Research on Intelligent Prediction and Forecast Model for Construction Period of Transmission and Transformation Engineering Based on BP Neural Network

Jianpei Xu¹, Jun Tong¹, Tielin Zhao¹, Chao Chen*²

¹ State Grid Zhejiang Electric Power Co., Ltd. Construction Branch, Hangzhou, Zhejiang Province, 310016, China
² School of Economics and Management, North China Electric Power University, Beijing 102206, China.

*Corresponding author’s e-mail: juzen123@163.com

Abstract. The construction period is one of the important control objectives of the construction and management of power transmission and transformation projects. If the construction period is not well controlled, it will lead to the failure of the project, cause disputes between all parties to the construction, and the economic and social benefits of the project cannot be ignored. Negative Effects. Therefore, it is of great significance to carry out the research on the construction period prediction method to improve the economic efficiency of the construction of power transmission and transformation projects. Based on the systematic analysis of the factors affecting the construction period of power transmission and transformation projects, this paper constructs an intelligent prediction model for the construction period of power transmission and transformation projects based on BP neural network theory, and verifies the validity and prediction accuracy of the model through empirical analysis. Reasonable control of construction period provides reference and reference.

1. Introduction

With the modernization process of our country and the steady growth of the national economy, the investment and construction of power transmission and transformation projects have developed rapidly. Transmission and transformation engineering projects have the characteristics of large engineering volume, complex structure, multiple construction links, long period, strict technical quality requirements, many related parties and many influencing factors. Construction period and quality, cost, and safety have become the four most important control objectives in the management of power grid projects. The four control objectives are interrelated. On the premise of ensuring project quality and construction safety, construction period management is particularly critical. If the construction period is well controlled, other factors will be more efficient and effective, otherwise it will lead to the failure of the project, cause disputes between the construction parties, and have a non-negligible impact on the economic and social benefits of the project.

The theoretical research on power engineering construction project management started early in foreign countries, and a relatively complete management method system has been formed up to now. From the preparation of the project schedule to the reasonable control of the progress, quality, safety,
and cost of the construction process, there are complete theories, methods and serialized information-based auxiliary tools. Especially in the application of modern computer information technology, the enterprise profit center and the line construction project cost center are combined into one, and the enterprise and project management are implemented at a level. It has achieved the advanced "two hearts into one heart, zero kilometers in different places", Management method [3].

In recent years, many power construction companies in my country have begun to introduce project management methods, reengineer business processes, establish project management systems (P3, MIS, etc.), and gradually establish a complete set of power transmission and transformation projects in line with international standards. Build the actual construction management system [4-5]. But on the other hand, the application level of information technology in the process of project construction is still low, which restricts the improvement of project construction efficiency and benefit level to a certain extent.

Based on the above reasons, this article systematically analyzes the main factors affecting the construction period of the transmission and transformation project in combination with the construction characteristics of the transmission and transformation project and the demand for construction period management. On this basis, constructs the construction period intelligence of the transmission and transformation project based on the BP neural network theory. The predictive model provides a reference for the reasonable control of the construction period of power transmission and transformation projects.

2 Analysis of factors affecting the construction period of power transmission and transformation projects based on system dynamics

2.1 Basic theory of system dynamics
System dynamics (called SD system dynamics) appeared in 1956. The founder is Professor J. W. Forrester of the Massachusetts Institute of Technology (MIT). System dynamics is a system simulation method proposed by Professor Forrest in 1958 to analyze production management, inventory management, and other business issues. It was originally called Industrial Dynamics. It is a discipline that analyzes and studies information feedback systems, and is also an interdisciplinary discipline that identifies and solves system problems. As far as system methodology is concerned: system dynamics is the unity of structural method, functional method and historical method. It is based on system theory and absorbs the essence of cybernetics and information theory. This is a level subject that integrates natural sciences and social sciences.

2.2 Identification of influencing factors
The investment and construction of power transmission and transformation projects requires a large amount of capital, time, manpower, material resources and other resources. At the same time, scientific design and management are also required to ensure the smooth completion of the project. Combined with the construction process and construction characteristics of power transmission and transformation projects, the factors that affect the construction period can be roughly divided into: capital factors, construction factors, design factors, material factors, management factors and environmental factors. The specific analysis is as follows:

1) Funding factors
Funds are the primary factor to ensure the smooth implementation of power transmission and transformation projects. As the basic carrier of electric energy supply, transmission and transformation engineering projects often require huge funds for their construction. If the fund supply cannot be implemented according to the fund plan, and the excess budget gap cannot be compensated in time, it will have a huge impact on the construction of the project and cause the problem of project suspension and postponement.

2) Construction factors
Construction factors have a direct impact on the construction period of power transmission and transformation projects. To ensure the smooth and orderly construction and implementation of power
transmission and transformation projects, it is necessary to ensure the efficient cooperation of people, materials, and machines during the construction process to ensure the orderly overlap of key processes. During the construction process, if there are conditions such as construction preparation supplementary points, insufficient manpower and material resources, and construction procedures that are not effectively overlapped, they will affect the construction progress of the power transmission and transformation project, causing the power transmission and transformation project to fail to meet the planned schedule.

3) Design factors The impact of design factors on the schedule is mainly reflected in the poor design level or the inability to complete the design drawings on time, which will not only cause problems in the construction quality of power transmission and transformation projects, cause project rework problems, and lead to the extension of the project construction period.

4) Material supply factors Material supply mainly includes two parts: equipment and materials. Equipment installation is the main content of the investment and construction of power transmission and transformation projects. Therefore, if the equipment and materials are not supplied in time, it will directly adversely affect the construction period of civil engineering and installation projects.

5) Management factors
Management factors mainly include internal organization management and external coordination management. The impact of internal organization and management is reflected in the inefficiency of management due to unreasonable organizational settings, ineffective management mechanisms, backward management methods, or insufficient managerial quality, resulting in delays in construction schedules. The impact of the Ministry’s coordination and management is reflected in the fact that power transmission and transformation projects have many contacts with the outside world, and there are many external units and personnel that need to be coordinated, such as government departments, banks, equipment providers, and the public. It will also affect the progress of power transmission and transformation projects.

6) Environmental factors
Most of the power transmission and transformation projects are constructed in the open-air environment, and are susceptible to severe weather such as strong winds, thunderstorms, and hail. At the same time, the topography and topography of the construction site are also easy to increase the difficulty of construction, causing the extension or delay of the construction period.

Applying system dynamics theory to identify the main factors affecting the construction period of power transmission and transformation projects and their impact mechanisms are shown in Figure 1:

| Influencing factors of civil construction period | Start time | Terrain conditions | Climatic conditions | Precipitation | Geological conditions | Altitude | Transport conditions | Factors affecting the construction period |
|-------------------------------------------------|------------|--------------------|--------------------|---------------|----------------------|---------|---------------------|------------------------------------------|
| Factors affecting the installation period | Transformer capacity | Arrival of equipment and materials | Construction team work ability | Start time | Influening factors in the construction period | Construction period of power transmission and transformation project | Factors affecting the installation period |
| Factors affecting the commissioning period | Blackout plan arrangement | Debugging unit capacity | |

Figure 1. Analysis of factors affecting the construction period of power transmission and transformation projects based on system dynamics.
3. BP neural network theory

BP (back propagation) neural network is a concept proposed by scientists led by Rumelhart and McClelland in 1986. It is a multi-layer feedforward neural network trained according to the error back propagation algorithm, and it is currently the most widely used neural network.

The BP neural network can be regarded as a multilayer perceptron network. The learning of the network uses the Error Back Propagation Method (Error Back Propagation Method), which is called the BP neural network.

The basic BP algorithm includes two processes: forward propagation of the signal and backward propagation of the error. That is, the error output is calculated in the direction from input to output, and the adjustment weights and thresholds are made in the direction from output to input. During forward propagation, the input signal acts on the output node through the hidden layer. After a nonlinear transformation, the output signal is generated. If the actual output does not match the expected output, the error is transferred back to the reverse propagation process. Error back-propagation is to pass the output error back to the input layer layer by layer through the hidden layer, and distribute the error to all units of each layer. The error signal obtained from each layer is used as the basis for adjusting the weight of each unit. By adjusting the connection strength of the input node and the hidden layer node and the connection strength and threshold of the hidden layer node and the output node, the error is reduced along the gradient direction, and after repeated learning and training, the network parameters (weights and thresholds) corresponding to the minimum error are determined. The training will stop. At this time, the trained neural network can process the input information of similar samples by itself with the smallest output error and the non-linear conversion information.

4. Empirical analysis

The input variables of the construction period prediction model of the substation construction based on the BP neural network method are factors such as prefecture number, voltage grade number, construction section number, annual rainfall, substation type and other factor variables.

Randomly select 54 samples from the 64 samples of power transmission and transformation engineering as training samples, the remaining 10 samples as verification samples, the number of neurons in the input layer is 11, the number of neurons in the output layer is 1, and the middle layer neurons are set to 15 to establish a three-layer neural network structure. The prediction results of BP neural network are shown in Table 1.

| Sample number | Actual duration | Forecast duration | Deviation | Deviation percentage |
|---------------|-----------------|-------------------|-----------|----------------------|
| 1             | 326             | 303.53            | -22.47    | -6.89%               |
| 2             | 217             | 211.56            | -5.44     | -2.51%               |
| 3             | 379             | 400.32            | 21.32     | 5.63%                |
| 4             | 468             | 489.25            | 21.25     | 4.54%                |
| 5             | 332             | 310.8             | -21.2     | -6.39%               |
| 6             | 292             | 286.18            | -5.82     | -1.99%               |
| 7             | 273             | 290.6             | 17.6      | 6.45%                |
| 8             | 321             | 304.42            | -16.58    | -5.17%               |
| 9             | 272             | 286.5             | 14.5      | 5.33%                |
| 10            | 328             | 309.44            | -18.56    | -5.66%               |
Figure 2. BP neural network prediction results of substation engineering. The effect of BP neural network training error is shown in the figure below.

Figure 3. BP neural network training error effect diagram.

5. Conclusion
Combined with the system dynamics theory, this paper systematically sorted out the influencing factors affecting the construction period of power transmission and transformation projects, and on this basis, constructed a BP neural network-based forecast model for the construction period of transmission and transformation projects. Through empirical analysis, the effectiveness of the prediction model is verified.

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