

Comparative Study of the Neural Network Method and the Traditional Method in Predicting the Budget and the Cost of Namazi Hospital in Shiraz, Iran

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Abstract: The aim of this study was to compare using neural networks method with the traditional method in predicting the budget and the cost of Namazi hospital in Shiraz, Iran. Artificial neural network is one of the computational methods which are trying to understand the inherent relationships between data by the help of learning process and the use of simple processors called neurons to provide mapping between the input space and optimal space. Neural network method and regression traditional methods were compared in this study, by using obtained data from financial statements of Namazi hospital in 2014. Data related to the cost was on monthly basis and data on the budget were on an annual basis. Excel software was used to save data and matlab2013 and SPSS software version 22 was used for evaluation. The results showed that the neural network was more efficient than the linear regression.

Keywords: Budget, Traditional Budgeting Methods, Artificial Neural Networks, Comparative Comparison.

Introduction

Today, with the development of advanced technologies in different dimensions with increasing complexity and diversity of activities, understanding these changes and evaluate their impact on organizational costs is important. The importance of this issue for service units is double because the diversity and changes are more towards productive activities. It is clear that identifying these activities and evaluating the impact of organizational cost requires the design of a proper costing system in this area. The importance of identifying and controlling costs is obvious both in public institutions and private organizations. But to achieve this, designing a proper and efficient system is needed that is able to recognize the diversity and complexity of activities, and evaluate its impact on the providing services cost. Traditional costing systems, especially systems that are used in the hospitals of the country, are not able to meet these expectations due to their nature. Because this systems are established based on a series of fixed tariffs, they calculates the cost of provided services regardless of the each hospital situation. Obviously, using this method, in addition to cause defects in the calculation of the actual cost it won't give the necessary information to managers to make decisions. Therefore, the use of new costing systems which are common in the world is considered as a basic necessity (Gilani Nia, 2012). In developing countries with low and middle income, there is

little information about the costs of services. Limited budgets devoted to health care in many developing countries required the health systems planners and managers to efficient use of resources in this important sector of the economy. In the meantime, costing and the services cost analysis can help the moderators, hospitals and policy makers in determining the fact that how and to what extent units and institutions under their supervision will meet the public needs. To achieve a clear picture of the costs and the development of performance-based budgeting process and effective use of resources, determining the cost is taken into consideration from the viewpoint of health economics in recent years. Costing and cost analysis as a management tool are able to provide the necessary data to make more informed decisions about investment for and actions Infrastructure (Hadian et al., 2010). In traditional budgeting, objectives and emphasis were solely based on financial instruments and the accounting of public sector receipts and payments, and distribute funds exclusively focused on the "Device- cost" leading to traditional accounting system cannot communicate between consumption of resources and obtained results directly or indirectly, and only concerns with collecting costs. Most managers are used to the same point and only concerned with costs collecting of the device in each of the cost classes. And accounting system which is formed in the same direction will strengthen the viewpoint of these managers. There are different methods for estimating costs. Methods such as traditional methods or conventional methods which are based on the last year's information, Average method, which are estimated by calculating the costs' average growth rate of previous years and multiplying it by amount of the costs of the next year. Regular measuring method is a method that estimated the costs of the next years by using regression models. All of these methods have its strengths and weaknesses. One of the weaknesses of the methods is deviation of the costs, which is less in the latter method than other methods (Abdoli, et al., 2006). In recent years, managers by understanding their position, are seeking appropriate strategies for effective use of the resources, accurate demand forecasting for all organizations, whether in private sector or the public sector is vital in theory and in practice. For this reason, predicting the costs analytically is difficult or impossible. In these circumstances, the use of intelligent systems can be considered as a helpful solution. As a result of new technology, artificial intelligence technology has affected many Sciences. Accounting knowledge not only is an exception but also is one of the most prone areas to use the results of the systems based on artificial intelligence. Therefore, this study tried to compare using the neural networks method with traditional method to predict the costs and the budget of the Namazi hospital in Shiraz, Iran.

Materials and Methods

This research, in terms of its purpose was in the category of applied research and based on modeling. The study sample is the Namazi hospital of Shiraz, Iran. In this study, for the data needed to conduct the research, the 2014 financial statements of Namazi hospital of Shiraz have been used. In the present study, to estimate the function of the cost of hospital it was necessary to explain the costs of hospital, and then estimate and predict the function based on neural network and regression methods. Medical expenses types have different classification, which in some of these; costs are divided into direct and indirect costs and some other have divided costs of the hospital into two groups of operating and non-operating (Hadian et al., 2010). Of course, there are other divisions, but in this research the following classification has been used in which the presented costs were as independent variable:

- The costs of personnel, medical and treatment staff which are actually operating costs. Operating expenses as defined by accounting standard No. 25 are costs related to the main and continuous activities which are directly attributable or allocable to parts on a reasonable basis, whether related to sales to external customers or transactions with other parts of the business units.

- The costs of buildings and equipment, including the costs of depreciation, maintenance, repair, construction, installation of equipment such as heating and cooling, security and ... which are used in the hospital building to be able to continue its activities.

- The cost of the final services, included hospitals three cost of (outpatient, inpatient and emergency) that provide services directly to patients.

And the dependent variable was the total cost of hospital. According to the background of an artificial neural network which has high predictive power, this research aims to compare the prediction of traditional funding cost of public hospitals with the neural network predicting method. Because of the nature of text processing in neural networks, false and erroneous statistical variables have very little impact on the results. So far, different methods and algorithms are presented for training neural networks. One of the most important algorithms is error back propagation algorithm, which is used in this study. This algorithm is a leading multi-layer neural network topology supplements. Also, along with the propagation algorithm, multi layer perceptron networks have been used, which are very conversant in recognizing Pattern and function that is applicable to a specific problem. The neural network

architectural form plays an important role in the power of understanding the relationships by the network. Part of the neural network architecture is always dictated by the situation. Different architecture were created and trained to obtain the best neural network architecture. Finally, a two-layer network with 16 neurons in the hidden layer and 1 neuron in the output layer was used in this study. In the case of functions, the sigmoid function is used for hidden layer and the linear transfer function for output layer. According to the topics of cost in government hospitals, the most important headlines affecting the cost of hospital which are the three groups of personnel costs, building and equipment costs and the cost of the services were examined and the results of the following model were compared with results of traditional budgeting methods by using linear regression (Figure 1).

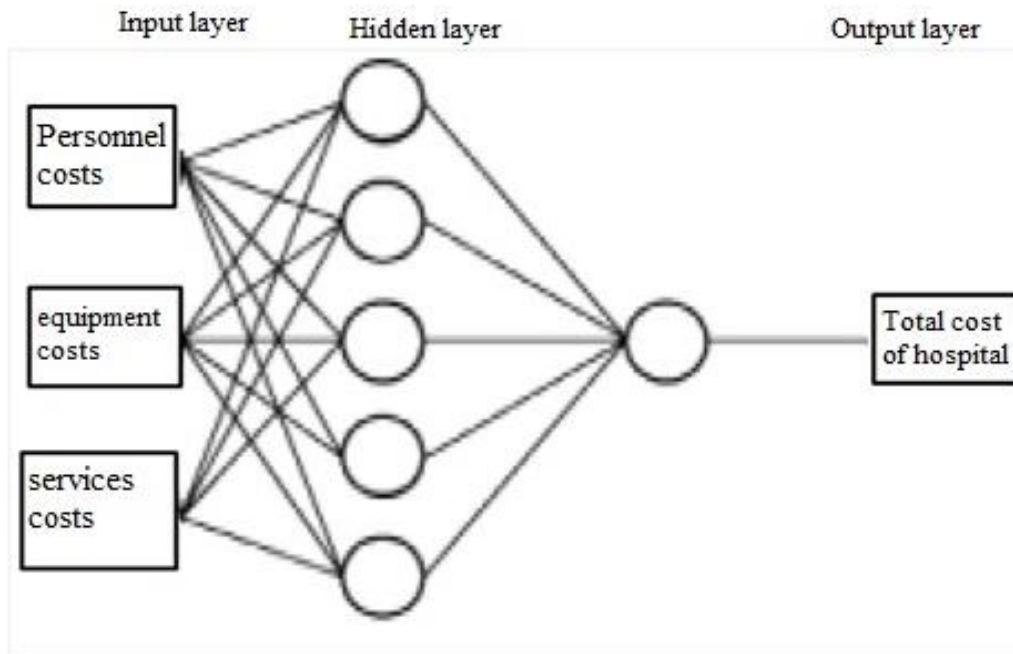


Figure 1. The neural network model used in this study.

MATLAB 2013b software was used for data analysis, and the criteria such as mean squared error of prediction (MSE), root mean squared error of prediction (RMSE), and the coefficient of determination (R^2) was used.

Results

Using the neural network, the cost predicting was compared by the neural network model with the cost predicting by the traditional method. To apply neural network, toolbox of neural network available in MATLAB software was used. Diagram of the regression in neural network is shown in Figure 2.

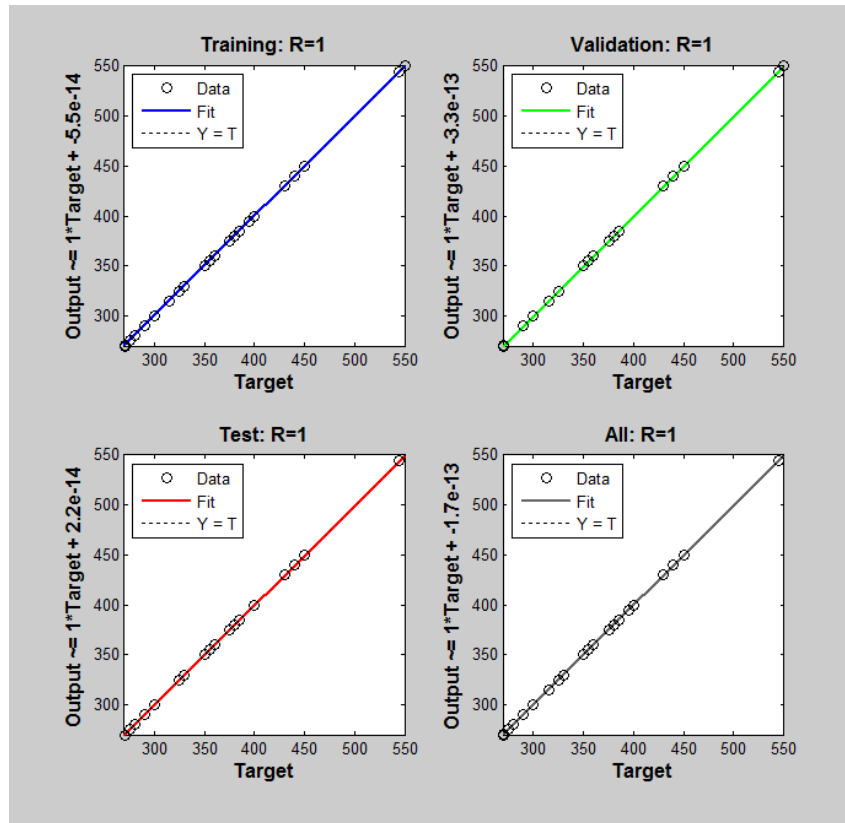


Figure 2. Regression diagram of neural network in this research.

Figure 3 is also showing a diagram of the network performance. In this diagram, the horizontal axis is number of epochs and vertical axis is the MSE error.

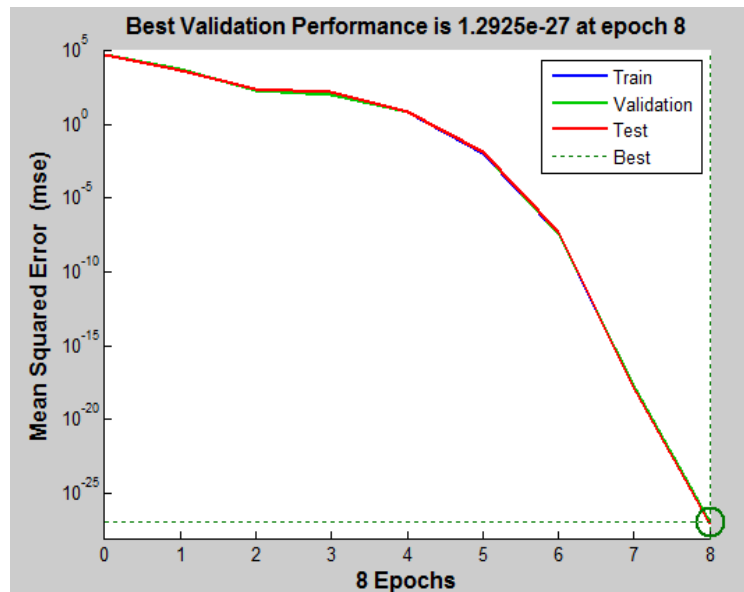


Figure 3. The Diagram of the performance of the neural network with dataset used in this study.

Data were analyzed by using linear regression, in which the independent variables are the three variables of personnel costs, costs of building and equipment and the cost of the final services and the independent variable is the total cost of the hospital. Table 1 shows the table of coefficients in the output.

Table 1. Results of regression analysis.

Model	Unstandardized Coefficients			t	Sig.	95% Confidence Interval For B		Correlations		Collinearity Statistics		VF
	B	Std. Error	Beta			Lower Bound	Upper Bound	Zero-Order	Partial	Partial Tolerance		
Constant	11.113	1.207	None	9.208	0	8.738	13.488	None	none	None	None	none
H1	0.981	0.004	0.638	220.276	0	0.99	0.99	0.853	0.997	0.577	0.818	1.222
H2	1.075	0.012	0.346	91.212	0	1.052	1.098	0.797	0.983	0.239	0.476	2.099
H3	1.19	0.016	0.267	75.067	0	1.159	1.221	0.664	0.975	0.197	0.543	1.842

As can be seen in Table 1, the coefficients are as follows: 11.113 / 0.981 / 1.075 and 1.190, it means that the regression equation is as follows:

$$R = (0.981 * H_1) + (1.075 * H_2) + (1.190 * H_3) + 11.113$$

In which; H_1 , H_2 and H_3 are personnel costs, building and equipment costs and final service charges, respectively. Table 2 shows model Summary which can be seen in output.

Table 2. Model summary of regression output in predicting the costs of hospital.

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Change Statistics					
					R Square Change	F Change	df1	df2	Sig. F Change	Durbin Waston
1	0.999	0.998	0.998	3.59536	0.998	48438.41	3	296	0	2.181

Figure 4 also shows the ratio diagram of the predicted values to the actual value output in regression analysis.

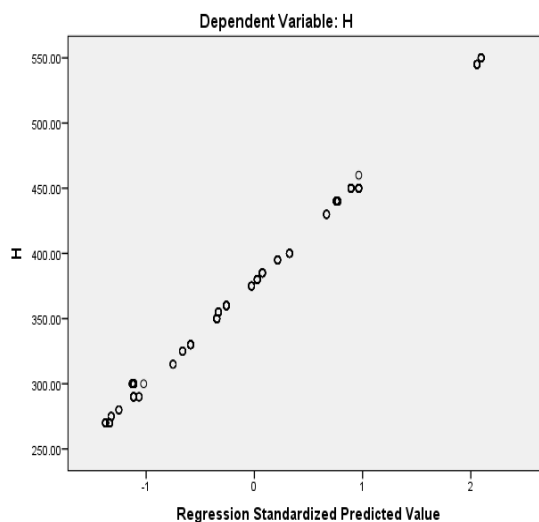


Figure 4. Ratio diagram of the predicted values to the actual in linear regression to predict the cost of hospital

In Table 3, comparisons have been made between the methods of regression and neural networks.

Table 3. Comparison of neural networks and linear regression to predict the costs.

Methods	MSE	RMSE	R^2
Regression	1.2×10^{-4}	1.09×10^{-2}	0.9980
Neural network	1.4×10^{-27}	3.7×10^{-14}	0.9999

As can be seen from the point of view of examined criteria, the neural network is more efficient than linear regression. Next, a comparison was analyzed between the predicting cost by using neural network model and predicting cost by using the traditional method. Results of neural network regression are as shown in Figure 5.

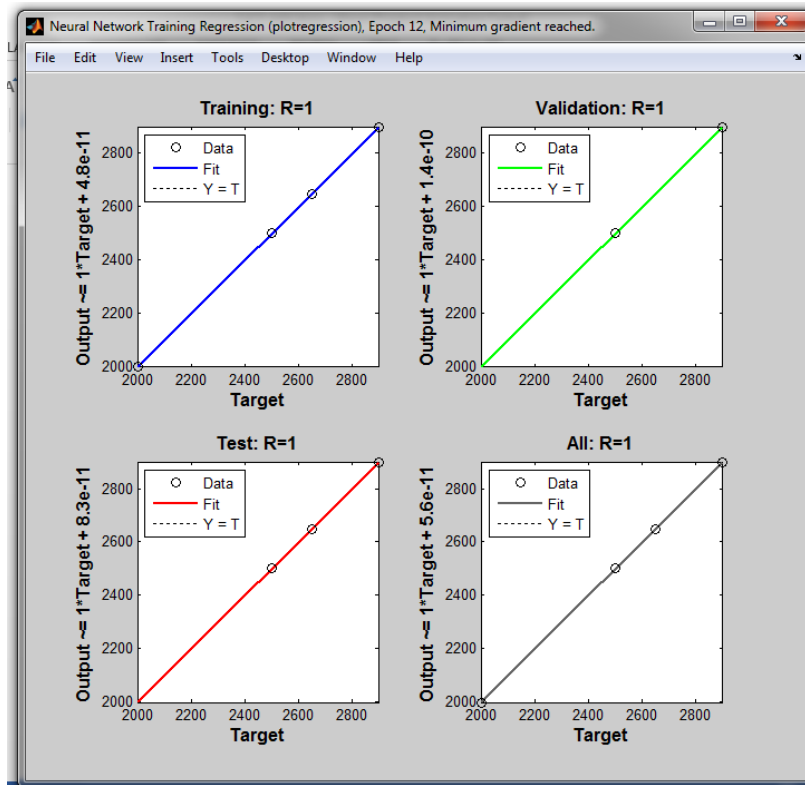


Figure 5. Regression diagram (predicting cost) related to the Neural Network.

Figure 6 also shows diagram of the network performance. In this diagram, the horizontal axis is the number of epochs and vertical axis is the MSE error.

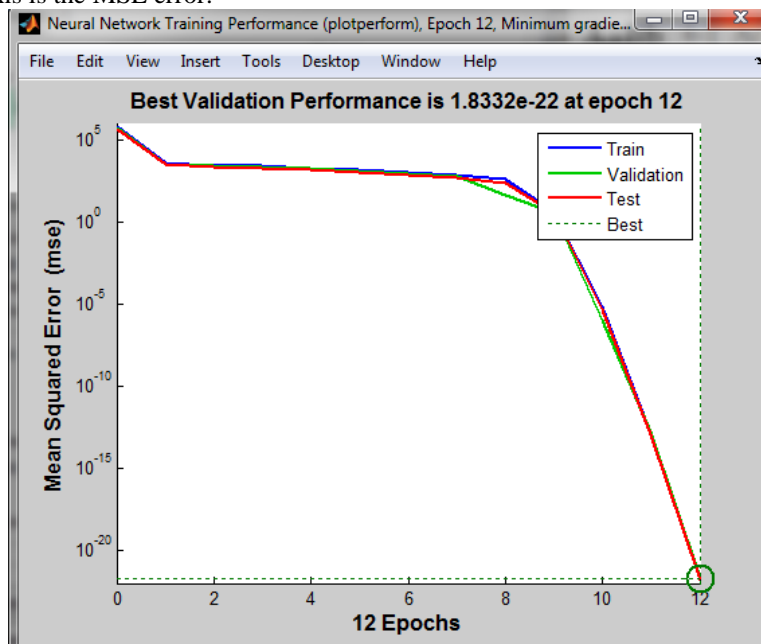


Figure 6. The performance Diagram of the neural network in predicting budget.

In linear regression costs and incomes variable are independent variables and the budget is the dependent variable. Table 4 shows the table of coefficients output.

Table 4. SPSS output of regression coefficients in predicting budget.

Model	Unstandardized Coefficients		Beta	t	Sig	Correlations			Collinearity Statistics	
	B	Std.Error				Zero-Order	Partial	Part	Tolerance	VF
Constant	-5736.22	93.606	None	-61.28	0	none	none	none	None	none
H	2.557	0.026	1.615	98.446	0	0.319	0.999	0.953	0.348	2.874
D	-1.609	0.016	-1.605	-97.847	0	-0.301	-0.999	-0.947	0.348	2.874

As can be seen in Table 4, the coefficients are: -5736.22 / 2.557 / -1.609. it means that the regression equation is as follows.

$$R = ((-1.609) * H) + (2.557 * D) - 5736.222$$

That *H* / *D* respectively represent the costs and income. Table 5 shows the model summary Table which can be seen in output.

Table 5. Model summary of the regression output in predicting budget.

Model	R	R Square	Adjusted R Square	std.Error of the Estimate	R Square Change	F Change	df 1	df 2	Sig. F Change	Durbin Waston
1	0.999	0.998	0.998	10.15538	0.998	5329.737	2	2	0	2.791

Figure 7 also shows the ratio diagram of the predicted values to the actual value output in regression analysis related to predicting the budget.

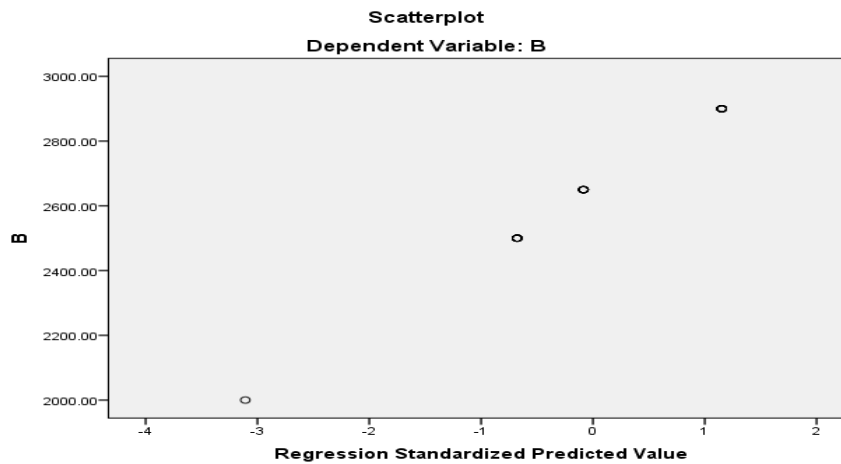


Figure 7. Ratio diagram of the predicted values to the actual in linear regression.

In Table 6, comparisons have been made between regression and neural networks.

Table 6. Comparison of neural network and linear regression in predicting budget.

Methods	MSE	RMSE	R ²
Predicting budget - Regression	1.5 × 10 ⁻⁵	0.38 × 10 ⁻²	0.9980
Neural network	1.32 × 10 ⁻²²	1.14 × 10 ⁻¹¹	0.9999

As can be seen from the point of view of examined criteria, neural network method has better performance than linear regression.

Conclusion

The aim of this study was to compare the using of traditional method with neural networks to predict the costs and budget of the Namazi hospital in Shiraz, Iran. The results showed that the neural network is more efficient than linear regression. The result of this research study were not compatible with the studies of White (1998) in the field of economic forecasting, which had shown that minimization algorithms used in econometric are better than neural network algorithm (According to Swanson, et al., 2011), but they are similar with other research results below. Moshiri and Cameron (2000) compared the artificial neural network performance with some other methods. The results show that the neural network has better performance. Fu (1998) examined the real gross domestic product growth in the United States of America by using artificial neural networks and linear regression. The results showed that artificial neural networks are better for predicting. In research carried out by the Khalili Iraqi and Nobahar (2011) which is about predicting the price of housing in Tabriz, Iran, the predictive power of Hedonic regression models was compared to artificial neural network. Test results indicated that the artificial neural network was superior to the Hedonic model. The results showed that neural network method provides more accurate estimates of the costs and therefore the hospital budget, and so that's why it's recommended to financial and planning managers of Namazi hospital in Shiraz, Iran, to use neural networks in order to control and manage costs, as well as budget forecast. Considering that hospitals work under the supervision of medical universities and in a close relationship with the academic environment, it is recommended that the results of this study also apply in other hospitals in the province with the supervision of Fars Medical University (as a prototype), and to be presented to the Ministry of Health in the form of a comprehensive proposal if the results are desired.

Conflict of interest

The authors declare no conflict of interest

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