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A Study on Optimal Duration Estimation for Construction Activity

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***Abstract:** As a construction project is recently becoming large-scaled and complex, construction process plan and management for successful performance of a construction project has become more important. Especially a reasonable estimation plan of activity duration is required because the activity duration is directly related to the determination of the entire project duration and budget. However, the activity duration is used to estimate by the experience of a construction manager and past construction records. Furthermore, the prediction of activity duration is more difficult because there is some uncertainty caused by various influencing factors in a construction project. This study suggests an estimation model of construction activity duration using neural network theory for a more systematic and objective estimation of each activity duration. Because suggested model estimates the activity duration by a reasonable schedule plan, it is expected to reduce the error between planning duration and actual duration in a construction project. And it can be a more systematic estimation method of activity duration comparing to the estimation method by experience of project manager.*

***Keywords:** Estimation of Activity Duration, Neural Network Theory, Resource and Quantity Take-off*

I. Introduction

Process planning in construction projects is an important work directly related with determination of total construction duration and project cost. Therefore, as one of the important items in process planning, construction duration requires high estimation accuracy. Particularly, detailed activity duration estimation for construction duration is one of major factors determining success/failure of construction [1]. However, in general, activity duration is estimated by referencing the experiences of the project manager and past construction records. Also, there are many difficulties in performing accurate estimation because of uncertainty due to various influence factors inherent in construction projects. To solve this, various studies are being carried out for construction duration estimation through the regression analysis technique [2] or construction duration estimation through analysis of climatic factors and productivity [3]. However, there are not enough integrated studies yet on the construction duration estimation that consider the various factors affecting construction duration as well as studies on the detailed activity duration estimation for each process. Therefore, in this study, factors affecting activity duration estimation are analyzed to establish a rational schedule plan and a model methodology is proposed for neural network-based activity duration estimation.

II. Neural Network Theory

Neural network theory models the biological neurons of brain mathematically, and in a neural network, neurons having mathematical operation capability are connected with each other and are operated by defined learning rules. The basic structure of a neural network has a structure for receiving certain input values and outputting result values through an arbitrary process. The core of the neural network is searching for an optimal connection weight through learning, and a typical learning method is the error back-propagation learning algorithm. This is actively used for prediction and classification problems with nonlinear input/output characteristics in various fields [4].

III. Neural Network-based Activity Duration Estimation Model

To increase the prediction accuracy of activity duration in construction project, an integrated analysis of the various factors affecting activity duration estimation is needed. To this end, in this study, a neural network-based activity duration estimation model is proposed, which can perform an integrated analysis of the various factors affecting activity duration, as shown in Fig. 1.

To construct a neural network structure, input/output variables and their data must be collected first, as shown in Fig. 1 In this study, quantitative factors and environmental factors affecting activity duration estimation are all considered and derived to set up input variables. Also, the target value of this study, i.e., activity duration is set up as an output variable. Based on the input/output variables set up, data for learning are collected. In this study, the most widely used error back-propagation algorithm method is applied as the learning method for the construction of the neural network structure.

The collected data are divided for the training process,

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verification process, and test process with respect to learning, and a final neural network structure is derived through learning of neural network structure.

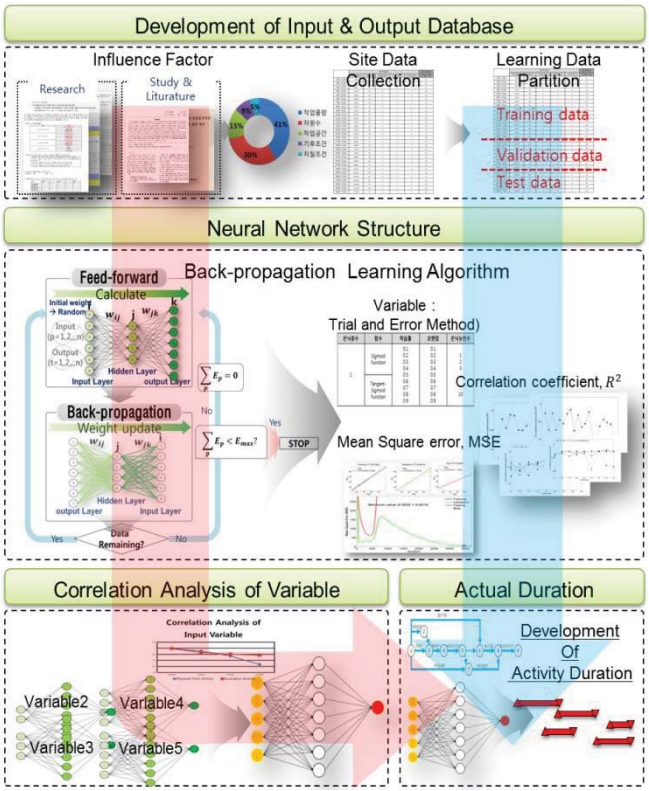

Fig. 1. Neural network-based activity duration estimation model methodology

Furthermore, to determine the suitability of the constructed neural network structure prior to deriving an actual activity duration through the derived neural network, an optimal neural network structure is determined by carrying out influence factor correlation analysis with many combinations of influence factors.

VI. Verification of Activity Duration Estimation Model Methodology

In this study, verification was carried out by targeting plywood formwork, which is a representative detailed work type of construction project to examine the applicability of the activity duration estimation model methodology. The input variables set up for activity duration estimation of plywood formwork were work quantity, number of resources, workspace condition, and weather condition, and the output variable was set up as the activity duration of plywood formwork.

Fifty data of plywood formwork were collected and divided for the training process, verification process, and test process by 70%, 15%, and 15%, respectively, for learning. In the model, learning is carried out with the error back-propagation algorithm method, and to find the optimal neural network structure, a connection weight and variable values are selected when the mean square error (MSE) is minimum with the trial and error method. In this study, MATLAB 2013b was used for neural network learning and for obtaining results. The optimal neural network structure of plywood formwork and the MSE value of the connection weight are shown in Fig. 2.

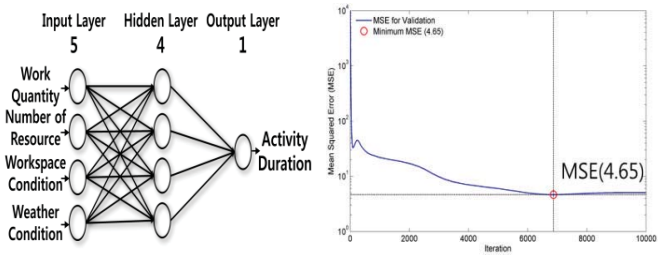

Fig. 2. Plywood formwork's optimal neural network structure and MSE

Furthermore, the accuracy of the predicted activity duration was measured by analyzing the absolute error rate and coefficient of determination (R^2) between the activity duration predicted through the neural network structure and the activity duration of conventional plywood formwork. As a result of analysis, the mean absolute error rate and R^2 value showed good results of 9.743% and 0.93588, respectively, confirming the suitability of the activity duration estimation model methodology.

V. Conclusion

Using the neural network theory, an activity duration estimation model was constructed, and its applicability was examined for plywood formwork activity. It is expected that the activity duration estimation model proposed in this study will be actively used as a decision making tool since it provides the optimal activity duration by allowing the input of influence factors in accordance with field conditions and performs an integrated analysis of various field conditions. Also, it is expected to reduce the error rate between planned construction duration and actual construction duration.

References

[1] H.D. Lee, S.H. Lee, Y.C. Seo, S.B. Lee, "Development of CBR-based DEPOT(duration estimator for project) system for construction project", *Journal of the Regional Association of Architectural Institute of Korea*, vol. 12, no. 2, pp. 201-208, 2010.

[2] A. Czarnigowska, A. Sobotka, "Estimating construction duration for public roads during the preplanning phase", *Journal of Engineering, Project and Production Management*, vol.4, no.1, pp.26-35, 2014.

[3] H.S. Lee, J.W. Shin, M.S. Park, H.G. Ryu, "Probabilistic duration estimation model for high-rise structural work", *Journal of Construction Engineering and Management*, vol.135, no.12, pp.1289-1298, 2009.

[4] H. Y. Han, "Introduction to Pattern Recognition", Korea: Hanbit, pp.1-572, 2009.