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Study of Conceptual Cost in Construction Project in Indian Sub-Continent Field Using ANN

Rajib Thakuria[1], Ananya Punyotoya Parida[2]
[1] Research Scholar, [2]Assistant Professor, Gandhi Institute for Technology, Bhubaneswar, Pin- 752054[1,2]

Abstract: An important piece of information for sustainable building project planning is conceptual cost. The present approach for estimating the conceptual cost is based mostly on conventional methods that make use of available data and the estimator's own expertise. In most projects, a systematic strategy to calculating and anticipating the conceptual cost for long-term project planning is inadequate. A comprehensive neural network model was built in this study to evaluate the conceptual cost of building projects. A wide variety of micro and macro impacting elements have been explored. The proposed engineering solution was pragmatic in that it used the artificial neural network (ANN) technology to represent labour and material costs incurred at various phases of development.

Keywords: conceptual cost, construction project, ANN model development

I. INTRODUCTION

Due to increasing resource limits, environmental degradation, and waste produced by the building sector, sustainable project design is gaining traction and acceptance in the modern day. Construction authorities are constantly encouraging sustainable construction techniques in the Indian subcontinent area, with the goal of generating resource efficient and eco-friendly construction projects. The project planning phase is the initial stage in sustainable building. Sustainable construction project planning is primarily concerned with the planning, monitoring, and management of projects and their supporting processes in order to address sustainability-related issues, particularly for large-scale projects. Because financial planning is critical to the effective execution and completion of projects integrated with sustainability, conceptual cost modelling is required for resource allocation in order to perform sustainable project planning. For sustainable building, construction practitioners have acknowledged the importance of early planning to the project's end outcomes. The Conceptual Cost Estimate (CCE) is created at the early stages of project formulation to assess the economic feasibility of moving on with the project. When developing conceptual cost estimates, planning engineers take into account a variety of complicated aspects that influence project costs. A conceptual cost estimate is created using the bare minimum of technical and design data. As a result, estimators and planning engineers must do critical conceptual cost planning for sustainable building projects. In general, the effective completion of construction projects is heavily reliant on the accurate estimate of the project's conceptual cost. As a result, project managers place a greater premium on conceptual cost estimates. Because conceptual cost is critical to the successful completion of sustainable building projects, a variety of methodologies are employed to model the conceptual cost.

Among several prediction tools, Artificial Neural Network (ANN) is regarded as one of the most reliable ways for modelling the project's conceptual cost. A previous assumption of the functional connection is not required for the neural network technique. Artificial neural networks are capable of learning from examples and mapping their functional features. In terms of accuracy, the neural network outperforms other functional approximation algorithms. The better capacity of neural networks to learn from examples aids in the modelling of complicated conceptual cost estimation. Among Many neural networks have been suggested to handle complicated issues, with back propagation networks being particularly popular because to their unique learning capabilities.

II. DEVELOPMENT OF NEURAL NETWORK MODE

To anticipate the conceptual cost for sustainable building project planning, a neural network model was built. The back propagation strategy was used to create an effective neural network model. The back propagation neural network technique is made from of

1) Identification of input variables and suitable neural architecture
2) Training the network using gathered data from various sources
3) Testing of network model
4) Prediction and validation of test results.

III. LITERATURE REVIEW

ANN (Artificial Neural Network) applications in construction management date back to early 1980s. These apps address a wide range of construction difficulties. Many critical building choices need the use of neural network models, which have been created globally to aid managers and contractors. Some of these models were created to help with cost estimate, decision making, forecasting percentage of markup, and predicting production rate, among other things (ElSawy, 2011).

Despite enormous number of academics who have used neural networks in numerous disciplines of engineering, studies & research on using neural networks to predict cost of building projects at many phases of work are quite restricted (Arafa and Alqedra 2011). Shtub & Zimer created models for evaluating cost of assembly systems in (1993), which were the first attempts to incorporate ANN approach within the cost estimate field (Wang 20017).

According to Al-(2003) Shanti's research, the majority of contracting organisations still estimate projects manually, with just a few adopting user-friendly estimating software packages due to a shortage of competent employees in using computer-based estimating systems. As a result, he (AL-Shanti) attempted to create a cost estimating system that is known to many cost estimators & is built to work on Microsoft Excel sheets.

Arafa & Alqedra (2011) created an ANN model to estimate early phases of building construction projects. A database of 71 building projects gathered from Gaza Strip's construction industry was employed in a constructed ANN model with one hidden layer and seven neurons. The trained models' findings suggested that neural networks were relatively successful in forecasting early stage cost estimation of structures utilising minimal project information and without the requirement for a more thorough design.

IV. IDENTIFICATION OF INPUT VARIABLES

Input factors are critical in forecasting conceptual costs and performing successful project management. In general, academics have been evaluating a variety of elements for long-term project planning. From the standpoint of long-term project planning, a conceptual cost estimate is a must. The concept cost is mostly determined by the area of construction. Various resource information from many building projects were gathered based on the location. To calculate the conceptual cost, the area of construction was used as an input variable. 13 distinct building projects were chosen, and data was gathered from senior project managers. The data collected was utilised to train the network. Only data from completed projects was utilised to train the neural network. To avoid variance, comparable types of construction are examined while selecting projects (e.g grade of steel, flooring material etc). The labour and material costs incurred at various stages of construction were obtained from the construction sites.

V. DEVELOPMENT OF NEURAL NETWORK MODEL

Back-propagation is one of the most widely used methods for training neural networks (Hegazy & Ayed 1998). The MATLAB programme was utilised to train the neural network in this study. MATLAB was chosen for its ease of use and quickness in training neural networks. The network was trained using the Levenberg-Marquardt method. A single layered feed-forward neural network was created using the ideas outlined above. The performance of a single-layered feed-forward network was evaluated using Mean Absolute Percentage Error (MAPE) and R2 values. An input layer, hidden layers, & an output layer comprise a neural network. The hidden layer is linked to the other layers by weights, bias, and activation function. Each layer is made up of a large number of neurons. Each neuron receives input from the data set. Weighted inputs are mixed and processed by an activation function, yielding output. Figure 1 depicts structure of an ANN model.

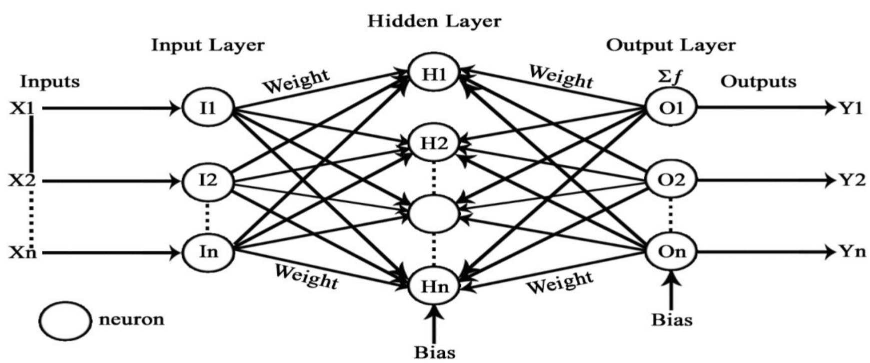

Figure11 Structure of IANN Model

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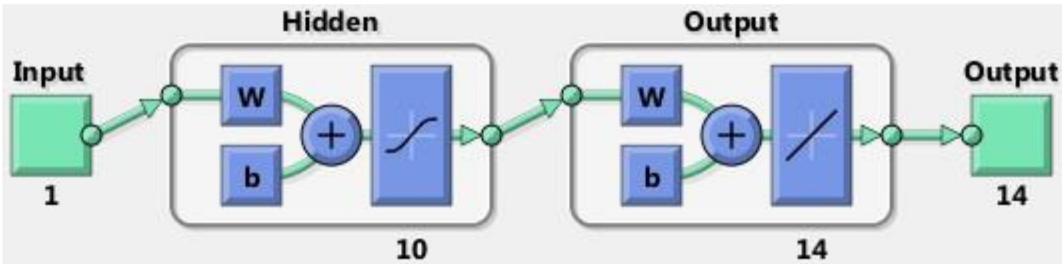
VI. TRAINING AND TESTING OF NEURAL NETWORK

The model built consists of an input layer with ten nodes & an output layer with fourteen nodes. In general, one hidden-layer neural network is appropriate for most construction applications (Hegazy et al. 1998), and the model is fixed with one hidden-layer neural network. Some trial and error is essential to maintain accuracy in creating the neural network architecture and adjusting its parameters. The neural network was tested with 5, 7, and 10 hidden nodes. In terms of the corresponding MAPE value, the neural network with 10 hidden nodes performed the best among these trials. Figure 2 depicts structure of created ANN model in MATLAB.



Figurei2 Structure of Developediann Model in Matlab

The network was trained to match inputs to the desired output. Normally, when a network stops training, generalisation stops increasing. This is seen by an increase in the value of mean squared error (MSE). The average squared difference between the input and the desired output is referred to as the mean squared error (R). The correlation between output and targets is represented by the R value.

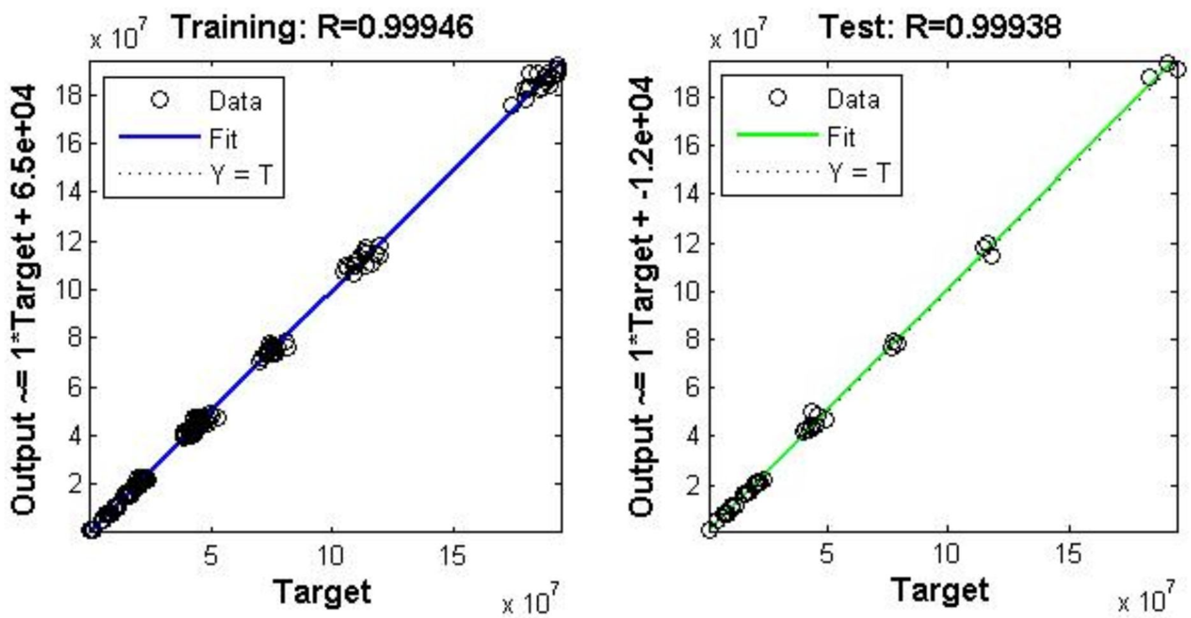


Fig.3 Regression Plot of the Neural Network

The mean squared error is calculated from the following equation (Chen 2010)

$$MSE = \frac{1}{N}\sum_{i=1}^{N}(t_i - a_i)^2$$

where 'N' denotes the number of data points utilised, ti denotes the output values, and ai denotes the goal values Figure 4 depicts the network's regression plot.

Back-propagation training, in general, uses a gradient-descent strategy to altering neural network weights. The data from hundreds of training cycles (called epochs) processed throughout the neural network's training phase. Following the conclusion of each cycle, the difference between the neural network outputs and the real outputs is propagated backward in order to adjust the weights for greater accuracy (Hegazy & Ayed 1998). The training procedure includes 143 testing epochs. Figure 4 depicts the neural network's current state.

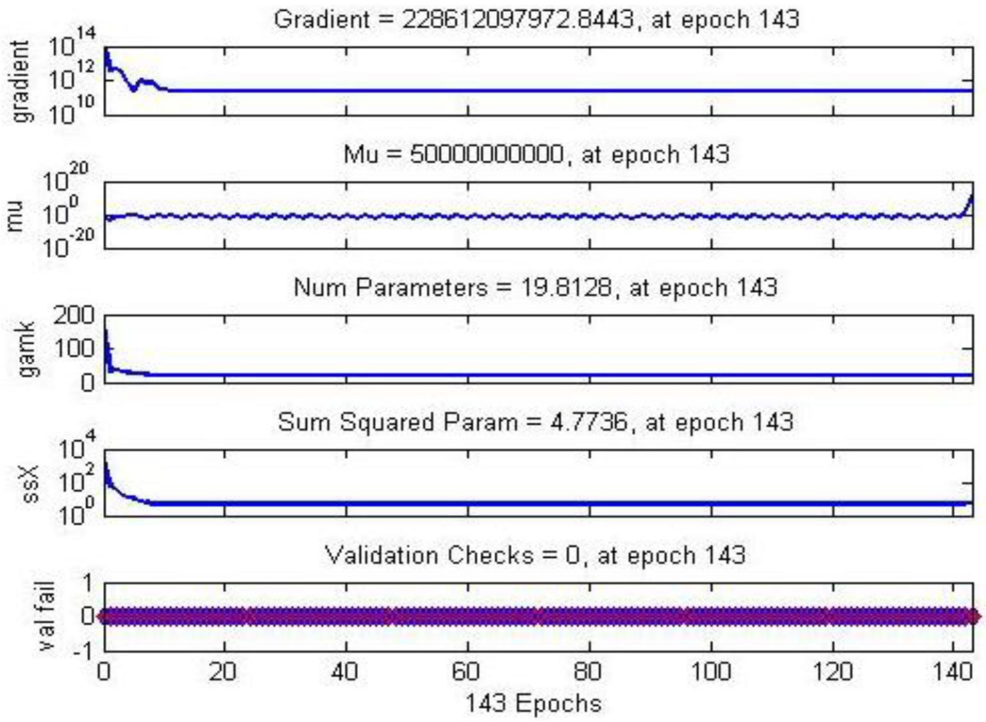


Figure 4 Overall Status of the Neural Network

For neural network model validation, 80 percent of the data from the original data set were used to train the network, and a R value of 0.999 was obtained for testing. 10% of the data was examined for testing, and a R value of 0.999 was attained for testing, while the remaining 10% of the data was evaluated for validation. The neural network model was trained for 143 epochs using the saved training data set. At epoch 5, the error was minimised. Figure 5 depicts the network's best validation performance.

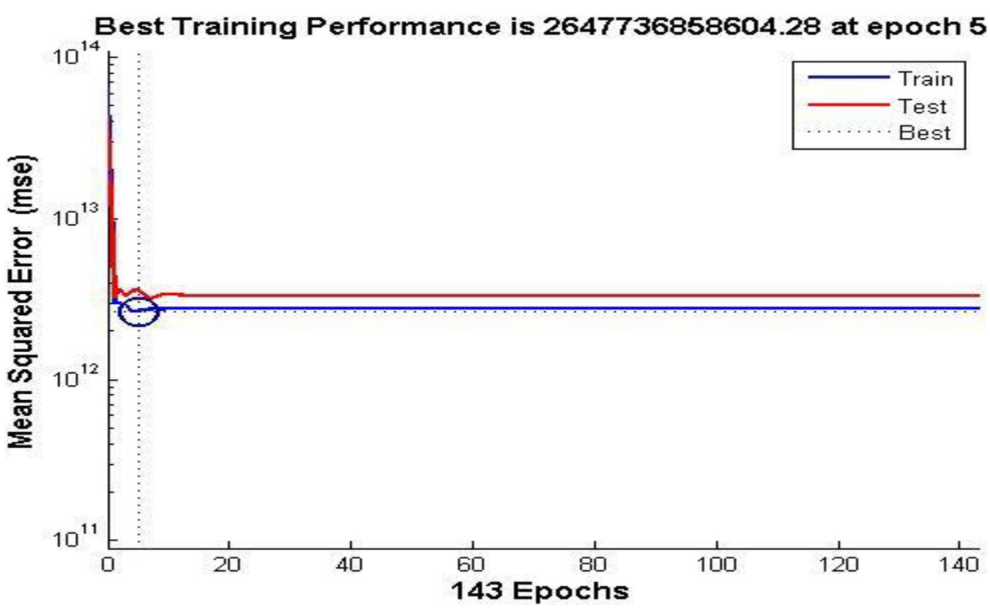


Figure 5 Best Validation Performance of the Network

The projected output values are more accurate than the actual values. The percentage of difference between the actual and anticipated values is determined. The percentage error variation for substructure is 6.48 to -7.05, for superstructure it is 4.67 to -3.68, for flooring it is 6.52 to -7.99, for plastering it is 8.98 to -6.17, for tiles fixing it is 5.64 to -7.67, for electrical and plumbing it is 7.87 to -8.12, and for painting it is 3.98 to -7.56.

VII. CONCLUSIONS

The cost of construction will be critical in the future decades for the advancement of sustainable development. To model the conceptual cost for sustainable construction project finance, a systematic technique is required. The creation of a neural network model to predict the conceptual cost of building projects for long-term project planning has piqued the interest of academics and practitioners alike. The finest conceptual cost estimate will assist project managers in taking proactive initiatives for the implementation of sustainable construction. An ANN model can be a helpful tool for project managers in estimating conceptual costs. The established model in this research is helpful and gives a holistic picture of sustainable building planning for construction professionals, hence boosting their skill in these processes.

1) Identifying input variables
2) Putting a value on the information gathered
3) Identification of Input Variables for Project Conceptual Cost
4) Validation of findings
5) ANN model development to forecast conceptual cost
6) Creating a neural network design and adjusting its parameters
7) Using obtained data, train a neural network model to forecast conceptual cost.

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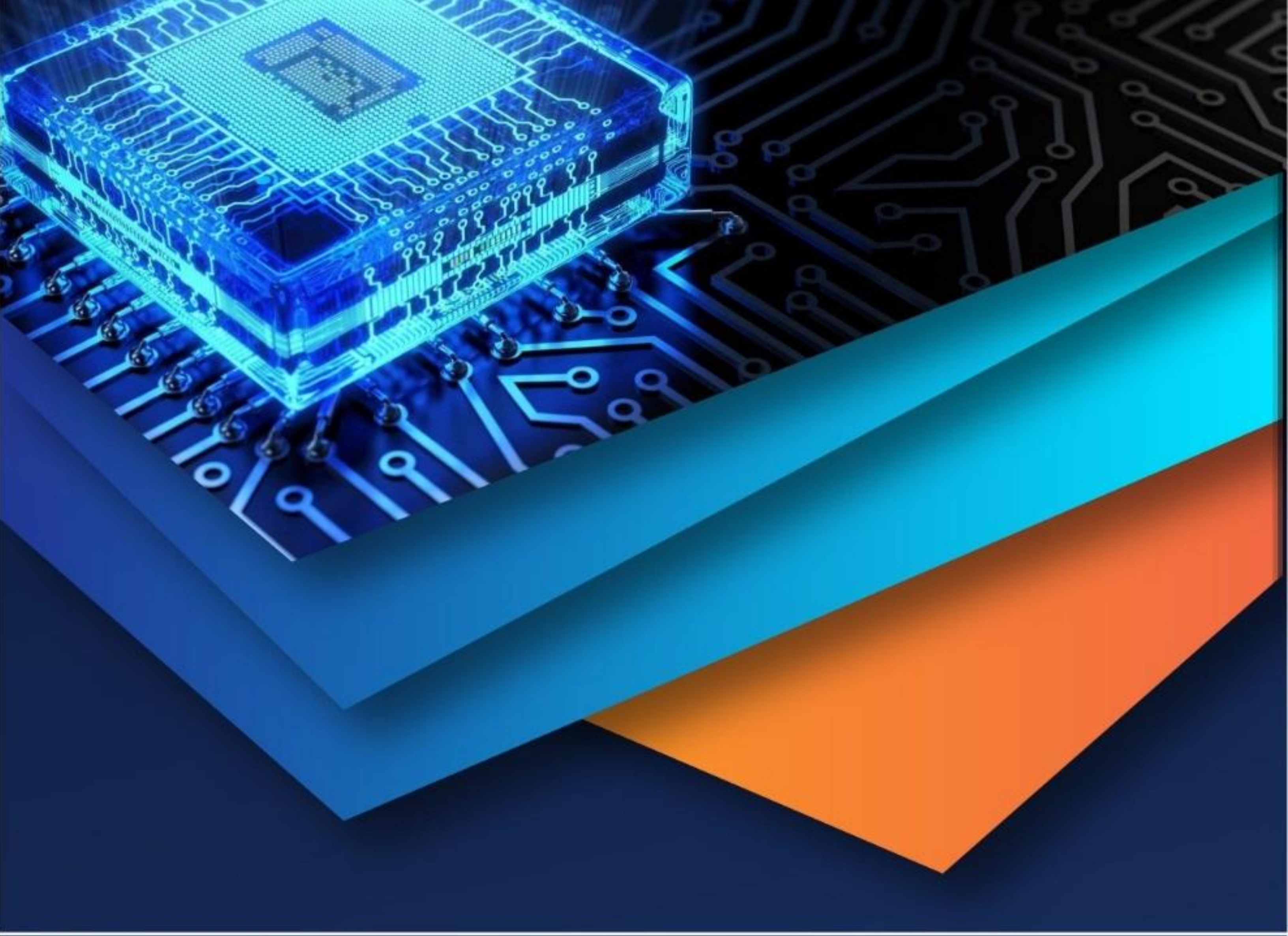

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