Quality Control of Key Processes in Construction Engineering Based on BP Neural Network

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Abstract: In the construction engineering activities, the control of project quality is a very important link. The quality of the project directly affects the service life of the construction project, indirectly affects the economic benefits of the project, and there are even security risks. The development of science and technology has made the complexity of construction engineering increase day by day, and there are many factors affecting the construction quality. In the construction project construction activities, these influencing factors dynamically change with the construction progress of civil engineering according to the characteristics of the project and the environment. This makes it difficult to control the quality of construction projects. Therefore, it is necessary to propose appropriate methods to establish the mapping relationship between the influencing factors of construction quality and the forming process of the engineering entity. In this paper, the BP neural network model is used to track and analyze the data in the engineering quality forming process, so as to find out the important factors causing the quality deviation of the process, and provide a scientific basis for the quality control of construction engineering. At the same time, it has a universal reference value, which is conducive to improving the quality of construction engineering and reducing the occurrence of quality accidents during construction of construction projects.

1. Introduction

The quality of construction engineering is mainly formed by the quality of each process. It is a dynamic process, and there are many factors affecting the quality of construction engineering. Quality control theory generally believes that five aspects of people, machinery, materials, methods and environment are affecting the quality of engineering. The final factor [1-4]. However, since the implementation of the project is a dynamic process, the conventional process quality control plan is mostly based on the experience of similar engineering projects completed, which is based on the quality of the project management personnel and the long-term accumulated experience of the construction unit. [5-7]. To a certain extent, it is difficult to accurately determine the degree of influence of the above-mentioned factors affecting the quality of the process at a certain stage of the project on the quality formation process of the stage [8, 9]. The neural network technology that has emerged in recent years has attracted more and more attention due to its parallel processing, self-adaptation, self-organization, associative memory, fault tolerance and robustness [10-14]. This paper uses BP neural network to establish the relationship between quality influencing factors and engineering quality forming processes, and expects to predict the quality risk factors of each process in the construction process of the construction project, and to correct the process quality formation process in a targeted manner. Improve the overall quality of construction projects and reduce the occurrence of quality accidents.

2. Construction Process Key Process Quality Control Concept

2.1 The Key Process Connotation of Construction Engineering.

The process refers to the order in which the construction work of an engineering entity is completed. The construction process has the following characteristics: the work process is relatively continuous, the work content and working methods are basically similar, and the processes are

mutually connected and independent. In the process of forming the quality of engineering products, process quality is the most basic part of product quality formation. The quality of each process ultimately directly or indirectly affects the quality of engineering products. Therefore, the core of engineering process quality control is process quality control. In the process of forming the quality of engineering products, the impact of each process on the quality of the project varies, and the process that has a great impact on the quality of the project is called a key process. The key processes mainly refer to the construction process of important components or parts, the construction process that has a major impact on the quality of the next process, the construction process with a long process duration, and the construction process with high raw material value, which has a great impact on the surrounding environment. Process.

2.2 Analysis of Factors Affecting Process Quality.

There are many factors affecting the quality of the project. The quality control theory holds that people, materials, machinery, methods and environment determine the quality of the process. People are the main body of process operations, directly involved in the organization, management, operation of the process, etc., the quality of the personnel directly affects the quality of the process. The quality of personnel includes quality awareness, physiological state, mental state, theoretical level and technical level. Materials are the basis of process operations. They refer to the use of raw materials, semi-finished products, structural components, installation equipment, and measures materials during process operations. The quality of materials directly affects the quality of the process. The quality control of engineering materials includes quality control in the procurement phase, quality control in the transportation phase, quality control in the storage phase, and quality control in the use phase. Mechanized operation is a means to improve the efficiency of process operations. Advanced mechanical operations can improve the accuracy of operations. With the development of industrialization, the influence of mechanical factors on process quality will become more and more important. Mechanical factors mainly include the rationality of mechanical selection, the performance of the machine itself, the level of mechanical operators, and the maintenance and maintenance of machinery. The method refers to the organization and management of resources in order to complete the process and form a relatively standard process. With the continuous development of technology, there are many different methods, and the advanced level of the process is also the embodiment of the company's technical level and construction capability. The advanced level of the method is mainly reflected in whether the construction period is shortened, whether the labor consumption is reduced, whether the accuracy is improved, whether the material consumption is reduced, and the operability is satisfactory. The environment mainly refers to the sum of other external influence factors in the process operation, and its impact on the process may be direct or indirect. It mainly includes management environment, technical environment, labor environment, economic environment, climate environment, social and human environment. In the engineering analysis of historical quality accidents, it was found that the above five factors jointly determine the quality of the process.

3. Feasibility of BP Neural Network Technology in Process Quality Control

3.1 The Basic Concept of Neural Network.

Artificial neural network is a nonlinear, adaptive, self-organizing system composed of a large number of simple processing units (neurons) according to specific connection methods. It is used to simulate human beings based on the research results of modern neuroscience and information science. An information processing system that processes, processes, and memorizes information in the nervous system. Artificial neural networks use mathematical methods to abstract, simplify, and simulate the functions of some human brains. Although there is still a big gap between the human and the brain in terms of function and complexity, they are far stronger in the ability to process data and the intensity of computation. In the human brain.

Artificial neurons are the most basic information processing unit, which takes one or more inputs into a certain set of operations to get an output for conduction. A neuron consists of nodes, weights, thresholds, transfer functions, and input and output values, mathematically expressed as:

$$Y_i = f(\sum W_{ij}X_i - \theta_i) \tag{1}$$

Artificial neurons use a set of node weights W_{ij} to simulate the effects of synapses, with positive values representing positive stimuli and negative values representing suppressed output. The unit sums the $\sum W_{ij}X_i$ to simulate the integration of all neurons with neurons. When the stimulus reaches a certain level, the neurons respond, and the degree is expressed by the threshold θ_i. When the external stimulus exceeds the threshold, the biological neuron sends a signal to respond to the stimulus, and the transfer function f is used to simulate the process in the artificial neuron. The input value is multiplied by the node weight and compared with the threshold. After the threshold is exceeded, the output Y is derived from the conduction function f after the threshold is exceeded.

3.2 BP Neural Network Concept.

BP neural network is also called multi-layer feedforward network, and it is also one of the most widely used network models. The BP neural network error back propagation neural network refers to the multi-layer neural network model using the algorithm. The model generally consists of an input layer, an intermediate layer, a hidden layer, and an output layer, Fig. 1 BP neural network structure. The learning process is divided into two parts, one is signal forward propagation and the other is error back propagation. When the signal is propagating in the forward direction, the information is transmitted from the input layer, processed through the hidden layer and then transmitted to the output layer. The state of each layer of neurons only affects the next layer. If the actual output value and the target value are inconsistent, the error back propagation process is entered. When the error propagates back, the error is transmitted to the input layer through the hidden layer. In this process, the error signals of each layer are obtained, and the connection weight between the neurons in each layer is modified based on the error signal. This forward and reverse propagation is repeated over and over, until the error narrows to an acceptable target range.
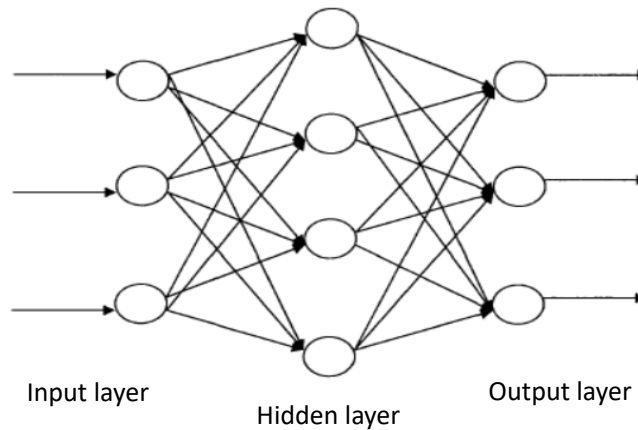

Input layer   Hidden layer   Output layer

Fig 1. BP neural network structure

3.3 Feasibility of BP Neural Network Technology in Process Quality Control.

The quality control of the process is the smallest unit of quality control of the entire project. The quality of each process is up to standard, and the quality of the project can reach the standard. For the same enterprise, the resources, technical strength and quality management methods of different engineering projects are generally similar. However, the quality results of the same process in different engineering projects are different. How to find the deviation of the process quality? The reason is the key to improving the quality of the project. The characteristics of the BP neural network enable this vision to be realized. BP neural network is an intelligent algorithm, which has the following advantages in terms of process quality control. First of all, it can deal with various nonlinear relationships in complex quality control. It is systematic and global. It can theoretically approximate arbitrarily complex nonlinear relationships. In terms of engineering quality evaluation, it is actually a multivariate nonlinear problem. The classification of the second neural network can

input multiple variables, in the application can be incorporated into the assessment system, and it also has a strong information integration ability, based on a large number of data parallel operations, further weights Accuracy; the artificial neural network has the ability to self-learn, generalize and generalize, and can find out the factors affecting quality from the data of existing engineering.

4. Process Quality Control Design of BP Neural Network

4.1 Process Quality Control Data Sample Collection Principles and Control Indicators.

In the actual engineering process quality analysis, the selection of samples should follow the following principles: First, select the key processes that are common in engineering activities, operability, and easy to collect data; second, the sample data should be comparable and certain Elastic space; the third is that the sample should be representative of the management level and technical level of the enterprise or engineering project; the fourth is that the evaluation results should be intuitive and quantifiable. According to the above principles and the analysis of the five major factors affecting the process (people, materials, machinery, methods, environment), and considering its authenticity, representativeness, and operability, the following evaluation indicators are proposed: The operator is the main body of the process implementation, using the proportion of trained technicians and the proportion of the age of 25 to 35 as the evaluation index; the material is the basis of the process activities, using the factory qualification certificate and the sampling rate on site The rate is used as the evaluation index; the means of modern process operation when the machine is used, the proportion of the remaining life of the machine used and the training ratio of the mechanical workers are used as the evaluation index; the method represents the technical level of the enterprise or the project, and the proportion of the mechanized automation of the process is used as the evaluation. Indicators; for the environment, the management environment, economic environment, climate environment, and social and human environment of the same enterprise are basically the same. For the technical environment and the labor environment, the project cost of the relatively harsh environment is generally increased, so the environmental indicators The proportion of the project cost is used as the evaluation index. According to the engineering quality grade, the output index is 95% excellent, 85% good, and 75% qualified.

4.2 Modeling Using BP Neural Network of MATLAB Software.

1) Sample data preparation

According to the above sample data collection principle and control indicators, the same key process of different construction projects in the same area of a certain enterprise is the data collection sample, as shown in the following table (Tab. 1 sample data preparation):

Tab 1 sample data preparation

sample	people		material		mechanical		method	surroundings	Evaluation
	Ratio of trained personnel	25-35 Age ratio	Certificate of Compliance	On-site sampling pass rate	Performance Trial Residual Life	Certified employment ratio	Process automation ratio	Proportion of project fees for measures	Qualified 75%, good 85%, excellent 95%
1	0.223	0.515	0.587	0.982	0.322	0.951	0.568	0.012	0.75
2	0.298	0.328	0.772	0.983	0.324	0.802	0.637	0.011	0.75
3	0.351	0.534	0.846	0.974	0.334	0.625	0.667	0.011	0.75
4	0.325	0.358	0.857	0.985	0.356	0.925	0.758	0.012	0.75
5	0.352	0.342	0.872	0.985	0.448	0.872	0.788	0.01	0.75

2) MATLAB neural network establishment

In order to prevent the large input value, the limit value of the saturated zone trend function of the S-type function makes the convergence speed of the network very slow. Therefore, the data are normalized first, and the processed data are shown in Tab. 2:

Tab 2 Sample data normalization

sample	people		material		mechanical		method	surroundings	Evaluation
	Ratio of trained personnel	25-35 Age ratio	Certificate of Compliance	On-site sampling pass rate	Performance Trial Residual Life	Certified employment ratio	Process automation ratio	Proportion of project fees for measures	Qualified 75%, good 85%, excellent 95%
1	0	0.742	0	0.978	0	1	0	0.25	0
2	0.387	0.139	0.468	0.981	0.004	0.630	0.218	0.125	0
3	0.660	0.803	0.656	0.960	0.024	0.191	0.312	0.125	0
4	0.526	0.235	0.684	0.986	0.068	0.935	0.600	0.25	0
5	0.664	0.184	0.722	0.986	0.250	0.804	0.694	0	0

The BP neural network structure is shown in Fig. 2 BP neural network structure:
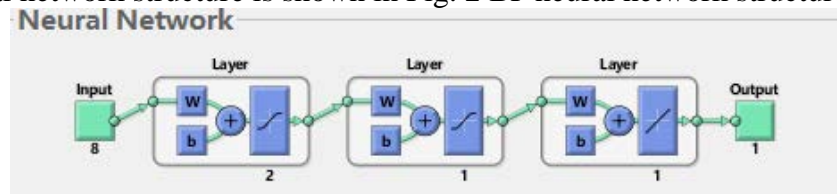

Fig 2. BP neural network structure

The process of changing the network error during the training process is shown in Fig. 3. When the actual error and the target error intersect, the training ends.
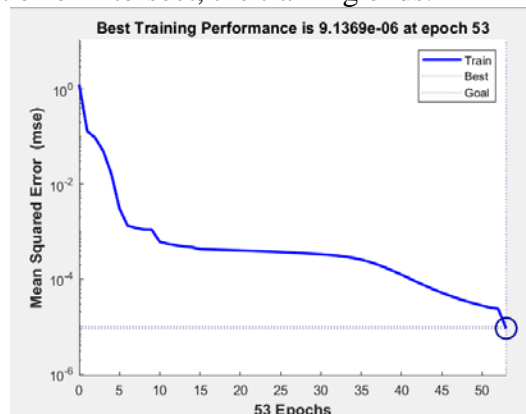

Fig 3. Error curve

After the training, a set of data of the same key process of different construction projects in the same area of the enterprise is randomly selected for simulation verification. The results show that the simulation results are basically consistent with the actual situation, and the accuracy of the network simulation meets the application of the project. This also shows that the established network better reflects the quality of the process workers.

3) Weight analysis

After the training is completed, the weight values of each node are analyzed. Since the influence of the weight of each node may be positive or negative, in order to objectively display the influence of the node weight, the absolute values of the weights are added together. The percentage is as shown in Tab. 3 Process Influencing Factors Sensitivity.

Tab 3 Process Influencing Factors Sensitivity

Influencing factor	people		material		mechanical		method	surroundings
	Ratio of trained personnel	25-35 Age ratio	Certificate of Compliance	On-site sampling pass rate	Performance Trial Residual Life	Certified employment ratio	Process automation ratio	Proportion of project fees for measures
Sensitivity index	0.012	0.096	0.573	0.109	0.886	0.086	0.521	0.954
percentage	0.38%	2.97%	17.70%	3.36%	27.38%	2.64%	16.08%	29.47%

It is not difficult to see from the above table that the establishment of a good environment for the construction of the company in this process is a weak link that needs to be intervened. This also reflects the current situation that most small and medium-sized construction enterprises are insufficient to invest in construction costs in order to save construction costs.

5. Conclusion

The simulation function of BP neural network provides a new idea for the quality control of construction engineering. Enterprises can also start from the smallest process unit according to their own characteristics, and regularly conduct self-discrimination to find problems and continue to improve. This also reflects the idea of the PDCA cycle in total quality management. Compared with the traditional quality analysis methods such as causal analysis, it can objectively analyze the quality influencing factors at a certain stage, thus guiding the construction enterprises to do a good job in the process quality management, and improve the accuracy and scientific quality management.

References

[1] Asif R, Ming Z. Lane-Based Short-Term Urban Traffic Parameters Forecasting Using Multivariate Artificial Neural Network and Locally Weighted Regression Models:, A Genetic Approach[J]. Canadian Journal of Civil Engineering, 2018: cjce-2017-0644-.

[2] Jinxing L, Junling Q, Zhihua F, et al. Prediction of Soil Deformation in Tunnelling Using Artificial Neural Networks[J]. Computational Intelligence and Neuroscience, 2016, 2016:1-16.

[3] Dai H, Cao Z. A Wavelet Support Vector Machine-Based Neural Network Metamodel for Structural Reliability Assessment[J]. Computer-Aided Civil and Infrastructure Engineering, 2017, 32(4):344-357.

[4] Derbal I, Bourahla N, Mebarki A, et al. Neural network-based prediction of ground time history responses[J]. European Journal of Environmental and Civil Engineering, 2017:1-18.

[5] Zhou H, Zhou Y, Zhao C, et al. Feedback Design of Temperature Control Measures for Concrete Dams based on Real-Time Temperature Monitoring and Construction Process Simulation[J]. KSCE Journal of Civil Engineering, 2017, 22(6).

[6] Xu B, Dan H C, Li L. Temperature prediction model of asphalt pavement in cold regions based on an improved BP neural network[J]. Applied Thermal Engineering, 2017, 120:568-580.

[7] Cascardi A, Micelli F, Aiello M A. Analytical model based on artificial neural network for masonry shear walls strengthened with frm systems[J]. Composites Part B: Engineering, 2016:S1359836816301548.

[8] Le M , Perez G C, Solomatine D, et al. Meteorological Drought Forecasting Based on Climate Signals Using Artificial Neural Network – A Case Study in Khanhhoa Province Vietnam[J]. Procedia Engineering, 2016, 154:1169-1175.

[9] Ebrahim E, Masoud M, Mohammad R K , et al. Prediction and optimization of back-break and rock fragmentation using an artificial neural network and a bee colony algorithm[J]. Bulletin of Engineering Geology & the Environment, 2016, 75(1):27-36.

[10] Liza R, Fenton G A, Lake C B, et al. An analytical approach to assess quality control sample sizes of cement-based "solidification/stabilization"[J]. Canadian Geotechnical Journal, 2017, 54.

[11] Fan Junnan, Zhang Wei, He Xiaomin, and so on. Prediction and evaluation of heavy metal pollution in soils around key industries based on BP neural network[J], Journal of Huazhong Agricultural University, 2019(4): 001.

[12] Pitoňák, Martin, Filipovsky, Ján. GPR Application – Non-destructive Technology for

Verification of Thicknesses of Newly Paved Roads in Slovakia[J]. Procedia Engineering, 2016, 153:537-549.

[13] Hutyrová, Zuzana, Makiela W, Michalik P , et al. Creation of Mathematical Prescription of Residual Stress Depending on Various Cutting Conditions[J]. Key Engineering Materials, 2015, 669:126-133.

[14] FU Kelan, LI Hui, ZHANG Xia. Prediction Model and Application of BP Neural Network[J]. Information and Computer (Theoretical Edition), 2016(11): 47-48.