# Research on the Stimulus and Conduction Analysis Technology of Power Transmission Project Cost by Market Factor Change Based on DEMATEL Method

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**Abstract.** power transmission and transformation project construction is an important guarantee of the safe and stable supply of energy power, unified market deepening development under the power transmission and transformation project cost components will have multiple influence and dynamic evolution, enhance the cost level and cost management of "toughness" and "elasticity", fit power grid enterprises of project cost management of precision and dynamic control requirements. Therefore, this paper puts forward the stimulus transmission analysis technology of the change of market factors based on the DEMATEL method which has the ability to visually express the relationships between internal factors is crucial for understanding the complex interactions among cost-influencing factors, explores the influence of the change of market factors on the cost level of power transmission and transformation projects, and provides reference for improving the efficiency and quality of the cost control of power transmission and transformation projects of power grid enterprises.

**Keywords:** Power Transmission and Transformation Project，DEMATEL Method，Cost Transmission Analysis Technology.

## 1 Introduction

To ensure the safe and stable supply of energy and electricity, and to adapt to the multifaceted impacts and dynamic changes of the cost elements of power transmission and transformation projects under the deepening development of a unified large market, this paper employs the DEMATEL method to explore the influence of market factors on the cost of power transmission and transformation projects. The DEMATEL method is capable of conducting nonlinear correlation analysis of complex factors, which allows it to more accurately reflect the interrelationships and interactions among various factors when dealing with cost impact factors. This approach has distinct advantages when analyzing complex systems, especially socio-economic issues. Fur-


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thermore, by calculating centrality and causality, the method can identify key factors within the system, assisting power grid enterprises in determining which factors are crucial for cost control and providing them with guidance and recommendations.

In Literature [1], an analysis model of power grid influencing factors based on the explanatory structure model was established, and an empirical analysis of the influencing factors of power grid engineering at each stage of power grid engineering was carried out by taking a power grid project as an example, so as to provide a reference for power grid cost control. Literature [2] combined with historical line engineering projects, based on the grey correlation analysis method, this paper constructs an analysis model of the influencing factors of power grid line engineering cost, and points out the key links of power grid line engineering cost risk control, which can provide reference for other power grid line engineering cost control. Based on historical statistical data, Ref. [3] decomposes the influencing factors of the cost level, and analyzes the real cost level after deducting the influencing factors of the price. Ref. [4] explores the influencing factors and cost control measures of power engineering cost. Ref. [5] analyzes the influencing factors of engineering cost in the construction stage of substation into deep influencing factors, shallow influencing factors and surface influencing factors, in order to reduce the engineering cost in the construction stage of substation. Ref. [6] takes the power grid overhaul project as the research object, identifies the influencing factors affecting the cost of the power grid overhaul project from multiple perspectives such as technology, design, construction, and operation, and puts forward reasonable optimization suggestions for the review problems, so as to provide a reference for the refined control of the cost of the subsequent power grid overhaul project.Ref. [7] combined with the development law of historical cost data, the main factors affecting the project cost were analyzed from the aspects of technology, design, equipment price, and environment, and suggestions for project evaluation and optimization were put forward. The analysis method of influencing factors of power transmission and transformation project cost in DEMATEL [8] provides a reference for project cost control.

In summary, current scholars mainly focus on the factors affecting the cost of power grid projects and the importance of each factor. However, the analysis of the impact degree of market factor changes on the cost of power transmission and transformation projects and the impact chain is relatively weak, which does not meet the requirements of the deepening development of the unified large market, and cannot effectively guide power grid enterprises to clarify the impact chain of market factor changes on the cost of power transmission and transformation projects. Therefore, this paper mainly uses mathematical models to study the impact of market factors on the cost of power transmission and transformation projects, which is of great significance for the safe and stable operation of the power grid and the development of power grid enterprises.

## 2 DEMATEL Method Principle

DEMATEL The method can effectively analyze the internal correlation between the factors in the system and reflect the contribution of each factor in the system, which provides a scientific theory for the solution of complex problems. DEMATEL The specific implementation steps are as follows:

(1) Establish the direct influence matrix O1.

(2) Establish the normalized influence matrix B. In order to facilitate the analysis and comparison between index factors, the direct influence matrix A is normalized to obtain the normalized influence matrix B, and the b ij value is [0,1]. The specific calculation formula is follows:

$$B = \frac{1}{\max\limits_{1 \le i \le n} \sum_{j=1}^{n} a_{ij}} A \tag{1}$$

Where, n is the number of indicators.

(3) Calculate the comprehensive influence matrix T. The comprehensive impact matrix T is calculated as follows:

$$T = B^1 + B^2 + \ldots + B^n = B\frac{E - B^{n-1}}{E - B} \tag{2}$$

Where, E is the identity matrix. Since 0 bij 1, there is limnBn-1=0, so the above equation can be simplified to:

$$T = B\frac{E - B^{n-1}}{E - B} = B(E - B)^{-1} \tag{3}$$

(4) Calculate the index factor of "four degrees". According to the comprehensive influence factor T (T= [t, the value of the calculation matrix T, the column tij, according to equation (4) and (5), respectively, the influence degree Fi indicates the influence of the i th factor on other index factors, and the influence of other index factors on i th factor.

$$F_i = \sum_{j=1}^{n} t_{ij}, i = 1,2,\ldots, n \tag{4}$$

$$H_i = \sum_{j=1}^{n} t_{ji}, i = 1,2,\ldots, n \tag{5}$$

According to Equation (4) and (5), the index factor centrality Mi and cause Ni are calculated. Among them, the center degree Mi indicates the comprehensive influence degree of the i index factor on the cost; the larger the center degree of Mi, the greater the factor on the project cost; the cause degree Ni means the net influence degree of the i index factor on the project cost.

# 3 Empirical Analysis

## 3.1 Construction Directly Affects the Matrix O1

The Delphi Method is a structured approach to expert consultation, aimed at achieving reliable and accurate predictions or decisions on specific issues by synthesizing the opinions and judgments of multiple experts through multiple rounds of anonymous questionnaires or discussions. Essentially, it is a feedback anonymous correspondence method that uses collective wisdom to produce objective decision outcomes. It relies on a group of experts who have in-depth understanding and experience in a particular field.

The Delphi method consulted 20 experts in related fields to evaluate the relationship between the market factors of the change on the cost of the transmission project, and construct the direct influence matrix $O_1$(Table 1).

**Table 1.** Direct influence relationship matrix $O_1$。

| | Manual unit price | Mechanical unit price | Material unit price | land price | CPI | PPI | PMI | GDP | Main cost | miscellaneous expenses |
|---|---|---|---|---|---|---|---|---|---|---|
| Manual unit price | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 4 | 4 |
| Mechanical unit price | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 4 | 4 |
| Material unit price | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 4 | 3 |
| land price | 0 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 2 | 4 |
| CPI | 1 | 1 | 1 | 1 | 0 | 2 | 1 | 1 | 3 | 2 |
| PPI | 0 | 1 | 1 | 1 | 0 | 0 | 1 | 2 | 2 | 2 |
| PMI | 1 | 1 | 1 | 1 | 0 | 1 | 0 | 2 | 3 | 1 |
| GDP | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 0 | 1 | 1 |
| Main cost | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| miscellaneous expenses | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

## 3.2 Calculate the Comprehensive Impact Matrix

Firstly, according to Equation (1), the matrix O1 is normalized to obtain the normalized matrix N1 (Table 2).

**Table 2.** Specification directly affects the matrix $N_1$。

| | Manual unit price | Mechanical unit price | Material unit price | land price | CPI | PPI | PMI | GDP | Main cost | miscellaneous expenses |
|---|---|---|---|---|---|---|---|---|---|---|
| Manual unit price | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0.308 | 0.308 |

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Mechanical unit price | 0 | 0 | 0.077 | 0 | 0 | 0 | 0 | 0 | 0.308 | 0.308 |
| Material unit price | 0 | 0.077 | 0 | 0 | 0 | 0 | 0 | 0 | 0.308 | 0.231 |
| land price | 0 | 0.077 | 0.077 | 0 | 0 | 0 | 0 | 0 | 0.154 | 0.308 |
| CPI | 0.077 | 0.077 | 0.077 | 0.077 | 0 | 0.154 | 0.077 | 0.077 | 0.231 | 0.154 |
| PPI | 0 | 0.077 | 0.077 | 0.077 | 0 | 0 | 0.077 | 0.154 | 0.154 | 0.154 |
| PMI | 0.077 | 0.077 | 0.077 | 0.077 | 0 | 0.077 | 0 | 0.154 | 0.231 | 0.077 |
| GDP | 0.077 | 0.077 | 0.077 | 0.077 | 0.077 | 0.077 | 0.077 | 0 | 0.077 | 0.077 |
| Main cost | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| miscellane-ous expens-es | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

Calculate the comprehensive influence matrix T1 (Table 3) using Equation (2) or Equation (3).

**Table 3.** Comprehensive influence matrix $T_1$。

| | Manu al unit price | Me-chani-cal unit price | Ma-terial unit price | land price | CPI | PPI | PMI | GDP | Main cost | mis-cella-neous ex-penses |
|---|---|---|---|---|---|---|---|---|---|---|
| Manual unit price | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0.308 | 0.308 |
| Mechanical unit price | 0 | 0.006 | 0.077 | 0 | 0 | 0 | 0 | 0 | 0.333 | 0.327 |
| Material unit price | 0 | 0.077 | 0.006 | 0 | 0 | 0 | 0 | 0 | 0.333 | 0.256 |
| land price | 0 | 0.083 | 0.083 | 0 | 0 | 0 | 0 | 0 | 0.205 | 0.353 |
| CPI | 0.095 | 0.126 | 0.126 | 0.108 | 0.009 | 0.172 | 0.1 | 0.12 | 0.415 | 0.329 |
| PPI | 0.021 | 0.117 | 0.117 | 0.1 | 0.013 | 0.022 | 0.093 | 0.173 | 0.289 | 0.28 |
| PMI | 0.093 | 0.117 | 0.117 | 0.1 | 0.013 | 0.094 | 0.022 | 0.173 | 0.382 | 0.231 |
| GDP | 0.093 | 0.117 | 0.117 | 0.101 | 0.08 | 0.099 | 0.093 | 0.036 | 0.251 | 0.237 |
| Main cost | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| miscellaneous expenses | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

The comprehensive influence matrix is used to calculate the index values, including D of influence, affected degree C, centrality D + C, and cause degree D-C. The results are as follows:

**Table 4.** DEMATEL Calculate the index value-power transmission.

| | Impact de-gree D value | The impact degree C value | Centrality degree DC value | Cause degree D-C value (R) |
|---|---|---|---|---|
| Manual unit price | 0.615 | 0.302 | 0.917 | 0.314 |
| Mechanical unit price | 0.744 | 0.643 | 1.387 | 0.101 |
| Material unit price | 0.673 | 0.643 | 1.316 | 0.029 |
| land price | 0.724 | 0.409 | 1.133 | 0.316 |
| CPI | 1.598 | 0.115 | 1.713 | 1.482 |
| PPI | 1.225 | 0.388 | 1.613 | 0.838 |
| PMI | 1.341 | 0.308 | 1.649 | 1.033 |
| GDP | 1.225 | 0.501 | 1.725 | 0.724 |
| Main cost | 0 | 2.517 | 2.517 | -2.517 |
| miscellaneous expenses | 0 | 2.32 | 2.32 | -2.32 |

### 3.3 Draw the Centrality-Cause Degree Diagram to Analyze the Relationship Between Centrality and Cause Degree

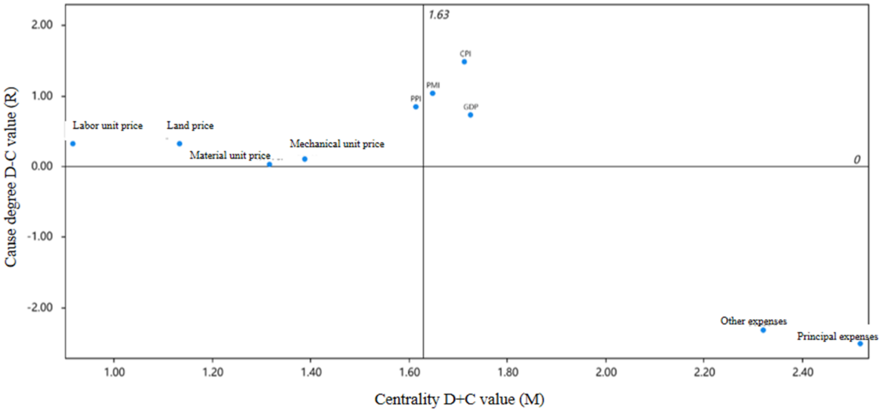


**Fig. 1.** Centrality-Reason degree diagram (transmission).

As shown in Figure 1, CPI, PMI, and GDP are the first quadrants in the centrality-reason chart, representing high centrality and cause. PPI, labor unit price, land price, material unit price and mechanical unit price are the second quadrants in the centrality-cause degree diagram, which represents low centrality and high cause.

### 3.4 Draw the Influence and Affected Relationship of the Influence and Affected Elements

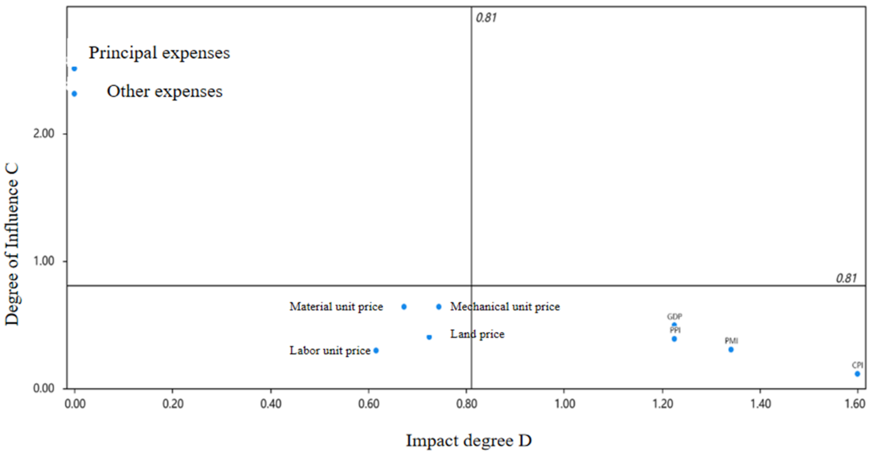


**Fig. 2.** Impact degree-Impact degree diagram (transmission).

As shown in Figure 2, CPI, PMI, PPI, and GDP are in the fourth quadrant of the influence-to-be graph, representing high and low influence factors The unit price of labor, land, material and machinery in the third quadrant of the influence-to-be graph represents the low and high influence of the factors; the second quadrant of principal and other costs, the low impact and high impact of representative elements indicate that the principal and other costs are mainly influenced by the other elements.

### 3.5 Draw the comprehensive impact diagram

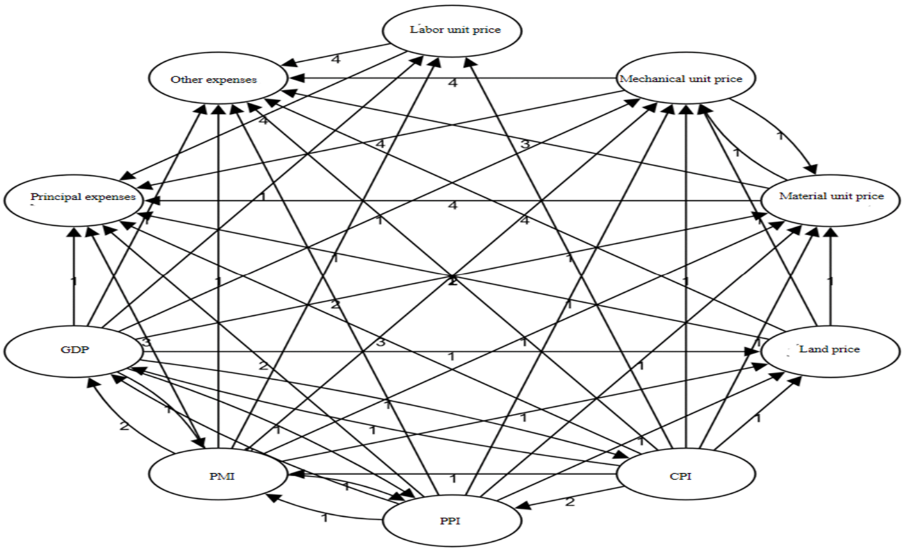


**Fig. 3.** Comprehensive impact diagram (transmission).

The numbers on different arrows in Figure 3 represent the magnitude of influence between different elements, with the greater the numbers the greater the effect.

## 4 Conclusion

This paper puts forward the market factors based on DEMATEL method of the transmission project cost stimulus conduction analysis technology, combing the market factors of the transmission project cost influence link, the following conclusion: substation project cost, electricity construction cost is the higher cost, the human unit price, material unit price, mechanical unit price, market factors such as PPI changes on the cost, leading to the greater influence on substation project cost. The cost of transmission project is mainly composed of the main cost and other costs, among which the main cost is mainly composed of various project costs. Typical market factors such as personnel machine unit price and PPI have a great impact on it, while other costs include the site cost, and the land price directly affects other costs. Therefore, it is recommended that power grid enterprises establish a dynamic monitoring mechanism for market factors that have a significant impact, regularly pay attention to their change cycles, and reasonably analyze their future trends in order to better meet the requirements of power grid enterprises for project cost estimation.

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