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Construction Site Monitoring and Predictive Analysis Using Artificial Neural Network

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Abstract:

Artificial Neural Network (ANN) is a subdivision of Artificial Intelligence are extensively used to answer a complex civil engineering concern. Construction site monitoring tools are based on expert judgments and parametric tools. The successful performance of construction project cannot be achieved without challenges and obstacles. To meet these challenges and hit these obstacles, an organization must have a clear awareness of its performance. Project manager spend most of his time for developing and updating of reports instead of execution and to take in-time decision to finish the work within prescribed time scale. The development of an artificial neural network tool by MATLAB that will help the project manager in this task. In this study, From the literature study construction site monitoring area has been decided and then 30 parameters are identified and questionnaire was prepared. After analysis resulted in 8 factors Objective of this research is to develop Artificial neural network (ANN) models to predict cost performance, schedule performance, quality performance and satisfaction level. This are determined by ANN through its machine learning which is identified by validation, testing and training results.

Keywords — **construction project, cost performance, schedule performance, quality performance, satisfaction level, neural networks**

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I Introduction

Construction industry is very large and mixed industry which plays a vital role in the progress of any nation. Construction projects are complicated, multidisciplinary and time-consuming in nature. They may involve the participation of owners, designers, contractors, subcontractors, specialists, consultants, etc. The number of participants also increases with the size of the project. It is commonly agreed that for a construction project to be fulfill it has to be completed on time within budget and according to the specification. Schedule overrun is also related to cost overrun, and if schedule overruns could be controlled a major part of the cost overrun is also controlled. The success of a project is measured in terms of its performance on schedule, cost, and quality. Efficiency of the construction performance can be defined as the project completed within the time schedule and cost budget.

Schedule and cost are still the widely used performance measures because of their simplicity. The objective of construction planning is to guarantee a successful project. For the study, more amount of documented data on completed projects is required. Most current project control systems measure quantitatively cost and schedule status and forget other important aspects of project performance like quality, safety, project team satisfaction, and client satisfaction which are also as important as cost and schedule. Due to non-availability of documented data of completed projects for study in India, a questionnaire survey approach is considered to find out impacts of various attributes on project performance. Forecasting project performance is one of the most demanding tasks in

predicting whether the project will be successful. The effective performance of construction project cannot be achieved without challenges and obstacles. To meet these challenges and beat these obstacles, an organization must have a clear awareness of its performance. Whether the project is

big or small, every team member needs to know in a timely and accurate manner, how is the project progressing, where they are currently in comparison to the initially set plans, whether deadlines are met, budgets are safely measured and followed. It is mainly the responsibility of the general contractor to update. Project manager spend most of his time for developing and Although the Indian construction industry has gained far more importance in recent times because of opening up of Indian markets and the arrival of megaprojects for infrastructure development, the performance of Indian construction projects has however, not been very encouraging. Infrastructure, airport, metro rail and power sector projects constitute a significant portion in this sector. Hence to define the success or failure of a project without specifying the participant and without specifying the criteria for judging the performance holds no meaning. The traditional planning and controlling methods practiced in the construction industry demand the project manager to base the estimate of various control parameters (e.g. cost, quality and schedule variances) on status reports that become available from time to time. Project managers evaluate these status reports to predict the variations in these control parameters over the duration of the project. These methods are satisfactory, but when hundreds of tasks have to be precisely arranged, these predictions become difficult to make. For effective control, project managers have to corn pare the performance of future work against the original baseline estimate to identify likely problems and possible solutions. The efficiency of the project manager in making an instinctive estimate about the future, and how far he could effectively integrate this information with the current plan, has a strong bearing on the success of a construction project.

II. Concept of ANN

Artificial Neural Network is a soft computing tool which has the ability of human mind to effectively apply modes of reasoning and pattern recognition. ANN's were found to learn from the relationships between input and output provided through training data and could generalize the output, making it suitable for non-linear problems where judgment, experience and surrounding conditions are the key features. ANNs typically comprise of 3 layers viz. input layer with input neurons, hidden layer(s) with hidden neurons and output layers with output neurons. As shown in fig 1.

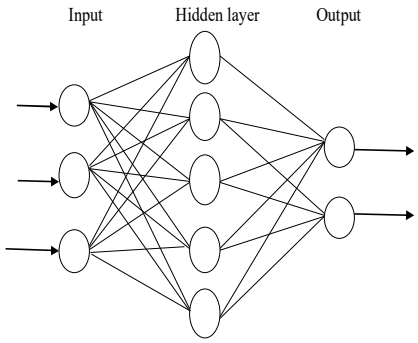

Fig 1 Input, Hidden, Output layer

Each neuron in the input layer is connected to each neuron in the hidden layer and each neuron in hidden layer is connected to each neuron in the output layer. The number of hidden layers and number of neurons in each hidden layer can be one or more than one. The number of input neurons, hidden neurons and output neurons constitute the network architecture. Before its application the network is trained, i.e. the connection weights and bias values are fixed, with the help of a mathematical optimization algorithm and using part of the data set until a very low value of error is attained. The network is then tested with an unseen data set to judge the accuracy of the developed model. The network is trained using various training algorithms which aim at minimizing the error between the observed and network predicted values.

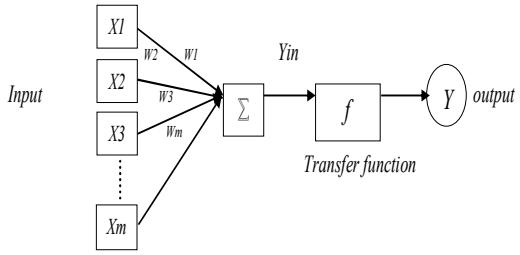

Fig 2 Model of ANN

Function as shown in fig 2 is the general model of artificial neural network, the net input can be calculated as follows

yin = x1.w1+x2.w2+x3.w3… xm. Wm

i.e., Net input yin= ∑mi xi. Wi

The output can be calculated by applying the activation function over the net input.

Y=F (yin)

Output = function net input calculated

Transfer functions: A sigmoid function is a mathematical function having a characteristic "S"-

shaped curve or sigmoid curve. A standard choice for a sigmoid function is the logistic function shown below:

F (x)=1/(1+e^(-x))

The input which may have any value between plus and minus infinity and the output into the range 0 to 1.

III. Process of methodology

Based on the literature review, various factors have been identified which may consider while construction site monitoring at project work. All those 30 factors are identified to focus on, which generally affect performance of project on construction field. **Q**uestionnaire survey is conducted to determine the level of importance given to these attributes during making the decision. Questionnaire survey is chosen as the ideal procedure for determining level of importance of the attributes as the respondents were situated in Amravati. Questionnaires are prepared by adding the respondent profile which collects general information such as name, education, age working experience. The next set of questions is targeting the Identified Factors from construction site monitoring which affect project performance. Hence, each respondent has to answer the questions according to their understanding, knowledge and experience of that project. This simple and straight method is selected to collect the data from the construction site. Starting neural network tool, one window appears on the screen naming, select data. This is for the selection of the data from either from workspace or from collected dataset.

The data was then imported to MATLAB and network formed using the nntool function. NNTOOL opens the Network window as shown in fig. 1 which allows you to import, create, use, and export neural networks and data. The network type selected for the training was feed-forward back-propagation because it is good for non-linear fittings. Trainlm was the training function adopted because it is the fastest backpropagation algorithm in the toolbox. Trainlm function updates weight and bias values according to Levenberg-Marquardt optimization. The learning functionality used was the Learngdm and this function takes several inputs. Learngdm is the gradient descent with momentum weight and bias learning function. The performance function e.g. Mean square

error (MSE), the number of layers, the number of neutrons and the transfer function e.g. tansig are all selected accordingly in order to create the network. After successfully creating a network, the next step is to train the network. Training of the network was performed using the Levenberg-Marquardt backpropagation algorithm as it is very fast. For the given set of inputs, a set of targets are decided. Using the random weights, the network calculates some outputs using transfer functions (i.e logsig). The calculated outputs are compared with the targets to obtain the network error. The connecting weights are adjusted to reduce the errors using the same learning rule. a regression curve showing the relationship between the outputs and targets for training, validation and testing stages. There is an excellent correlation between the output and target datasets for the training, validation and testing stages.

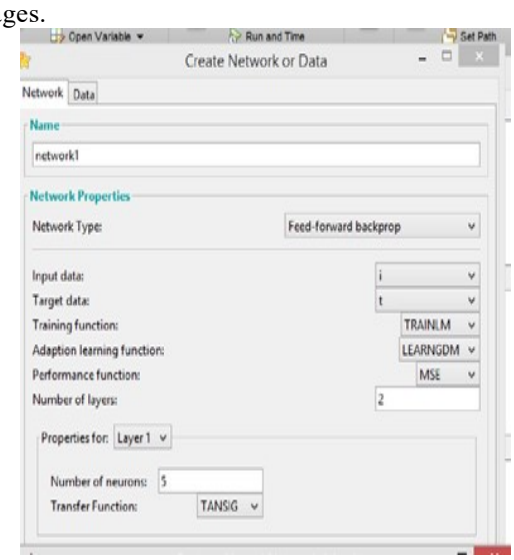

Fig 3 Typical ANN network window

After filling the necessary information train the model as shown in the fig 2

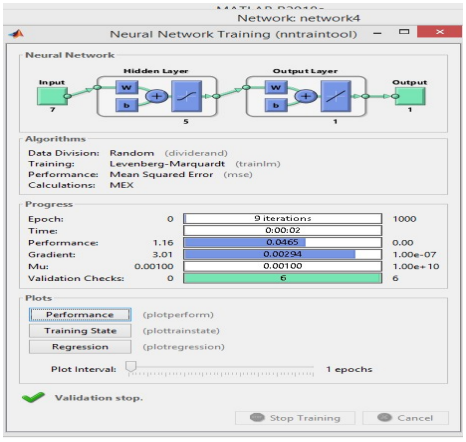

Fig 4 Training of ANN

After training the network the required results are given below.

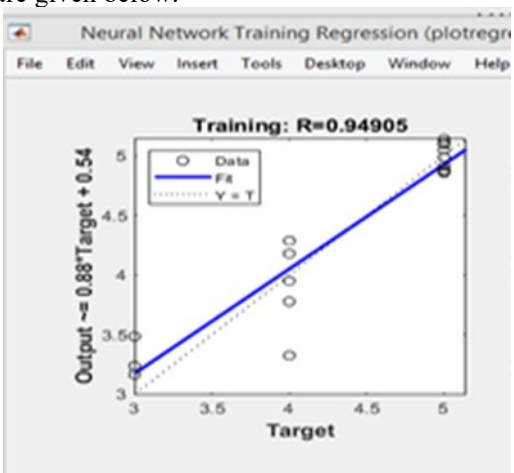

Fig 3 ANN- (1) Regression with Traning data

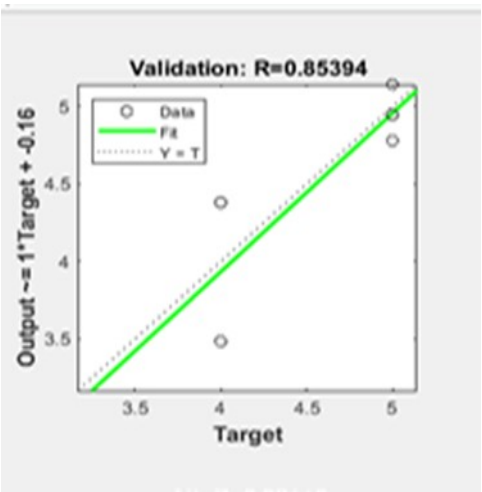

Fig 4 ANN- (1) Regression with Validation data

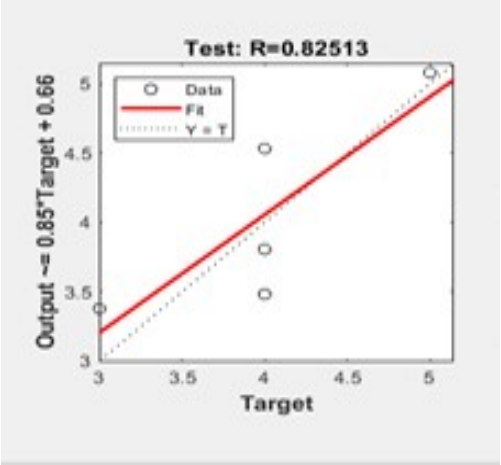

Fig 5 ANN- (1) Regression with Testing data

In case of more accurate results, retraining of the network can be carried out. Retraining the network will change the initial weights and biases of the network and may produce an improved network after retraining. The best validation performance is 0.062379 at epoch 8. As shown in fig 6

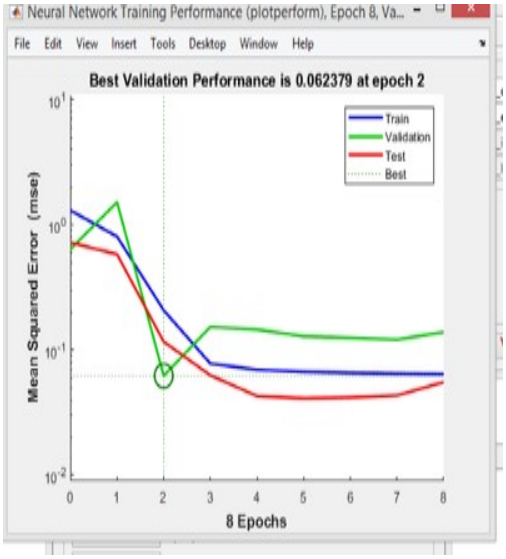

Fig 6 best validation performance

IV. Result and Conclusion

The network was decided to consist of two hidden layers with 5 neurons with feed forward back

propagation network. The best validation performance is 0.062379 at epoch 8. Results are calculated for ANN- (1) the result of training, the record values of R, MSE, RMSE values are found as 0.94905,0.08065 and 0.2839 respectively. During testing, these values are found as 0.82513, 0.23642 and 0.4862 respectively. the result of validation, the values of R, MSE, and RMSE 0.85394, 0.0885 and 0.2974 from validation**.** As shown in following table 1 From the results, as the training R values higher and nearly closer to one and lower values of MSE and RMSE ensures good prediction. Therefore, it is concluded that the neural network model's performance is not ideal but approximate.

Table 1 Statistical Values of the ANN-(1)

Statistical Parameters	ANN-1		
	Training data	Validation data	Testing data
R	0.94905	0.85394	0.82513
Mean Squared Error	0.08065	0.0885	0.23642
RMSE	0.2839	0.2974	0.4862

For construction site monitoring prediction in the cost, schedule, quality area the predicted values are approximate to the target values.

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