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Model for Rate Prediction of Commercial Properties in PMC

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Abstract: ***Considering the extent of money involved in real estate, there is a need of accurate prediction of value of a property which can be achieved through application of some artificial intelligence technique. This study mainly focuses on case study of Pune city in India and tries to predict value of commercial properties in the study area. The prime aim of the present investigation is to study the ascertaining value of property using neural networks. The results show 99% correlation coefficient for selected combination of cases with a high percentage rate of prediction. This study would help the prospective buyer to make the best buying decision so as to gain maximum returns in future.***

Keywords: Artificial Intelligence, Commercial property, Factors, Neural Networks, Valuation

1. Introduction

Housing being one of the basic needs of human,. Real property has always observed high demand in developing cities. Property prices have been major criteria for buyers in purchase decision [1]. Several studies have indicated that property price usually comprises of physical and economical characteristics, location, environment and branding etc. [2]. Traditionally, methods like sales comparison method, rental method, land and building method, profit method have been used to predict the property value. Market evidences from real estate transactions show that the analysis of property data over time has always faced difficulties [3]. An accurate prediction of real property price is important to prospective owners, developers, investors, appraisers, tax assessors and other real estate market stakeholders. It is thus required to prepare a prediction model which would take into consideration the effect of various changing factors on commercial property value. Various researchers have implemented techniques such as multiple regression analysis (MRA), hedonic model, ANN, expert system, case based [4] and rule based reasoning [5], fuzzy logic, genetic algorithm for house price prediction. This study makes an attempt to understand the various price models developed and also summarizes the work carried out regarding value prediction of properties [1].

Commercial properties include office buildings, industrial property, medical centres, hotels, malls, retail stores, farm land, multifamily housing buildings, and garages. Commercial Real Estate (CRE) is simply defined as any property owned to produce income. From investment point of view, commercial real estate encompasses any kind of property, including land, which brings or has the potential to bring income. From a business point of view, commercial real estate is any offering of office, retail, industrial, medical, hospitality and other commercial space that can be leased go the use of the business. This study mainly focuses on commercial property value prediction.

2. Factor Identification

There are so many factors which are going to be critical for valuation of commercial property. A few of these factors are location, weather, accessibility, future growth, availability of water, ambience, R sector, connectivity with main central location of the city, security, environment, buyer's comfort, budget, economic weather etc. [2]. Factors to be considered for the present study are locality, area of property (in Sq. Ft), distance from city Centre, nearness to IT/ MIDC, location, parking availability which are explained as follows:

2.1 Location

A commercial area is always considered for profit business, such as office complexes, shopping malls, service stations and restaurants. The zones which separate commercial area and residential area are clearly marked. For any commercial property, business prospect is an important criteria and hence location of the property plays a vital role as it generates income for the property owner. follows:

2.2 Availability of local transport

New transport infrastructure may increase commercial property values due to improved accessibility and agglomeration benefits. Classic urban location theory states that lower transport costs will result in higher land property values. The impact of transport on property values depends on four factors, the availability of transport, the costs, transport time and convenience of transport modes.

2.3 Distance from city center

Distance from city center that is distance from main railway station is a prime factor for urban area. Due to shift in the global economy, as well as recent technological and economic development, city centers have begun to act as central business districts (CBDs) by offering a wealth of business, retail, leisure, finance, accommodation, education, culture, recreation and health facilities. Commercial property

values at CBD are homogeneous and the property values of each lot differ at the street level and go on decreasing as the distance from CBD increases.

2.4 Locality

Here we consider locality of any property means the standard of living of the surrounded area. It is a crucial factor because sometimes your locality decides the type of business. Like in Pune Peth area is the one of the oldest area so obviously huge business hub is formed. Basically this area is famous for textile market and large shopping centers are situated over here. It is a middle class and developing area with all primary businesses situated there. On the other hand, bhandarkar road, prabhat road, bhamburda, shivaji nagar are high profile areas, hence mainly famous for residential area and not for commercial use.

2.5 Nearness to IT Park or MIDC

Pune is emerging as a prominent location for IT and manufacturing Pune has the eighth largest metropolitan economy and the sixth highest per capita income in the country. Automotive companies such as Tata Motors, Mahendra and Mahendra, Mercedes Benz, Force Motors, Kinetic Motors, Land Rover, Jaguar and Fiat have set up green field facilities near Pune, leading the independent to city Pune as India's "Motor City". The Hinjewadi IT park is a project being started by MIDC to house IT sector in Pune. With increasing population and demand, commercialization is a must and has affected the value of commercial properties near these IT hubs and automobile hubs in and around Pune city [6].

3. Use of Neural Networks

NN is a simplified model of the biological nervous system and therefore has drawn its motivation from the kind of computing performed by a human brain and is defined as a data processing system consisting of a large number of highly interconnected processing elements/artificial neurons in architecture to mimic structure of the brain (Rajasekaran et al., 2003). NN learns by examples therefore can be trained with known examples of a problem 'to acquire' knowledge about it. Once appropriately trained, the network can be put to effective use in solving unknown or untrained instances of the problem. Determining an appropriate architecture of a neural network for a particular problem is an important issue, since the network topology directly affects its computational complexity and its generalization capability [7].

3.1 Use of NN in general applications

Applicability of NN has been experimented in various areas of civil engineering by number of experts. [11] Proposed NN model for predicting the failure loads of laterally loaded masonry wall panels based on their corresponding cracking patterns derived from laboratory experiments. [12] Studied the prediction capability of NN for pile capacity, settlement of foundation, soil properties and behaviour, liquefaction, slope stability etc. Application of NN in tide level forecasting, problems such as earthquake induced liquefaction and wave induced seabed instability was studied [13]. [14] Proposed the use of NN in early cost estimation of road tunnel construction work. [15] Implemented NN to predict groundwater levels of shallow aquifers and found NN to be a viable option as compared with traditional methods. [16] Developed NN model to predict the ferrite fraction of microalloyed steels during continuous cooling and observed NN to give fairly accurate results [7].

3.2 Use of NN in property valuation

Tay D. and Ho D. [8] used the back propagation ANN model in reckoning sale prices of apartments and compared it with the traditional MRA model for residential apartment properties in Singapore. The study revealed an absolute error of 3.9% for ANN model and 7.5% for the MRA model. Do A. and Grudnitski G.[9] also used both these techniques to predict residential housing value wherein the ANN model was more accurate than the MRA model. Evans A., et al [10] tested neural networks for accuracy in valuation for estimating residential property prices in England and Wales. The study investigated the effects on the average prediction error when outliers in the data set were removed and obtained an average absolute error ranging from 5% to 7% for neural network models. Based on above literature observations, neural networks have been finalized for present study to predict value of commercial property in Pune city.

4. Methodology adopted or work

A methodology is a model, which project manager employ for the design, planning, implementation and achievement of their project objectives. In this chapter we will try to discuss the methodology which is specially used for this project. Methodology chart is follow as below.

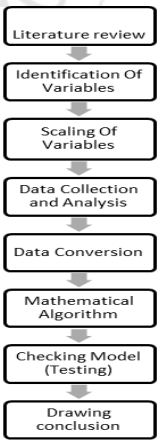

Figure 1: Methodology of Study

4.1 Sacking of variables

In this research, all variables are scaled by using the 5 point scale since many studies have indicated that 5- point scale was able to efficiently capture the meaning of the subjective judgments. Specification of scaling is as follows

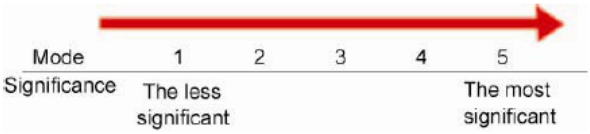

Figure 2: Scaling of variables

4.2 Data Collection and analysis

Data has been collected from doing personal technical visits for total 150 commercial property cases in Pune in which shops, offices and show rooms are included [5]. For each case we have found latest rate, project location, locality, distance from city Centre, nearness to IT park terms of distance etc. For convenience, we make 6 sectors namely central city as sector 1, southern area as sector 2, south western as sector 3, north western as sector 4, north eastern as sector 5 and lastly eastern as sector 6 [6] and the collected data has been converted in to the selected scale format.

4.3 Processing using Neuro- Solutions

Neuro-solutions is a highly graphical neural network development tool for windows. Neuro-solutions for excel simplifies and enhances the process of getting data into and out of a neural network. Processing basically involves four functions namely training, Cross Validation (CV), testing and production [7]. Training the network is a process where training cases are presented to the network, one by one (Arditi et al., 1998). Being a supervised learning process, case inputs and its corresponding outputs are studied and analysed by the network to learn the pattern of resolution. To check network's overtraining, some cases out of training cases are given for cross validation. When Mean Square Error (MSE) for CV increases, the network automatically stops training. Effectiveness of the training process can be assessed by testing the cases for desired output and software generated output. If there is a large discrepancy in these two outputs, the contributing parameters to the network can be varied in the successive runs to minimize this difference and arrive at optimum solution [7].

Total 150 cases are identified initially as data. These are applied to the network for finalizing the parameters such as learning rule, activation function, number of epochs, number of hidden layers, number of processing elements in hidden layers, number of runs, type of network etc. A three layer NN is chosen for the present study, which comprises of input layer with 8 neurons, hidden layer with 4 number of processing elements and the output layer with one node [7]

5. Model Development

Observations and results from parameter selection process are applied in the model development. Model development consists of checking the rate of prediction of the software for provided set of data by experimenting with number of combinations. One hundred and fifty cases are given for network development in various combinations of training, testing and Cross Validation (CV) sets.

Below table 1 shows combinations which are tested during model development. For combination 1 we put a total 10 CV cases. Similarly we have put values for CV as 13, 15, 17 and 20 for combinations 2, 3, 4, 5 respectively. Similarly testing cases for each combination vary from 30, 25, 20, 15, 10 and 4 respectively. Software takes training value automatically which is directly dependent upon number of CV and testing cases.

Table 1: Case Combinations

Sr. No	*Combination*	*Training*	*CV*	*Testing*	*r Value*
1	1 a	60	10	30	0.4930
2	1 b	65	10	25	0.4475
3	1 c	70	10	20	0.5972
4	1 d	75	10	15	0.6887
5	1 e	80	10	10	0.8721
6	1 f	86	10	4	0.9817
7	2 a	57	13	30	0.5113
8	2 b	62	13	25	0.5517
9	2 c	67	13	20	0.5769
10	2 d	72	13	15	0.6471
11	2 e	77	13	10	0.8673
12	2 f	83	13	4	0.9908
13	3 a	55	15	30	0.5319
14	3 b	60	15	25	0.5635
15	3 c	65	15	20	0.5793
16	3 d	70	15	15	0.5999
17	3 e	75	15	10	0.8673
18	3 f	81	15	4	0.9908
19	4 a	53	17	30	0.5225
20	4 b	58	17	25	0.5761
21	4 c	63	17	81	0.5823
22	4 d	68	17	53	0.6131
23	4 e	73	17	10	0.8113
24	4 f	79	17	4	0.9908
25	5 a	50	20	30	0.4342
26	5 b	55	20	25	0.5836
27	5 c	60	20	20	0.5925
28	5 d	65	20	15	0.6166
29	5 e	70	20	10	0.8111
30	5 f	76	20	4	0.9908

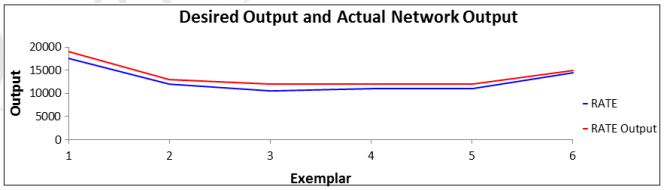

Figure 3: Comparison of desired and actual network outputs

Figure 3 shows graph plotted for desired and actual network output generated by testing of the cases. It shows the relation between actual value which we provide and predicted output generated by the network combination. It is observed that all the six cases have nearly same values of actual and desired outputs.

Table 2: Performance parameter for selected network

Performance	*RATE*
RMSE	1136.25117
NRMSE	0.039181075
MAE	1083.135933
NMAE	0.037349515

Min Abs Error	500.0049664
Max Abs Error	1500.011893
R	0.990895588
Score	96.66483336

Table 3: Training and CV MSE values

Minimum Training MSE	*Minimum Cross Validation MSE*
0.00114324	0.00619393

Table 2 and table 3 gives the performances statistics for the 30th case i.e. 5f with 0.990895588 R value as seen in table 1.

6. Observations

From the outputs obtained from Neuro-solutions software, it is observed that:

Total 30 different training runs were performed in neuro solutions with varying combinations of cases.

Combination 5f is observed to give the best results. Out of the hundred and fifty cases, 76 cases are given for training, 20 for cross validation and 4 for testing. This combination gives optimum results in terms of rate of production and correlation coefficient. Compared with other combinations, Table 2 shows that the correlation coefficient for combination 5f is 0.990895588 which is the highest as compared with all the cases and combinations. Table 2 also gives values of Root Mean Square Error (RMSE) which is acceptable. Table 3 shows values of training Mean Square Error (MSE) and CV MSE which is well below zero and hence acceptable.

7. Conclusion

1) The results of various networks developed are studied and compared which throw light on various aspects and pattern the network executes.
2) Transfer function chosen is Tanh and learning rule levenberg marquardt is observed to be best suited for this case study.
3) Training is terminated at CV MSE and number of epochs is considered as 1000.
4) Out of the various combinations, combination number 5f gives optimum results.
5) The sequence of cases when kept as testing, cross validation and then training, the network gives higher prediction rate and hence it is identified as optimum sequence.
6) Maximum rate of prediction is 97% for 5f combination.
7) Neural networks is an effective tool for any prediction problem and hence should be explored more to figure out its applicability in various fields.

This model can be used to effectively predict value of commercial property in Pune. Further research can be carried out on similar lines to prepare a model for a specific geological area or with the effect of different variables or with different type of property.

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