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A STUDY ON ARTIFICIAL INTELLIGENCE FORECASTING OF RESORT DEMAND

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ABSTRACT

In recent years, the number of foreign visitors to Taiwan continued to increase, and people paid greater attention to quality of life, thus, the domestic tourism industry has become increasingly active. Resorts are very popular and are the hot mainstream commodity of the leisure and tourism industry. However, leisure and tourism are not livelihood necessities, and consumer demand is subject to many other factors. The resort industry must be able to master the demand volume in order to achieve advance planning of resource management and allocation, human use, financial management, marketing management, etc. Therefore, this study applies artificial intelligence technology to establish the resort demand forecasting model. The empirical results show that forecasting model Mean Absolute Relative Error (MARE) is 0.1232, and correlation coefficient is 0.9408, indicating that the model has a good forecasting ability and can be used as a reference for the resort industry and related industries in Taiwan.

Keywords: *Resort, Demand, Forecasting*

1. INTRODUCTION

The number of resort accommodations is mainly affected by general economic factors, business and consumer factors, the number of visitors to tourist attractions, and recreational weather factors. If the changes in the number of accommodations can be accurately forecast, we can learn more about the amount of accommodations at each time point, which is helpful for the industry's operations and allocation of resources management, manpower, financial management, marketing management, etc., to achieve effectiveness of advance planning and cost reduction. Therefore, with the construction of the resort demand forecasting model as the objective, and the forecasting of the number of accommodations in Kenting Caesar resort as the target; we select according to literature review input variables affecting the number of accommodations and apply neural networks to establish the forecasting model. The proposed model uses Mean Absolute Relative Error (MARE) and correlation coefficient as the assessment criteria for verifying the performance of the forecasting model. The purposes of the study are, as follows:

(1) To clarify the number of factors affecting accommodations, and select the variables that affect the number of accommodations of the resort;
(2) To construct the forecasting model for the resort's number of accommodations by using the back-propagation neural network and the results can be used for the industry as a reference.

2. LITERATURE REVIEW

2.1 Accommodation Demand

Factors affecting accommodation demand can be mainly divided into the overall economic factors, the industrial factors, the consumer factors, the number of visitors to tourist attractions, and the weather factors. This study selects the input variables for the forecasting of the number of accommodations by referring to the following studies:

(1) Law[1] applied artificial neural networks to construct the Japanese demand on visiting Hong Kong forecasting model. The proposed forecasting model considers numerous variables, including labor prices, the average hotel occupancy rate, foreign exchange rate, population, marketing expenses, gross national expenditure amount, etc. The empirical results show that neural network's forecasting performance is better than the performance of simple arithmetic, moving average, exponential smoothing, and regression methods.
(2) Chang[2] used an econometric model to forecast the demand on resort accommodation of visitors to China by selecting variables

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including income, CPI, accommodation price, foreign exchange rate, the number of visitors to China, and other unexpected events. The results show that the most important variables affecting the accommodation demand of visitors to China include long term CPI, long term number of visitors to China, and short term number of visitors to China.

(3) Tsai[3] used the time series data and two stage least squares (2SLS) to assess the influential factors of demand and supply of hotel rooms in Las Vegas by selecting room rates, room rates of one lag, disposable income, CPI, the Dow Jones industrial index, unemployment rate, and other independent variables, for the forecasting the number of room occupancy. The empirical results show that CPI has a positive impact on the demand on hotel rooms in Las Vegas.

(4) Chang [4] used the artificial neural networks model for the forecasting air passenger traffic by inputting variables including population, personal income, labor force, CPI, and urban gross production. Moreover, by using the gravity model concept, the distance between airports is used as one of the factors affecting the number of airline passengers. It is found that population is an important variable affecting the number of airline passengers.

(5) In a study on the economic analysis of target consumers' demands for accommodation of international tourist hotels in Taiwan, Jiang [5] used the simultaneous equation model of planned economy and established five demand models including the total number of guests in international tourist hotels. Additionally, in accordance with different models, the average price, number of rooms, hotel sites, business type, distance from the international airport, the number of visitors to Taiwan, the average disposable income per capita, CPI, the average foreign exchange rate, unemployment rate, international oil prices, and dummy variables, were selected to analyze the influential factors of the accommodation demand of different target customer groups.

Based on the above literature, this study selects eight variables, including unemployment rate, CPI, TAIEX, foreign exchange rate, international oil prices, the number of rainy days per month in the Hengchun area, the number of foreign visitors to Taiwan, and the number of visitors to Kenting National Park, as the input variables for forecasting of the number of accommodations.

2.2 Artificial Neural Network

This study constructs the model for forecasting the number of accommodations by referring to the studies of Burger and Law [6], Lin [7], Jiang and Li [8], and Wang [9].

Burger and Law [6] applied the intuition method, moving average method, exponential smoothing, regression, autoregressive integrated moving average model, BPN, genetic regression, and other methods, in forecasting the demand of tourism in southern Africa, and the performance of BPNN was the best.

Lin [7] applied the back-propagation neural network combined with multiple regression analysis, exponential smoothing, and gray forecasting for the forecasting of number of tourists. The input variables include CPI, GDP, and events, which lead to increased numbers of tourists, as well as events leading to the decreased number of tourists. The results suggested that the performance of the WINTER exponential smoothing combined with BPNN is better.

Jiang and Li [8] applied the artificial neural network based on the back-propagation learning algorithm to construct the forecasting model for forecasting the number of American tourists to Taiwan, and found that the forecasting results can achieve the required accuracy.

Wang [9], in the study of the neural networks forecasting model of air passenger transportation and freight transportation, used eight variables, including Japanese population, working population in Japan, Japanese personal income, Japanese GDP, Japan's GNP , foreign exchange rate, the number of flights , and Taiwanese personal income for forecasting Japan's air passenger traffic to Taiwan. The Mean Absolute Percentage Error is 0.34%. When using 10 variables including population in Taiwan, Taiwan's employed population, personal income in Taiwan, Taiwan's gross domestic product, Taiwan's GDP, Taiwan's economic growth rate, the import price index in Taiwan, the number of listed companies in Japan, Japan's total cargo to Taiwan, and Japan's employed population for forecasting Japan's total cargo to Taiwan. The MAPE is 7.74%, thus, the forecasting ability is excellent.

Therefore, in this study, artificial neural networks are used to establish the forecasting model of resort accommodation demand. ANN (Artificial Neural Networks) is an information processing system constructed by imitating the biological brain and neural network system, which

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can store, learn, and recall the input signals. The relatively accurate definition of ANN is: "ANN a computing system including software and hardware. It uses a large number of simple associated artificial neurons to imitate the biological neural network's ability. The artificial neuron is the simple simulation of the biological neuron. It obtains information from outside environments or other artificial neurons, conducts very simple operations, and outputs the result to the outside environment or other artificial neurons." According to the structure, ANN can be divided into three parts, including a processing unit, layers, and network summarization, as follows:

(1) Processing unit: the basic computing unit in the composition of ANN, which is generally termed as the artificial neuron. The output of each unit in ANN is the input of many other subsequent processing units. The relationship of the output and input values of the units can be represented by the weighted multiplication of input values and functions.
(2) Layer: the part composed of processing units of same function is known as a layer. In the general ANN architecture includes input layer, hidden layer, and output layer, as shown in Figure 1.
(3) Network: an architecture composed of different layers is the network. The layers are connected by neuron junctions to form the neural network. It has two functions, including the learning process and the recall process.

3. RESEARCH METHOD

3.1 Variable Selection

The subject of this study is the Kenting Caesar resort, which was Taiwan's first resort founded in 1986. Located on the Hengchun Peninsula, southern Taiwan, it has blue skies, beautiful beaches, and a pleasant tropical resort style. Its operating performance is highly appreciated by many domestic and foreign travelers, and was awarded a five-star rating in 2010 [11].

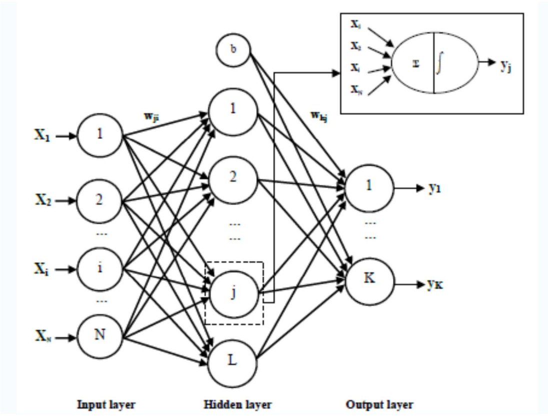

Figure 1: Three-layer back-propagation network model structure[10]

After literature review, the input variables of this study include unemployment rate, CPI, TAIEX, foreign exchange rate, international oil prices, the number of rainy days per month in the Hengchun area, the number of foreign visitors to Taiwan, and Kenting National Park tourist arrivals (Table 1). The independent variables are used as the input variables and the number of accommodations of the resort is used as the dependent variable, that is, the output variable. The data is based on the period from March 1993 to April 2004, with the exception of the period from November 2004 to February 2006, when the resort was being redecorated. The data is based on the "monthly" statistics.

Table1: Selected variables

Variable	Name	Data source	Time of data publication
X1	Unemployment rate	Directorate General of Budget, Accounting and Statistics, Executive Yuan, Taiwan[12]	The data of the previous month is published on the 23rd day of each month
X2	CPI		The data of the previous month is published on the 5rd day of each month
X3	TAIEX		The data of the previous month is published on the first day of each month
X4	International oil prices		The data of the previous month is published on the first day of each month
X5	Foreign exchange rate	Central Bank of the Republic of China [13]	The data of the previous month is published on the first day of each month
X6	Number of rainy days per month in Hengchun area	Central Weather Bureau, Taiwan [14]	The data of the previous month is published on the first day of each month

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Variable	Name	Data source	Time of data publication
X7	Number of foreign visitors to Taiwan	Tourism Bureau, Taiwan [11]	The data of the previous month is published on the first day of each month
X8	Kenting National Park tourist arrivals	Kenting National Park Headquarters, Taiwan [15]	The data of the previous month is published on the 25rd day of each month
Y	Kenting Caesar resort number of accommodations	Tourism Bureau, Taiwan [11]	The data of the previous month is published on the 23rd day of each month

3.2 THE ASSESSMENT CRITERIA

The assessment indicators of the quality of the forecasting model include:
(1) Mean Absolute Relative Error (Eq. 1)

$$MARE = \frac{1}{n}\sum_{j=1}^{n}\frac{|T_j - Y_j|}{T_j} \quad (1)$$

Where, T_j is defined as the actual value, Y_j is defined as the predicted value, and n is defined as the number of samples for forecasting. If the MARE value of forecasting has an error closer to 0, it means the model's forecasting ability is stronger, and the accuracy rate is higher. As a result, the forecasting results are closer to the actual data. Martin and Witt [16] divided the model forecasting ability into four levels, as shown in Table 2.
(2) Correlation coefficient (Eq.2)

$$r = \frac{\sum_{j=1}^{n} T_j \times Y_j}{\sqrt{\sum_{j=1}^{n} T_j^2 \times \sum_{j=1}^{n} Y_j^2}} \quad (2)$$

It is used to measure the strength of the relationship between the predicted (forecasted) and the actual value. If the correlation coefficient is higher, the relationship between two variables is closer. Otherwise, the relationship is less correlated. Chen [17] categorized the correlation coefficient degree into five levels, as shown in Table 3.

Table 2: Levels of model forecasting ability [16]

MARE	<0.1	0.1~0.2	0.2~0.5	>0.5
Level	Forecasting excellent	Forecasting good	Forecasting reasonable	Forecasting inaccurate

Table 3: Levels of correlation coefficient degree [17]

Correlation coefficient	1~0.8	0.8~0.6	0.6~0.4	0.4~0.2	0.2~0
Correlation degree	Extremely high	High	Normal	Low	Extremely low

4. EMPIRICAL ANALYSIS

This study uses the Neuro-Intelligence artificial neural networks software package, which can effectively deal with the artificial neural networks, data mining, model identification, forecast modeling, and other problems. The variable data is based on the statistical data from March 1999 to April 2012; with 6 abnormal data samples excluded; a total of 166 samples were selected; 70% of the samples were used as the model training data; 15% as model validation data; and 15% as the model testing data.

4.1 Network Architecture

The optimization method is applied to select the optimal network architecture of highest fitness (8-17-1). The input layer consists of 8 neurons, the hidden layer consists of 17 neurons, and the output layer has one neuron, which are the settings for the network architecture of the forecasting model of the number of accommodations (Figure 2).

4.2 Forecasting Model Training And Validation

The selected 8-17-1 back-propagation neural network architecture model, as described in the above section, uses seven learning rules including Batch Back propagation (Figure 3) in model training and validation. The error convergence, error improvement rate, and the weights of various input variables are as shown in Figure 4.

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4.3 Forecasting Model Results

Model results can be summarized, as shown in Table 4, by training, validation, and testing. By comparing the predicted number of visitors and the actual value, it can be found that the predicted number can move with the fluctuation trends of the actual value (Figure 5); additionally, as shown in the scatter plots of the predicted and actual values of the number of tourists, the points are clustered around the diagonal line (OUTPUT/TARGET=1), suggesting that the correlation between the predicted value and the actual value is very strong (Figure 6). According to the above, after training, the forecasting model can accurately forecast the number of tourists to the resort in the following period.

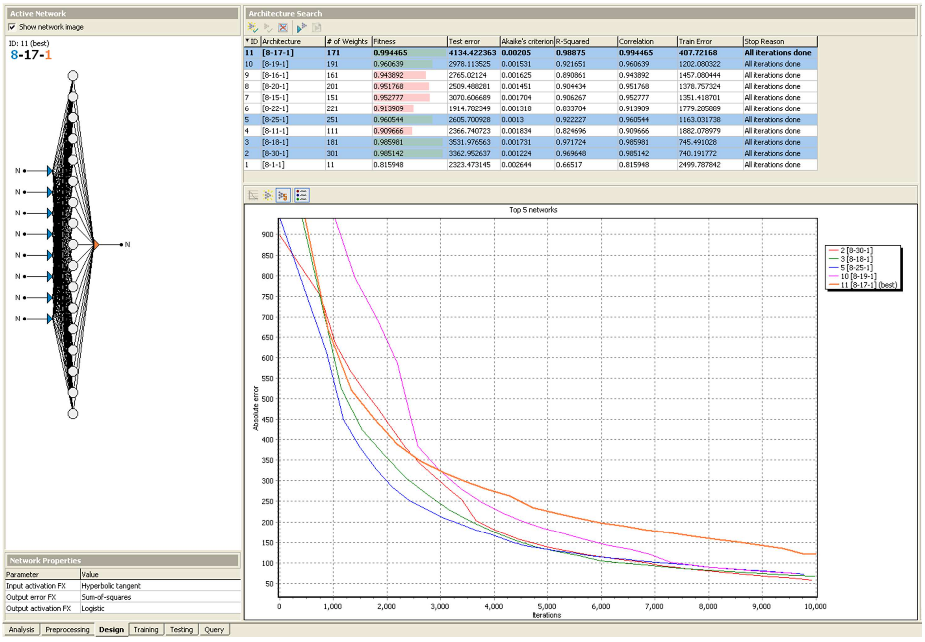

Figure 2: Forecasting model network architecture

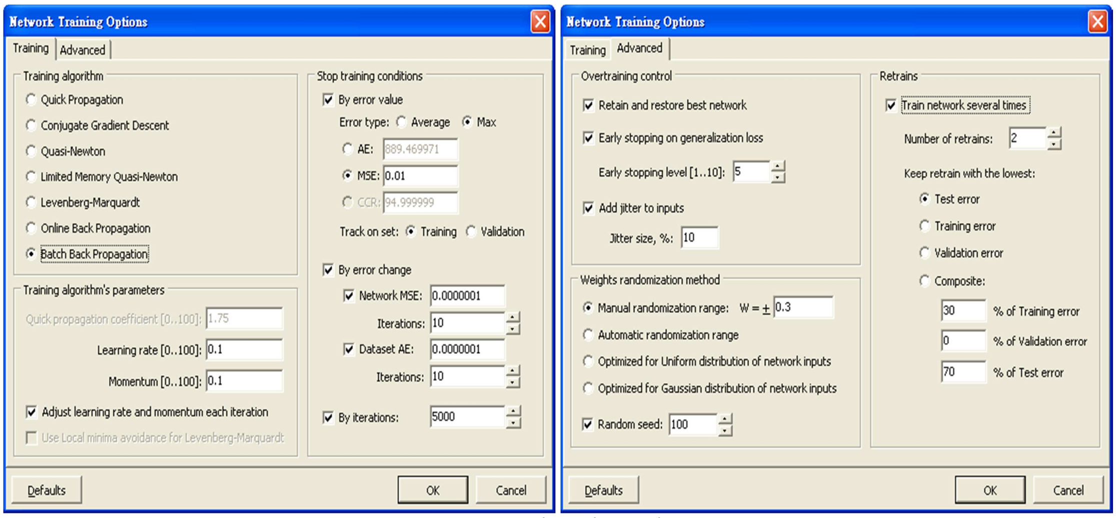

Figure 3: Training algorithm and parameters

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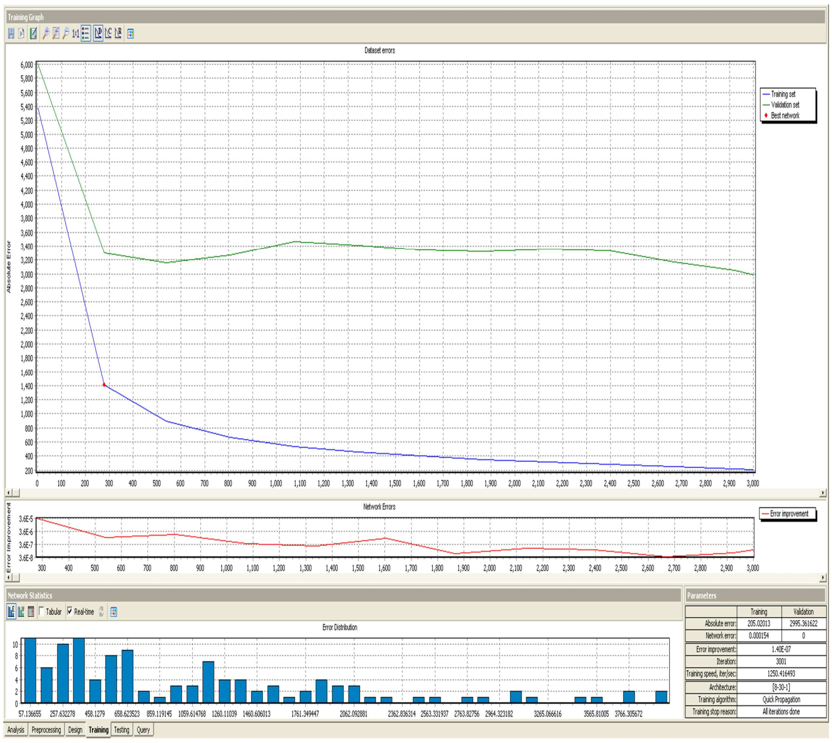

Figure 4: Forecasting model training and validation results

Table 4: Model training, validation and test results

Data type / Assessment criteria	Training data	Validation data	Testing data
MARE	0.117981	0.151296	0.123255
Correlation Coefficient	0.955137	0.834881	0.940814

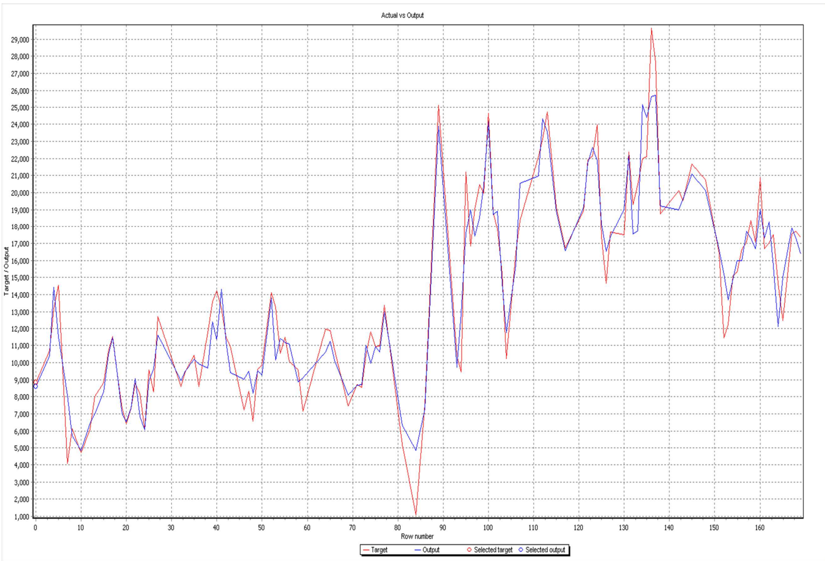

Figure 5: Comparison of the predicted value and the actual value trends

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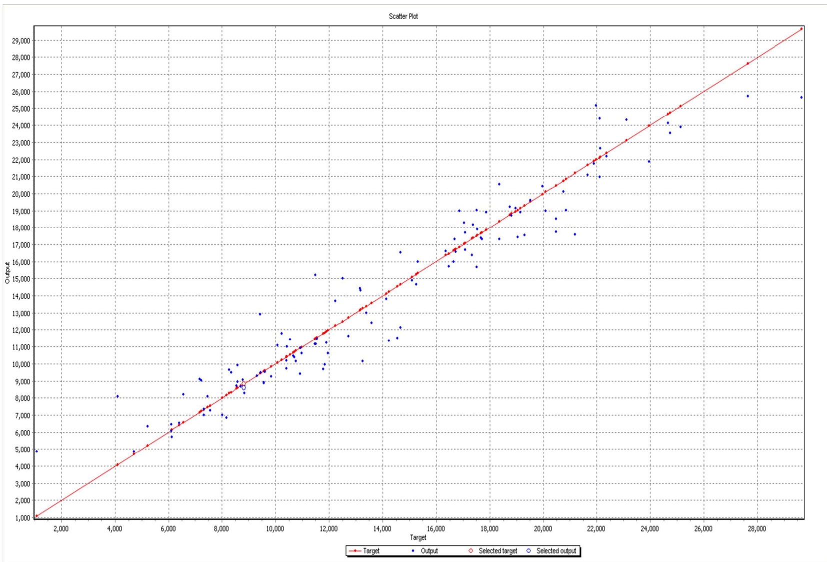

Figure 6: Scatter Plot Of Predicted Value And Actual Value

5. CONCLUSIONS

Through BPNN, this study uses various factors influencing accommodation demand as the input variables for forecasting the accommodation demand, finding that MARE is 0.1232 and its correlation coefficient is 0.9408. Hence, the ability of the forecasting model is excellent and can serve as reference for the industry and related industries. Although the predicted values and the actual values in some months were considerably different, forecasting is accurate as a whole. The predicted value can move along the actual value fluctuation trends, and effectively forecast the turning point of the number of accommodations. Overall, the forecasting model can help the industry to learn about the trends of changes in the accommodation demands of tourists for labor force adjustments, marketing strategy planning, financial management, and development of operating strategy in order to reduce unnecessary costs and effectively make use of various resources.

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