# Artificial Neural Network in Construction Project Management Effectiveness – A Review

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*Abstract*— Construction trade is very large and multifaceted industry which plays a vital role in the progress of any nation. Every construction projects requires diverse teams to plan, design, construct and uphold the project. It is commonly agreed that for a construction project to be fruitful it has to be completed on time within budget and according to the specification. Artificial Neural Networks has gained considerable application in construction engineering and management in recent time. ANNs have been successfully applied to many construction engineering areas like cost estimation, construction scheduling, predicting tender prices, risk analysis, decision-making, resources optimization, classification, and selection etc. for effective project management. This paper reviews applications of neural network in construction engineering articles published in various journals.

***Key words:*** Artificial Neural Network, Construction Project Management, Application of ANN

## I. INTRODUCTION

Effective project management is crucial to the success of any project. In the past, several projects have failed, not for want of competent technical professionals, neither for the lack of resources but due to the faulty project management practices. Construction projects intrinsically involve many uncertainties and risks throughout all phases from start-up to completion. There are external risks (economic, political, financial and environmental) and internal risks based on project management issues, i.e. projects manager's and his team competency, experience, strategic and tactic decisions made during construction project delivery. The opportunity to improve organizational performance through more effective project management could provide substantial savings for construction Management Company. It is becoming essential for construction firms to develop valid methods of assessing and predicting their level of organizational effectiveness. Utilizing a valid assessment method will enable construction firms to maintain their effectiveness and, hence, achieve consistency in the project's performance. A methodology utilizing artificial neural networks (ANNs) is seen to be competent to traditional techniques, which are used during competitive bidding process to evaluate management risk of construction project and predict construction cost variation.

## II. ARTIFICIAL NEURAL NETWORK

Artificial neural networks (ANNs) may be called by different names: (1) connectionist models; (2) parallel distributed processing models; (3) neuromorphic systems; and (4) neural computing. ANN is a branch of artificial intelligence (AI) in which structures is based on the biological nervous system. It can exhibit a surprising number of the human brain's characteristics, e.g. learn from experience and generalize from previous examples to new problems. ANN can provide meaningful answers even when the data to be processed include errors or are incomplete, and can process information extremely rapidly when applied to solve real world problems (Lippmann 1988; Smith 1993). Neurocomputing architectures can be built into physical hardware (or neurocomputer, or machine) or neurosoftware languages (or programs) that can think and act intelligently like human beings. Among various architectures and paradigms, the back-propagation network is one of the simplest and most practicable networks being used in performing higher level human tasks such as diagnosis, classification, decision-making, planning, and scheduling.

## III. APPLICATION OF ANN IN CONSTRUCTION MANAGEMENT EFFECTIVENESS

Applications of ANN (Artificial Neural Network) in construction management in general go back to the early 1980's. These applications cover a very wide area of construction issues. Neural network models have been developed internationally to assist the managers or contractors in many crucial construction decisions. Some of these models were designed for cost estimation, decision making, predicting the percentage of mark up, predicting production rate …etc.

### *A. Application of ANN in Cost Estimation*

Hoijat Adeli and Mingyang Wu (1998) A regularization neural network is formulated and a neural network architecture is presented for estimation of the cost of construction projects. The model is applied to estimate the cost of reinforced-concrete pavements as an example. The new computational model is based on a solid mathematical foundation making the cost estimation consistently more reliable and predictable.

Ismaail ElSawy, Hossam Hosny and Mohammed Abdel Razek (2011) approached an Artificial Neural Network (ANN) to develop a parametric cost-estimating model for site overhead cost in Egypt. Factors that influence the percentage of site overhead costs for building construction projects were identified. Fifty-two actual real-life cases of building projects constructed in Egypt during the seven year period 2002-2009 were used as training materials. The neural network architecture is presented for the estimation of the site overhead costs as a percentage from the total project price.

Baba Shehu Waziri, Kabir Bala and Shehu Ahmadu Bustani (2017) The study revealed successful applications of ANNs in cost prediction, optimization and scheduling, risk assessment, claims and dispute resolution outcomes and decision making. It was observed that ANN have been

 

applied to problems that are difficult to solve with traditional mathematical and statistical methods.

Bipin Pal, Ashtaveer Mhashilkar, Anjali Pandey, Bhavesh Nagphase, Viren Chandanshive (2018) proposed cost estimation models which used Artificial Neural Network (ANN) tool and to suggest the most effectual algorithm for cost prediction and the factors predominantly affecting the total construction costs of building projects.

To build CEM, the most effective factors affecting cost in construction projects were identified based on a comprehensive survey among a collected sample of construction relevant model studies. The results of the trained models indicated that neural network reasonably succeeded in estimating the Total construction cost of building projects at the planning stage itself. The average error of test dataset for the adapted model was largely acceptable and can perform as a good indicator regarding the ability of the proposed model to predict the total construction cost of any future construction project at an appreciated degree of accuracy.

### *B. Application of ANN in Construction Scheduling*

Parminder Kaur (2016) proposed an ANN model that was prepared in order to predict the duration of any ongoing project in addition to conventional techniques of project planning. A large number of trials were applied for model training. The absolute variance of model's results varies from 1.7% to 2.6% which is less than variance calculated by use of PERT network technique (3.8 to 7.8%) in cases studied. Therefore the model testing is successfully passed and it can be concluded that Artificial Neural Networks are an effective project management tool that can be used to effectively predict the project duration and hence prevent scheduling and project duration overruns

Reenu M S, Rajeev Kumar P,Babu S(2017) developed Artificial neural network (ANN) models to predict cost performance, schedule performance, quality performance and satisfaction level. Four models were developed for each of the performance metrics. ANN models were developed using MATLAB-15(b) software. This enables project team members to understand the factors they must monitor closely in order for the project success and to forecast performance during the course of the project. It was found that the neural network model predicted the actual cost growth, schedule growth, quality performance and satisfaction level in construction projects. This will help the practitioners to estimate cost performance, schedule performance, quality performance and overall satisfaction level even before the construction stage.

### *C. Application of ANN to Predict Tender Prices*

T.M.S. Elhag and A.H. Boussabaine (1998) proposed two ANN models to predict the lowest tender price of primary and secondary school buildings. Thirty projects were involved, in this study and their pertaining data was extracted from the BCIS database. Model I utilizes 13 cost-determinant attributes, but in contrast only 4 input variables are involved in developing model II. The findings show that, the two ANN models effectively learned during training stage, and gained good generalization capabilities in testing session. The ANN model I and II managed to achieve average accuracy percentages of 79.3% and 82.2% respectively.

### *D. Application of ANN in Project Control and Organizational Effectiveness*

H. Al-Tabtabai, N. Kartam, I. Flood, And A.P. Alex (1996) described how artificial neural networks can be applied in the area of construction project control. A project control system capable of predicting and monitoring project performance (e.g., cost variance and schedule variance) based on observations made from the project environment is described. This project control system has five neural network modules that allow a project manager to automatically generate revised project plans at regular intervals during the progress of the project. These five modules are similar in design and implementation. Therefore, this paper will present the main issues involved in the development of one of these five neural network modules, that is, the module for identifying schedule variance.

Sunil K. Sinha and Robert A. McKim (2000) concluded that to improve the performance of the network, significant variables through statistical analysis are identified, and then these variables are used in the input and hidden layers of the ANN. This has resulted in obtaining simple and computationally efficient network that can predict organizational effectiveness of the construction firm.

R. Apanavicien and A. Juodis (2012) approached artificial neural network that allows the construction projects management effectiveness model to be built and to determine the key determinants from a host of possible management factors that influence the project effectiveness in terms of budget performance. The established neural network model can be used during competitive bidding process to evaluate management risk of construction project and predict construction cost variation. The model can serve as the framework for further development of the construction management decision support system.

### *E. Application of ANN in Decision Making*

Murtaza et al.(1994) presented an approach for decision making about construction modularization using neural networks. The model helps to make a decision whether use a conventional "stick-built" method or to use some degree of modularization when building an industrial process plant. The decision would base on several decision attributes which are divided into five categories: plant location, environmental and organizational, labor-related, plant characteristics, and project risks. The neural network is trained using cases collected from several engineering and construction firms and owner firms of industrial process plants.

## IV. CONCLUSION

It is clear from this review that ANNs have been successfully applied to many construction engineering areas like cost estimation, construction scheduling, predicting tender prices, risk analysis, decision-making, resources optimization, classification, and selection etc. for effective project management. Based on the results of case studies, it is clear that ANNs perform better than, or at par to the conventional methods. ANNs have been recognized to be more powerful than traditional mathematical and statistical methods in events of complex qualitative and quantitative reasoning.

 

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