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# Evaluation of the construction project success with use of neural networks

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**Abstract**

Construction project success is determined in terms of cost, schedule, performance and safety through many events and resultant interactions, plans, facilities and changes in participants and the environment. In the construction industry there are myriad uncertainties that make management exceedingly complex. Factors for success vary from project to project. Human experts can often achieve a satisfactory project outcome, however, shortfalls nearly always occur due to managers failing to take all relevant factors into consideration, in addition to lacking access to all relevant information. Statistical methods represent a basic approach to identifying significant factors from historical data or questionnaire results. However, the dynamic nature of critical factors means that changes in project conditions must be monitored continuously. Artificial intelligence techniques have a wide range of applications, including monitoring and forecasting of long-term projects; their main advantage is the ability to track and predict trends in changing project implementation factors. In this article, the authors describe the structure and algorithm of the neural network for assessing the success of construction projects, taking into account the individual influence of the initial conditions as well as their combined impact.



*Keywords: Construction project success, neural network, artificial intelligence techniques ;*

## 1. Introduction

Once a construction project has been proposed, the primary contract is typically subdivided into multiple subcontracts. Large numbers of participants are, therefore, involved in project planning and implementation phases (see Fig. 1.). Expectations can only be met by conducting a comprehensive analysis of participants [1-4]. Project

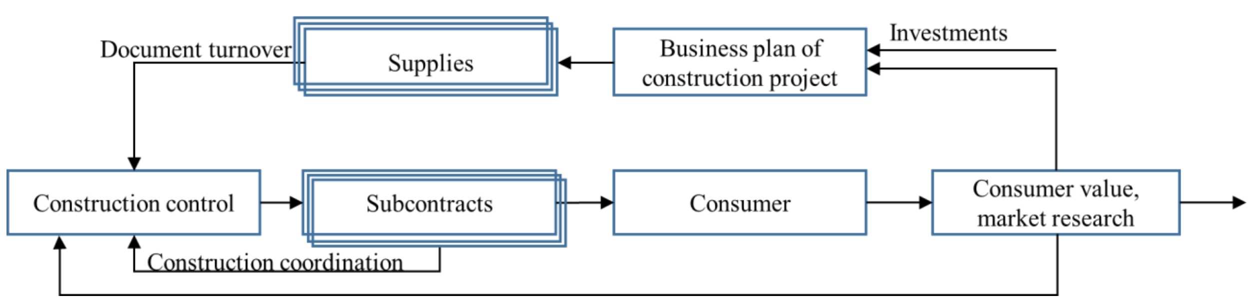


Fig. 1. Basic information and resource flows of construction production

success is determined in terms of cost, schedule, performance and safety through many events and resultant interactions, plans, facilities and changes in participants and the environment. Project managers able to identify key determinants to project success can monitor project performance continuously and make proper decisions based on objective performance predictions related to project success targets.

Artificial intelligence, a novel technology for extracting knowledge, is already widely applied to various civil engineering problems, including project management. To predict project performance, an appreciation of critical factors are crucial to achieve of the project objectives successfully. Statistical methods represent a basic approach to identifying significant factors from historical data or questionnaire results. However, the dynamic nature of critical factors means that changes in project conditions must be continuously monitored.

In the construction industry, neuro fuzzy intelligent systems are used not only to predict the technical performance of the construction project, but also to compare them with the results of statistical methods of reducing variables [5,6].

## 2. Success in construction industry

The final objective of construction management is to accomplish construction projects ‘successfully’. From an owner's perspective, the definition of a successful project is one that meets or surpasses budget and schedule expectations. Consequently, a less-than-successful project fails to achieve budgetary and/or schedule expectations [7]. Project managers are responsible for project success, and must monitor project performance continuously in order to take proper corrective actions essential to controlling project progress.

Project outcomes are affected by different factors at various points in time. During the course of a project, predicting project outcomes at different stages requires an ability to analyze dissimilar factors [8]. A dynamic prediction methodology is thus required for project managers to monitor project performance on a continuous basis. However, each time, numerous time-dependent variables can affect project outcome. In addition, due to the nature of the construction industry, such variables remain uncertain [9]. While human experts can predict project outcomes based on their personally accumulated experience and knowledge, the significance of such judgments is restricted by their subjective cognitions and/or knowledge limitations.

## 3. Neural network for evaluation of the construction project success

For the proposed neural network, “hybrid” refers to the combination of traditional neural and high order neural networks. The high order neural network is constructed of three layers with a high order connection and a linear connection between the 1st and 2nd layers and 2nd and 3rd layers, respectively. This study extends the use of high order connections for all connection alternatives, i.e., all layer connections can switch between linear and high order formats (see Fig. 2). An HNN neuron is dominated by an alternative of the following equation:

Linear connection: $y_i = f(\sum w_{ji} x_i + b_{j0})$; (1)

High order connection: $y_i = f(\prod x_i^{p_{ji}} * 1^{b_{j0}})$; (2)

Activation function: $f(x) = \frac{1}{1+e^{-ax}}$; (3)

where $w_{ij}$ – coupling weight coefficients; $y_i$ – output neuron signal; $x_i$ – input neuron signal.

An activation function $f$ uses a sigmoid function with a slope coefficient of $a$. Therefore, each layer connection features an attached connection type that represents the corresponding operation selection (see Fig. 2).

This implies that each layer depending on the operating mode may change the type of connection between neurons. For example, for a neural network consisting of 3 layers, the following options are possible (linear - L, higher order - HO): L-L; L-HO; HO-L and HO-HO.

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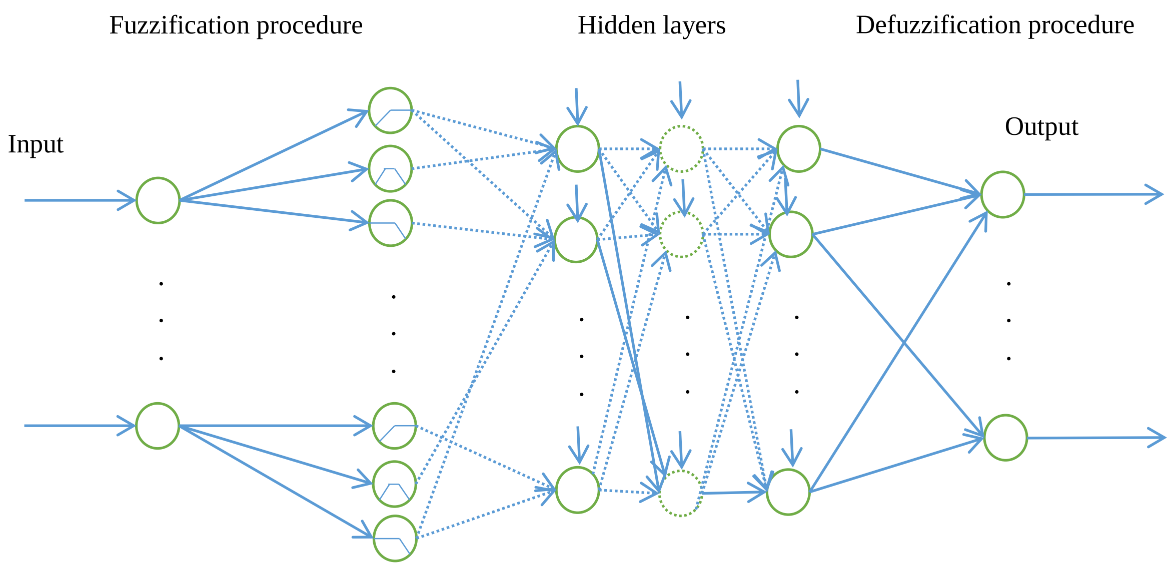


Fig. 2. Hybrid Neural Network Structure

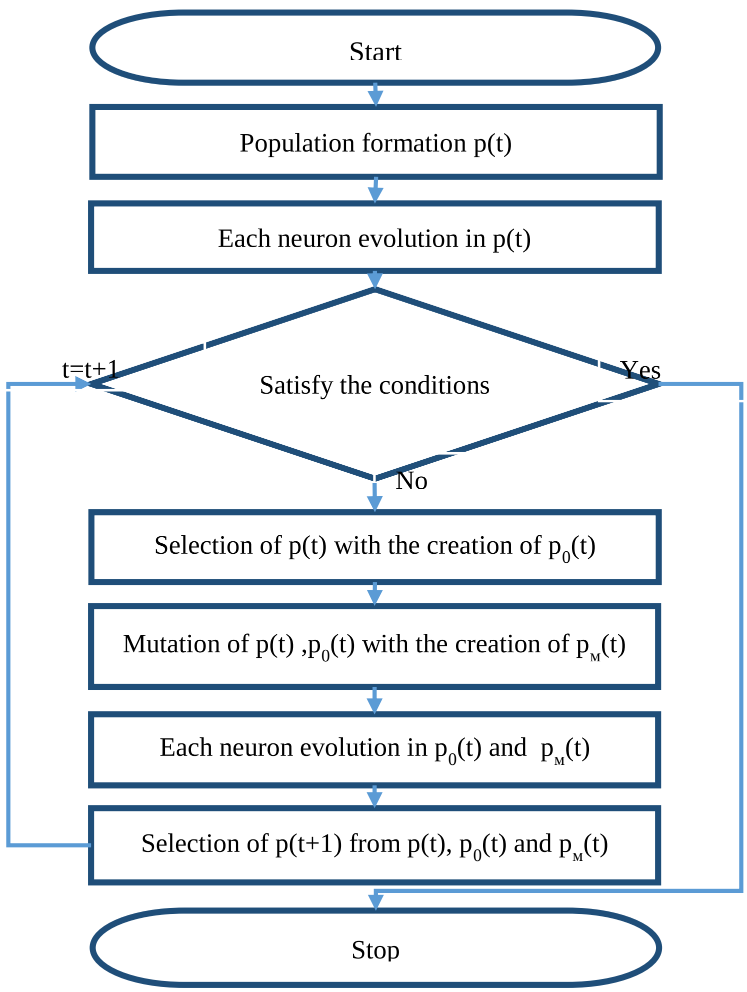


Fig. 3. Optimization genetic algorithm

## 4. Optimization genetic algorithm

Optimization of the created neural network is possible with the help of the genetic algorithm adaptation [10, 11] (see Fig. 3). Genetic algorithm, which imitates elements of the natural evolution process, were first proposed in Holland [12]. To apply the genetic algorithm to problem optimization, one must identify all essential parameters to determine chromosome length. The chromosome (i.e., one individual) in this study represents neural network parameters: interconnection coefficients, connection types, a slope coefficient of activation function, and network topology (total layers and layer neurons). Fuzzy logic parameters include membership function summit points, membership function widths and defuzzification weights.

Genetic algorithm is a method of random search with elements of adaptation, which is based on principles similar to the Darwin's evolution process of biological organisms. In this case, three types of operations are performed: crossing, mutation, selection. The fitness degree (how the population corresponds to the given task) is defined through the fitness function that can also include penalty functions for violation of additional restrictions on variables. There are various forms of crossing [13]. They make a selection of the fittest specimen, which constitute a parental pair and the crisscrossing of the chromosomal chains takes place, i.e. the descendant line code inherits fragments of codes of parental chromosomes. The selection operator allows the creation of a new population from a set of specimen, which are generated and modified descendants of specimen after mutation. The genetic algorithm is used to adjust the membership functions that are defined within the accuracy of a few changeable parameters, such as triangular, trapezoidal, and radial functions. When simultaneously configuring several membership functions, the parameters of each are coded by their own segment of the chromosome, so that during the process of crossing the code, sharing occurs only between chromosome segments of the same type. For configure the rule base, to each element of the chromosome is assigned an element of this rule base and based on the received encoding is selected a type of genetic operator. Thus, the architecture of the systems for evaluation of the construction project success can be represented as follows (see Fig. 4).

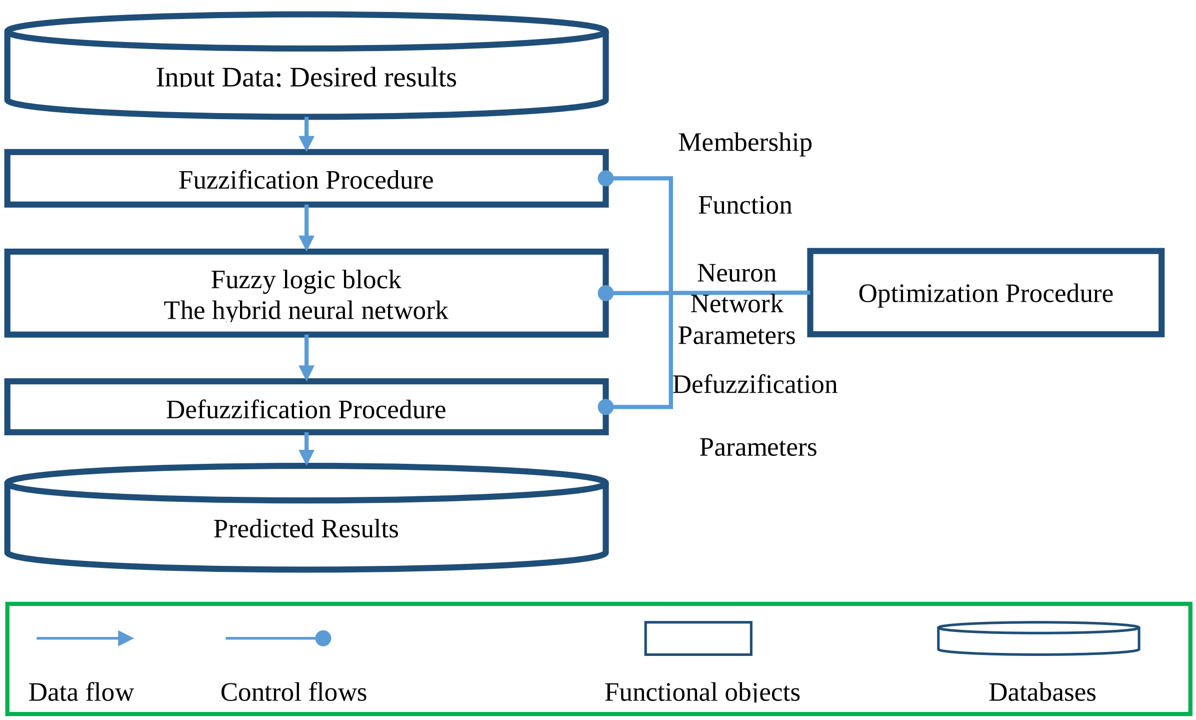


Fig. 4. Architecture of the systems for evaluation of the construction project success

## Conclusions

This paper described an evolutionary fuzzy hybrid neural network to enhance project cash flow management. Neural networks and high order neural networks are combined in the developed evolutionary fuzzy hybrid neural network to form a hybrid neural network, which acts as the major inference engine and operates with alternating linear and non-linear neural networks layer connections. Fuzzy logic is employed to sandwich the hybrid neural network between a fuzzification and defuzzification layer. The authors developed this evolutionary fuzzy hybrid neural network to assess construction industry project success by fusing hybrid neural network, fuzzy logic and genetic algorithm.

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