Artificial Neural Network Modeling of Land Price at Sowcarpet in Chennai City

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Abstract: In this paper Artificial Neural Network (ANN) models are employed to forecast the unit land price of Sowcarpet, which is located in the core city as well as a part of Central Business District (CBD) of Chennai. The monthly average value of the selected factors such as National Gross Domestic Product, cost of crude oil, dollar equivalence to Indian currency, rate of inflation, gold and silver price, Mumbai and National share index, population in the study area, interest rate on home loan, unit cost of construction, guideline value and time factor from the year 1997 to 2008 are considered in the study and the models are validated with the land price of 2009 and 2010. The models are used to forecast the land price for the next five years and found that there will be a uniform annual increase of 17 % in the selected location.

Keywords: Land Price, economic factors, neural network, land price model, future trend.

1. Introduction

Over the last two decades there have been a lot of research studies analysing land prices. Each study includes attributes of land price such as geographical location, the environment, size of plot, land use pattern, soil productivity, topography, drainage, population growth, economic development, infrastructure, agriculture, nearby developments, etc. [1]- [3]. Statistical models have been commonly used to estimate land prices [4] – [7]. Recently, artificial neural network models have been applied in real estate prediction [8]-[11]. The studies show reasonable accuracy for complex problems using ANN models.

From the literature review, the following significant factors that influence the land price trend are selected for the study: Gross Domestic Product (%), Cost of crude oil ($),Dollar equivalence to Indian currency (Rs), Rate of inflation (%), Gold and Silver price per gram (Rs),Mumbai and National share index,Population in the study area, Interest rate on home loan (%),Unit cost of construction per Square foot, Guideline value per ground (Rs) and Time

factor (Year and Month). This study focuses on artificial neural network to evaluate the influence of economic factors on land price and its future trend.

Land is an immovable, scarce resource, which helps to fulfill the basic need of a human. Owning a land and house is a prestigious issue in the society and because of potential it becomes an investment option now. Effective usage of land becomes an integral part of urban development. The urban-based economic activities account for more than 50 % of Gross Domestic Product (GDP) in all the countries. In India by 2011, urban area will contribute 65 % to GDP. The agricultural land was 84 % in the year 1980 and it will shrink to 35 % in 2020 due to rapid urbanization. Major urbanization pressure is to be addressed due to mass migration of people from small towns to urban centers. Presently 41 cities in India have more than one million population but before two decades, it was only 33 cities. In 2050, India needs to accommodate 900 million more people in cities, which requires 18500 square kilometers of land as per the conventional planning norms. According to World Development Indicator report, India's urban population will increase to 75 % in 2050 from 38 % in 2009. Due to limited availability of land and to utilize it optimally, the development trend slowly shifted in vertical direction rather than radial and horizontal. This compact vertical development will make positive environmental impact and leads better accessibility and efficient transport.

Economic base of Chennai city has shifted from trade and commerce to administration and services. Buoyant Economy, increased employment rate, high disposable income, cosmopolitan atmosphere and improved life style are instrumental in driving the demand for high-rise apartments. The demand on residential property is consistent, price are also climbing up due to hike in the input cost. There is huge demand on developed plots and the supply level is virtually shrunk leads to hike in land price. In a market dominated by the end users, demand to supply mismatch continues. Invest on land for a secure future becomes a reality in India. Investment made on land yields better returns than apartments and other traditional investment options, at the range of 100 to 300 % over past

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few years in South and West suburbs of Chennai. Generally, the land price depends on economical, social and physical features. Compared to previous years the market has stabilized. Projects along the Old Mahabaliburam Road (OMR) have seen most new sales. The market is seeing a positive momentum with job security which increased number of end users. Most housing finance companies have kept their home loan rates stable without much increase helps to stabilize the market. Reasonable interest rate, increased supply and affordable prices are some reasons to predict the market will continue to do well. The revival of Information Technology (IT) sector leading to creation of new jobs and increased liquidity is also expected to give the land and housing market in Chennai a positive momentum. The study on land price trend becomes important to have a better idea on future land price which helps in planning issues.

3. About Chennai Metropolitan Area (CMA) and the Study Area

3.1 CMA

Vision 2026 is to make Chennai as a prime Metropolis, which will be livable, economically vibrant and environmentally sustainable. Chennai is the 4th largest metropolitan city in India. The City is at the core of CMA and is the centre for all commercial and social activities as well as a living area for majority of population. It is the place of focus on economic and cultural development. Chennai is situated on the Coromandel Coast in South India and the land is plane, which is located with latitude between $12^{0}50^{'}49^{''}$ and $13^{0}17^{'}24^{''}$ and longitude between $79^{0}59^{'}53^{''}$ and $80^{0}20^{'}12^{''}$. CMA comprises Chennai City Corporation, 16 municipalities, 20 town panchayats, 204 villages forming part of 10 panchayat unions in Thiruvallur and Kancheepuram districts. It extends over 1189 square kilometer area.

Chennai city and CMA have 55 and 70 lakhs of population respectively in 2009. It has a firm base of large industries and commerce including insurance, shipping and banking. The city has dramatically changed over a period and mushrooming of commercial building is an out-come of the changing spatial dynamics. From 1994 to 2007, Chennai city's GDP grew at 6.5 % while the states GDP grew at 6 %. The contribution of CMA to state GDP is 40 %. Chennai accounts for 30 % of national auto industry, 15 % of software exports and 50 % of leather exports. Land price scouring in city area and the development along IT corridor in South and electronic hardware corridor on West has given a virtual boost to land owners to increase the price. The exorbitant land value, which in turn upped the apartment prices to a new high in the city areas and in suburban properties, has a thrust on infrastructure development.

In real estate slump, the suburbs first bear the burnt, followed by City area and finally the CBD. Similarly, during an upturn, property revival first happens in muffussal area and the CBDs are the last to improve. Second master plan released by Chennai Metropolitan Development Authority (CMDA) [12] envisages a series of pragmatic measure for optimum utilization of available land. Higher FSI at 2.0 and redefining special buildings will move the belated developments. A survey by ICICI property services reveals that 30.70 million sq.ft. of residential space involving more than 21000 units by category A, B and C developers will enter in to the market by the end of 2009. Tidel park, existing industrial estates in Guindy and Ambattur, upcoming Sipcots on the fringes and IT units in West and Southern regions, proposed international airport, rapid transport and metro trains, over bridges, elevated and circular ring roads are the additional power of Chennai realty sector and the land price rise.

3.2 Study Area

Sowcarpet is one of the important parts of George Town (GT), which is the CBD of Chennai city. This area is abounding with jewelry shops, electrical shops, hardware shops, transport booking offices, vegetable and fruit markets, etc. The mixed land use pattern, narrow and winding unplanned road network which carries huge volume of mixed traffic more than its capacity have resulted a gradual degradation in the environmental quality of the area. It is filled with resettled population from North India, doing commercial, retail and wholesale business. Sowcarpet has 0.62 square kilometer area with latitude of $13^{0}05'29.15''$N and longitude $80^{0}16'52.39''$E and an elevation of thirteen meter above mean sea level and its location in Chennai city is shown in Figure 1.

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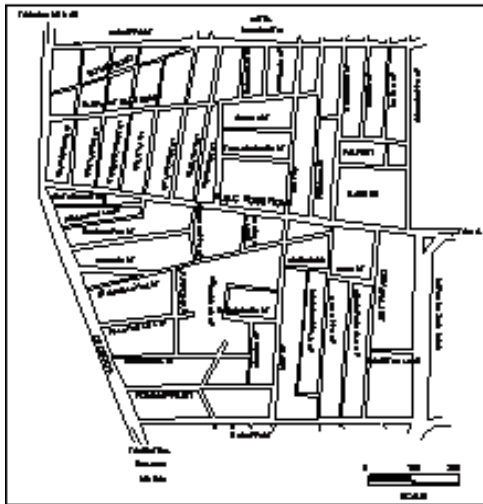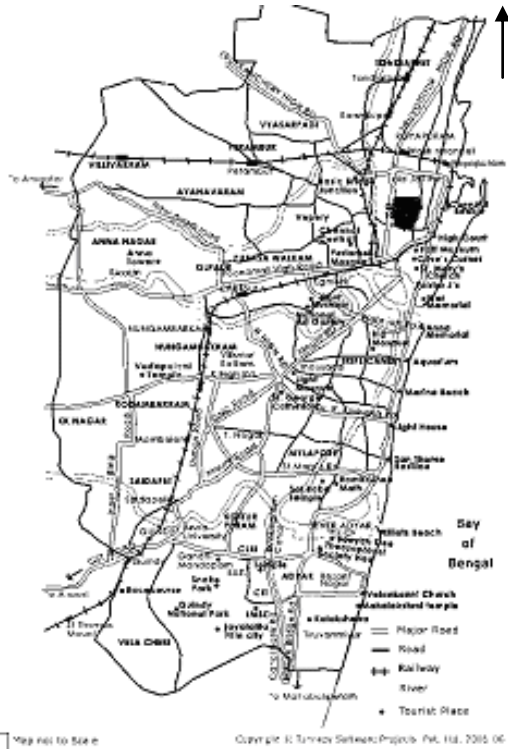*Volume 1, Issue 4, December 2010*

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Figure1.Location of Sowcarpet

The road network of Chennai is dominated by a radial pattern converging at GT. Arterial roads leading to CBD carrying heavy traffic due to concentration of commercial, industrial and huge volume of employment related activities in the CBD are highly congested. Capacity of all the roads in CBD is reduced due to poor quality of riding surface and inadequate footpath facilities and unplanned intersections. Sowcarpet has 52 roads with total length of 14.6 kiolmeter and road to area ratio of just 0.14 which very much lesser than the urban planning guidelines. Even though the scope of widening of existing roads is negligible, many roads are converted into commercial zones. GT and Harbour becomes the commercial centre of the city. GT and its extension in South into Annasalai had the

wholesale trade, specialized retail trade and banking and financial institutions and commercial activity was intense. More than two lakhs jobs constituting 48 % of the total work places in the CMA in 1971 were located here. General Hospital and Government Stanly Medical Hospital serves the CMA, is located next to sowcarpet. The growth rate of population in Chennai city and GT was in descending trend in the past two decade from 28 to 16 % and from 12 to 7.4 % respectively. The growth of area and population is shown in Table 1.

Table 1. Population and its Growth in Chennai City (CC) and George Town (GT)

Year	Area (Sq. Km)		Population (Lakhs)	
	CC	GT	CC	GT
1961	128.83	5.34	17.5	2.67
1971	128.83	5.34	25.7	2.80
1981	170.0	5.34	32.75	3.13
1991	170.0	5.34	37.95	3.39
2001	172.0	5.34	44.0	3.64

Due to the influence of economic slowdown the annual number of land transactions registered in the registration office of Sowcarpet starts declined upto 80 % compared to the year 2007 after a sustained growth of past two decades. The results of questionnaire survey from the respondents of Sowcarpet yields the following information that it is located very close to Central railway station. Location of school, multi specialty hospital, vegetable markets and major bus terminus nearby High court are accessible from just 0.5 to 2 kilometer. Urban services like water supply, sewer drain, stome water drain and cleaning of garbage are satisfactory but the level of noise pollution is considerably high. Immigrated settlements from North India and from Andhra Pradesh, plenty of business and commercial activities like jewellery, cloth garments, hardware and electrical shops, are felt as the major factors of price rise of land and rental value of residence in Sowcarpet. Presently a two bedroom flat rents in five-digits and many house owners want to lease the house for huge sum of money.

The real estate growth in the city was dominated by the CBD and surrounding locations like Annasalai until 1990s. However, the scarce land availability and high real estate costs forced companies with large space requirements away from CBD. The current growth pattern of the city focused on the areas where government is planning roads and other infrastructure improvements. Decentralization of activities like vegetable market, flower bazaar and muffussal bus stand to peripheral areas like Koyambedu, Sathangadu and Madhavaram which are highly decongested the GT, will improve the living quality. Land price of CBD rise year by year. This is much above the affordability of the lower and middle in come group population. Triplicane, Mylapore,

Purasiwalkam and the Northern part of GT like Royapuram are the old residential characterized by row housing with shopping along main roads. Shopping facilities of local significance had developed along almost all major roads. Experts say that for long term investors CBD area offer scope as even among commercial and residential sector one takes a beating, other sector will come to rescue so that there will be consistency in the flow of return on investment. The land price modeling study helps to ascertain the changes in growth occurred in the past and the reasons for the same. It will help to identify the potential for future growth and in planning aspects. To quantify the rise of land price over a period of time is essential for future policy implicating and to assess the compensation amount for the land which will be acquired for public purpose.

4. Theory of Artificial Neural Network

ANN is a computational technology from the artificial intelligence discipline whose architecture emulates the network of nerve cells in the human brain. An NN is a parallel distributed information-processing structure consisting of processing elements (PEs) which contains local memory. The PEs can also carry out localized information processing operations interconnected via unidirectional signal channels called connections. NN architecture such as a standard Back-propagation (BP) NN can be developed by using the various indicators as PEs to be investigated upon. The structure of back propagation is shown in Figure 2.
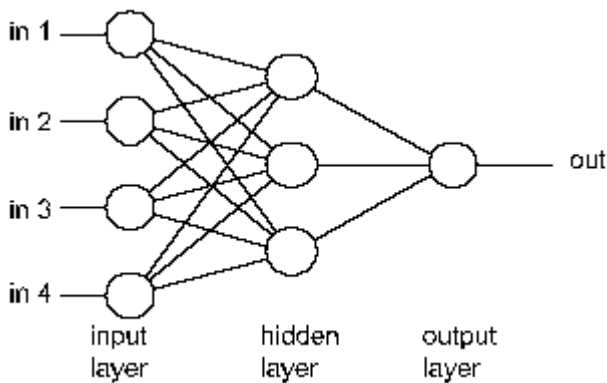

Figure 2. Back propagation Network

As in biological systems, the strength of these connections changes in response to the strength of each input and the use of transfer function by the PEs. All nodes (which are indicators) in the input-layer are fully connected to each of the hidden nodes in the hidden-layer and the process of learning involves all the input nodes and the hidden nodes. In other words, learning also involves all the other input nodes with each input node connected to every hidden node. The output value from each node of the hidden layer in turn becomes the excitatory input-value for a particular node in the output layer. In this study, there are 13 indicators, that is PEs, and one bias node in the input layer

of the NN model is constructed. All the input values are normalized using the MinMax Table.

The principle behind this normalization process is:

Normalized value, N= [Original value - Minimum value] / [Maximum value - Minimum value]

Where, $0 \leq N \leq 1$

The module learns the underlying latent function through an error gradient-descent method and the training stops when the root-mean-Square-error for Output-target values falls below 0.0001 percent. It takes 88 Epochs to reach the desired target. More iteration in the training of data improves convergence. Each hidden node (that is H_1 to H_3) receives a set of feed–in signals (or values) from which an output value is generated. Finally, all nodes in the hidden-layer are fully connected to the output node.

Share of Influence Input Node, I_i, asserts on the subject Output Node = S_i %

$$S_i = \frac{\Sigma^{nj}_{j=1} (|w_{ij}||o_j|) / (\Sigma^{ni}_{i=1}|w_{ij}|)}{\Sigma^{ni}_{i=1} \Sigma^{nj}_{j=1}(|w_{ij}||o_j|) / (\Sigma^{ni}_{i=1}|w_{ij}|)} \quad X\ 100 \quad (1)$$

Where
n_i = number of input nodes
n_j = number of hidden nodes
w_{ij} = connection – weight from input node I_i to hidden–node H_j
o_j = connection – weight from hidden node H_j to subject output node S_i

An ANN learns to solve specific problems without the need for problem - specific algorithms. The learning strategy incorporates the minimization of mean square error across all training patterns. The user can set a desirable result and compare the network's performance with the target training set.

In the development of feasible neural network solution all 13 indicators are used to ascertain the effect and to predict the trend of land price, thereby to preserve reliability in subsequent comparison on the accuracy of neural network solution. BP NN is chosen as a basic since, it is widely accepted. The aim of the learning process is to minimize the global error E of the system by modifying the weights. A gradient descent rule is adopted in the learning across the training set. Suppose a vector i is presented as the input layer of the network and the desired output is D. Let O denote the actual output produced by the network with its current set of weights. Then the measure of the error in achieving that desired output is given by:

$$E = 0.5 \sum_k (D_k - O_k)^2 \quad (2)$$

ANN is set to 10000 iterations. Training stops when convergence obtains at the required root-mean-square-

error or when the error across the learning maxim generated by network has become consistently stable. Forecasts are being made over a period between 2011– 2015 and the Run dialog box in the neural programme will help to establish the actual output. The share of influence of selected indicators is established using Garson's method. In this regard, the neural programme has the NN tool dialog box that shows the change in output by weightages. This helps to know which of the indicators has the most effect on the output.

5. Results and Discussion

The forecast ability of the neural network solution is shown in Table 2. The actual and ANN model prices are compared and it can be seen that the difference is about 3 to 4 %. This indicates that the identified indicators may be used as reliable inputs for modeling of land price and also the model is validated with the prices in the years 2009 and 2010.

Table 2. Prediction ability of ANN model

Year	Actual Market Price (Lakhs)	ANN Model Price (Lakhs)
1997	36	35.97
1998	39	39.30
1999	42	42.60
2000	45	45.95
2001	48	49.23
2002	60	62.43
2003	72	75.60
2004	84	88.80
2005	96	99.97
2006	108	115.20
2007	144	150.80
2008	156	158.00
2009	144	149.31
2010	150	155.90

Table 3 shows the share of influence of identified factors towards the output node. ANN solution has ranked Construction Cost, Dollar equivalence and Crude oil price as major influencing factors towards Land price.

Table3. Explanatory strength of indicators in ANN model

Indicators	$\sum_{j=1}[(|w_{ij}||o_j|)/(\sum_{i=1}|w_{ij}|)]$	Share of Influence	Strength of Indicators
Construction cost	2.933248	9.865645	1
Dollar	2.637307	8.870282	2

equivalence			
Crude oil price	2.587336	8.702212	3
Mumbai sensex	2.560612	8.612329	4
Inflation	2.53264	8.518246	5
Home loan interest	2.371333	7.97571	6
Time	2.347322	7.894949	7
Silver price	2.060556	6.930445	8
Population	2.02966	6.82653	9
National sensex	2.031778	6.833656	10
Guideline value	1.964782	6.60832	11
Gold price	1.849004	6.218914	12
GDP	1.826364	6.142767	13
Sum of signal transfer	29.73194	100	-

The validated land price model and the future model are shown in Figures 3 and 4, respectively. From the results, the predictions offered an average STDEV of 3.75 which is marginal and the annual rise of land price in Sowcarpet will be 17 %.
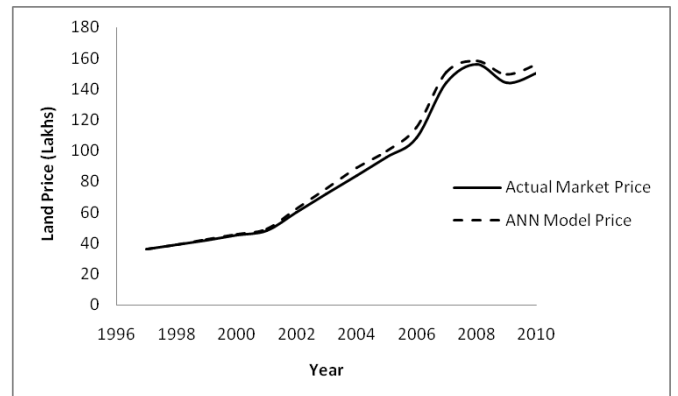
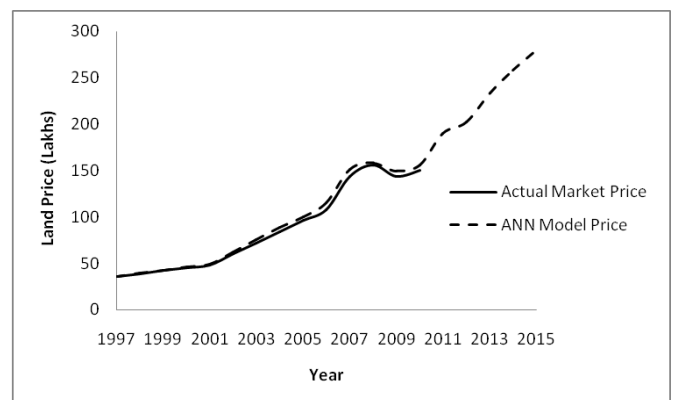**Figure 3. Validated Land Price Model**

Figure 4. Forecasted Land Price Model

6. Conclusion

In this paper, the land price at Sowcarpet in Chennai City is evaluated by Artificial Neural Network. Artificial neural network model prices are tested for their predictive power

u s i n g   e c o n o m i c   f a c t o r s
c o l l e c t e d   f r o m   t h e   y e a r
1 9 9 7   t o   2 0 0 8 . The forecasted results show
that the annual rise in land price at Sowcarpet is about 17 %
in the next 5 years.

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