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Use of Artificial Neural Network in Construction Management

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Abstract—Construction management (CM) is a professional service that uses specialized project management techniques to manage, control and execute the planning, design, and construction of a project, from its beginning to its end. The purpose of CM is to control a project's time, cost, safety and quality, hence construction management deals with number of uncertainties and this makes all construction process very unpredictable and risky. Therefore in this case artificial neural network method proves very effective as it uses discrete and insufficient information to arrive at best possible solution.This paper reviews application of ANNs in construction activities related to prediction of costs, risk, safety, as well as labour productivity and ideal work environment.This review proposes that ANN had been highly efficient in prediction of best possible solution.It was seen that most of the investigators used feed forward back propagation type of the network; however if a single ANN architecture was found to be insufficient then hybrid modelling in association with other machine learning tools. However accuracy of the data and the skill of the user are key factors in obtaining the precise solution.

Keywords— Artificial Neural Network, construction management, civil engineering.

I. INTRODUCTION

This paper reviews various journal papers published on the application of artificial neural network in construction engineering. This review paper focuses on construction management engineering field. Majority of civil engineering applications of artificial neural network are based on the simple back propagation algorithm.The purpose of CM is to control a project's time, cost, safety and quality, hence construction management deals with number of uncertainties and this makes all construction process very unpredictable and risky. To deal with these challenges, Artificial Intelligence (AI) techniques like fuzzy logic, case-based reasoning, probabilistic methods for uncertain reasoning, classifiers and learning methods, Artificial Neural Networks (ANN), Genetic Algorithms and hybrid techniques are widely used in the field of Construction Management (CM).

The most common application of artificial neural network in construction management is prediction. Artificial neural network have been applied in construction management field for the prediction of construction cost (Mohamed Marzouk, Ahmed Amin, 2013; Minh- Tu Cao; Min-Yuan Cheng; Yu-Wei Wu, 2015), Safe Work Behaviour(D. A. Patel and K. N. Jha, 2015), safety(Tae-Kyung Lim; Sang-Min Park, 2016), Building Valuation (Yi-Cheng Liu, Cheng Yeh, 2016), construction productivity (Li-Chung Chao, Miroslaw J. Skibniewsk, 1995; Jason Portas, Simaan AbouRizk, 1997), labour productivity (Rifat Sonmez, James E. Rowings,1998)

This paper contains overview of artificial neural network, along with definition of ANNs, area of application, advantages of ANNs over traditional mathematical methods. Further it reviews the application of ANNs in the field of construction management. At the end, conclusion extracted out from review papers.

II. ARTIFICIAL NEURAL NETWORK

According to Garrett (1994) engineering definition of the ANN as: "a computational mechanism able to acquire, represent, and compute mapping from one multivariate space of information to another, given a set of data representing that mapping." Artificial neural networking is the technique where one can attempt to mimic the human brain in computer system. As we know in brain, data transfer and data processing is done by neurons. In artificial neural networking system one neuron unit is replaced by the one unit of microprocessor. The original goal of the ANN approach was to solve problems in the same way that a human brain would.

ANNs is very effective pattern recognition and classification tool in the field of soft computing. It acts as a learning tool, which can be trained by the available data as an input and output in structure. ANNs is particularly adaptable for the complicated problems, having discrete and insufficient data, which makes it too difficult to solve by conventional methods. Most commonly used network type is feed forward back propagation, architectural structure of this network is as shown in fig (1)

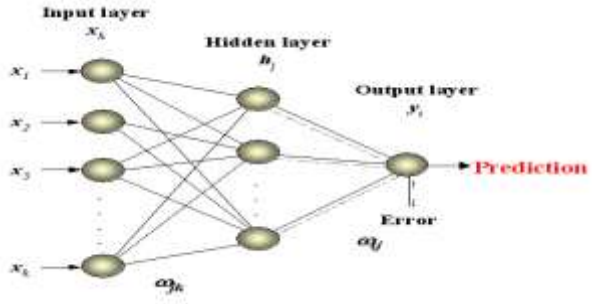

Figure 1 feed forward back propagation network.

In feed forward network, an input layer with five neurons, two hidden layers with three neurons each, and an output layer with two neurons are connected. The state function used is summation function and the transfer functions used is sigmoid squashing function. Here training algorithm is back-propagation algorithm. Neurons are the processing elements of network. The vocabulary in this area is not completely consistent and different authors tend to use one of a small set of terms for a particular concept. Neuron consists of a set of weighted input connections, a bias input, a state function, a nonlinear transfer function, an output. The following figure shows the structure of a neuron.

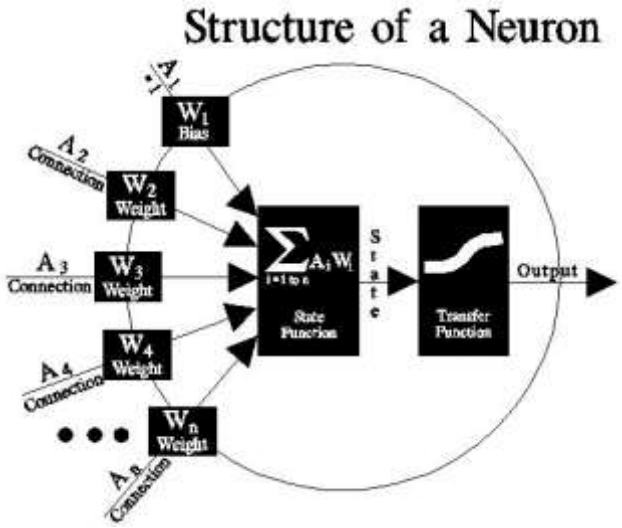

Figure 2 Structure of neutron

III. APPLICATION OF ANNS IN CONSTRUCTION MANAGEMENT

A. Construction Cost

Estimation of the cost of a construction project is an important task in the management of constructionprojects. The quality of construction management depends on accurate estimation of the constructioncost.Construction costs are very noisy and the noise is the result of many unpredictable factors. A regularization neural network is formulated and neural network architecture is presented for estimation of the cost of construction projects. The model is applied to estimate the cost of reinforced-concrete unit of structure as an example. The new computational model is based on a solid mathematical foundation making the cost estimation consistently more reliable and predictable. Further, the result of estimation from the regularization neural network depends only on the training examples. It does not depend on the architecture of the neural network, the learning parameters, and the number of iterations required for training the system.

B. Safe Work Behaviour

The safety of construction workers and employees is a major social responsibility and it is a challenging task to ensure zero incidents at construction sites all over the world. Annually, nearly60, 000 fatal accidents happen at construction sites worldwide. Hence model has been developed employing an ANNs to predict the safe work behaviour of employees using 10 safety climate constructs determined through literature review. The model utilizes safety climate constructs (determinants) as inputs and safe work behaviour as an output. Two hundred twenty-two responses from several construction projects across India were collected through a questionnaire survey. A three-layer feed-forward back-propagation neural network was appropriate in building this model which has been trained, validated, and tested with sufficient data sets. The model predicts the safe work behaviour of employees reasonably well. In addition, a sensitivity analysis was carried out to study the impact of each construct on the safe work behaviour of employees. As a result, safety climate constructs like supervisory environment, work pressure, employees' involvement, personal appreciation of risk, and supportive.Environment was significantly associated with the safe work behaviour of employees. This model has great potential in aiding contractor's andclients in promoting safe work behaviour and the efficient management of the safety of employees in construction projects.

C. Safety

It is necessary to adopt safe working methods on site to reduce the no of accidents. To ensure safe work environment asmart ANNs -based slip-trip classification method, which integrates a smart sensor and an ANN? It was trained to identify the slip and trip events that occur while a worker walks in a workplace. It encourages preventive and collective actions to reduce construction accidents by identifying the type of near miss, i.e., slip or trip, and the exact time that it occurs. The variation in the energy released by a worker is measured using a triaxial accelerometer embedded in a smart phone. This study is of value to researchers because the method measures a near miss quantitatively using acceleration. It is also of relevance to practitioners because it provides a computerized tool those records each and every moment of a near-miss event. A test was performed by collecting the three-axis acceleration streams generated by workers wearing a smart phone running the classifier as they walked around a simulated construction jobsite. It identified the type of near miss and the exact time of its occurrence. The test case verified the usability and validity of the computational methods.

D. Building Valuation

To overcome the drawbacks of current business valuation models, a model developedas a novel model, agrowth value model, by employing the income-asset-hybrid-based approach and with the application of quintile

neural networks. This modelis greatly strengthened by the main assumption of stockholders equity growth rates following the mean reversion principle. This makes thediscounted present value of stockholders equity in the infinite future converges to a bounded value. The empirical findings have significantcontributions to the business valuation of property development and construction industries. First, they include the business valuation modelof the aforementioned two industries is quite different from those of other industries. The enterprise values of these two can be significantlyoverestimated if the business valuation model for total industry is applied. Second, they also include the patterns of price-to-book value ratio curves that indicate that the growth value model is highly useful and effective in various industries only if the return on equity ratio is larger than zero.

E. Construction Productivity

To predict the construction productivity the system utilizes artificial neural networks, historical information, and input from experienced superintendents employed by a leading construction general contractor. It also summarizes a study undertaken to determine factors that affect labour productivity, the survey conducted to collect relevant data, and the design, training, and implementation of artificial neural networks at the participating company. A number of alternative neural network structures were investigated, the adopted one was a three-layered network with a fuzzy output structure. It was found that this structure provided the most suitable model since much of the input was subjective. A brief overview of the computer implementations and the overall experience with the system development is also provided. The method was compared to an existing statistical model developed by the same contractor and was found to improve the quality of the estimates attained.

3.6 Labour Productivity

Construction labour productivity is affected by several factors. Modelling of construction labour productivity could be challenging when effects of multiple factors are considered simultaneously. In this system a methodology based on the regression and neural network modelling techniques is presented for quantitative evaluation of the impact of multiple factors on productivity. The methodology is applied to develop productivity models for concrete pouring, formwork, and concrete finishing tasks, using data compiled from eight building projects. The predictive behaviours of the models are compared with the previous productivity studies

IV. CONCLUSION

From the results of case studies which are considered in this review, it is clear that ANNs have been successfully worked in the construction management field very effectively. ANNs is helpful in prediction, decision making, risk analysis, classification resource optimization and selection etc. Case studies demonstrated that ANNs based mathematical model gives best results than any conventional method does. ANNs resolves the civil engineering dilemmas which are complicated and not very easy to understand. ANNs simply makes use of available historical data, feed it as input and output and sets the relation between them by adjusting their weights. Hence ANNs has proven very effective as it uses discrete and insufficient information to arrive at best possible solution.ANNs can easily updated by introducing new training data. With this all qualities, ANNs has emerged out as a dynamic and factual tool in the area of construction management and moreover expecting new advancement in problem solving of this industry in future.

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