and external perspectives, and then the ANP method is used to determine the weights of SWOT factors, which are inputted in the fuzzy TOPSIS to calculate the priorities of optimization strategies. Finally, the above methodology is applied to academic disciplines optimization by a case study on the universities featuring mining. The methods employed are briefly described in the following sections.

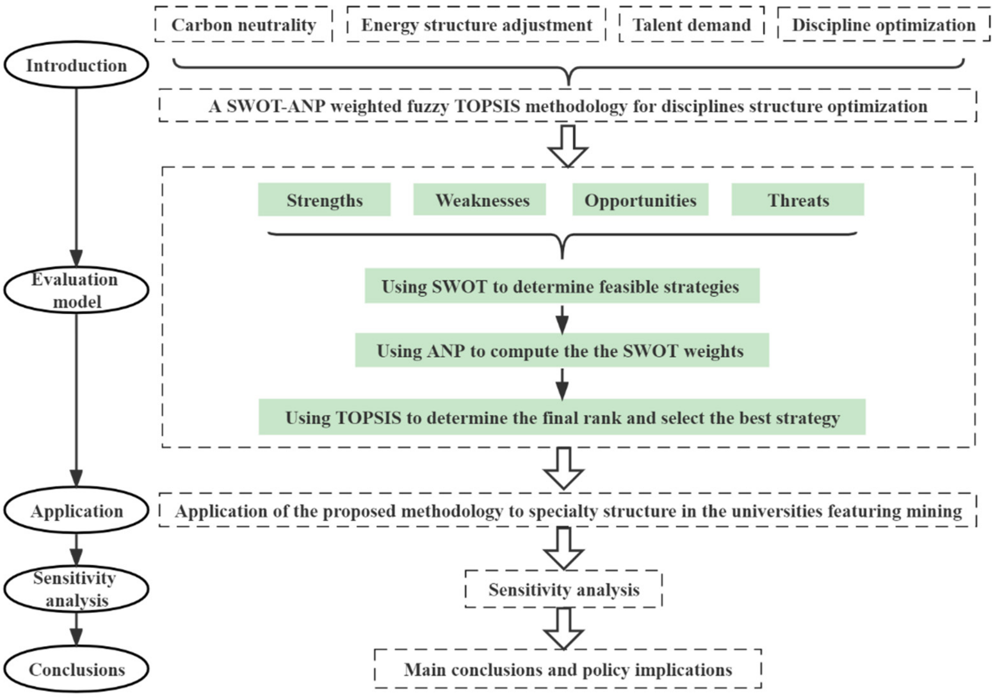

Figure 1. The integrated framework of discipline structure optimization.

2.1.1. SWOT Analysis

The SWOT analysis is a powerful strategic tool for strategy formulation and selection [7]. The method determines the best combination of strategies that maximizes strengths and opportunities and minimizes weaknesses and threats, and hence provides a good basis for the correct selection of strategies. Al-Haidous et al. made a SWOT analysis to identify the strengths, weaknesses, opportunities, and threats in liquefied natural gas supply chain [8]. Based on the SWOT method, high-level planning strategies are developed for Turkey's power supply chain [9]. Wang et al. employed ANP and SWOT to explore the suitable reutilization methods for abandoned mines [10]. In this study, SWOT could be helpful for discovering the possible directions for discipline optimization. The SWOT analysis framework applicable to the specialty structure adjustment of the universities and faculties featuring energy is shown in Table 1.

Table 1. The SWOT analysis framework applicable to the specialty structure adjustment of the universities and faculties featuring energy.

		Internal Factors	
		Strengths (S): Strengths of Discipline, Teachers and Scientific Research	Weaknesses (W): Lack of Preponderant Disciplines and Emerging Disciplines
External Factors	Opportunities (O): Advantages of fossil energy, support from the government and society for the universities and faculties featuring energy	SO strategy: Continuing to develop preponderant disciplines	WO strategy: Optimizing the inferior majors and matching the development requirement of the industry
	Threats (T): Competitive advantages of new energy and the universities' responsibility to promote low-carbon development	ST strategy: Making use of discipline advantages to increase new energy-related research	WT strategy: Adding emerging majors and participating in carbon neutrality initiatives

2.1.2. Analytic Network Process Method

The Analytic Network Process (ANP) method is the extension of the analytic hierarchy process (AHP), which can systematically evaluate all relationships by adding potential interaction, interdependence, and feedback to the decision system. The strength of this method is that it can easily represent decision problems involving many complex relationships [11]. Yang et al. established a comprehensive evaluation model based on ANP to evaluate the benefits of a 100-memawatt storage project [12]. Liu et al. analyzed the criteria of efficient carbon capture and separation technologies for sustainable clean energy usage with the ANP method [13]. The ANP method used in this research is feasible for measuring all connections between these possible optimization directions in the SWOT analysis.

2.1.3. Technique for Order Preference by Similarity to Ideal Solution

The Technique for Order Preference by Similarity to Ideal Solution (TOPSIS) was first proposed by HwangCL and YoonK in 1981 [14]. It is used to rank according to the proximity between the evaluation object and the idealized target [15]. Wang et al. constructed the evaluation system by using two multi-objective decision-making methods of AHP and TOPSIS, as well as a triangular fuzzy number, and concluded the convenience of TOPSIS in phytoremediation agent selection [16]. Solangi et al. provided a comprehensive decision support framework based on AHP and Fuzzy TOPSIS to prioritize suitable sites for the wind project development in Pakistan [17]. Djordjevic and Krmac evaluated energy-environment efficiency (EEE) of European transport sectors using non-radial Data Envelopment Analysis (DEA) and TOPSIS approach, and suggested that the TOPSIS method is more suitable in transport EEE evaluation [18].

2.2. The SWOT-ANP Weighted Fuzzy TOPSIS Methodology

Figure 2 shows the main steps of the proposed methodology. The calculation steps of the SWOT-ANP weighted fuzzy TOPSIS methodology are given below.

Step 1: Determine the SWOT matrix of structure optimization of academic disciplines by defining SWOT factors and sub-factors. This matrix should be checked by profession.
Step 2: Identify feasible strategies by using the SWOT matrix.
Step 3: Construct pairwise comparisons of the SWOT factors using the 1–9 scale of ANP method with respect to the objective (W_1). For pairwise comparison, the scoring criteria is shown in Table A1 and assessed by expert investigation.
Step 4: Determine the interdependence among the SWOT factors and obtain the relative importance weight (W_2). Then, the interdependence weight values of SWOT factors ($W_3 = W_1 \times W_2$) are calculated.

Step 5: Calculate the local importance of SWOT sub-factors.
Step 6: Determine the overall weights of SWOT sub-factors.
Step 7: Obtain normalized language variables and normalize each SWOT sub-factor for fuzzy TOPSIS modeling. The conversion rules of language variables are shown in Table A2. The decision matrix (X) is demonstrated by the following formula:

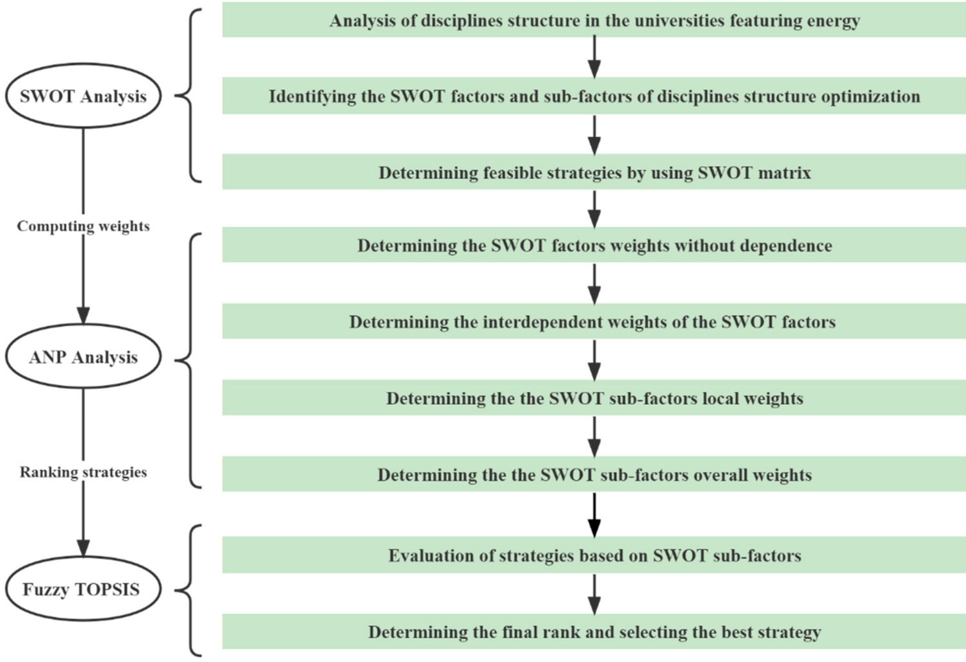

Figure 2. The main steps of the proposed methodology.

$$X = \begin{array}{c} \\ A_1 \\ \vdots \\ A_i \\ \vdots \\ A_m \end{array} \begin{array}{c} \begin{array}{ccccc} C_1 & \cdots & C_j & \cdots & C_n \end{array} \\ \begin{bmatrix} x_{11} & \cdots & x_{1j} & \cdots & x_{1n} \\ \vdots & \ddots & \vdots & \ddots & \vdots \\ x_{i1} & \cdots & x_{ij} & \cdots & x_{in} \\ \vdots & \ddots & \vdots & \ddots & \vdots \\ x_{m1} & \cdots & x_{mj} & \cdots & x_{mn} \end{bmatrix} \end{array} \quad (1)$$

where, $A_i(i = 1, 2, \ldots, m)$ is the ith strategy; $C_j(j = 1, 2, \ldots, n)$ is the jth criterion. x_{ij} represents the attribute value of the ith strategy of the jth criterion.

Then, the normalization process is performed by the following formula:

$$r_{ij} = \begin{cases} (a_{ij}/c_j^*, b_{ij}/c_j^*, c_{ij}/c_j^*), j \in B \\ (a_j^-/c_{ij}, a_j^-/b_{ij}, a_j^-/a_{ij}), j \in C \end{cases} \quad (2)$$

where, $c_j^* = \max_i c_{ij}, j \in B, a_j^- = \min_i c_{ij}$, and $j \in C$; B and C represent the collection of benefit attributes and cost attributes.

Step 8: Obtain the weighted normalized fuzzy decision matrix with respect to each SWOT sub-factor. The weight of each criterion is obtained from ANP method. And the weighted normalized fuzzy decision matrix is constructed as follows:

$$\widetilde{V} = [\widetilde{v_{ij}}]_{m \times n}, i = 1, 2, \ldots m\ j = 1, 2, \ldots n \quad (3)$$

$$\widetilde{v_{ij}} = \widetilde{r_{ij}} W_{ij} \quad (4)$$

where W_{ij} represents the weight of criterion C_j.

Step 9: Determine the distance to the fuzzy positive ideal solution (d_i^*) and fuzzy negative ideal solution (d_i^-) by using Equation (5).

$$\begin{cases} d_i^* = \sqrt{1/3\left[\left(1-\widetilde{v_{lij}}\right)^2 + \left(1-\widetilde{v_{mij}}\right)^2 + \left(1-\widetilde{v_{nij}}\right)^2\right]} \\ d_i^- = \sqrt{1/3\left[\left(\widetilde{v_{lij}}-0\right)^2 + \left(\widetilde{v_{mij}}-0\right)^2 + \left(\widetilde{v_{nij}}-0\right)^2\right]} \end{cases} \quad (5)$$

Step 10: Calculate the closeness coefficient for each alternative by the following formula:

$$CC_i = d_i^- / (d_i^* + d_i^-), i = 1, 2, \ldots, m \quad (6)$$

Step 11: Rank the order of alternative strategies according to closeness coefficients and select the best strategy.

3. Application of the Proposed Methodology to Academic Structure

In order to demonstrate the feasibility of this framework in the universities or faculties featuring energy, this study takes the universities or faculties featuring mining (e.g., Colorado School of Mines, USA; China University of Mining and Technology, China) and the universities or faculties featuring electric power (e.g., Faculty of Electrical Engineering and Information Technology, RWTH Aachen University, Germany; North China Electric Power University, China) as examples to exemplify SWOT analysis. The SWOT analysis of specialty structure optimization in the universities or faculties featuring electric power is shown as Table A3. Considering data availability, only the optimization decisions of the universities or faculties featuring mining are determined, and the results are shown as follows.

3.1. SWOT Analysis for the Structure Optimization of Academic Disciplines

This study determines the strengths (S), weaknesses (W), opportunities (O) and threats (T) of the structure optimization of academic disciplines for the targets of carbon neutrality. First, we reviewed the literature to fully understand the advantages and disadvantages. Then, experts are invited to distinguish the factors that may affect the strategies possibly. The SWOT analysis matrix is shown in Table 2.

3.1.1. Strengths

Advantage of mining disciplines (S1): The universities featuring mining have built a complete range of disciplines in the mining industry. They have disciplines and key laboratories with distinct energy characteristics.

Advantage of Industry–University–Research (S2): The interaction between coal-related industries and universities is an incomparable advantage of comprehensive universities to serve for industries.

Professional teachers in mining disciplines (S3): With the task of innovating and improving mining technology, the teachers should have a deep industry background, and their scientific research is closer to the production front line of the enterprise and the cutting-edge problems of the mining field.

3.1.2. Weaknesses

Few preponderant disciplines (W1): Due to the long-term reliance on industries, the universities featuring mining only pay attention to the development of applied disciplines closely related to mining industry in the initial stage, resulting in narrow discipline range and few preponderant disciplines.

The absence of majors in emerging industries (W2): From the perspective of majors setting and connotation construction, the universities featuring mining have insufficient research in emerging industries such as the information technology industry, new energy automobile industry, environmental protection industry, and digital creative industry, which is difficult to meet the social requirements [19].

Table 2. SWOT matrix of specialty structure optimization of the universities featuring mining.

	Internal Factors	Strengths (S)	Weaknesses (W)
	External Factors	S1: Advantage of mining disciplines S2: Advantage of Industry–University–Research S3: Professional teachers in mining disciplines	W1: Few preponderant disciplines W2: The absence of majors in emerging industries W3: Backward development of existing majors W4: Low social recognition
Opportunities (O)	O1: Importance of coal O2: "Double first-class" discipline construction O3: Intelligent and clean development of the coal industry O4: Development of coal-based carbon materials	Strategies (SO) SO1: Deep integration of industry, university and research SO2: Adding intelligent mining major SO3: Developing energy-saving technologies in mineral processing	Strategies (WO) WO1: Increasing the research directions of clean coal utilization and coal-based carbon materials WO2: Adding modern coal chemical engineering WO3: Holding academic forums, community activities, practices, and other teaching activities
Threats (T)	T1: Inevitable reduction of coal consumption T2: Competitive advantage of natural gas T3: Great potential for developing renewable energy T4: Responsibility of universities to promote low-carbon development	Strategies (ST) ST1: Increasing research on sustainable development of mining industry ST2: Increasing research on energy security ST3: Adding carbon storage science and Engineering ST4: Increasing the exploration direction of low-carbon energy, non-carbon energy, and metal energy ST5: Opening common recognize lessons on energy conservation and emission reduction	Strategies (WT) WT1: Adding natural gas-related majors WT2: Setting up new energy disciplines WT3: Adding green architecture major WT4: Adding smart grid and energy storage engineering WT5: Incorporating carbon finance, carbon management, and other carbon neutrality-related courses into the curriculum system WT6: Setting up social management and policy discipline WT7: Adding big data-related majors

Backward development of existing majors (W3): In the context of carbon neutrality, it is imperative for the universities featuring mining to cultivate innovative talents, lead the technology revolution, and boost the transformation of the coal industry. However, major construction and talent training cannot match the needs of coal industry transformation [19].

Low social recognition (W4): Due to the poor employment environment and remote employment areas, most of students are reluctant to choose mining-related majors.

3.1.3. Opportunities

Importance of coal (O1): In China, coal is still the basic energy to ensure the stable development of economy and society for a near future (2020–2035) [20].

"Double first-class" discipline construction (O2): The "double first-class" construction changes the current situation that policies support universities rather than disciplines, so as to encourage universities to facilitate discipline advantages and develop discipline characteristics [21]. The universities featuring mining can take this opportunity to develop advantageous disciplines.

Intelligent and clean development of the coal industry (O3): Under the carbon constraint goals, the coal industry should still focus on safe, green, and intelligent coal mining and intensive utilization to build a modern coal industry.

Development of coal-based carbon materials (O4): The realization of carbon neutrality will ultimately depend on industries with net-zero emission, so coal-based carbon materials will usher in development opportunities.

3.1.4. Threats

Inevitable reduction of coal consumption (T1): The carbon peak and carbon neutrality require the decline in the coal consumption. This decline will lead to the difficulty for the development of the universities featuring mining.

Competitive advantage of natural gas (T2): Compared with other fossil fuels, natural gas has its unique advantage, which is attributed to a clean, convenient, high-quality and efficient energy. Coal to gas is a novel road for a clean coal chemistry.

Great potential for developing renewable energy (T3): With the abundance of renewables, renewable energy development has become a new driving force to achieve the proposal of carbon neutrality.

Responsibility of universities to promote low-carbon development (T4): Universities undertake the functions of scientific research, talent training, and social service, and have the responsibility in promoting green and low-carbon transformation [22].

3.1.5. Strategies

By using SWOT analysis, four strategic plans can be proposed: SO strategies, WO strategies, ST strategies, and WT strategies. The strategies developed are detailed in the following.

1. SO strategies

Deep integration of industry, university and research (SO1): The development of the universities featuring mining is closely related to the mining industry. Therefore, it is necessary to form a multi-element collaborative interaction model with universities, enterprises, and research institutions as the core elements [23].

Adding intelligent mining major (SO2): According to the low-carbon requirements of the coal industry, the intelligent mining major should be added to innovate intelligent, unmanned, and safe mining technology [24].

Developing energy-saving technologies in mineral processing (SO3): Considering the efficient utilization of mineral resources, mineral process engineering needs to be improved by energy-saving technologies, and to cultivate high-quality professionals.

2. WO strategies

Increasing the research directions of clean coal utilization and coal-based carbon materials (WO1): The clean coal utilization technology is one of the leading technologies to solve environmental problems from coal-firing, coal processing, coal combustion, coal conversion, etc [25]. The carbon material industry is an emerging industry with high technology integration, strong economic driving force, fast development speed, and great comprehensive benefits. New carbon materials will effectively promote the industrial revolution in the fields of aviation, aerospace, transportation, energy, and environmental protection [26].

Adding modern coal chemical engineering (WO2): Modern coal chemical industry refers to taking clean coal chemicals as the target products by innovative coal transformation technologies in the future. It is a strategy for the coal industry to adjust the industrial structure and take the road of modern industrialization [27].

Holding academic forums, community activities, practices, and other teaching activities (WO3): The popularity and recognition of mining disciplines could be enhanced by academic forums, practice, and community activities such as mining knowledge competitions.

3. ST strategies

Increasing research on sustainable development of mining industry (ST1): This strategy can promote the sustainable development of the mining industry to increase the majors of green mine, green industrial engineering, and abandoned mines utilization.

Increasing research on energy security (ST2): With the development of new energy, energy security issues such as nuclear security, hydrogen security, and energy storage security cannot be ignored [28].

Adding carbon storage science and engineering (ST3): While emphasizing the source control of carbon dioxide emissions, the utilization of carbon dioxide resource cannot be ignored, which can effectively reduce emissions and make full use of carbon resources through carbon capture, utilization, and storage [29].

Increasing the exploration direction of low-carbon energy, non-carbon energy and metal energy (ST4): It takes a heavy burden for the investigation, evaluation, exploration, and development of low-carbon energy, such as shale gas and natural gas hydrate, non-carbon energy represented by geothermal, dry hot rock, and nuclear energy, and key metal minerals represented by lithium and rare earth.

Opening common cognition lessons on energy conservation and emission reduction (ST5): Common cognition lessons of carbon neutrality can popularize and improve college students' awareness of energy conservation and emission reduction, and cultivate their sense of social responsibility and innovation.

4. WT strategies

The first three WT strategies adding natural gas-related majors (WT1): Natural gas is a relatively clean energy compared with coal and oil. The natural gas market in China is still in the cultivation stage, and there is potential for the development of efficient and clean natural gas.

Setting up new energy disciplines (WT2): Considering the low proportion of new energy in China, new energy development is indispensable and essential for carbon neutrality goal.

Adding green architecture major (WT3): There are few and unsystematic green architecture knowledge and courses in China, and its development and demand for talents are very urgent.

Adding smart grid and energy storage engineering (WT4): Low-carbon transformation of power systems is an efficient tool to coping with climate change through developing smart grids, energy storage, and other technologies that can improve the flexibility of power systems.

Incorporating carbon finance, carbon management, and other carbon neutrality-related courses into the curriculum system (WT5): Based on the professionalism of carbon market, carbon finance and carbon trading, carbon-neutrality-related courses such as carbon finance and carbon management should be included in the curriculum system.

Setting up social management and policy disciplines (WT6): The prolonged and deep emission reduction is the inevitable trend of future development under the vision of carbon neutrality. It is necessary to ensure the long-term engagement and strengthen the implementation of emission reduction policies through legislation. Therefore, we should strengthen the academic research and discipline construction of social policy.

Adding big data-related majors (WT7): Based on the construction of a carbon-neutral society, big-data-related majors can concentrate on cultivating professionals with data mining and analysis serving for the carbon reduction of various industries.

3.2. The Weight Values of SWOT Indicators Based on ANP Method

The structure optimization of academic disciplines can be transformed into a hierarchical structure in order to convert the sub-factors and strategies into a state, in which they can be measured by the ANP method. The structure is shown in Figure 3.

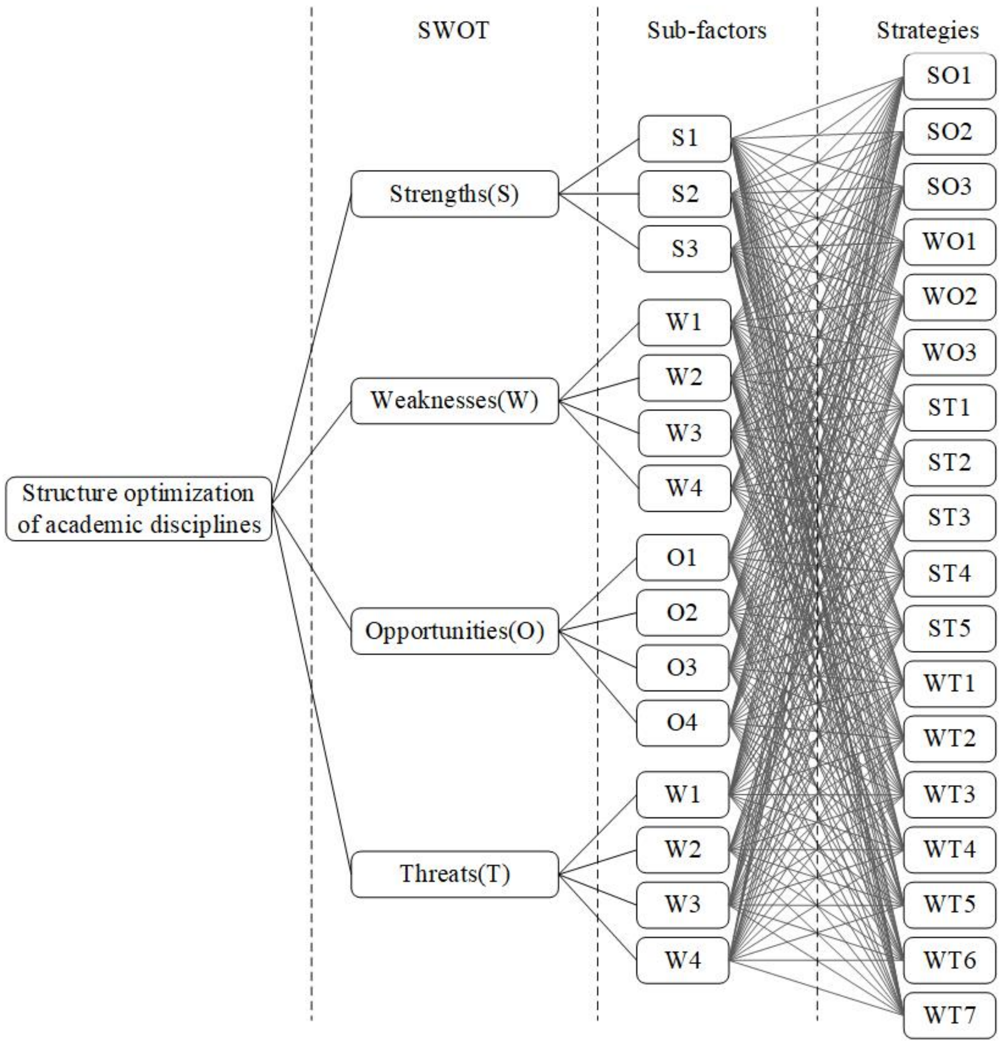

Figure 3. The hierarchy and network structure.

Assuming that there is no dependency between SWOT factors, a pairwise comparison of the SWOT factors with respect to the goal is conducted. Thus, the weight values of SWOT factors are calculated as follows:

$$W_1 = [S, W, O, T]^T = [0.2950, 0.0815, 0.5197, 0.1038]^T \quad (7)$$

The interdependence between SWOT factors is determined by comparing the impact of each factor on every other factor [30]. Based on the inner dependence of SWOT factors, the paired comparison matrices are formed and shown in Tables A4–A7.

Using the calculated relative importance weight values, the interdependent matrix of SWOT factors (W_2) are constructed by Equation (8):

$$W_2 = \begin{bmatrix} 0 & 0.6000 & 0.6483 & 0.5584 \\ 0.1667 & 0 & 0.2297 & 0.1220 \\ 0.6667 & 0.3000 & 0 & 0.3196 \\ 0.1667 & 0.1000 & 0.1220 & 0 \end{bmatrix} \quad (8)$$

The interdependent priorities of SWOT factors (W_3) are calculated as follows:

$$W_3 = W_2 \times W_1 = \begin{bmatrix} 0 & 0.6000 & 0.6483 & 0.5584 \\ 0.1667 & 0 & 0.2297 & 0.1220 \\ 0.6667 & 0.3000 & 0 & 0.3196 \\ 0.1667 & 0.1000 & 0.1220 & 0 \end{bmatrix} \times \begin{bmatrix} 0.2950 \\ 0.0815 \\ 0.5197 \\ 0.1038 \end{bmatrix} = \begin{bmatrix} 0.4438 \\ 0.1812 \\ 0.2543 \\ 0.1207 \end{bmatrix} \quad (9)$$

The next step is to conduct the pairwise comparison to calculate the local priorities of SWOT sub-factors. The overall weights of the SWOT sub-factors are obtained by multiplying the interdependent priorities of SWOT factors (W_3) with the local priorities of SWOT sub-factors. The overall weights of the SWOT sub-factors are shown in Figure 4.

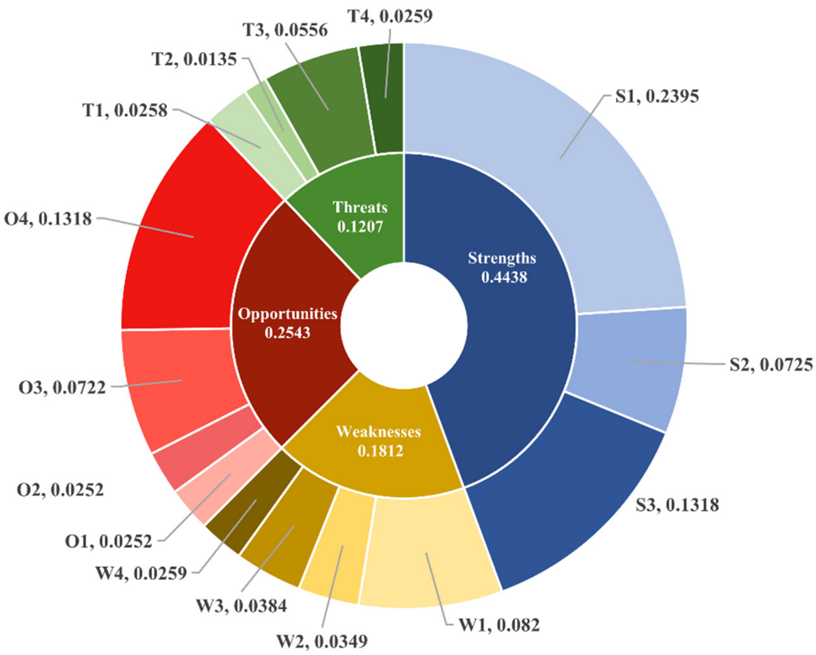

Figure 4. The weight values of SWOT factors and sub-factors.

As can be seen from Figure 4, the ranking of weight values is: advantage of mining disciplines (S1); professional teachers in mining disciplines (S3); development of coal-based carbon materials (O4); few preponderant disciplines (W1); advantage of Industry–University–Research (S2); intelligent and clean development of the coal industry (O3); great potential for developing renewable energy (T3); backward development of existing majors (W3); the absence of majors in emerging industries (W2); low social recognition (W4); responsibility of universities to promote low-carbon development (T4); inevitable reduction of coal consumption (T1); importance of coal (O1); "double first-class" discipline construction (O2); and competitive advantage of natural gas (T2), respectively.

3.3. The Priorities of Structure Optimization of Academic Disciplines Based on Fuzzy TOPSIS

With regards to the alternatives and SWOT sub-factors, the evaluation matrix is obtained by using the linguistic variables provided by the experts and is shown in Figure 5. Then, the weighted normalized fuzzy decision matrix with respect to each SWOT sub-factors is constructed in Table A8. Finally, the TOPSIS method is used to prioritize the evaluated SWOT factors, and the closeness coefficients of SWOT factors are given in Table 3. The alternatives in descending order could be ranked as ST1, SO2, WO2, SO1, WO1, ST3, ST4, SO3, ST2, ST5, WO3, WT2, WT4, WT3, WT5, WT7, WT6, and WT1.

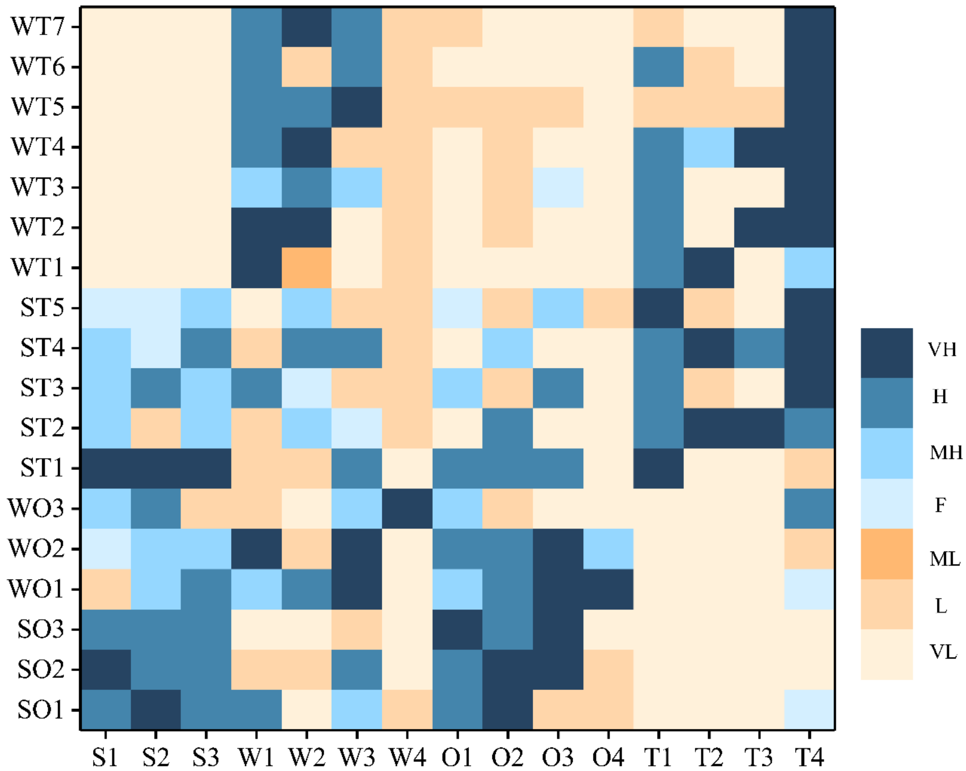

Figure 5. The evaluation matrix for TOPSIS method.

Table 3. The priority ranking of strategies using fuzzy TOPSIS.

Strategies	Distance to the Fuzzy Positive Ideal Solution	Distance to the Fuzzy Negative Ideal Solution	Closeness Coefficients of each Strategy	Ranking of Strategies
SO1	14.40	0.62	0.0412	4
SO2	14.39	0.63	0.0420	2
SO3	14.47	0.55	0.0365	8
WO1	14.41	0.61	0.0407	5
WO2	14.39	0.63	0.0419	3
WO3	14.63	0.40	0.0266	11
ST1	14.36	0.65	0.0435	1
ST2	14.52	0.50	0.0334	9
ST3	14.43	0.59	0.0394	6
ST4	14.46	0.56	0.0374	7
ST5	14.57	0.46	0.0304	10
WT1	14.82	0.20	0.0133	18
WT2	14.75	0.27	0.0182	12
WT3	14.77	0.25	0.0170	14
WT4	14.76	0.27	0.0182	13
WT5	14.78	0.25	0.0164	15
WT6	14.81	0.21	0.0143	17
WT7	14.80	0.23	0.0150	16

According to the results of the SWOT-ANP weighted fuzzy TOPSIS analytic methodology, increasing relevant research on sustainable development of mining industry (ST1) ranks as the first priority. The main reason that makes this strategy very important is the professional advantage of the universities featuring mining and the basic position of coal in the energy structure. On the one hand, the universities featuring mining have formed advantageous brands and distinctive characteristics in the fields of coal energy exploration, development, utilization, and production-related machinery, safety, and management engineering. On the other hand, with abundant resources in China, coal plays the role of stabilizer and ballast in the energy system.

Strategy SO2 (adding intelligent mining major) ranked as the second highest priority with a value of 0.042, and China University of Mining and Technology (Beijing) has added this major in 2021. Strategy WO2 (increasing modern coal chemical engineering) is the third highest with a priority rank value of 0.0419. In 2021, the plan to build a national modern coal chemical industry cluster has been proposed in China, which will be jointly built by Ningdong in Ningxia, Ordos in Inner Mongolia and Yulin in Shaanxi. The above two cases are consistent with the results of this study, which proves the efficiency of the integration of ANP, SWOT, and the fuzzy TOPSIS evaluation method to decide optimization direction of specialty structure.

One of the remarkable points in the results is that adding a natural-gas-related majors (WT1) strategy has the lowest priority rank among all strategies. Natural gas will play an important role as a bridge between high carbon fossil energy and non-carbon energy. However, under the constraints of the carbon neutrality target, the proportion of fossil energy in energy structures will shrink significantly, and the long-term demand of natural gas may be limited by resource endowment. The limited development of natural gas may have an impact on the experts' opinions and, hence, on the final ranking of this strategy.

As shown in the Figure 6, the order of Strategy SO is the highest, followed by Strategy ST, Strategy WO, and Strategy WT. The overall ranking of Strategy WT is at the lowest level, of which seven WT strategies are in the last seven places in the sub-strategies. The main reason is that although the strategies of WT are highly consistent with the carbon neutrality target, they are less connected to mining majors. The adoption of WT strategies is constrained by insufficient high-quality teacher resources, less practical teaching bases, limited high-quality curriculum resources, and imperfect experimental facilities.

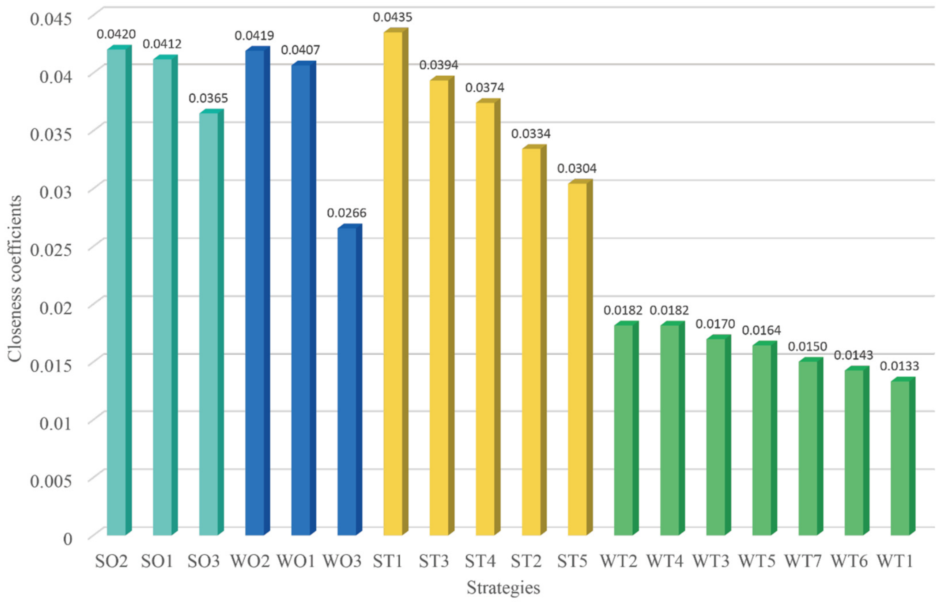

Figure 6. The priority ranking of strategies SO, WO, ST, and WT.

4. Sensitivity Analysis

To investigate the influence of criteria weights on the ranking order of the alternatives, a sensitivity analysis is carried out. The robustness of results is measured by the changes of criteria weights and rankings. Specifically, five cases were examined using a sensitivity analysis framework, but the results remained mostly solid. In some cases, the ranking values have a slight change but without impact on the rankings. The SWOT factors weights are given in Table 4, and the obtained sensitivity results for strategies are given in Table 5.

Therein, the first case is the baseline while the others are the outcomes of the sensitivity analysis.

Table 4. SWOT factors weights according to different cases.

	Case 1 (Current)	Case 2	Case 3	Case 4	Case 5
S	0.44	0.40	0.42	0.46	0.48
W	0.18	0.22	0.20	0.16	0.14
O	0.25	0.22	0.24	0.28	0.30
T	0.12	0.16	0.14	0.10	0.08

Table 5. Results of the sensitivity analysis.

Strategies	Case 1 (Current)	Case 2	Case 3	Case 4	Case 5
SO1	4	3	4	4	5
SO2	2	6	3	2	2
SO3	8	9	8	7	6
WO1	5	4	5	5	4
WO2	3	2	2	3	3
WO3	11	11	11	11	11
ST1	1	1	1	1	1
ST2	9	8	9	9	9
ST3	6	5	6	6	7
ST4	7	7	7	8	8
ST5	10	10	10	10	10
WT1	18	18	18	18	18
WT2	12	12	12	13	14
WT3	14	14	14	14	12
WT4	13	13	13	12	13
WT5	15	15	15	15	15
WT6	17	17	17	17	17
WT7	16	16	16	16	16

According to the results shown in Table 5, where the new cases are compared against the baseline (Case 1), only the order of Strategy SO2 and WO2 has changed in Case 3, while in Case 4, the order of Strategy SO3 and Strategy ST4 has changed. In Case 2 and Case 5, the order of six strategies and four strategies has changed slightly. In all cases, only 2.8% of the strategies ranking changed by more than two ranking positions.

5. Main Conclusions and Policy Implications

5.1. Main Conclusions

The goals of carbon peaking and carbon neutralization provide new opportunities and challenges for the transformation and development of traditional universities featuring energy. This study established a comprehensive evaluation model of specialty structures using SWOT, ANP, and fuzzy TOPSIS methods. Taking the universities featuring mining as an example, this study researches the structure optimization of academic disciplines from the aspects of talent training, major construction, and curriculum system construction. The following conclusions are drawn by the above analyses:

1. The research on the optimization of specialty structure can provide an evaluation framework for the discipline construction in the universities or faculties featuring in all fields of energy and has certain guiding significance for the sustainable development of the universities featuring energy. From the perspective of methodologies, the ANP-TOPSIS combination method is used to solve the complex SWOT multi-factors decision-making problem, which can not only overcome the independence of various factors and the subjectivity of difficult quantitative indicators in AHP method, but also avoid the neglect of factors weights by TOPSIS.

2. Decision factors for structure optimization of academic disciplines are summarized from strengths, weaknesses, opportunities, and threats. The discipline advantages of the universities featuring mining and the future development opportunities of coal are considered to be the main factors affecting the optimization results of the specialty structure. The top three important factors affecting the professional optimization of the universities featuring mining are mining disciplines (S1), professional teachers in mining disciplines (S3), and development of coal-based carbon materials (O4), with weight values of 0.2395, 0.1318, and 0.1318, respectively. The proposed influencing factors can aid decision makers the steps in formulating the optimization direction of specialty structure of the universities featuring mining.
3. The optimization of specialty structure of the universities featuring mining should focus on clean, intelligent, and sustainable development of the coal industry. According to the results of the SWOT-ANP and weighted fuzzy TOPSIS analytic methods, increasing research on sustainable development of mining industry (ST1) ranks as the first priority with a priority value of 0.0435. Second and third strategies, which are adding intelligent mining major (SO2) and increasing modern coal chemical engineering (WO2), come with the priority values of 0.0420 and 0.0419. In China, the importance of coal determines that economic and social development will still rely on coal for a long time in the future. In general, the order of Strategy SO is at the highest level with the average score of 0.0399, followed by Strategy ST, Strategy WO, and Strategy WT.

5.2. Policy Implications

The discipline optimization of universities featuring energy under the goal of carbon neutrality should be carried out from the aspects of specialty construction, talent training, green campus construction, exchange, and cooperation, so as to promote the sustainable development of universities featuring energy and cultivate talents in energy industry. Based on the above conclusions, the following implications can be arrived for the structure optimization of academic disciplines in universities featuring energy.

1. Conforming to the development trend and adjusting the research direction of core disciplines.

The research direction adjustment should not only conform to requirements of carbon neutral, but also determine the talent planning according to the frontier form of the discipline. Meanwhile, universities should pay attention to the transformation of scientific research results into real social and economic benefits.

2. Optimizing the layout of new discipline based on the characteristics of universities.

Universities should optimize the layout of disciplines according to their own characteristics. For example, new energy science and engineering should focus on the development of coal mine geothermal resources for the university with the mining characteristic. In addition, the construction of a “new discipline” should strive to realize the combination of discipline development, teacher development, and student training, and produce the construction experience of “new discipline” with its own characteristics and future development trend.

3. Creating carbon neutralization quality courses and learning atmosphere.

Universities should set up carbon neutralization courses with universality and quality, popularize carbon neutralization knowledge, and cultivate innovative talents in the field of carbon neutralization. In addition, universities should explore a road of “Zero Carbon Campus” in line with their own characteristics through campus carbon neutralization action plan and carbon neutralization construction with talent training. This action will encourage the youth for their overall engagement in carbon neutrality vision.

The model proposed in this research also has some limitations. The results of this study are based on the opinions of decision makers by the Delphi method, and their preference for some standards may affect the results. The case study on university featuring mining could be expanded on other universities.

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Appendix A

Table A1. Explanation of the pair-wise comparison scale.

Degree of Importance	Explanation
1	The I element has the equal effect as the J element
3	The I element has the weak effect compared to the J element
5	The I element has the strong effect compared to the J element
7	The I element has the very strong effect compared to the J element
9	The I element has the extreme effect compared to the J element
2, 4, 6, 8	The influence of the I element relative to the J element is between the two adjacent levels

Table A2. Transformation rules of linguistic variables.

Linguistic Variable	Triangular Fuzzy Number
Very low (VL)	(0, 0, 1)
Low (L)	(0, 1, 3)
Medium low (ML)	(1, 3, 5)
Fair (F)	(3, 5, 7)
Medium high (MH)	(5, 7, 9)
High (H)	(7, 9, 10)
Very High (VH)	(9, 10, 10)

Table A3. SWOT matrix of specialty structure optimization of the universities or faculties featuring electric power.

Internal Factors	Strengths(S)	Weaknesses(W)
External factors	S1: Advantage of electric power disciplines S2: Advantage of Industry–University–Research S3: Professional teachers in electric power disciplines	W1: Few preponderant disciplines W2: The absence of majors in emerging industries W3: Backward development of existing majors

Table A3. *Cont.*

Internal Factors		Strengths(S)	Weaknesses(W)
Opportunities(O)	O1: Development trend of electrification O2: The importance of thermal power to power security O3: Intelligent development of the power industry	Strategies (SO) SO1: Deep integration of industry, university, and research SO2: Adding smart grid information engineering SO3: Developing energy-saving technologies in thermal power units	Strategies (WO) WO1: Adding transportation electrification WO2: Adding industrial electrification WO3: Adding carbon storage science and Engineering WO4: Adding energy chemical engineering
Threats(T)	T1: Fossil fueled power generation reduction T2: Great potential of renewable energy T3: Substitutability of nuclear power to thermal power T4: The challenge of power system dealing with climate change T5: Responsibility of universities to promote low-carbon development	Strategies (ST) ST1: Setting up renewable energy disciplines ST2: Setting up energy storage disciplines ST3: Adding hydrogen energy science and engineering ST4: Adding smart energy engineering ST5: Increasing research on flexible grid technology	Strategies (WT) WT1: Adding energy and environmental systems engineering WT2: Opening fundamental courses of carbon neutrality WT3: Increasing research on power demand response WT4: Holding academic forums, community activities, practices, and other teaching activities

Table A4. The interdependence matrix of the SWOT factors with respect to ”Strengths”.

Strengths(S)	W	O	T	Relative Importance Weights
W	1	1/4	1	0.1667
O		1	4	0.6667
T			1	0.1667

Table A5. The interdependence matrix of the SWOT factors with respect to “Weaknesses”.

Weaknesses(W)	S	O	T	Relative Importance Weights
S	1	2	6	0.6000
O		1	3	0.3000
T			1	0.1000

Table A6. The interdependence matrix of the SWOT factors with respect to “Opportunities”.

Opportunities(O)	S	W	T	Relative Importance Weights
S	1	3	5	0.6483
W		1	2	0.2297
T			1	0.1220

Table A7. The interdependence matrix of the SWOT factors with respect to “Threats”.

Threats(S)	S	W	O	Relative Importance Weights
S	1	4	2	0.5584
W		1	1/3	0.1220
O			1	0.3196

Table A8. Fuzzy weighted decision matrix.

	SO1	SO2	SO3	WO1	WO2	WO3	ST1	ST2	ST3	ST4	ST5	WT1	WT2	WT3	WT4	WT5	WT6	WT7
S1	(0.19, 0.22, 0.24)	(0.24, 0.24, 0.24)	(0.19, 0.22, 0.24)	(0.00, 0.02, 0.07)	(0.08, 0.12, 0.17)	(0.13, 0.17, 0.22)	(0.24, 0.24, 0.24)	(0.13, 0.17, 0.22)	(0.13, 0.17, 0.22)	(0.13, 0.17, 0.22)	(0.08, 0.12, 0.17)	(0.00, 0.00, 0.02)	(0.00, 0.00, 0.02)	(0.00, 0.00, 0.02)	(0.00, 0.00, 0.02)	(0.00, 0.00, 0.02)	(0.00, 0.00, 0.02)	(0.00, 0.00, 0.02)
S2	(0.07, 0.07, 0.07)	(0.06, 0.07, 0.07)	(0.06, 0.07, 0.07)	(0.04, 0.05, 0.07)	(0.04, 0.05, 0.07)	(0.06, 0.07, 0.07)	(0.07, 0.07, 0.07)	(0.00, 0.01, 0.02)	(0.06, 0.07, 0.07)	(0.02, 0.04, 0.05)	(0.02, 0.04, 0.05)	(0.00, 0.00, 0.01)	(0.00, 0.00, 0.01)	(0.00, 0.00, 0.01)	(0.00, 0.00, 0.01)	(0.00, 0.00, 0.01)	(0.00, 0.00, 0.01)	(0.00, 0.00, 0.01)
S3	(0.10, 0.12, 0.13)	(0.10, 0.12, 0.13)	(0.10, 0.12, 0.13)	(0.10, 0.12, 0.13)	(0.07, 0.09, 0.12)	(0.00, 0.01, 0.04)	(0.13, 0.13, 0.13)	(0.07, 0.09, 0.12)	(0.07, 0.09, 0.12)	(0.10, 0.12, 0.13)	(0.07, 0.09, 0.12)	(0.00, 0.00, 0.01)	(0.00, 0.00, 0.01)	(0.00, 0.00, 0.01)	(0.00, 0.00, 0.01)	(0.00, 0.00, 0.01)	(0.00, 0.00, 0.01)	(0.00, 0.00, 0.01)
W1	(0.06, 0.07, 0.08)	(0.00, 0.01, 0.02)	(0.00, 0.00, 0.01)	(0.05, 0.06, 0.07)	(0.08, 0.08, 0.08)	(0.00, 0.01, 0.02)	(0.00, 0.01, 0.02)	(0.00, 0.01, 0.02)	(0.06, 0.07, 0.08)	(0.00, 0.01, 0.02)	(0.00, 0.00, 0.01)	(0.08, 0.08, 0.08)	(0.08, 0.08, 0.08)	(0.05, 0.06, 0.07)	(0.06, 0.07, 0.08)	(0.06, 0.07, 0.08)	(0.06, 0.07, 0.08)	(0.06, 0.07, 0.08)
W2	(0.00, 0.00, 0.00)	(0.00, 0.00, 0.01)	(0.00, 0.00, 0.00)	(0.03, 0.03, 0.03)	(0.00, 0.00, 0.01)	(0.00, 0.00, 0.00)	(0.00, 0.00, 0.01)	(0.02, 0.02, 0.03)	(0.01, 0.02, 0.02)	(0.03, 0.03, 0.03)	(0.02, 0.02, 0.03)	(0.00, 0.01, 0.02)	(0.03, 0.03, 0.03)	(0.03, 0.03, 0.03)	(0.03, 0.03, 0.03)	(0.03, 0.03, 0.03)	(0.00, 0.00, 0.01)	(0.03, 0.03, 0.03)
W3	(0.02, 0.03, 0.03)	(0.03, 0.03, 0.04)	(0.00, 0.00, 0.01)	(0.04, 0.04, 0.04)	(0.04, 0.04, 0.04)	(0.02, 0.03, 0.03)	(0.03, 0.03, 0.04)	(0.01, 0.02, 0.03)	(0.00, 0.00, 0.01)	(0.03, 0.03, 0.04)	(0.00, 0.00, 0.01)	(0.00, 0.00, 0.00)	(0.00, 0.00, 0.00)	(0.02, 0.03, 0.03)	(0.00, 0.00, 0.01)	(0.04, 0.04, 0.04)	(0.03, 0.03, 0.04)	(0.03, 0.03, 0.04)
W4	(0.00, 0.00, 0.01)	(0.00, 0.00, 0.00)	(0.00, 0.00, 0.00)	(0.00, 0.00, 0.00)	(0.00, 0.00, 0.00)	(0.03, 0.03, 0.03)	(0.00, 0.00, 0.00)	(0.00, 0.00, 0.01)	(0.00, 0.00, 0.01)	(0.00, 0.00, 0.01)	(0.00, 0.00, 0.01)	(0.00, 0.00, 0.01)	(0.00, 0.00, 0.01)	(0.00, 0.00, 0.01)	(0.00, 0.00, 0.01)	(0.00, 0.00, 0.01)	(0.00, 0.00, 0.01)	(0.00, 0.00, 0.01)
O1	(0.02, 0.02, 0.03)	(0.02, 0.02, 0.03)	(0.03, 0.03, 0.03)	(0.01, 0.02, 0.02)	(0.02, 0.02, 0.03)	(0.01, 0.02, 0.02)	(0.02, 0.02, 0.03)	(0.00, 0.00, 0.00)	(0.01, 0.02, 0.02)	(0.00, 0.00, 0.00)	(0.01, 0.01, 0.02)	(0.00, 0.00, 0.00)	(0.00, 0.00, 0.00)	(0.00, 0.00, 0.00)	(0.00, 0.00, 0.01)	(0.00, 0.00, 0.01)	(0.00, 0.00, 0.00)	(0.00, 0.00, 0.01)
O2	(0.03, 0.03, 0.03)	(0.03, 0.03, 0.03)	(0.02, 0.02, 0.03)	(0.02, 0.02, 0.03)	(0.02, 0.02, 0.03)	(0.00, 0.00, 0.01)	(0.02, 0.02, 0.03)	(0.02, 0.02, 0.03)	(0.00, 0.00, 0.01)	(0.01, 0.02, 0.02)	(0.00, 0.00, 0.01)	(0.00, 0.00, 0.00)	(0.00, 0.00, 0.01)	(0.00, 0.00, 0.01)	(0.00, 0.00, 0.01)	(0.00, 0.00, 0.01)	(0.00, 0.00, 0.00)	(0.00, 0.00, 0.00)
O3	(0.00, 0.01, 0.02)	(0.07, 0.07, 0.07)	(0.07, 0.07, 0.07)	(0.07, 0.07, 0.07)	(0.07, 0.07, 0.07)	(0.00, 0.00, 0.01)	(0.06, 0.06, 0.07)	(0.00, 0.00, 0.01)	(0.06, 0.06, 0.07)	(0.00, 0.00, 0.01)	(0.04, 0.05, 0.06)	(0.00, 0.00, 0.01)	(0.00, 0.00, 0.01)	(0.02, 0.04, 0.05)	(0.00, 0.00, 0.02)	(0.00, 0.01, 0.02)	(0.00, 0.00, 0.01)	(0.00, 0.00, 0.01)
O4	(0.00, 0.01, 0.04)	(0.00, 0.01, 0.04)	(0.00, 0.00, 0.01)	(0.13, 0.13, 0.13)	(0.07, 0.09, 0.12)	(0.00, 0.00, 0.01)	(0.00, 0.00, 0.01)	(0.00, 0.00, 0.01)	(0.00, 0.00, 0.01)	(0.00, 0.00, 0.01)	(0.00, 0.01, 0.04)	(0.00, 0.00, 0.01)	(0.00, 0.00, 0.01)	(0.00, 0.00, 0.01)	(0.00, 0.00, 0.01)	(0.00, 0.00, 0.01)	(0.00, 0.00, 0.01)	(0.00, 0.00, 0.01)
T1	(0.00, 0.00, 0.00)	(0.00, 0.00, 0.00)	(0.00, 0.00, 0.00)	(0.00, 0.00, 0.00)	(0.00, 0.00, 0.00)	(0.00, 0.00, 0.00)	(0.03, 0.03, 0.03)	(0.02, 0.02, 0.03)	(0.02, 0.02, 0.03)	(0.02, 0.02, 0.03)	(0.03, 0.03, 0.03)	(0.02, 0.02, 0.03)	(0.02, 0.02, 0.03)	(0.02, 0.02, 0.03)	(0.02, 0.02, 0.01)	(0.00, 0.00, 0.01)	(0.02, 0.02, 0.03)	(0.00, 0.00, 0.01)
T2	(0.00, 0.00, 0.00)	(0.00, 0.00, 0.00)	(0.00, 0.00, 0.00)	(0.00, 0.00, 0.00)	(0.00, 0.00, 0.00)	(0.00, 0.00, 0.00)	(0.00, 0.00, 0.00)	(0.01, 0.01, 0.01)	(0.00, 0.00, 0.00)	(0.01, 0.01, 0.01)	(0.00, 0.00, 0.00)	(0.01, 0.01, 0.01)	(0.00, 0.00, 0.00)	(0.00, 0.00, 0.00)	(0.01, 0.01, 0.00)	(0.00, 0.00, 0.00)	(0.00, 0.00, 0.00)	(0.00, 0.00, 0.00)
T3	(0.00, 0.00, 0.01)	(0.00, 0.00, 0.01)	(0.00, 0.00, 0.01)	(0.00, 0.00, 0.01)	(0.00, 0.00, 0.01)	(0.00, 0.00, 0.01)	(0.00, 0.00, 0.01)	(0.06, 0.06, 0.06)	(0.00, 0.00, 0.01)	(0.04, 0.05, 0.06)	(0.00, 0.00, 0.01)	(0.00, 0.00, 0.01)	(0.06, 0.06, 0.06)	(0.00, 0.00, 0.01)	(0.06, 0.06, 0.02)	(0.00, 0.01, 0.02)	(0.00, 0.00, 0.01)	(0.00, 0.00, 0.01)
T4	(0.01, 0.01, 0.02)	(0.00, 0.00, 0.00)	(0.00, 0.00, 0.00)	(0.01, 0.01, 0.02)	(0.00, 0.00, 0.01)	(0.02, 0.02, 0.03)	(0.00, 0.00, 0.01)	(0.02, 0.02, 0.03)	(0.03, 0.03, 0.03)	(0.03, 0.03, 0.03)	(0.03, 0.03, 0.03)	(0.01, 0.02, 0.02)	(0.03, 0.03, 0.03)	(0.03, 0.03, 0.03)	(0.03, 0.03, 0.03)	(0.03, 0.03, 0.03)	(0.03, 0.03, 0.03)	(0.03, 0.03, 0.03)

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