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Evaluation of the Trend of Land Price using Regression and Neural Network Models

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ABSTRACT

This paper focuses on the modeling and forecasting of land price in Chennai Metropolitan Area, Tamilnadu, India using multiple regression and neural network techniques. Thirteen locations spread over Chennai Metropolitan Area are selected at random as study areas. The monthly average values of the selected factors from the year 1997-2011 are considered to develop the models. Both multiple regression and neural network models are validated with the market price in the year 2012 and 2013. After validation the models are used to forecast the land price in Chennai Metropolitan Area for the years 2014 and 2015. Both the models are found to be well fit for the modeling of land price, however the model using neural network shows better accuracy. A careful examination of the results of forecasting bring to lime light the surge in growth of land prices in the southern and western parts of Chennai Metropolitan Area.

Key words: Economical factors, modeling of land price, performance evaluation, validation, forecast

INTRODUCTION

The study on land price trend is felt important to support the decisions in urban planning. (Thomas, 2000). The real estate system is an unstable stochastic process. Investors' decisions are based on the market trends to reap maximum returns. Developers are interested to know the future trends for their decision making. To accurately estimate property prices and future trends, large amount of data that influences land price is required for analysis, modeling and forecasting (Brown and Reed, 2012). The various factors that affect the land price have to be studied and their impact on price has also to be modeled. A simple analysis of the past data revealed that the prices show a non- linear characteristic (BenDor *et al.*, 2014). It was inferred that establishing a simple linear mathematical relationship for these kinds of time-series data was found not viable for forecasting. Hence it became imperative to establish a non-linear model which can well fit the data characteristic to analyze and forecast future trends. As the real estate sector is fast developing in Chennai Metropolitan Area (CMA), the analysis and forecast of land prices using mathematical modeling and other scientific techniques is an immediate urgent need for decision making by all those concerned.

The present extent of CMA is 1189 sq. km. Apart from the Chennai Corporation, the CMA comprises of 16 municipalities, 20 town panchayats and 204 villages that forms part of

10 Panchayat Unions in the adjoining Thiruvallur and Kancheepuram districts (CMDA., 1976). The Chennai City is the core of CMA and is the nerve centre for all commercial and social activities as well as living area for majority of the population. Chennai has immense potential to become the cynosure of economic and cultural development. The document "VISION 2026" stipulates guidelines to make Chennai as a prime metropolis which will be inhabitable, economically vibrant and environmentally sustainable.

Recent past has witnessed a substantial growth in population in both Chennai City and Chennai Metropolitan Areas. Statistics reveal that the population in the year 2009 was 55 lakhs in the City and 70 lakhs in CMA. It has been found that the contribution of CMA to state Gross Domestic Product (GDP) is around 40%. Chennai alone accounts for 30% of National Auto Industry, 50% of leather exports and 15% of software exports (Sampathkumar and Santhi, 2010). The increase in population as well as the industrial activity is attributed to various factors, the most prominent being the recent spurt in the knowledge sector viz. Information Technology (IT) and Information technology enabled services. Demand for land started of showing an upward trend and housing and the real estate activity started booming. All barren lands and paddy fields ceased their existence to pave way for multistoried and high rise buildings. Investments started pouring in real estate industry and there was no uniform pattern in the land price over the years. The need for predicting the trend in land prices was felt by all in the industry viz. the Government, the regulating bodies, lending institutions, the developers and the investors. The main objective of this study is to determine the distribution of land prices in CMA, to find the interaction effect of influencing factors on land price and to model the land price by multiple regression and Neural Network (NN) techniques and validate them with the current market values and to forecast the land price for the next two years.

Over the last two decades there have been a large number of empirical studies analyzing land prices. Mundy and Kilpatrick (2000) showed the usefulness of time-series regression model which used economic data to provide more accurate forecast of Central Business District (CBD) land price in moving market. Location, corner or non-corner, zonal character, employment and vacancy were identified as influencing factors which explain 83% of real time trend. Wilson *et al.* (2002) studied the residential property market accounts for a substantial proportion of United Kingdom economic activity. Professional valuers estimate property values based on current bid prices (open market values). However, there was no reliable forecasting service for residential values with current bid prices being taken as the best indicator of future price movement. This approach had failed to predict the periodic market crises or to produce estimates of long-term sustainable value. In this paper, the national housing transaction data was trained using Artificial Neural Networks (ANN) which forecasts future trend of the housing market was presented. Birch and Sunderman (2003) developed a regression model with improved and vacant land sales incorporated into the single data set. Individual land values were found by estimating and removing the predicted values for improvements. For the case illustrated, the model explained up to 93% of the market values and final results were largely adopted. Wang and Tian (2005) used the wavelet NN to analyze and forecast the real estate price index. This kind of wavelet NN integrated the merit of the wavelet analysis and the tradition NN. It had the time-frequency localization analysis and the capability of self-learning of the data, thus it had displayed the superior adaptiveness in processing the nonlinear data fitting and the forecast aspect. They also compared the forecasting result with smoothing method and the NN forecast and explained that the wavelet NN convergence rate was quick.

Hu (2006) forecasted the real estate price index by using the Back Propagation (BP) NN. The BPN used the Sigmoid function. It added the overall characteristics. Each node had the influence of the export value in very wide range of the input value and excitation function mutual influence in very wide range of input value. Therefore, the BPN training consumes more time. Haoting (2007) used the Auto Regressive Integrated Moving Average (ARIMA) model and carried the demonstrative analysis on the quarter year data from the first quarter's real estate price index of 1998 to the third quarter of 2006. He used the established model to make the forecast to the real estate price index of the fourth quarter of 2006 and the first quarter of 2007 and gave the precision magnitude of error which had received the good effect. Dowall and Monkkonen (2008) documented Chennai's spatial development with detailed data on land use, population density and land values. A hedonic regression on the price of land suggested that de facto policy differences between political jurisdictions have had a significant effect on land prices. However, the data presented in this paper suggested that land policy reforms in Chennai have been successful in reducing some of the sprawling urban development patterns evident in the 1970's and 1980's. Nevertheless, policymakers in Chennai continue to face the double challenge of an extremely dense urban core combined with extensive urban. Peterson and Flanagan (2009) used a large sample of 46,467 residential properties spanning 1999-2005 and demonstrated that using matched pairs that relative to linear hedonic pricing models, ANN generate significantly lower dollar pricing errors have greater pricing precision out-of-sample and extrapolate better from more volatile pricing environments. While a single layer ANN was functionally equivalent to ordinary least square, multiple layered ANNs were capable of modeling complex nonlinearities. Moreover, parameter estimation in ANN does not depend on the rank of the regression matrix, ANN is better suited to hedonic models that typically utilize large numbers of dummy variables. Sampathkumar and Santhi (2010) studied the land price trend of Sowcarpet which is the central part of Chennai city. They developed statistical model using economic factors and predicted that the annual rise in land price would be of 17%.

Urmila (2010) reported that the past trends are analyzed to ascertain the rate of growth or decline, as the case may be and these trends are then used as a first attempt of forecasting. Statistical forecasting techniques might also be used but care should be taken to see that before curve fitting, the historical data were also plotted to detect relationship giving the best fit. The trend extrapolation used for long term forecasting can be extremely misleading. Therefore, after acquiring a general idea of growth trends, economic parameters might be introduced to formulate more realistic relationship. A study by Sampark Public Relations Pvt Ltd. (2011) in their article revealed that the property price trends for the Chennai region had seen an escalation in 2011 over 2010. Chennai market was relatively strong and stable in nature as indicated by the year on year healthy price increase. There was adequate supply and demand in this market and the increase is of 15% annually. Chennai North shows that the property prices of Ambattur witnessed at 7% increase, Porur in Chennai West witnessed price appreciation by 17%. Chennai South had witnessed price appreciation. Thiyagaraya Nagar, Valasaravakkam, Pallikaranai and Medavakkam saw prices appreciate within the range of 20 and 23%. Madipakkam and Urapakkam saw prices move up by 6 and 3%, respectively in the past one year.

ICICI Property Services (2012) reported that the micro markets closer to the city would continue to show homebuyer interest. The micro markets of Oragadam and Sriperumbudur were witnessing

key infrastructural developments which would help to improve connectivity to the city and aid in the development of these micro markets as self-sustaining hubs. In the current scenario, the products in this segment were expected to witness a moderation in pricing of 5-10% over a 12 month horizon. The suburban markets along west of Porur, Poonamallee High Road and the southern micro markets of Pallavaram, Chrompet and Tambaram were witnessing infusion of fresh supply. The surrounding catchments, proximity to the CBD and industrial corridors were expected to help these micro markets witness a moderate appreciation of 5-10% over a 12 month horizon. The CBD and surrounding catchments would continue to show buyer interest. With the Reserve Bank of India increasing the interest rates, continuously during CY 2011, taking the repo rates to 8.5%, the purchasing power of homebuyers as well as their loan eligibility has decreased, impacting market sentiment. The products in this segment along the micro markets of Old Mahabalipuram Road (OMR), Grant Southern Trunk road (GST), Oragadam and Sriperumbudur were witnessing a moderation in pricing to the tune of 5-10% over a 12 month horizon. The projects located in the CBD and surrounding areas are expected to sustain absorption levels due to their location dynamics, inherent demand and limited upcoming supply in these micro markets. The demand for real estate in North Chennai is predominantly driven by the business community and public sector employees residing in the region. Ayanavaram, a region dotted with locomotive workshops had seen real estate prices firming up during the last 12 months. It was expected that the micro market to remain stable in the coming quarters. The micro markets of Vyasarpadi, Tondiarpet, Madhavaram, Manali, Tiruvottiyur had smaller builder projects with basic amenities catering to the surrounding catchments.

ICICI Property Services (2013) showed that over the long term, it is expected that the residential real estate prices in Chennai to increase at 7-10% every year as the city emerges into a major IT, automobile and electronic manufacturing hub. GST Road, Sriperumpudur and Porur have witnessed significant increase in terms of inquiries and conversions over the previous year, whereas Oragadam and OMR has witnessed stagnation on these fronts. Chennai residential real estate market was witnessing demand from the Non Residing Indian investors. The residential real estate market of Chennai had witnessed significant improvement in terms of buyer interest which had translated into higher transactions over the last one year. GST Road, Sriperumpudur and Porur have witnessed significant increase in terms of inquiries and conversions over the previous year, whereas Oragadam and OMR had witnessed a slowdown in absorption. They discussed the price index trend of many locations in Chennai between 2008 and 2012 which involves Perambur, Tondiarpet, Adyar, Thyagaraya Nagar, Annanagar and Alwarpet within the city limit, along OMR, Tambaram, Pallikaranai and Medavakkam in southern part and Ambattur, Avadi and Sriperumbudur in the west of Chennai. Almost in all the locations a small drag is observed in the year 2009. The previous studies reveal that very few studies have been made in modeling and forecasting of the land price using economic attributes as influencing factors. The present study aims to bring out the significance of economic and social attributes pertaining to the modeling and forecasting of land price in CMA.

A list of such attributes which influence the land are shown in Table 1 and the price of land is treated as dependent variable. From the study area the market price is collected at thirteen locations spread over CMA. The selected areas lie in six zones of CMA, namely Central, North, North West, South East, South West and West. The zone-wise distribution sample locations in CMA are presented in Table 2 and the locations are shown in Fig. 1.

Table 1: List of Independent variables

Variables	Abbreviation
Gross domestic product (%)	GDP
Cost of crude oil ($)	Croil
Dollar equivalence to Indian currency (≤)	Doll
Rate of inflation (%)	Infla
Gold and silver price per gram (≤)	Gold, Sil
Mumbai and national share index	BSE, NSE
Population in the study area	Pop
Interest rate on home loan (%)	HL
Unit cost of construction per Square foot (≤)	CC
Guideline value per ground (≤)	GLV
Time factor (Year and Month)	Time

Table 2: Study areas

Zones	Name of the locations
Central	Sowcarpet, Chindadripet
North	Thiruvottiur, Tondiarpet
North west	Madavaram
South east	Thiruvanmiyur, Neelankarai, Sholinganallur
South west	T. Nagar, Tambaram
West	Avadi, K.K.Nagar, Ambattur

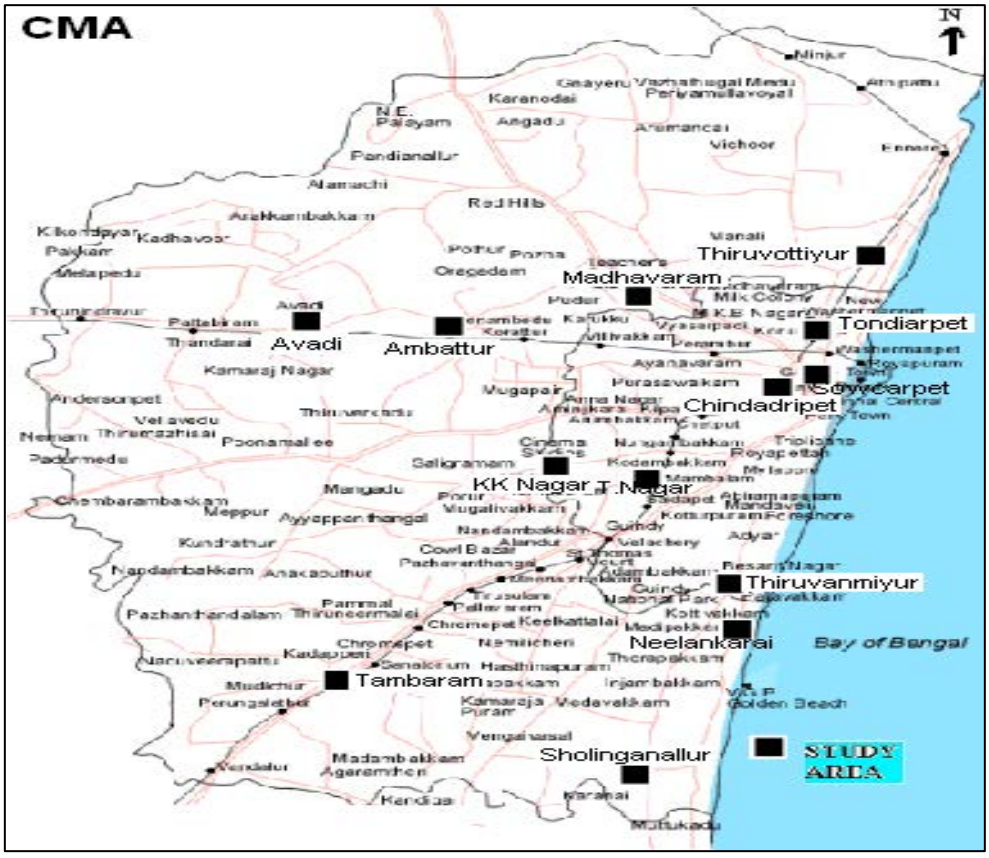

Fig. 1: Location of study areas in CMA

MATERIALS AND METHODS

Analysis and modeling

Data collection: Property data is available from a variety of private and public sources. The study involves both primary and secondary data. Primary data has been collected through interviews and personal visits to the various companies to know the present situation of the market and the secondary data is collected mainly through various newspapers, magazines, Internet and Reserve Bank of India review. The data between January 1997 and December 2013 are used in the analysis. The data is useful for assessing the performance of property as a key to future investment.

Multiple regression technique: Regression analysis is widely used for prediction and forecasting. Regression analysis is also used to understand which among the independent variables are related to the dependent variable and to explore the forms of these relationships. If more independent variables are added, it is able to determine an estimating equation that describes the relationship with greater accuracy. Multiple regression looks at each individual independent variable and test whether it contributes significantly to the way the regression describes the data.

The general multiple regression equation is:

$$Y = a+b1x1+b2x2+....+b3x3 \quad (1)$$

where, Y = Estimated value corresponding to the dependent variable:

a	=	Y intercept
x1, x2... xn	=	Values of n independent variable
x1	=	Guideline value (GLV) in rupees (≤)
x2	=	Population
x3	=	Bombay Sensex (BSE) Index
x4	=	National Sensex (NSE) Index
x5	=	GDP (%)
x6	=	Inflation (%)
x7	=	Crude oil per barrel ($)
x8	=	Gold price per gram (≤)
x9	=	Silver price per gram (≤)
x10	=	Dollar equivalence (≤)
x11	=	Cost of construction per square foot (≤)
x12	=	Home loan interest (%)
x13	=	Time (Year and Month)
b1, b2... bn	=	Slopes associated with x1, x2... xn, respectively

Neural network technique: The NN is a computational technology from the artificial intelligence discipline whose architecture emulates the network of nerve cells in the human brain. A NN is a parallel distributed information-processing structure consisting of Processing Elements (PEs) which contains local memory. The NN architecture such as a standard BP NN can be developed by using the various indicators as PEs to be investigated upon. The approach presents the application of NN for modeling the land price trend with the support of economic and social factors. The NN model is

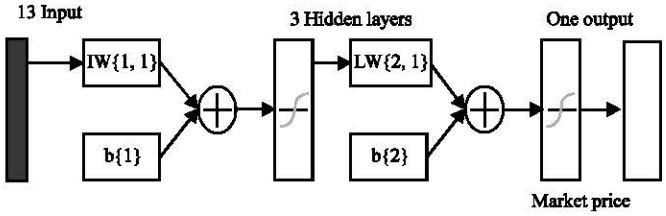

Fig. 2: Neural network architecture

constructed with 13 indicators that are PEs with one bias node as input. All the input values are normalized using the MinMax table. The principle behind normalization process is given in Eq. 2:

$$\text{Normalizedvalue N} = \frac{\text{Original value} - \text{Minimum value}}{\text{Maximum value} - \text{Minimum value}} \tag{2}$$

where, $0 \leq N \leq 1$

Initially 204 sets of exemplars are generated as monthly basis from the year 1997-2013 for thirteen parameters (GDP, cost of crude oil, dollar equivalence, rate of inflation, gold and silver price, Mumbai and National Share Index, population, interest rate on home loan, cost of construction, GLV and time) as input and unit land price as output parameter.

The NN architecture, used in this study is a multilayer feed forward network. Levenberg-Marquardt algorithm is used for training in multilayer NN. A five layered BPN has been developed with three hidden layers and one output layer. The architecture which provides the best fit for the data is the networks with three hidden layers and an output layer is shown in Fig. 2. The neurons in the hidden layers are 20, 13, 13, respectively and one neuron in the output layer. The learning and momentum parameters are 0.6 and 0.9, respectively and error convergence to fall below 0.01%. Tan sigmoid is the activation function chosen for hidden layers and pure linear is the function for output layer which are the real time values. The network is efficiently trained with 204 exemplars and the weights are properly updated. In order to implement the trained network for land price validation and forecasting the updated weights are copied from NN tool box as the weights of BPN. The weights are obtained in layers as input to first hidden layer, first to second hidden layer and second to third hidden layer and with bias values. The 24 exemplars are used to validate the network for the years 2012 and 2013 and 24 exemplars of 2014 and 2015 are used for forecasting the land price for which the trained network runs again.

RESULTS

Interaction of influencing factors: To measure the magnitude of linear relationship of land price (Y) on individual factor (X), correlation analysis is performed. Correlation analysis is a statistical tool which is used to determine the degree of which one variable is linearly related to another. The general form of correlation is given by Eq. 3:

$$\text{Correl}(x, y) = \frac{\sum (x - x')(y - y')}{\left[\sum (x - x')^2 \sum (y - y')^2\right]^{1/2}} \tag{3}$$

The interaction of all the selected factors on land price is analyzed and is shown in Table 3. Other than Inflation, Dollar equivalence and home loan interest all factors show good closeness.

Table 3: Interaction of the selected factors on land price

Locations	Thiruvottiyur	Tondiarpet	Madhavaram	Sowcarpet	Chindadripet	K.K Nagar	Ambattur	Avadi	T.Nagar	Tambaram	Thiruvanmiyur	Neelankarai	Shollinganallur
GLV	0.92	0.88	0.94	0.88	0.76	0.86	0.90	0.53	0.86	0.91	0.79	0.90	0.78
Pop	0.99	0.70	0.90	0.95	0.88	0.98	0.69	0.69	0.95	0.91	0.83	0.86	0.90
Time	0.88	0.96	0.90	0.96	0.89	0.99	0.94	0.94	0.95	0.88	0.85	0.88	0.85
BSE	0.86	0.89	0.87	0.90	0.94	0.84	0.90	0.90	0.86	0.87	0.92	0.87	0.93
NSE	0.86	0.92	0.88	0.93	0.97	0.87	0.92	0.92	0.89	0.87	0.93	0.89	0.95
GDP	0.39	0.60	0.44	0.64	0.62	0.59	0.56	0.56	0.53	0.41	0.45	-0.18	0.50
Infla	-0.21	-0.05	-0.21	0.03	0.02	-0.05	-0.09	-0.09	-0.04	-0.19	-0.13	0.44	-0.08
Croil	0.88	0.89	0.88	0.88	0.87	0.88	0.90	0.90	0.85	0.88	0.88	0.86	0.87
Gold	0.96	0.93	0.97	0.91	0.93	0.88	0.95	0.95	0.92	0.97	0.99	0.97	0.97
Sil	0.88	0.92	0.90	0.93	0.96	0.88	0.93	0.93	0.91	0.89	0.94	0.91	0.96
Doll	-0.10	-0.03	-0.16	-0.04	-0.16	0.07	-0.09	-0.09	0.08	-0.13	-0.19	-0.11	-0.20
CC	0.99	0.97	0.99	0.94	0.94	0.96	0.98	0.98	0.97	0.98	0.98	0.99	0.96
HL	-0.47	-0.64	-0.47	-0.67	-0.54	-0.69	-0.60	-0.59	-0.55	-0.47	-0.39	-0.45	-0.41

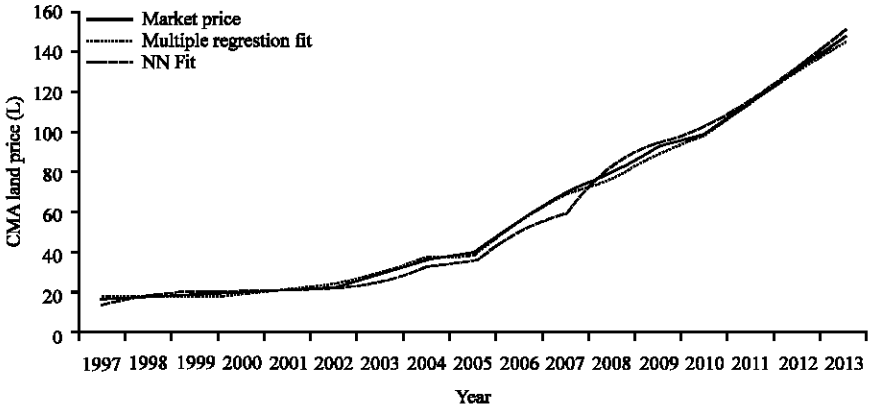

Fig. 3: Validation of land price at CMA

Multiple regression analysis is performed with 95% confidence level and 5% error significance and the analysis explains the trend very closely with a R^2 ranges between 0.97 and 0.99.

Behaviour of land price in CMA: The market price is collected from the year 1997-2011 and the models are derived using Multiple Regression and ANN. The models are validated for the years 2012 and 2013. The land price model for the entire CMA is developed using the details of data collected from all the thirteen study locations and is given in the Eq. 4:

$$\begin{aligned}\text{Land price per 5.5 cents of CMA} = {} & -1.24E9+1.737^{*}\,x1+3.954^{*}\\ & x2+495.572^{*}\,x3-937.873^{*}\,x4-46827.42^{*}\,x5-10085.013^{*}\\ & x6-66334.343^{*}\,x7+667.16^{*}\,x8+56462.602^{*}\,x9-129139.534^{*}\\ & x10-3848.863^{*}\,x11+2508025.019^{*}\,x13\end{aligned} \quad (4)$$

The land price performance using multiple regression and ANN models for the CMA is plotted in the Fig. 3. It can be seen that the behaviour of actual land price goes well along with the NN prediction than regression. Both the models over estimated the land price in CMA. This may be due to the accumulation of erroneous data in various locations of area under study and the limited number of locations considered in the investigation.

Performance evaluation of the model: Accuracy of model is examined using standard measures, such as Chi-square test (χ^2), Mean Absolute Percentage Error (MAPE) and Percentage Root Mean Squared Error (PRMSE). The consolidated results of model evaluation by Chi-Square Test, MAPE and PRMSE are tabulated in Table 4.

Null hypothesis is assumed in the chi-square test that there is no significant difference between the observed and expected price of land. The χ^2 values are obtained for all the thirteen locations under study. The table value of χ^2 is 21.03 with 5% level of significance. It can be seen that the χ^2 values are much lower than the table value, so the null hypothesis is accepted and proved that the models developed are significant.

MAPE is commonly used in quantitative forecasting methods because it produces a measure of relative overall fit. In general a MAPE of 10% is considered very well, a MAPE in the range 20-30% or even higher is quite common. In this investigation it is observed that the MAPE values

Table 4: Model evaluation

	Chi-Square test		MAPE		PRMSE	
Location	Regression	NN	Regression	NN	Regression	NN
Thiruvottiyur	0.50	0.22	6.78	0.00	7.03	0.05
Tondiarpet	0.10	0.09	1.80	0.72	4.46	0.84
Madhavaram	0.18	0.48	1.80	3.82	6.18	3.11
Sowcarpet	0.75	1.66	1.80	3.85	3.60	4.69
Chindadripet	1.89	0.79	9.60	0.80	8.44	0.03
K.K.Nagar	0.03	0.02	1.80	0.34	1.22	0.01
Ambattur	1.57	1.40	13.15	0.20	16.20	0.04
Avadi	0.61	0.43	1.80	1.00	7.38	1.03
T. Nagar	1.23	1.09	1.80	0.80	4.95	0.05
Tambaram	0.80	0.47	11.03	0.88	9.61	0.06
Thiruvanmiyur	1.72	1.36	8.91	0.87	11.69	0.12
Neelankarai	2.41	4.20	8.86	2.63	10.66	0.12
Sholinganallur	0.70	0.74	11.75	0.79	10.08	0.03

obtained from Regression is less than 15% and the same from ANN model is lesser than 5%. This observation reveals that both the models are found good for the prediction of land price in CMA. In PRMSE, both regression and NN models show errors less than 16% which demonstrates the significance of the modeling methods. The low PRMSE values (<5%) indicate the performance of NN in predicting the system.

Forecasting of land price in CMA: To forecast the future price of land, predicted values of factors are plugged in the model. Gold price, Silver price and Home loan interest are predicted by polynomial method and rest of the factors by least square method for the period of 2014 and 2015. The interest on home loan is expected to climb by 2015 and its growth is projected as 9% annual. Construction cost is believed to rise by 6%. The GDP is expected to increase by 3.2% and the inflation will remain at comfort level of 5%. A marginal annual rise of 0.6% on Dollar equivalence and 7% on crude oil price is expected. Based on the past trends, the consumption of precious metals, gold and silver show a remarkable increase in price of more than 20%. As far as increase in stock is concerned, the projected increase is 6.6 and 7% on BSE and NSE respectively to reflect a progressively healthy economy. An annual increase in population in study areas are assumed as per development authority's draft. These above assumptions on the factors are plugged in the regression and neural network model, trained and the hypothetical data is allowed to test. The average increase in land price for the next two years of 2014 and 2015 is forecasted for all the selected thirteen locations in CMA and the same is presented in Fig. 4.

The five factors such as GLV, silver price, population in study area, cost of crude oil and unit cost of construction itself has more than 80% influence on the unit land price which is the output. Independent and combined effect of factors such as home loan interest, inflation, GDP and cost of construction are tested as different scenarios on the regression models of all the areas. Home loan interest assumed at an acceptable level of 6-8%, inflation at a comfortable zone of 4-6%, GDP at a better range between 8 and 10% and cost of construction at a tolerable level of Rs 1000-1100 ft^2 area. The results show that a small Increment in home loan interest will drag the land price and rise in remaining three factors further lifts the land price. The study areas such as Tondiarpet, Chindadripet and Neelankarai show the above scenarios effect well. Combination of 8% home loan,

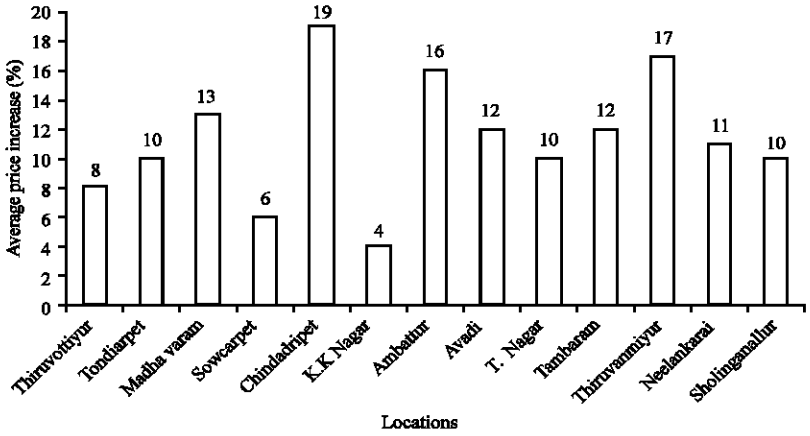

Fig. 4: Average increase of land price (2014-2015)

6% inflation and GDP of 10% will have good control on the land price and pulls down the price upto 4%. The reduction in cost of construction will pull down well the price of land and has one to one ratio in percentage (20% reduction in construction cost is expected to reduce the land price upto 20%). So the policy focus should be on bringing down the construction cost by having control on material cost, by usage of alternate affordable materials and advanced cost effective construction methodologies in a large scale will have enough control on land price rise in future.

DISCUSSION

The study focuses on the modeling and forecasting of land price at thirteen different locations in CMA with economic and social attributes as influencing factors. The modeling and forecasting of land price in the selected study areas is made using multiple regression and neural network techniques. The data between January 1997 and December 2011 are used in the models.

Based on the analysis, modeling and forecasting of land price the following conclusions are drawn:

- The study reveals that economic factors influence land price more than the social factors
- The interaction of the selected factors (X) on land price (Y) is analyzed. It is found that four factors viz. GLV (84%), silver price per gram (92%), population (86%) and cost of crude oil (88%) have more positive effect on land price in CMA
- Economic factors such as Inflation (5%), Dollar equivalence (9%) and home loan interest (53%) show negative correlation with land price in all thirteen locations
- The forecast envisages that central (Chindadripet 19%), South east (T.Nagar 10%, Tambaram 12%) and South West (Thiruvanmiyur 17%, Neelankarai 11% and Sholinganaluur 10%) zones of CMA are poised for growth in the forthcoming years. As a consequence, price rise will be more in these areas compared to other zones
- The land price model of Sowcarpet within CBD explains the price trend upto 90% which is closer than the time-series regression model developed by Mundy and Kilpatrick (2000). It explained about 83% of real trend. The annual price rise in Sowcarpet was found about 17% by Sampathkumar and Santhi (2010) but it will drag to 6% in 2014-2015 in current study due to saturation

- The study shows that the annual price rise of Ambattur and T. nagar in 2014 and 2015 will be about 5 and 7%, respectively and the same was 7 and 20% between 2010 and 2011 as per the study by Sampark Public Relations Pvt Ltd. (2011)
- The model forecasts the price rise of Sholinganallur upto 6% between 2013-2014 and it is matches with the prediction made by ICICI Property Services (2013)
- Even though both the models are found to be well fit with the data set of the land price in all locations, the model using NN (correl 98%) shows better accuracy than the regression model (correl 96%)
- The forecast predicts the average growth in the next two years will be an average of 11% in all the selected locations of CMA. The common CMA model explains the trend upto 88% which is lesser the regression model made by Birch and Sunderman (2003) which explained up to 93 % of the market values

The outcome of this study can be used in annual revision of guideline value of land which may add more revenue to the State Government while land transaction is made. This study will support the policy makers to relook the movement of the identified factors to have control on rise in the land price and stabilize it. Since there is a greater need for good long term data analysis about land price, general land market behavior and spatial development, the results produced in this research may be of great use for Government and non-Government agencies which involve in land administration.

REFERENCES

BenDor, T., D.A. Shoemaker, J.C. Thill, M.A. Dorning and R.K. Meentemeyer, 2014. A mixed-methods analysis of social-ecological feedbacks between urbanization and forest persistence. Ecol. Soc., Vol. 19. 10.5751/ES-06508-190303

Birch, J.W. and M.A. Sunderman, 2003. Estimating price paths for residential real estate. J. Real Estate Res., 25: 277-300.

Brown, G. and P. Reed, 2012. Values compatibility analysis: Using Public Participation Geographic Information Systems (PPGIS) for decision support in national forest management. Applied Spatial Anal. Policy, 5: 317-332.

CMDA., 1976. Master plan. Second Master Plan Report, Volumes 3, Chennai Metropolitan Development Authority (CMDA), Chennai, India. http://www.cmdachennai.gov.in/masterplan.html.

Dowall, D.E. and P. Monkkonen, 2008. Urban development and land markets in Chennai, India. Int. Real Estate Rev., 11: 142-165.

Haoting, O., 2007. Real estate price index based on ARMA model. Statistics and Decision, No. 7.

Hu, Z.M., 2006. [Research on forecasting real estate price index based on neural networks]. J. Graduates Sun Yat-Sen Univ. (Social Sci.), 27: 100-115, (In Chinese).

ICICI Property Services, 2012. Chennai residential real estate overview February 2012. http://www.icicihfc.com/property_pdfs/chennairealestateoverview-february2012.pdf.

ICICI Property Services, 2013. Chennai residential real estate overview April 2013. http://www.icicihfc.com/property_pdfs/Chennai-Real-Estate-2013.pdf.

Mundy, B. and J.A. Kilpatrick, 2000. Factors influencing CBD land prices. J. Real Estate, 25: 28-29.

Peterson, S. and A.B. Flanagan, 2009. Neural network hedonic pricing models in mass real estate appraisal. J. Real Estate Res., 31: 147-164.

Sampark Public Relations Pvt. Ltd., 2011. Property prices in the Chennai region moved up by 15% in Q1-11 over Q1-10. http://www.afaqs.com/news/company_briefs/?id=50577_Property+prices+in+the+Chennai+region+moved+up+by+15%+in+Q1-11+over+Q1-10.

Sampathkumar, V. and M.H. Santhi, 2010. Artificial neural network modeling of land price at sowcarpet in Chennai City. Int. J. Comput. Sci. Emerg. Technol., 1: 44-49.

Thomas, M.R., 2000. A GIS-based decision support system for brown field redevelopment. pp: 1-18. http://ippsr.msu.edu/publications/ARUrbanConcerns.pdf.

Urmila, S., 2010. Ports logistics and connectivity with inland container depot. Module No. 3, Institute of Rail Transport, Delhi, pp: 1-61.

Wang, J. and P. Tian, 2005. Real estate price indices forcast by using wavelet neural network. Comput. Simul., 22: 96-98.

Wilson, I.D., S.D. Paris, J.A. Ware and D.H. Jenkins, 2002. Residential property price time series forecasting with neural networks. Knowledge-Based Syst., 15: 335-341.