Diyala Journal of Engineering Sciences

ISSN 1999-8716
Printed in Iraq

Vol. 09, No. 04, pp. 62-70, December 2016

PREDICATING THE DURATIONS OF IRREGATION CHANNELS PROJECTS IN IRAQ BY USING ANN MODELLING

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(Received: 1/11/2015; Accepted: 14/2/2016)

ABSTRACT:- The average accurate prediction of the duration of an irrigation channel project represents a critical factor for the feasibility study of this project. This research aims to develop an artificial neural network model for predicting the duration of irrigation channel projects at early stage, where no detailed information is available. Statistics Package Social Sciences (SPSS) program was used as a suitable environment for developing the proposed model. The required field data was collected from 50 Irrigation Channel project in Iraq. Validity of ANN model clearly showed that it has a excellent prediction capability with an average accuracy of 93.5%.
Keywords: *Neural Network Modelling; Project Duration; Irrigation Channel; Predicating*

INTRODUCTION

The time of a project can only be estimated once when resources are available. The objective of efficiency the project management is to bring the project to achievement on cost and on schedule. Individual activities compose the schedule, and also the estimates of their duration determine the time of project. The accuracy of the general schedule depends on the accuracy of those estimations.

RESEARCH AIM

The aim of this research is to improve a mathematical model using neural network for predicating the duration of irrigation channel project.

RESEARCH JUSTIFICATION

Research justification can be summarized follows:
There are different methods currently used to estimation of project duration. Some of these techniques suffer from the major obstacle due to lack of precision, slow and uncertainty. Therefore, the irrigation channels projects in Iraq need for novel estimation techniques that have more advantages such as fast, accurate, simple, flexible and easy to utilize.

RESEARCH METHODOLOGY

The following methodology is adopted in this research:

a) Literature review

Duration estimate, time control, time management, and duration overrun related literatures are reviewed to identify the main topics to be handled in this research. The types of Artificial Neural Networks (ANN), their built, as well as their uses in construction project are outlined. Capabilities of some useful commercial programming such as: Neuframe, and Statistical SPSS are also explored in this paper.

b) Data collection

Historical data is collected from (50) completed irrigation channels projects in Iraq from 2007 to 2013 .The projects were awarded having the same design. Questionnaires have been directed to 25 experts in this field. These experts are asked to pinpoint the foremost important factors influencing the duration of irrigation channels projects.

c) Model formulation

Previous researches showed different methods used to interpret the relation between the duration of project and factors believed to influence the final duration project. Most of them are parametric cost estimating approaches that use statistical analysis methods ranging from simple graphical curve fitting to multiple correlation analysis. In this research, the Artificial Neural Network methods is adopted. (ANN) have a great potential in dealing with historical cost data effectively for the sake of developing duration estimating models. SPSS program was used to develop the desired model.

d) **Model evaluation**

The developed model is assessed using a data set that is not used in constructing the model. Observed data are plotted to explore the model efficiency. This validation is dispensed to make sure that the model is applicable within the limits set by the training information. The coefficient of correlation (r), and the mean absolute error MAE, as the main parameter that are always used to evaluate the estimation performance of ANN models are checked. Therefore, the final model can be used estimated new project (duration) with no changes needed in the structure of the ANN model.

ARTIFICIAL NEURAL NETWORK APPROCH

The most popular Artificial Neural Network (ANN) design is multilayer Feedforward Network with backpropagation (BP) learning algorithmic program. This network, as its name indicates is formed of multilayer so design architecture of this class besides method on input, an output layer have one or more intermediary layers called hidden layers. The computational units of the hidden layer are referred to as the hidden neurons or hidden units. The hidden layer aids in activity helpful intermediator computations before leading the input to the output layer. The input layer neurons are links are named to as input hidden layer weights. Once more the hidden layer neurons are linked to the output layer neuron and the corresponding weights are named hidden output layer weights. [1].

A two layers network in which one is input layer and the other is an output layer called single layer, feed forward network. In this architecture the input layer receives the input signals and after processing them, they are forwarded to output layer for output the information. The synoptic links carry the weights connect each input nerve cell to the output nerve cell however not vice-versa. Such a network is claimed to be feed forward in kind or a cyclic in nature. Despite the two layers, the network is termed as single layer, since it's the output layer, alone that performs computation [2].

There are several different training algorithms use for feed-forward networks. Of these algorithms use the gradient of the performance perform to see the way to modify the weights to attenuate performance. The gradient is determined using a method known as back-propagation. Back-propagation may be a systematic technique of training multilayer Artificial Neural Networks. It's is designed on high mathematical foundation and has excellent application potential. Even though it has it's own limitations, it is applied to a large vary of sensible issues and has with success incontestable its power. The error is equal to the squared difference between the desired output and the real output obtained at the output layer of the network because application of an input pattern from the given input-output pattern pair. The output is determined using the current setting of the weights in all the layers. The optimum weight is also obtained if the weight are adjusted in such some way that the gradient descent is created on the entire error surface [2].

DURATION PREDICTION OF IRRIGATION CHANNEL PROJECT

A primarily crucial factor impacts of a project budget represents the project time demanded for finishing of the project. For a pre design accurate project cost determination early design duration of construction projects is required. Previously, varied models and tools were developed to forecast duration of irrigation channel project. However, a little researches attempted to predict the future duration of the irrigation channel project. Therefore, this study attempts to enhance the models based on the historical knowledge data to determine the future duration of the irrigation channel project**.** [3]

ARTIFICIAL NEURAL NETWORK DESIGNING PROCESS

The designing of ANN process consist of five steps: [14].

1) Collocation input and output data.
2) Normalizing the input and output data.
3) Choosing the ANN architecture.
4) Training and testing the neural network.
5) Verification and validation of the neural network.

Gathering Input Data

The first step, which content data description and identification input and output data, explain the factors affecting on the duration of irrigation channel project.

Through the literature review, various factor influencing on the duration of irrigation channel project. Six independent variables and one dependent variable were chosen and defined for each irrigation channel project. Details of these variables as shown in table (2).
The required data for developing of an irrigation channel duration predicting model was received from **The Ministry of Water Resources (MOWR).** The Fifty completed project, as the past data of irrigation channel compiled from the projects completed between 2007 and 2013, were analyzed and evaluated.

Normalization of input and output data sets

Normalization of information is a importance method of scaling the numbers in a data set to develop the average accuracy of the subsequent numeric computation also is an very important stage for training and testing of the ANN. Normalization helps in shaping the transfer function. For this reason, [-1, 1] normalization function has been used. [2]

Choosing the ANN architecture

The main part of ANN is the architecture of the designed ANN for any application and for it is a trail and error based. Trial and error based is a good technique but it takes lot of time to find the optimum architecture of the ANN [4].
Optimization of ANN architecture is difficult and important. It involves several of the new features that are quite different from the general practices of ANN. The models of the applications of the ANN are expensive to create and applicability is limited as well. For these reasons, design of ANN should be optimized. However in past few years, efforts are created for many applications. These different optimization techniques for ANN architecture optimization are given in this section in detail.

Park [5] used new selection strategy of the adaptive inertial weight and weight optimization of ANN is proposed. This technique has based on the training error of ANN. The simulation results showed that by using this strategy the results were more accurate and speedy.

Zhong [6] proposed the PSO for the radial base function neural networks. The weights and the structure of the RBF neural networks are optimized. The simulations results using PSO base neural networks on the gearbox fault diagnosis application showed that it has better classification effect as compared to RBF based neural networks.

The proposed technique is described here. Particle Swarm Optimization (PSO) will have some dimensions. These dimensions will have the same number as the output nodes only. Each output node will be represented by one dimension of PSO, and each particle will

represent one node in the hidden layer. Then the technique of the PSO as specified above will be applied on the solution space. Solution space has some dynamic solutions of the ANN architecture. The PSO will dynamically predict the best ANN architecture for any application. It is important to note that the number of hidden neurons in the hidden layer should not be specified by the user. The PSO will predict the optimum and the suitable architecture of the ANN.

SPSS program that was designed to see the relationship between the independent variables (inputs) and the dependent quantity variable (output).

The data used in this program were divided into three groups, represented by the training data group, testing data group and output data group.

The format of the knowledge input data consisted of the field data studied and it equals to the quantity of the independent variables. These variables were fed within the program as follows:

1) X1= Length of channel
2) X2= Width of channel
3) X3= Depth of channel
4) X4= The size of the concrete lining
5) X5= Temperature conditions
6) X6= Ground condition

The format of the knowledge output information consisted of the field data for contract duration studied as wall as it equals to one variable as the dependent variable.

In this study, the testing of the number of hidden nodes in hidden layer was performed through increase in hidden nodes by one and the network weights were reinitialized and the training starts again until arriving to the optimum numbers of hidden nodes and hidden layers corresponding to the training error, testing error and correlation coefficient. The number of hidden layers is one node in one hidden layer.

To investigation the neural network model, the learning rate equal to (0.2) and momentum rate equal to (0.8) are suitable for estimating of the duration of irrigation channel projects by the neural network which represents the default value of SPSS program. These criteria's were in agreement with recommendations suggested by Alzwainy et al [7] (2015). The transfer function used is sigmoid function in hidden layer and output layer respectively. In this research, the information of the ANN architecture and the connection weights are obtained for the optimize ANN models which were shown in table (3), table (4) and Figure (1).

Verification and validation of the neural network

To assess the validity of the ANN model in predicting the duration of the irrigation channel projects, (predicted values) were plotted against that measured (observed) values for validation data set as shown in fig. (2). It is clear from this figure that the resulted ANN has a generalization capability for any information set used within the range of data used in the training phase. It is a proven fact that neural networks have a powerful generalization ability, which implies that, once they need been properly trained, they are able to give accurate results even for statuses they have never seen before.

Additional statistical measures are used to determine the performance of the model as shown in table (5):

1) Mean Absolute Percentage Error.
2) Average accuracy (AA %).
3) Determination coefficient (r^2).
4) Stationary R-squared.

The coefficient of determination is found to be (94.2%). Also it can be concluded that this model shows an excellent agreement with actual measurements and an average accuracy equal to 93.5%.

SENSITIVITY ANALYSIS OF THE ANN MODEL INPUT

Sensitivity analysis is carried out on the ANN model to identify that of the input variables has the most significant impact on the duration. The results shown in table (6) and figure (3) indicate that length of channel (x1) ranked first with normalized importance (100%), also the variable (x4) of the size of the concrete lining has (98.8%), while the variable (x6) ground condition has lowest percentage (7.1%).

CONCLUSIONS

This research aims to developed duration predicating model for Iraqi irrigation channel projects using neural network techniques. The model was developed based on 50 set of past data collected in Iraq construction sector. Such types of models are very useful, particularly in its simplicity and ability to be handled by calculator or an easy computer program. The validation of the neural network for irrigation channel project in Iraq was very good with the coefficient of determination found to be (94.2%), and an average accuracy equal to 93.5%. Sensitivity analysis indicated that the length of channel has the most significant (31.9%) effect on the predicted duration.

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Table (1) shows the estimation of duration for construction project of past studies

Input	Method	Output	References
• Project length Geometric design standard • Two-lane length • Bridge type Bridge width • Shoulder and gutter	Statistical regression analysis is developed to predict highway construction duration	Highway construction duration prediction	Williams, Hildreth, & Vorster, 2009
• Physical shape of the building • Total floor area • Vertical designing of the floor area • Storey heights and basement useable area • Storey enclosure area	Cross validation based on regression analysis to predict project duration	• JESM model used to predict the early design construction duration	Cheung & Skitmore, 2006
General organization information • Project characteristic • Client characteristic • Architect/engineer characteristic • Building contractor characteristic • General assessment of construction speed • Construction cost/time	A model based on construction time performance index has been developed to determine the building construction duration and its critical factors	Constructed a Benchmark model to predict the overall construction time	A. P. C. Chan & Chan, 2004

Table (2) Independent and dependent variables for irrigation channel project

No.	Description	Unites	Type of variables
1	Length of channel	Km	independent variables
2	Width of channel	M	independent variables
3	Depth of channel	M	independent variables
4	The size of the concrete lining	M^3	independent variables
5	Temperature conditions	Category	independent variables
6	Ground condition	Category	independent variables
7	Contract duration	Day	dependent variables

Table (3) Neural Network Information

Input Layer		1	X1
		2	X2
		3	X3
		4	X4
		5	X5
		6	X6
	Number of Units		6
Hidden Layer(s)	Number of Hidden Layers		1
	Number of Units in Hidden Layer 1		1
	Activation Function		Sigmoid
Output Layer	Dependent Variables	1	Y
	Number of Units		1
	Rescaling Method for Scale Dependents		Normalized
	Activation Function		Sigmoid
	Error Function		Sum of Squares

Table (4): Parameter Estimates (weights)

Predictor		Predicted	
		Hidden Layer 1	Output Layer
		H(1:1)	Y
Input Layer	(Bias)	.741	
	X1	3.640	
	X2	1.441	
	X3	.472	
	X4	3.486	
	X5	1.886	
	X6	-.975	
Hidden Layer 1	(Bias)		-.998
	H(1:1)		3.323

Table (5) Model Fit statistics

Model	Average accuracy percentage AA%	Stationary R-squared	R-squared	MAPE
Y-Model_1	93.583	.807	.942	6.417

Table (6) Independent Variable Importance

variables	Importance	Normalized Importance
X1	.319	100.0%
X2	.087	27.3%
X3	.102	32.0%
X4	.315	98.8%
X5	.155	48.8%
X6	.023	7.1%

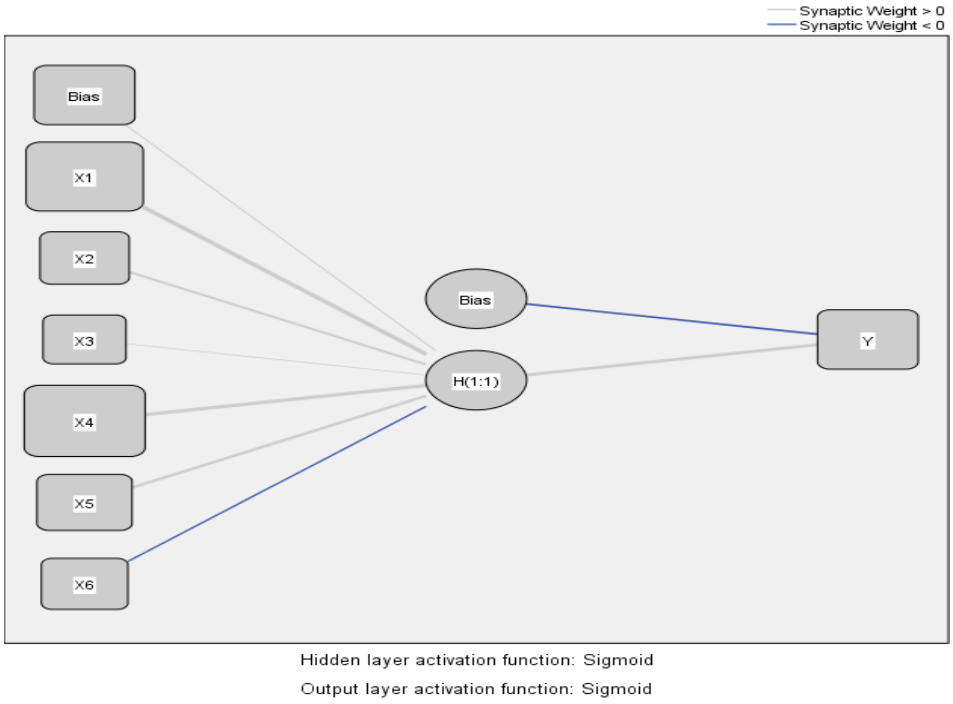

Figure (1) ANN architecture for irrigation channel project

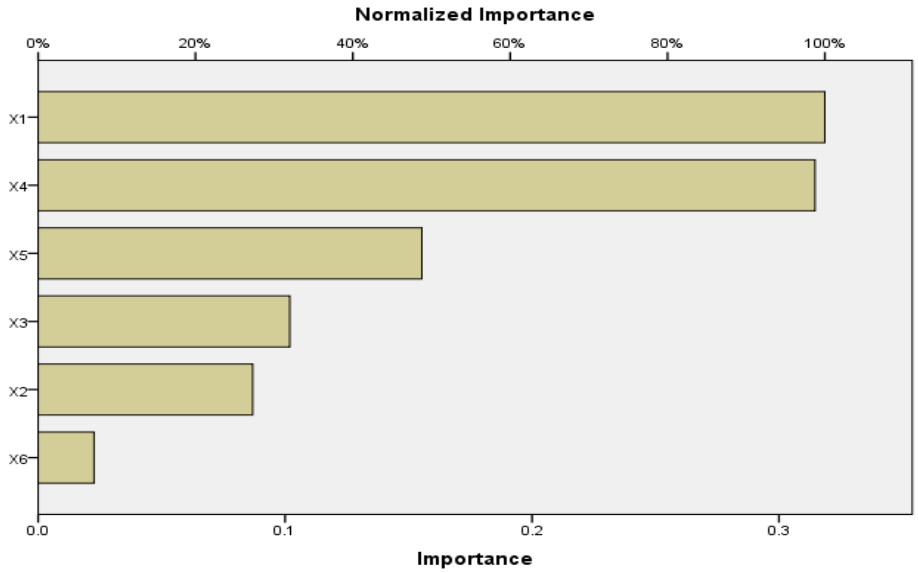

Figure (2) Independent variable normalized importance

تخمين مدد انجاز مشاريع قنوات الري في العراق باستخدام نموذج الشبكة العصبية الذكية

هادي صالح مجول

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الخلاصة

ان إدارة المشروع الناجحة والكفؤة هي التي تحقق او تنجز المشروع باقل كلفة وبالمواصفات المطلوبة وفي الموعد المحدد. وهناك طرق مختلفة تستخدم حاليا لتقدير مدة المشروع. بعض من هذه الطرق او الاساليب او التقنيات تعاني من عقبة كبيرة بسبب عدم الدقة، والتاخير وعدم اليقين. ولذلك، فإن عملية تنفيذ مشاريع قنوات الري في العراق تحتاج لتقنيات تقدير مدة الانجاز التي لديها المزيد من المزايا مثلا ان تكون سريعة ودقيقة وبسيطة ومرنة للاستفادة منها بشكل كبير. لذلك التنبؤ الدقيق لمدة مشروع قناة الري يمثل عاملا مهما وحاسما لدراسة جدوى هذا المشروع. يهدف هذا البحث إلى تطوير نموذج الشبكة العصبية الذكية للتنبؤ بمدد مشاريع قنوات الري في مرحلة مبكرة، حيث لا تتوفر معلومات مفصلة ودقيقة في هذه المرحلة وقد تم استخدام حزمة معلومات لمشاريع مشابه سابقه والبرنامج الإحصائي (SPSS) لتطوير النموذج المقترح. تم جمع البيانات الميدانية المطلوبة من 50 مشروع قناة ري منفذة سابقا في العراق. ان دقة تنبؤ نموذج ANN المقترح كانت بدرجة ممتازة بمتوسط دقة 93.5٪. لذلك فإن النموذج النهائي يمكن استخدامها في مشروع جديد مشابه مع عدم وجود تغييرات في هيكل نموذج ANN المقترح وان كانت هنالك تغييرات فسوف تكون قليلة وطفيفة.