

The DEMATEL-ISM Analysis on Influence Factors of Economic Operation of Wind Power Projects

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Abstract

In recent years, China's wind power industry has developed rapidly, however, factor of economic operation of the wind power project is complex, it is necessary to define the influence degree of factors and correlation. To improve the analysis and management of economic operation of the wind power project, the DEMATEL - ISM method for wind power projects in various factors for identification and analysis, identification of the factors that affect wind projects economic operation model was constructed, according to the multilevel hierarchical structure model is established for analysis. Results show that the influence factors of wind energy resources is the deepest level, in the actual wind power economy should focus on it for analysis; Five economic factors such as profitability for chain type influencing factors, two factors restricting influence each other, in the actual wind power project should be focused on it. This article can provide the basis for enterprise managers at all levels of management decision-making and reference.

Keywords: *Wind power project; economic operation; Integrated DEMATEL - ISM method*

1. Introduction

As the traditional energy consumption increased year by year, the worsening of ecological environment and the climate warming trend is increasing, the threat of the sustainable development of the human society is more and more serious. The development of new energy industry has very important strategic significance to reduce carbon emissions, improve the energy structure, ensure China's energy supply, solve the energy supply and demand structural contradictions, and promote economic and social sustainable development. The development of wind power can effectively increase the energy supply capacity, so as to realize the sustainable development of energy.[1] In recent years, China's wind power industry is developing rapidly. By the end of 2014, China's wind power industry development momentum, the new wind power installed capacity refresh record.

Wind power installed capacity of the good momentum of development shows that a large amount of wind power for construction and operation of the project is in an orderly way. However, behind the momentum of development, China's wind power industry also appears some problems. Some large state-owned developers and local government's only hopes to increase wind power installed capacity, without considering to promote wind power project of the key factors of economic operation

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such as if the wind resource is enough or if the electricity is reasonable. Wind power project investment and development has certain blindness. Therefore, in the development and utilization of wind power projects investment boom, how to realize the economic operation of wind power project is related to energy utilization and the sustainable development of the important factors.

Previous literature and data is analyzed the influence factors of wind power construction costs, they don't have to analysis how to improve the economic benefit of wind power project. The purpose of this article is based on the existing literature and data to establish wind power project identification factor model of economic operation, identify the influence factors and the correlation between the factors, provide the theory to the healthy development of the wind power project and wind power industry.

2. Analysis of Economic Operation of the Wind Power Project

By analyzing the literature, this paper is based on technology, economy and social impact to analysis the influence factors of economic operation of the wind power project, from the perspective of comprehensive analysis of economic operation of the wind power project. Therefore, this paper determine 12 representative factors that affect the economic operation of wind power projects by collecting and reading a lot of relevant literature and conducting in-depth analysis, and summarize them.

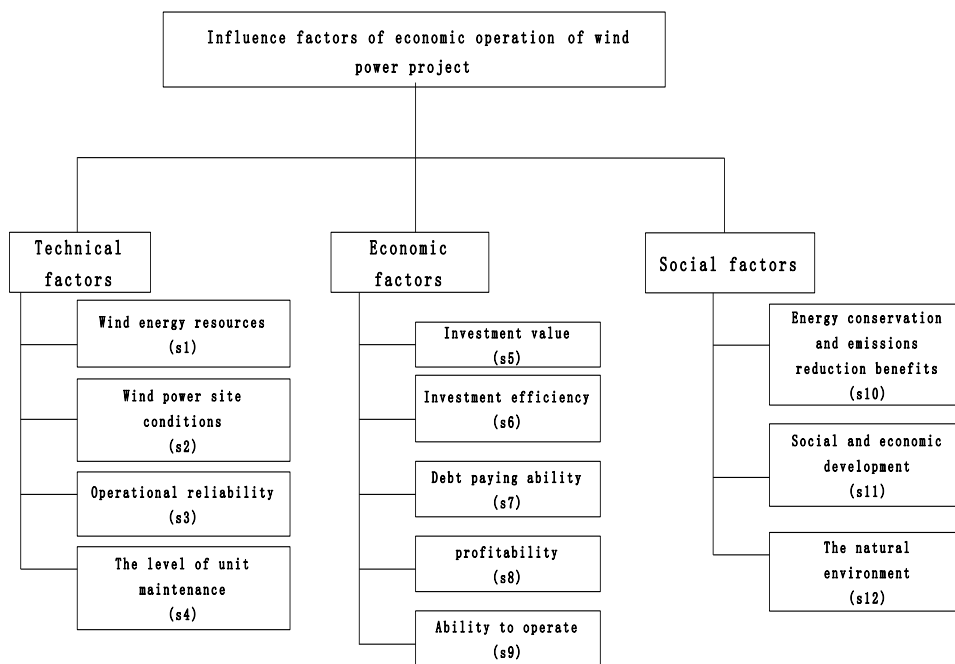


Figure 1. Influence Factors of Economic Operation of Wind Power Project System

3. Determine the Factors Influencing the Model of Economic Operation of the Wind Power Project Based on DEMATEL-ISM

3.1. The ISM and Its Improvement

Previous analysis and evaluation methods can be concluded that the weights of affecting factors and ratio, but they can't obtain the logic and correlation between

various influencing factors. ISM method is with the aid of the logical relationship between various factors in the system building directly influence matrix, calculating the influence degree of each factor on other factors as well as the influence degree, thus calculating the center of the factors and reasons. DEMATEL is a kind of system factor analysis method, using the graph theory and matrix theory, through the relationship between the indexes to establish direct influence matrix, to solve the impact on the rest of the indicators and every index by influence degree.

The DEMATEL and ISM has certain commonality, the overall impact matrix of DEMATEL and the nonzero elements in reachability matrix of ISM represent the mutual influence between the indicators, and zero element represents that there is no relationship between the indicators. The overall impact matrix of DEMATEL contains more information than reachability matrix of ISM. So, we can use the overall impact matrix of DEMATEL to obtain the reachability matrix of ISM. This article use ISM as center model and DEMATEL as auxiliary model to analyze the influence factors of economic operation of wind power projects.

3.2. Establish Structure Model and Calculate Steps

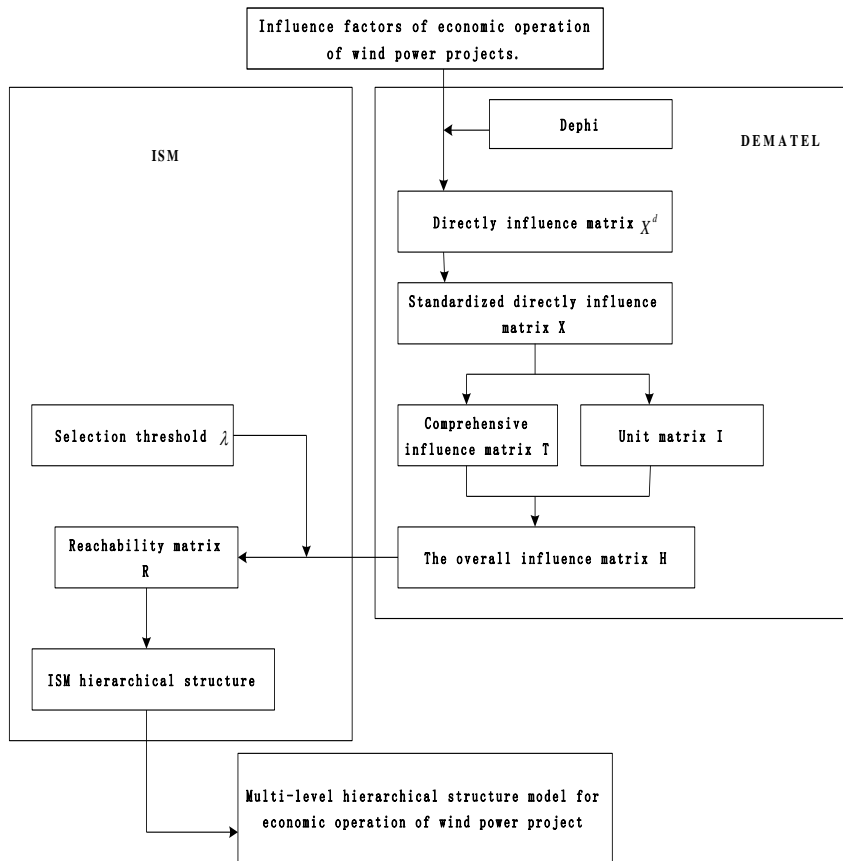


Figure 2. Multi-Level Hierarchical Structure Model for Economic Operation of Wind Power Project

1. Direct influence matrix: This paper uses the Delphi method to determine the relationship between various influencing factors by collecting and reading a lot of relevant literature and conducting in-depth analysis. By summarizing the questionnaire, I analyze the relationship between the related factors, establish direct influence matrix.

Table.1 Direct Influence Matrix

NO.	1	2	3	4	5	6	7	8	9	10	11	12
1	0	3	1	1	3	3	2	3	2	2	1	2
2	1	0	1	1	2	2	1	2	2	3	1	3
3	0	0	0	3	3	3	3	3	3	1	1	0
4	0	0	3	0	2	2	2	3	3	0	1	0
5	0	1	1	0	0	2	3	3	2	1	1	1
6	0	0	1	1	2	0	3	3	3	1	0	0
7	0	0	0	0	2	1	0	2	2	0	2	0
8	0	0	0	0	2	2	3	0	2	1	1	0
9	1	0	1	1	2	2	3	3	0	1	1	0
10	1	1	1	0	1	1	0	1	0	0	2	2
11	0	1	0	0	1	1	0	0	0	1	0	1
12	1	1	0	0	1	0	0	0	1	2	1	0

In the Table.1, 3 means the relationship between the two factors is “strong”;2 means the relationship between the two factors is “medium”;1 means the relationship between the two factors is “weak”;0 means there is no relationship between the two factors

2. Standardized directly influence matrix X:
$$X = \frac{1}{\max_{1 \leq i \leq n} \sum_{j=1}^n a_{ij}} X^d$$

X^d ($X^d = [a_{ij}]_{n \times n}$) is the directly influence matrix.

3. Comprehensive influence matrix T:

Because of $\lim_{k \rightarrow \infty} X^k = 0$, $T = \lim_{k \rightarrow \infty} (X + X^2 + \dots + X^k) = X(1 - X)^{-1} = t_{ij}$

I is the Unit matrix, and it shows the effect of factors of its own.

4. Overall influence matrix H:

$H = T + I = h_{ij}$

reachability matrix R:

$R = [r_{ij}]_{n \times n}, (i = 1, 2, \dots, n; j = 1, 2, \dots, n)$

$$r_{ij} = \begin{cases} 1, & h_{ij} \geq \lambda \\ 0, & h_{ij} < \lambda \end{cases}$$
 λ is the threshold, according to the actual situation of this

article, $\lambda = 0.1$.

Table 2. Reachability Matrix

NO.	1	2	3	4	5	6	7	8	9	10	11	12
1	1	1	1	0	1	1	1	1	1	1	1	1
2	0	1	0	0	1	1	1	1	1	1	1	1
3	0	0	1	1	1	1	1	1	1	1	1	0
4	0	0	1	1	1	1	1	1	1	0	1	0
5	0	0	0	0	1	1	1	1	1	0	1	0
6	0	0	0	0	1	1	1	1	1	0	0	0
7	0	0	0	0	1	0	1	1	1	0	1	0
8	0	0	0	0	1	1	1	1	1	0	0	0
9	0	0	0	0	1	1	1	1	1	0	1	0
10	0	0	0	0	1	1	0	1	0	1	1	1
11	0	0	0	0	0	0	0	0	0	0	1	0
12	0	0	0	0	0	0	0	0	0	1	0	1

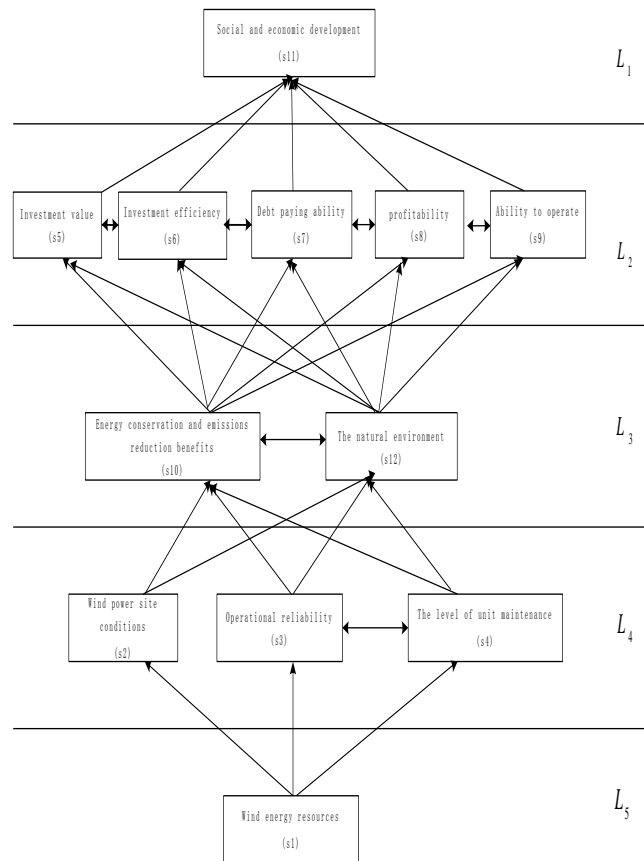


Figure 3. Multi-Level Hierarchical Structure Model for Influence Factors of Economic Operation of Wind Power Project

4. Establish the Model

First, according to the reachability matrix, set up Reachable Set $R(S_i)$, First Set $A(S_i)$ and Common Set $T(T = \{S_j \in N \mid R(S_i) \cap A(S_i) = A(S_i)\})$ of each other, and the highest collection elements set $H(H = \{S_j \in N \mid R(S_i) \cap A(S_i) = R(S_i)\})$. After identifying the most senior of level 1, delete the rows and columns of all the most senior factors of level 1 from the reachability matrix. Then find the most senior factors of level 2 from the rest of the reachability matrix; Do it again until you find the most senior factors of each level. And then we will record the reachability matrix according to the results of level-division. As a result, the most senior factors set of each level can be obtained:

$$L_1 = \{S_{11}\}$$

$$L_2 = \{S_5, S_6, S_7, S_8, S_9\}$$

$$L_3 = \{S_{10}, S_{12}\}$$

$$L_4 = \{S_2, S_3, S_4\}$$

$$L_5 = \{S_1\}$$

Then we establish the Multi-level hierarchical structure model as shown below:

5. The Analysis and Conclusions of DEMATEL-ISM

Through the analysis of Multi-level hierarchical structure model we can see that, social and economic development directly affect the economic operation of wind power projects. The first layer is surface directly influence factors of economic operation of the wind power project. To improve the wind power industry and the efficiency and economy of the project, we will follow the country's economy support policy, and then we will benefit from the social and economic development.

The second layer includes investment value, investment efficiency, solvency, and profitability and operation ability of wind power project. These are the economic indicators of economic operation of the wind power project, which are affected the shallow layer of economic operation of the wind power project. It is important to note that these factors belong to the chain type influencing factors. There is a mutual influence and mutual restriction between two relations. It means that the above five factors is not stable. They can not only affect other factors, but also can affect themselves. So when we are considering economic indicators, we have to comprehensively consider all factors.

The third layer includes energy conservation and emissions reduction benefits and the natural environment. The fourth layer includes wind power site conditions, operation reliability and the level of unit operation. The two layers belong to the middle layer of the model.

Wind energy resources is the most fundamental factor of economic operation of the wind power project, it has the deepest influence on the whole wind projects. Based on the wind energy resource census results, investors will preliminarily determine several wind energy available areas. Then they will have further analysis for these areas, such as topography, geology, transport, power grids and other external conditions. They also predict whether the whole economic indicators meet expectations. Therefore, wind energy resources plays the most basic and the deepest influence in the evaluation of the economic operation of the wind power project.

Results show that the influence factors of wind energy resources is the deepest level, in the actual wind power economy should focus on it for analysis; Five economic factors such as profitability for chain type influencing factors, two factors restricting influence each other, in the actual wind power project should be focused on it. This article can provide the basis for enterprise managers at all levels of management decision-making and reference.

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