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PREDICTING THE REALIZATION OF PROJECT GOALS (TIME-COST) ON CONSTRUCTION PROJECTS BASED ON THE ACQUIRED VALUE TECHNIQUE

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Abstract:

In this study, in order to evaluate the correct performance of project management to control time and cost, which will be effective in managing other project elements, control of cost and time of project implementation was considered one of the most important factors for project success. Be. In this case, using this technique, the value gained, the project performance was evaluated up to a specific time period, project problems were identified and appropriate decisions were made to improve the project process. Also, using the parameters and performance indicators of this technique, time And the final cost of the project was predicted. In general, this study shows that the proposed model can provide more accurate and stable prediction results. Given the better performance of neural-fuzzy networks than neural networks and the acquired value technique, we conclude that neural-fuzzy networks due to their ability to solve complex and poorly

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structured problems and use data from multiple projects, can be Help managers to make better decisions.

1. Introduction:

To create and develop a project, is a set of processes that are used with the successful goals of the project throughout its life cycle, the emphasis and sensitivity of employers and investors for the proper implementation of the project along with reducing mistakes and wasting resources., Has required the knowledge and application of management tools. The success of a project depends to a large extent on the definition and implementation of a proper and effective project management system, and one of the main tasks of a project manager is to manage cost and time during construction. Timely completion and estimated cost of each project is one of the main criteria for its success and failure to complete on time and with projected cost, will not meet the demands of the employer and the goals of the project.

If the project is completed on time or with a slight delay compared to a certain time that can be ignored, the detrimental effect of many factors, including inflation, which in itself affects the efficiency, productivity and ultimately the cost of the project is reduced and in the result of the project is completed at a certain cost. Therefore, the correct performance of project management to control its time and cost will be effective in managing other elements of the project. Controlling the cost and time of project implementation is one of the most important factors for project success, which has always been at the forefront of all project stakeholders. Earned Value Management, or the definition of the three main parameters, Earned Value (EV), Planned Value (PV) and Actual Cost (AC), is able to control and evaluate project time and cost. This method calculates the values of variance of project time and cost and calculates the performance, schedule and final cost of the project at different levels of the project by calculating performance indicators. EVMS is one of the most widely used methods during the four The last decade has been used in project control.

Using this technique, the project manager will be able to measure the project performance up to a specific point in time, identify project problems and make appropriate decisions to improve the project process, as well as using the parameters and performance indicators of this technique time and final cost and predict the final cost of project.

2. Research background:

Mohammadzadeh and partners. (2021) in a study entitled "Dynamic reduction of time and cost uncertainty in tunnel projects" examined the project time and cost forecast. Estimation of cost and time plays an important role in the successful completion of tunnel construction, but in most cases this estimate is not accurate compared to real time and cost of tunnel construction due to several geological and geotechnical reasons. This creates uncertainty in the construction of the tunnel in terms of time and cost. In this paper, the effects of geological / geotechnical uncertainty on tunnel construction are minimized through continuous updating techniques. Prediction of geological conditions is based on Markov's continuous space-discrete trend. While the forecast of construction time and cost is based on Monte Carlo simulations. To evaluate the applicability of the tool, it has been used for the Hamro tunnel in Iran (on the Sanandaj-Marivan road under construction in the east of Kurdistan province). Also, the tool has been updated twice to assess the impact of the update on the results obtained during construction. In the first update, total uncertainty at construction time and costs (measured by standard deviation) were reduced by

about 45% and 52%, respectively, followed by a decrease of about 66% and 61% in the second update. Finally, it can be concluded that the proposed method is a useful tool for tunnel project managers to identify hazards and possible deviations in their construction time and costs.

Pojita et al. (2020) in a study entitled "Construction cost forecasting using a unit-based estimation model" examined the project time and cost forecast. In general, construction projects will be long-term. In this regard, forecasting price increases and estimating construction costs are basic steps for project estimators, contractors and owners. The pricing process is a challenging one due to fluctuations in building elements and increasing long-term trends. Many forecasting techniques such as value-added management (EVM) have been developed in recent years to address the complexity of forecasting problems, while the present work provides an approach to forecasting the total cost of a construction project, based on available data from The system explains the main cost of the project, ie the updated cost. This data is collected and calculated daily or weekly for each account and then added to the entire project. In the case study project, basic structural elements such as columns, beams and slabs are considered as products and the unit production cost is found based on the project completion estimate data (EAC) and then to predict the project completion estimate (ETC)

Sroudi et al. (2020) examined project time and cost forecasting in a study entitled "Using Real Project Schedule Data to Compare Scheduled Schedule and Project Time Predictability." In the construction industry, conflicts are escalating. First of all, these encounters are very important for improving project implementation in terms of cost and program to overcome these encounters. To do this, one tool is to obtain a method for analyzing and measuring the effectiveness of construction projects. Acquired Value Management (EVM) is the best way to track progress in a construction project. This method considers time and cost factors to evaluate effectiveness and estimate completion time and costs. The main purpose of this paper is to analyze the cost and plan for a residential building using acquired value management. In this regard, based on a case study, the performance and progress of the project in construction with respect to time, cost, and project resources have been studied. Using this technique, delays and serious time and cost issues can be found and controlled. Compared to manual calculations, the proposed method is an effective method for calculating the analysis of the value obtained for projects. This method verifies whether our project is on schedule and on time on budget or not.

De Anderd et al. (2019) examined project time and cost forecasting in a study entitled "Using Real Project Scheduling Data to Compare Scheduled Scheduling and Project Time Predictability." Because project control involves decisions that affect the future, the ability to accurately predict the final timing and cost of projects is critical. In this paper, researchers focus on improving the accuracy of project duration forecasts by introducing a forecast approach to value-added management (EVM) and earnings-time management (EDM), in which program performance and project adherence to the project. It combines the present tense. Because program adherence has not yet been formally defined for EDM, measurement of program adherence, p-factor, has been extended to EVM based on EVM, and this criterion is considered as c-factor. In addition, the aim is to improve the ability to demonstrate the projected accuracy of the project by extending the concept of EVM from project regularity to EDM. The introduced forecasting approach indicates the EDM project order for a large number of real projects, mainly in the construction sector. Experimental experiments show that the accuracy of project duration forecasting can be increased by focusing on program performance and adherence to the plan. In

addition, this study shows that the EDM project regularity index is actually a more reliable indicator than the forecast accuracy.

Koke et al. (2019) in a study entitled "Green Value Management for Project Management: A Systematic Review" examined the project time and cost forecast. Traditional acquired value management can be adopted to measure sustainability. The acquired green value management is intended for use in the portfolio and application level. To ensure that the benefits are realized, project control must extend beyond the end of the project. Sustainability value is determined by the opportunity costs of improving performance. Acquired value reduces costs, while acquired green value measures costs. However, general tools for measuring the performance of sustainability goals and measures are limited. Project Performance Evaluation uses the Acquired Value Management (EVM) method to measure project time, cost, and length of time. The purpose of this paper is to examine whether EV can be used to measure the performance of project sustainability goals. This paper examines the knowledge structures of "sustainability in project management" and "acquired value management" using two systematic effects review (SLR). Finally, a conceptual framework for "acquired green value management" is presented. Thus, by combining sustainability, expanding product lifecycle monitoring, addressing the triple bottom line, and converting general sustainability metrics into monetary terms to express value created by improving resource performance (rather than costs), EVM can be translated and Used to measure project sustainability and performance. The conceptual framework presented here provides a theoretical basis for a new project management tool to pursue the achievement of sustainable project goals. This approach assists current research in sustainable project management by bridging the gap between traditional tools and principled issues at an operational level.

Balstros et al. (2019) in a study entitled "Maximum-Minimum Schedule Achieved: Two New EVM Criteria for Project Monitoring and Control" examined project time and cost forecasting. Acquired Value Management (EVM) is a well-known project management method for monitoring project progress. Over the past 15 years, many EVM performance metrics have been proposed to more accurately predict project real-time and cost estimates, among other improvements. In this paper, a comprehensive simulation and experimental comparison of 26 definitive project duration prediction techniques under the EVM framework is investigated. Also, two new criteria have been proposed: Minimum Schedule Earned (ESmin) and Maximum Schedule Earned (ESmax). ESmin and ESmax offer a new and simpler approach to calculating activity levels from the traditional scheduling benchmark. Top Criteria (Most Accurate): Achieved Schedule (ES), Achieved Project Execution Time (ED), and High-Performance Effective Schedule (ES (e)) are new criteria compared to other criteria They have better performance to control the progress of the project.

3- Research model and estimation method:

3-1- Accuracy:

The accuracy parameter represents the percentage of correctly separating data into their respective classes, which for classification models is the ratio of the number of data correctly classified in the class to the total amount of data in the data set. For example, an accuracy of 0.82 means that 0.82 of the data set data are correctly classified according to the model. Now, according to the concept of clutter matrix, different criteria for classification evaluation and

accuracy measurement can be defined. The Accuracy parameter is the most common, basic and simplest criterion for measuring the quality of a category and is the degree of correct detection of the category in a total of two categories. This parameter actually indicates the amount of patterns that have been correctly identified and based on the matrix presented above, it is formulated and defined as Equation (3-1).

$$Accuracy = \frac{TP + TN}{TP + FN + FP + TN} \quad (3\text{-}1)$$

The accuracy parameter is usually expressed as a percentage.

3-2- Sensitivity:

There is another parameter in addition to the accuracy criterion that can be easily extracted from the clutter matrix. One of the most common is the Sensitivity Criterion, also known as the Positive Response Rate. Sensitivity means the proportion of positive cases that the test correctly marks as positive and the total number of positive cases. This parameter is calculated as Equation (4-2).

$$Sensitivity\ (TPR) = \frac{TP}{TP + FN} \quad (3\text{-}2)$$

This parameter is also known as the Recall parameter.

3-3- Specificity:

In contrast to the sensitivity parameter, the accuracy of the negative class detection may sometimes be important. One of the most common parameters that is usually considered along with sensitivity is the specificity parameter, which is also called the correct negative response rate. Characteristic means the ratio of negative cases that the model correctly identifies as a negative sample to the total number of negative samples. This parameter is calculated as Equation (3-3).

$$Specificity\ (TNR) = \frac{TN}{TN + FP} \quad (3\text{-}3)$$

These two parameters (sensitivity and specificity) are similar to the accuracy criterion, usually expressed as a percentage. Clearly, an excellent forecast is a forecast in which the Sensitivity and Specificity values are both 100%; But the probability of this happening in reality is very low and there is always a minimum of error.

3-4- Precision:

The accuracy parameter indicates what proportion of the data that the categorizer detects is positively positive. This parameter is defined as Equation (3-4).

$$Precision = \frac{TP}{TP + FP} \quad (4\text{-}3)$$

3-5- Criterion (F1-Score)

In addition to the two parameters of sensitivity and specificity, other parameters are extracted from the disorder matrix, each of which is a conceptual expression and has different applications. There is another parameter called "F1-Score" which is widely used to evaluate the performance of categories. This parameter is defined by combining the two parameters Recall and Precision, which is actually the harmonic mean of these two parameters, as relation (3-5).

$$F1-Score = 2 \times \frac{(\text{Recall} \times \text{Precision})}{(\text{Recall} + \text{Precision})} \qquad (5\text{-}3)$$

4- Experimental data and results:

In this section, after definition and pre-processing, the data of the desired construction projects are given to the mentioned system. The output of the system is based on the method of mean squared error and its square root. The output is expressed in the form of three graphs and the average error percentage. In the proposed method, the input data were divided into two categories of training and testing.

In the design of a hybrid network model, the input variables are 6 variables (project progress percentage (AD), project cost percentage (AC), percentage of acquired value (EV), percentage of achieved time (ES), cost performance index (CPI) , Schedule Performance Index (SPI)) and project completion cost estimation (EAC) and project completion time EAC(t) are estimated as model output variables. Input variables areconverted to fuzzy numbers(Fuzzification).

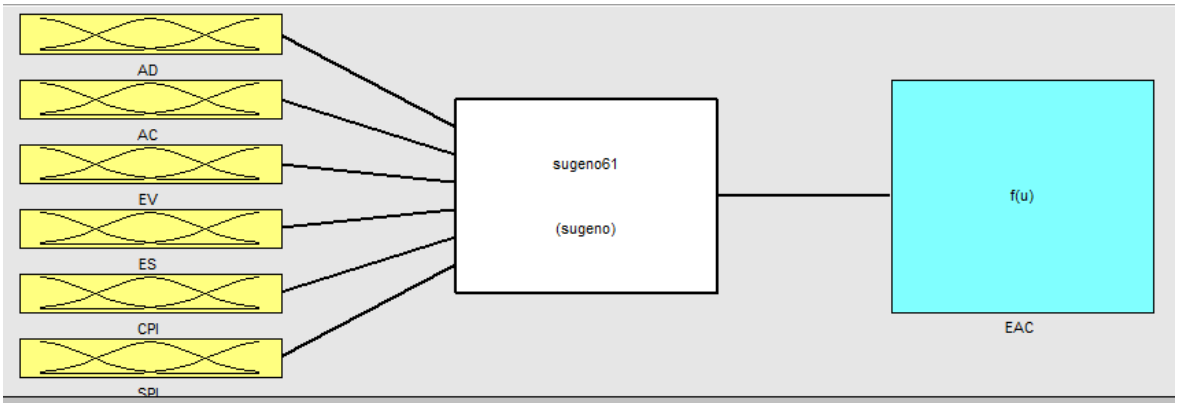

Figure 4-1. Enfis model estimates the cost of completing the (final) project (EAC) using 6 input variables in MATLAB

In order to design a basic fuzzy inference system (FIS) model, it is designed for training data, which is followed by membership functions related to basic FIS.

In this regard, membership functions related to the variable of project progress percentage (AD) in the range of 0 to 90% of project progress with Gaussian functions and using FCM clustering method based on data, this variable is formed in 10 clusters in different intervals in ten clusters. Took.

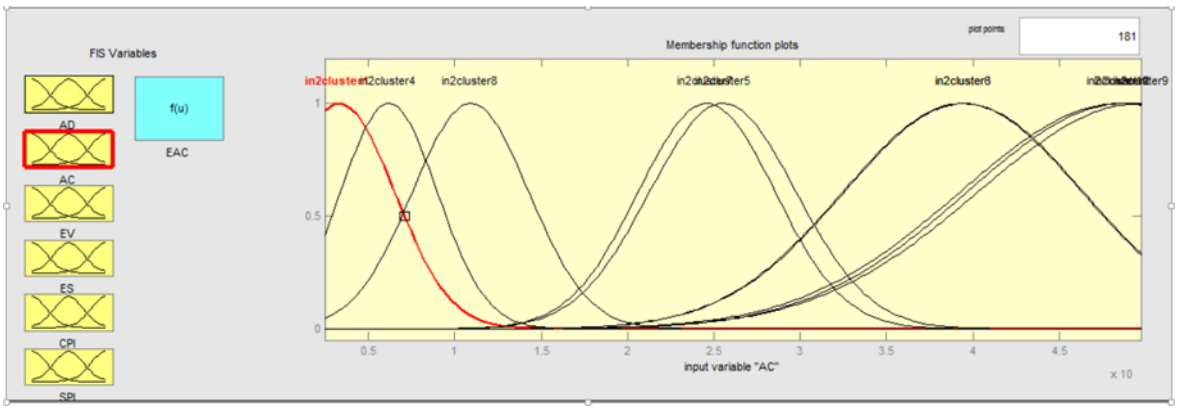

Figure 4-2. Membership functions related to the project progress percentage (AD) variable related to the basic FIS

Then the fuzzy rules of the optimal model were determined in 10 fuzzy rules.

If the percentage of project progress (AD) in the first cluster, the percentage of project cost (AC) in the first cluster, the percentage of value gained (EV) in the first cluster, the percentage of scheduling (ES) in the first cluster, the cost-performance index (CPI) In the first cluster, the scheduling performance index (SPI) is in the first cluster, then the project completion (EAC) cost estimate will be in the first cluster.

If AD is in the second cluster, AC in the second cluster, EV in the second cluster, ES in the second cluster, CPI in the second cluster, SPI in the second cluster, EAC will be in the second cluster.

If AD is in the third cluster, AC in the third cluster, EV in the third cluster, ES in the third cluster, CPI in the third cluster, SPI in the third cluster, EAC will be in the third cluster.

If AD is in the fourth cluster, AC in the fourth cluster, EV in the fourth cluster, ES in the fourth cluster, CPI in the fourth cluster, SPI in the fourth cluster, EAC will be in the fourth cluster.

If AD is in the fifth cluster, AC in the fifth cluster, EV in the fifth cluster, ES in the fifth cluster, CPI in the fifth cluster, SPI in the fifth cluster, EAC will be in the fifth cluster.

If AD is in the sixth cluster, AC in the sixth cluster, EV in the sixth cluster, ES in the sixth cluster, CPI in the sixth cluster, SPI in the sixth cluster, EAC will be in the sixth cluster.

If AD is in the seventh cluster, AC in the seventh cluster, EV in the seventh cluster, ES in the seventh cluster, CPI in the seventh cluster, SPI in the seventh cluster, EAC will be in the seventh cluster.

If AD is in the eighth cluster, AC in the eighth cluster, EV in the eighth cluster, ES in the eighth cluster, CPI in the eighth cluster, SPI in the eighth cluster, EAC will be in the eighth cluster.

If AD is in the ninth cluster, AC in the ninth cluster, EV in the ninth cluster, ES in the ninth cluster, CPI in the ninth cluster, SPI in the ninth cluster, EAC will be in the ninth cluster.

If AD is in the tenth cluster, AC is in the tenth cluster, EV is in the tenth cluster, ES is in the tenth cluster, CPI is in the tenth cluster, SPI is in the tenth cluster, EAC will be in the tenth cluster.

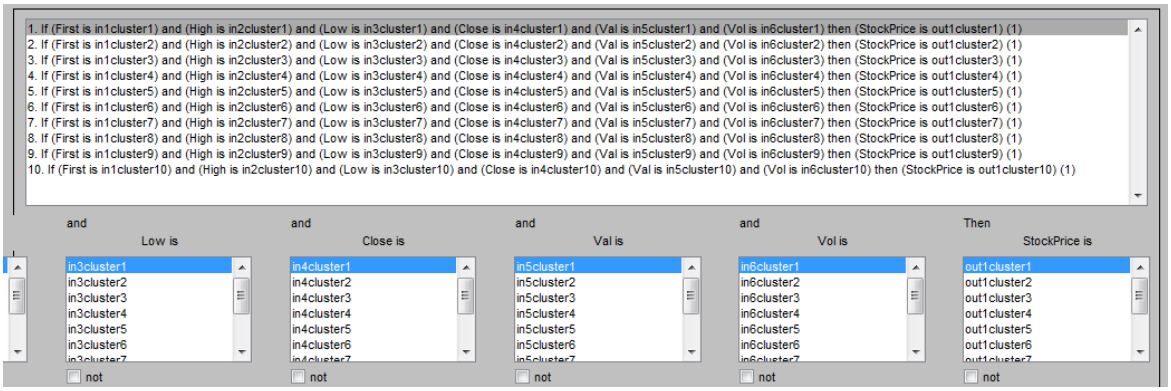

Figure 4-3. Fuzzy rules of time-cost forecasting model in construction projects

In this study, Sugeno fuzzy-neural inference system has been used. For each input, 10 Gaussian membership functions were defined, which eventually led to the creation of 10 rules. The genfis3 function was used to create the fuzzy inference system. The structure of the fuzzy-neural inference system used in this research is shown in Figure (4-4). Modeling is done by this method in MATLAB software.

In general, the final infinitive model of the present study, in which first the input variables (6 inputs) are entered, then fuzzy is performed for the inputs, in other words, membership functions for these variables were defined. Then imposition or 10 fuzzy rules were formed.

- Weight normalization (summary)
- Create weighted outputs
- plural
- output

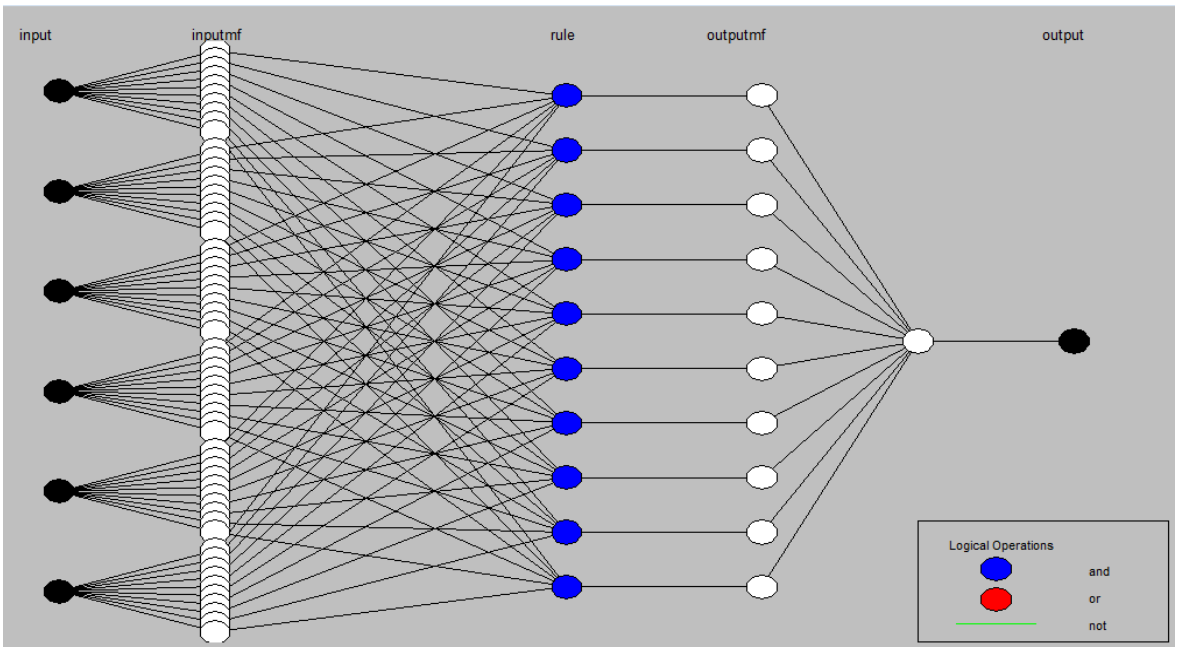

Figure 4-4. Enfis model estimates project cost using 6 input variables

The following figures show the type and how the input parameters affect the cost forecast in construction projects based on the acquired value technique.

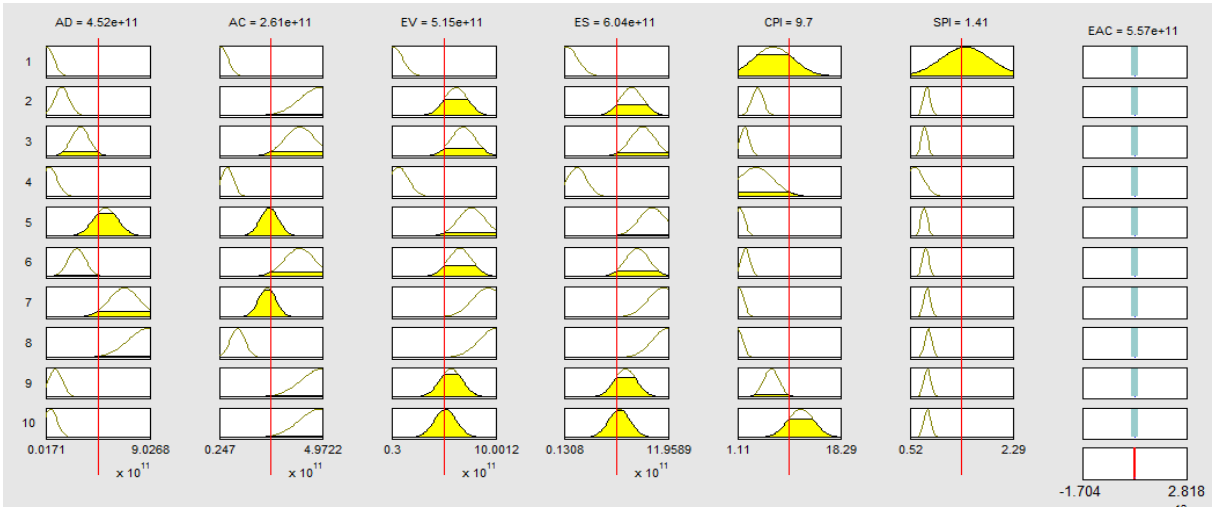

Figure 4-5. The final model of cost forecasting in construction projects based on the value-added technique by ANFIS method

Similarly, the membership functions of the 6 input variables, fuzzy rules for the time prediction model on construction projects based on the acquired value technique were calculated, and finally the final model of time prediction of construction projects was determined. In fact, in the final model, which was designed based on the data of the completed projects, it has the ability to receive 6 input variables defined in this research for the future projects in each period of the

project, and to the input title is given to the model. The model has the ability to intelligently predict the time and cost of project completion.

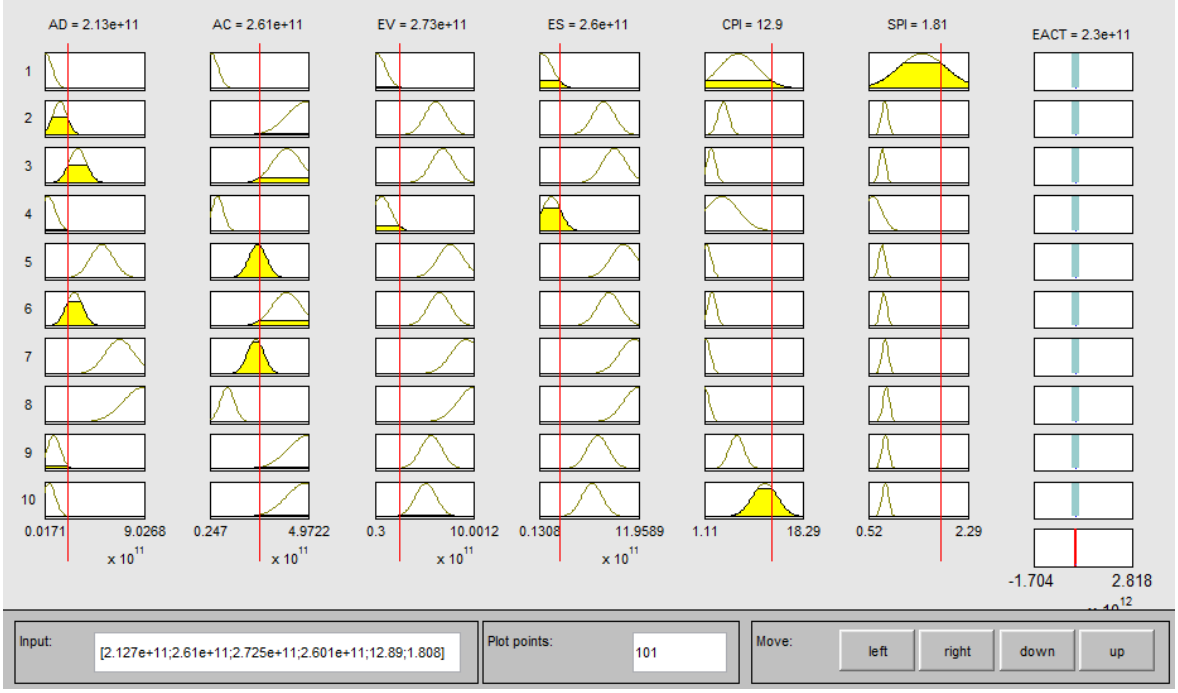

Figure 4-6. The final model of time forecasting on construction projects based on the value technique obtained by ANFIS method

The performance of the Enfis method compared to the neural network method for time-cost forecasting in value-based construction projects is summarized in Table (1-4). In evaluating the performance of the two algorithms and according to the results, the combined neural-fuzzy method (Enfis) has performed better than the neural network.

Table 4-1. Summary of performance of different implementation methods

Validation data		Test data		Training data		Method
percentage error	RMSE	percentage error	RMSE	percentage error	RMSE	
16/25 %	0./00306	17/32 %	0./00349	16/84 %	0./00351	neural network
15/82 %	0./00252	16/94 %	0./00288	16/25 %	0./00293	Neural-fuzzy network

5. Conclusion:

The most important result of the implementation and application of cost management system is to obtain the actual cost of activities and control the cost performance of project activities. It should be noted that the registration and maintenance of information resulting from the operational cost management process (such as calculating the actual cost) Activities, by resources used and costs incurred for them), are not only required for processes related to project

cost management. Rather, this information can be used, for various purposes, such as estimating bids in future tenders, as well as (in analytical cases) to compare costs incurred in one project with similar works in other projects (such as resource estimates and costs in Used future projects, depreciation calculations, general costs, etc.) as well as preparing technical-economic evaluation reports of projects.

In general, this research shows that the proposed model can provide more accurate and stable prediction results. Considering the better performance of neural-fuzzy networks than neural networks and the acquired value technique, we conclude that neural-fuzzy networks due to their ability to solve complex and poorly structured problems and use data from multiple Projects can help managers make better decisions.

6- Future suggestions:

In subsequent studies, combined data can be used to better describe the time and cost characteristics of the time series and make more accurate predictions. In fact, with the current inflationary conditions of the country, in order to increase the accuracy of the model, changes in the exchange rate or the index of changes in the cost of construction can be considered as another input variable. Also, considering that weather conditions and contractors' payment methods are also variables that can be added to make the model realistic and improve the forecast results. These factors help to adjust the projected cost and final time error of projects.

In future research, to predict the cost and completion time of projects, other techniques can be used to learn radial base neural network machine (RBF), support vector machine (SVM), etc. and then compare These methods were compared with the acquired value management technique.

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