Implementation of Artificial Neural Networks to Forecast the cost of Road Projects

[1]Amit Sanjay Waikar, [2]Prof. Trupti V. Kulkarni
[1]Student, [2]Professor
Dr.D Y Patil Institute of Engineering and Technology,Talegaon Ambi

***Abstract* - Estimation of the cost of road construction projects is an important task in the management of these projects. Accurate cost estimation is key element for the quality of construction management. For proper functioning of any construction company, cost Estimating is one of the most significant aspects. Construction costs prediction becomes very difficult as well as sophisticated task especially when using manual calculation methods. This paper contains Artificial Neural Network (ANN) approach to develop a parametric cost-estimating model for site cost estimation. An ANN (artificial neural network) is an analogy-based process, which is suitable for the cost forecasting domain. The primary advantages of ANNs include their ability to learn by examples (past projects), and to generalize solutions for forthcoming applications (future projects). Data used in the study are for road projects from different sites in Pune. Data is collected from predominantly primary sources using real-life data contained in project files, with some data obtained from the road project Cost Information Service, supplemented with further information, and some from a questionnaire. These are used in training the model and evaluating its performance. MATLAB software is used for artificial neural network preparation. The neural network architecture is presented for the estimation of the costs as a percentage from the total project price.**

***keywords* - ANN, MATLAB, Hidden Layers, Output Layer, Input Layer**

I. INTRODUCTION

An Artificial neural network (ANN) is a mathematical model which predicts the system performance (i.e., system output). It is inspired by the structure and function of human biological neural networks. The ANN is developed and derived to have a function similar to the human brain by memorizing and learning various tasks and behaving accordingly. It is trained in such a way that it can predict specific behavior and also remembers that behavior in the future like the human brain does. As far as functionality and inter-neuron connection is concerned, ANN's architecture is similar to human neuron layers in the brain. ANN has been successfully used in various applications. The knowledge of previous treatments in cultural preservation becomes more important in conservation. To avoid implementation of an improper conservation strategy and/or evaluate suitable re-conservation, suitable materials should be chosen and criteria should be adopted. The conservation professional is likely to select methods and materials in such a way to the best of current knowledge do not adversely affect cultural property or its future examination, scientific investigation, treatment, or function. By using artificial neural network tool calculating the cost of infrastructure road projects. For this ANN tool input parameters are required.

An expert system is relying on human experts existing knowledge based on set up knowledge system; the expert system develops the earliest, the most effective in the artificial intelligence research field. The expert system is widely used in road and bridge, construction engineering, geotechnical engineering, underground engineering, disaster prevention project, material engineering, geological exploration and petroleum chemical industry, and so forth. The application of artificial intelligence simulates human experts in solving the problem of the thinking process in the field and reaches or approaches the level of experts.

II.ANN IN CIVIL ENGINEERING

An Artificial Neuron Network (ANN) is a computational model based on the structure and functions of biological neural networks. Information which flows through the network affects the structure of the ANN. The main reason behind this is a neural network changes - or learns, in a sense - based on that input and output. An Artificial Neural Network (ANN) is an information processing system which is inspired from biological nervous systems, such as the brain, process information. The key element of a large number of articles has been published on civil engineering applications of neural networks. A neural network can be trained to learn to perform a particular task. When it is hard-to-learn problems and also when there is no formal underlying theory for the solution of the problem, approach becomes particularly attractive. Image recognition and Engineering design are two such problems. The great majority of civil engineering applications of neural net-works are based on the simple back propagation algorithm. The most common application of ANNs in the construction management area is prediction.

Artificial neural networks have many advantages over the conventional methods of modeling due to their distinct features. The traditional regression methods require explicit representation of the relationship in statistical models. Further, they are not conducive for complex multi attribute nonlinear mappings.

III.ARTIFITIAL NEURAL NETWORKS FOR COST ESIMATION

A good number of researchers are there who studied and apply artificial neural network approach in various fields of engineering prediction and optimization.

Pratyush states that ANNs have been used successfully in pile capacity prediction, modeling soil behavior, site characterization, earth retaining structures, settlement of structures, slope stability, design of tunnels and underground openings, soil permeability and hydraulic conductivity, soil compaction, soil swelling, classification of soils and liquefaction, In this paper the various architectures of NN and learning process have been examined. The needs for neural networks, training of neural networks, and important algorithms used in realizing neural networks along with identifying limitations, recent advances and promising future research have also been briefly discussed. Its applications in civil, agricultural engineering and electrical engineering were also examined.

Jamshid SODIKOV, had done a research on development of a more accurate estimation technique for highway projects in developing countries. The study was done at the conceptual phase using artificial neural networks. Also, in this paper, an attempt was made to prove that cost estimation inaccuracy at the conceptual phase can be reduced to half of what it is at the present time. In conclusion, ANN could be an appropriate tool to help solve problems which come from a number of uncertainties such as cost estimation at the conceptual phase. Future work will be focused on developing an ANN model of cost estimation by incorporating other methods including fuzzy logic, case based reasoning, and other up to date techniques.

Emad Elbeltagi, OssamaHosny, Refaat Abdel-Razek and Atif El-Fitory, had done research study& it support decision makers in predicting the conceptual cost of highway construction projects in Libya. At very early stage, the factors which majorly influence highway construction are identified. Then, an artificial neural network model is developed for predicting the cost. Total of 67 projects historical data is taken and network is trained and tested. Training of the model is administered via back-propagation algorithm. The model is coded ad implemented using MATLAB to facilitate its use. An optimization module is also added to the Neural Network model with the objective of minimizing the error of the predicted cost. The model is then validated and the results show better predictions of conceptual cost of highway projects in Libya. Also, the work presented in this paper aimed to develop an accurate and practical method for conceptual cost estimating that can be used by organizations involved in the planning and execution of highway construction projects in Libya. Eleven factors that significantly influence the cost of constructing highway projects were identified by the researcher.

M. Gopal Naik and V. Shiva Bala Radhika studied Time and Cost Analysis for Highway Road Construction Project Using Artificial Neural Networks. The database consists of data collected from completed projects. The models are trained, tested and validated using MATLAB R2013a Software. ANN predicted outputs are the results which are compared with the actual data from which deviation is calculated. Two successfully completed highway road projects are considered for this study. The Nnftool (Neural network fitting tool) and Nntool (Neural network/ Data Manager) approaches are used in this study. Both the Projects A and B have been carried out using Nftool with trainlm as training function and Nntool with trainer as the training function. Statistical analysis is carried out for the developed models. The time and cost of data processing would be reduced by using application of neural networks and forming a preliminary estimate.

IV.METHODOLOGY ADDOPTED

For achieving objectives of my research, a methodology is proposed. The methodology has been schematically shown. This following data gives a clear and structured overview of the different steps that have been followed during the research.

- Literature survey was carried out from various relevant journals papers, conferences proceeding, and different management books with effect of cost estimation to clear the concept of ANN.
- Collection of data from various construction organization regarding cost, expenditure on their project to study, compare the basic requirement for implementation of ANN and problem face by different ANN Implemented & Non-implemented organization.
- Analysis of cost estimation in detail with the help of different software use in traditional methods and modern method.
- Application of ANN on the construction projects regarding cost estimation with the help of software and implement the model in construction project.
- Analysis the result and suggest the recommendations for company.

V.DESIGN OF ARTIFICIAL NEURAL NETWORK MODEL

Network architecture for back-propagation

Multi-layered feed forward neural network architecture was used to develop the early cost estimate model of Highway road construction project. A typical feed forward ANN commonly consists of input layer, one or more hidden layers and output layer. Each layer has a number of neurons (nodes or perceptions). Each neuron in one layer is connected to every neuron on the next layer. Thus, information is constantly fed forward from one layer to the next. This process explains why these networks are called feed-forward networks. It should be mentioned also that there is no connection among nodes in the same layer. In back-propagation, to achieve the desired outputs the weights, which represent the connection strength between nodes and biases are adjusted using a number of training inputs and the corresponding target values. The difference between the calculated and expected target, sets is nothing but the network error. This network error is then back propagated from the output layer to update the network weights and biases. This adjusting mechanism of weights and biases is repeatedly performed until the network error reaches at a certain level of accuracy.

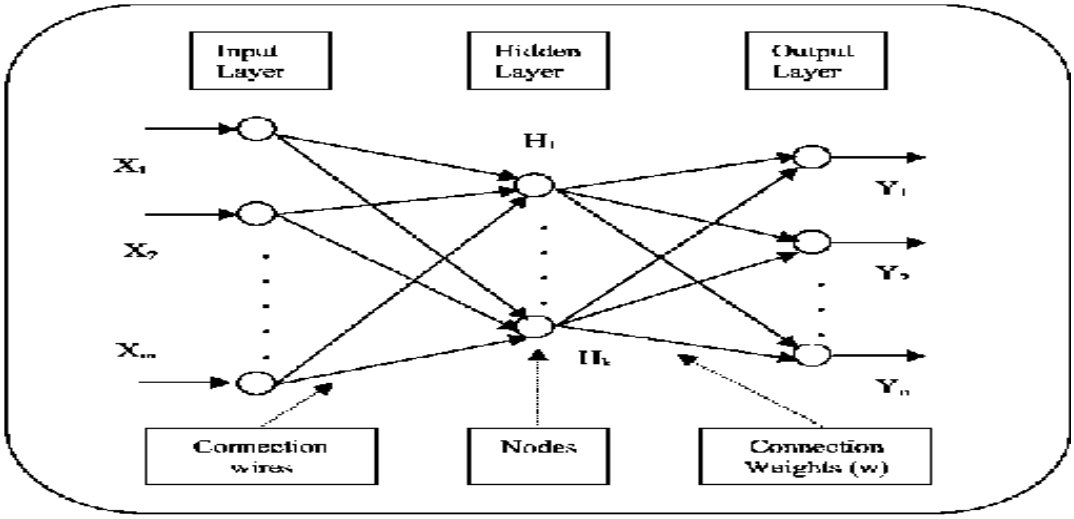

Figure 1: A Simple Artificial Neural Network Structure

Each neuron receives input(s), processes the input(s), and delivers an output as delineated in Figure 2.
The processing element computes a weighted sum, S (x), of its input signals, x i (i = 1, 2… m) and their corresponding weights (w i). The neuron generates an output through an activation function, F(s). Different types of activation functions are portrayed in Figure 3.

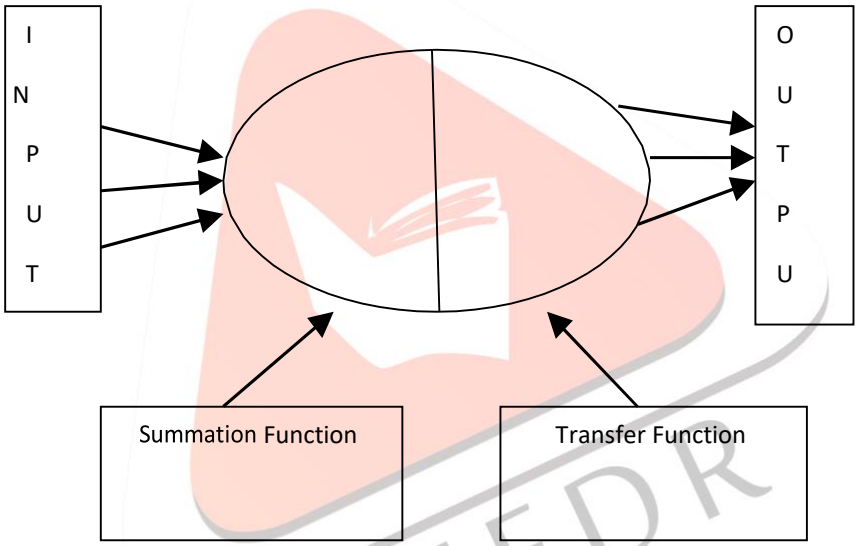

Figure 2: A simple Neuron model

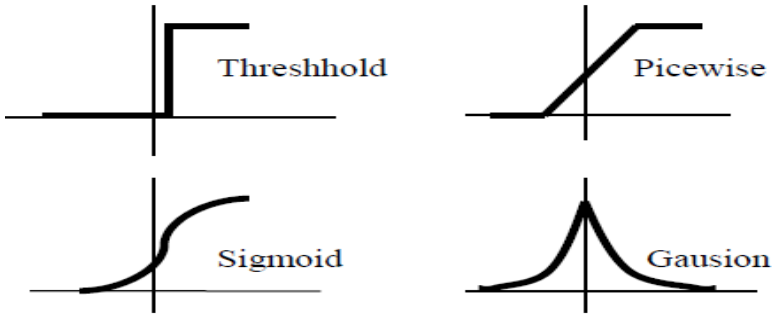

Figure 3: Different types of activation function

A back-propagation neural network is employed during this study to develop the cost values estimation models. The back-propagation algorithm is the most popular ANN paradigm used for adjusting the weights of a multi-layer neural network that is because of its simplicity and good generalization capability. It is supported a gradient descent approach to attenuate the output error with relevancy the association weights within the network. A summary of the process of a standard back- propagation algorithm can be illustrated as follows: (Figures 1 and 2).

- A set of input factors is presented to the ANN as well as their desired outputs.

- A training stage starts by arbitrary selecting a set of connection weights for each layer. Each neuron calculates its summation function value and accordingly computes its transfer function value, which represents its output.This method is command in a very feed- forward manner.
- A set of computed outputs is delivered in the output layer.
- For each process component within the output layer miscalculation is calculated, each represents a deviation of the computed output from the desired output.
- Using a learning rule (e.g. generalized-delta rule, extended delta-bar-delta rule, etc.) the errors square measure back propagated through the hidden layer(s) and therefore the association weights are going to be adjusted and updated consequently.
- A feed forward process will start over again.Values are going to be computed and also the on top of cycle continues till a desired set of necessities is achieved.
- To validate the model a testing session is undertaken using a new set of data, which has never been exposed to the network. The generalizationof the model and its accuracy capability could then be examined.

VI. DATA COLLECTION

The project data from Road projects were collected from different construction companies in Maharashtra especially in Pune. Following table, no 1 shows the various parameters (factors) selected for model development.

The period of data collection as well as the time at which the cost estimation of the Roads was done, was not taken into consideration in this study. Doing therefore might have improved the results as inflation rates have an effect on the price of materials. From above data it is cleared that some parameters are missed during planning, designing, construction and maintenance of project. Due to this the cost estimation will be incorrect i.e. there is lot of difference between estimated cost of project before construction and actual cost of project after construction. ANN considers all these missing parameters and calculates the total cost of project. The difference between estimated cost and actual cost is minimum for developing the model of ANN MATLAB software is used. The algorithm is prepared and used.

Table no 1. Factors Affecting the Road Construction Cost

Sr. No	FACTORS
1	Excavation
2	Embankment
3	Subgrade
4	Strom water line
5	Chambers
6	Granular sub base (GSB)
7	Wet mix macadam (WMM)
8	Bituminous Bound Macadam (BBM)
9	Bituminous Macadam (BM)
10	Dense bituminous concrete (DBM)
11	Bituminous concrete (BC)
12	Kerb
13	Footpath
14	Utility line
15	Thermoplastic paint
16	Blinkers
17	Signage boards

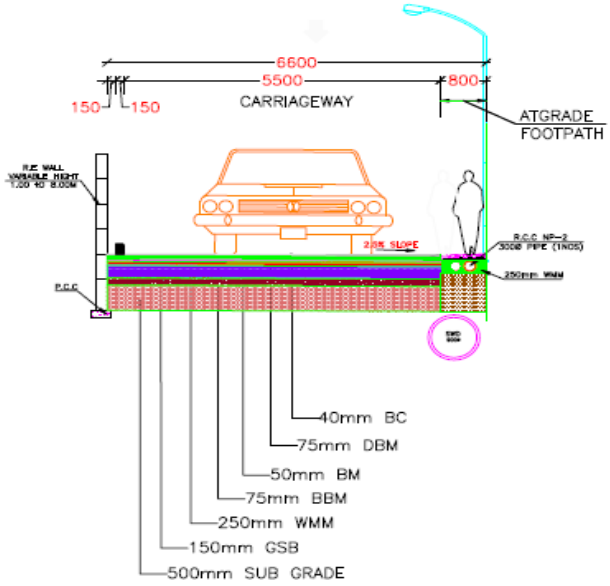

Figure 4: A Typical cross section of any Road Construction project showing factors which affects its construction cost.

VII. BUILDING PHASE OF ANN MODEL

ANN algorithm in MATLAB is implemented and used in this paper. In the present study, the non-linear tan-sigmoid transformation function was utilized in the hidden layers and a linear transformation function was employed in the output layer. The upper and lower bounds of the returned value of the tan-sigmoid function is ranged between + 1 and 1 respectively. Therefore, it is recommended to normalize the input and target in the training database in order to obtain better efficiency of the training process. Equation 1 presents the formula applied for normalizing the training sets so that they fall in the interval [-1, 1]. The training process using multi-layer feed forward neural networks calculates the error between the cost predicted by the output layer and the actual cost. This error then was back-propagated from the output layer to the input layer in which the connected weights and biases were modified. This process is repeated until one of the stopping criteria is satisfied. ANN model is as follows-

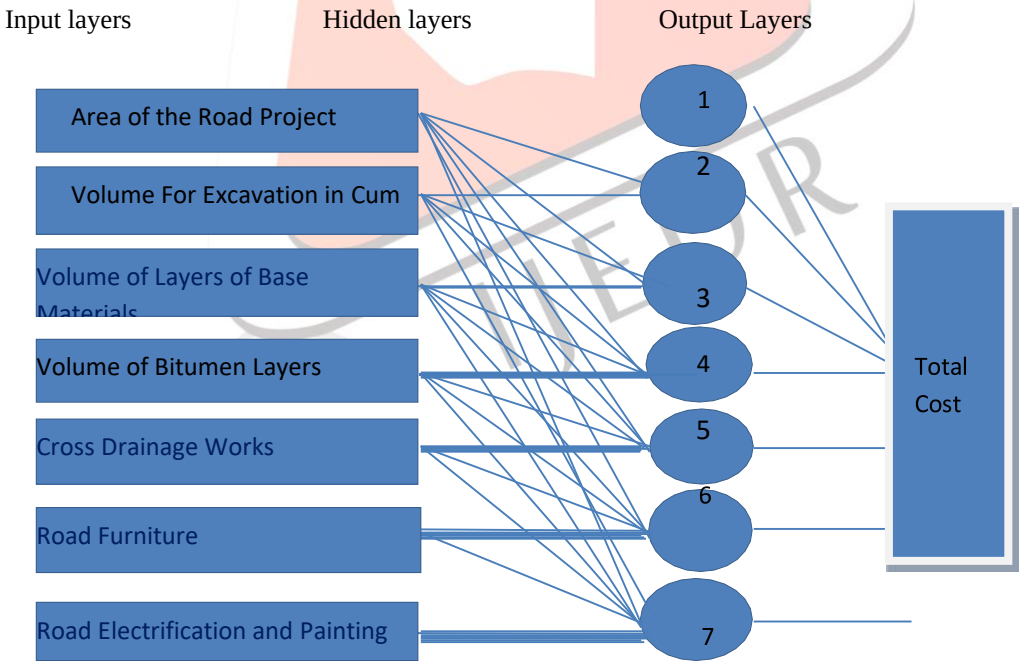

Figure 5: Structure of ANN model

VIII.CONCLUSION

It is concluded that the total area of the Road project i.e. Overall length and Width Volume of different Bituminous Layers, their costs and at last the different CD works and Road furniture items were the most effective design parameters.

It can be concluded that the trained models of neural networks reasonably succeed in predicting the cost estimation of buildings at early stages by just using the basic and fundamental information of the comes while not the necessity for a lot of elaborated style. It is recommended that more reliable project data to be collected and added to the training set in order to improve the predictions and widen the ranges the current ANN model work through detailed design. It is recommended that

more reliable project data to be collected and added to the training set in order to improve the predictions and widen the ranges the current ANN model work through.

IX. REFERENCES

[1] Anshul, Nitin Jain, 'Review on Cost Estimation Prediction Using ANN' In International Journal of Science and Research (IJSR).

[2] Asem Ali Ahmed Alshahethi, K. L. Radhika, 'Estimating the Final Cost of Construction Project Using Neural Networks: A Case of Yemen Construction Projects' in International Journal for Research in Applied Science & Engineering Technology (IJRASET).

[3] Atheer Mahmood Al-saadi, Salah Kh. Zamiem, Luma Ahmed A. Al-Jumaili, MunqithJameelJubair, Heba Abdalla Al-Hashemi, 'Estimating the Optimum Duration of Road Projects Using Neural Network Model' In International Journal of Engineering and Technology (IJET).

[4] Baba Shehu Waziri, Kabir Bala and Shehu Ahmadu Bustani, 'Artificial Neural Networks; In Construction Engineering and Management in International Journal of Architecture, Engineering and Construction.

[5] Emad Elbeltagi, OssamaHosny, Refaat Abdel-Razek and Atif El-Fitory, 'Conceptual Cost Estimate of Libyan Highway Projects Using Artificial Neural Network' In Int. Journal of Engineering Research and Applications.

[6] Hadi Salih MijwelAljumaily, 'Predicating the Durations ofIrregation Channels Projects in Iraq by Using Ann Modelling' In Diyala Journal of Engineering Sciences.

[7] Isaac Mensah, Gabriel Nani, Theophilus Adjei-Kumi 'Development of a Model for Estimating theDuration of Bridge Construction Projects in Ghana' In International Journal of Construction Engineering and Management 2016.

[8] Jamshid SODIKOV, 'Cost estimation of highway projects in developing countries: artificial neural network approach' In Journal of the Eastern Asia Society for Transportation Studies.

[9] M. Gopal Naik and V. Shiva Bala Radhika 'Time and Cost Analysis for Highway Road Construction Project Using Artificial Neural Networks' in KICEM Journal of Construction Engineering and Project Management.

[10] MarijanaLazarevska, Milos Knezevic, Meri Cvetkovska, Ana Trombeva-Gavriloska, 'Application of Artificial Neural Networks in Civil Engineering'

[11] Megha Jain KK Pathak, 'Applications of Artificial Neural Network in Construction Engineering and Management-A Review' in International Journal of Engineering Technology, Management and Applied Sciences.

[12] Pratyush, 'Application of Artificial Neural Networks in Civil Engineering' In International Journal for Research in Applied Science & Engineering Technology (IJRASET).

[13] Seyed Hossein Iranmanesh, and MansourehZarezadeh, 'Application of Artificial Neural Network to Forecast Actual Cost of a Project to Improve Earned Value Management System' In World Academy of Science, Engineering and Technology International Journal of Educational and Pedagogical Sciences

[14] Silvana Petruseva, VahidaZujo, Valentina Zileska-Pancovska, 'Neural Network Prediction Model for Construction Project Duration' In International Journal of Engineering Research and Technology

[15] Smita K. Magdum and Amol C. Adamuthe, 'Construction Cost Prediction Using Neural Network' In Ictact Journal on Soft Computing, October 2017, Volume: 08, Issue: 01.

[16] T.M.S. Elhag and A.H. Boussabaine 'An artificial neural system for cost estimation of construction projects'

[17] Viren B Chandanshive and Ajay R. Kambekar 'Prediction of early stage construction cost of Building projects using Artificial Neural Network' In International Journal of Scientific & Engineering Research, Volume 5, Issue 7, July-2014.