

TREND OF LAND PRICE AT PONDICHERRY IN INDIA

Submitted in partial fulfilment of the requirements for the award of
Bachelor of Engineering Degree in Civil Engineering

By

ARUN A (37200007)

HARIKRISHNAN S (37200025)



**DEPARTMENT OF CIVIL ENGINEERING
SCHOOL OF BUILDING AND ENVIRONMENT**

SATHYABAMA

**INSTITUTE OF SCIENCE AND TECHNOLOGY
(DEEMED TO BE UNIVERSITY)**

Accredited with Grade "A" by NAAC

JEPPIAAR NAGAR, RAJIV GANDHI SALAI, CHENNAI – 600119.

APRIL 2021



SATHYABAMA

INSTITUTE OF SCIENCE AND TECHNOLOGY
(DEEMED TO BE UNIVERSITY)

Accredited with Grade “A” by NAAC

JEPPIAAR NAGAR, RAJIV GANDHI SALAI, CHENNAI - 600 119

www.sathyabama.ac.in



DEPARTMENT OF CIVIL ENGINEERING

BONAFIDE CERTIFICATE

This is to certify that this Project Report is the bonafide work of **ARUN A(37200007)** and **HARIKRISHNAN S (37200025)** who carried out the project entitled “**TREND OF LAND PRICE AT PONDICHERRY IN INDIA**” from JANUARY 2021 TO APRIL 2021.

Internal Guide

Dr. V. SAMPATHKUMAR (M.A, M.Sc, Diploma in IRT Delhi,M.E,Ph.D.,)

Head of the Department

(Sathyabama Institute of Science and Technology)

Submitted for Viva voce Examination held on _____

Internal Examiner

External Examiner

DECLARATION

We **ARUN A (37200007)** and **HARIKRISHNAN S (37200025)** hereby declare that the Project Report entitled “**TREND OF LAND PRICE AT PONDICHERRY IN INDIA**” done by us under the guidance of **Dr.V. SAMPATHKUMAR(M.A, M.Sc, Diploma in IRT Delhi,M.E,Ph.D.,)** is submitted in partial fulfilment of the requirements for the award of Bachelor of Engineering Degree in Civil Engineering.

DATE:

PLACE:

SIGNATURE OF THE CANDIDATE

1.

2.

ACKNOWLEDGEMENT

We are pleased to acknowledge our sincere thanks to Board of Management of **SATHYABAMA** for their kind encouragement in doing this project and for completing it successfully. We are grateful to them.

We convey our thanks to **Dr. Devyani Gangopadhyay, B.Arch., M.T.P., Ph.D.**, Dean, School of Building and Environment and **Dr. S. Packialakshmi, M.E., Ph.D.**, and **Dr. R. Padmapriya, M.E., Ph.D.**, Head of the Department, Dept. of Civil Engineering for providing us necessary support and details at the right time during the progressive reviews

We would like to express my sincere and deep sense of gratitude to my Project Guide Assistant Professor **Dr. V. SAMPATHKUMAR(M.A,M.Sc, Diploma in IRT Delhi,M.E,Ph.D.,)** for her valuable guidance, suggestions and constant encouragement paved way for the successful completion of our project work.

We wish to express my thanks to all Teaching and Non-teaching staff members of the Department of Civil Engineering who were helpful in many ways for the completion of the project.

ABSTRACT

This report focuses on modelling and forecasting of land price in Pondicherry, India using multiple regression and neural network techniques. Four locations spread over Pondicherry area are selected at random as study areas. The monthly average values of the selected factors from the year 2000-2020 are considered to develop the models. There are several factors considered to check the trend of Land Price. Social and Economic Factors are Mainly considered here to find out the trend. When the R^2 is equal to 1, which is best type of prediction pattern to find out the trend of Land Price. There are many types of predicted pattern, but we mainly considered here polynomial pattern. There are many researches are successful in find out the land price trend using both ANN and Regression Technique.

The Values of the factors are found after that they are feed into spss statistics. Both multiple regression and neural network are validated with the market price for the 2019 and 2020. After validation the models are used to forecast the land price in Pondicherry area from the year 2021 to 2025. Both the models are found to be well fit for the modelling of land price, however the model using Regression shows better accuracy. A careful examination of the results of forecasting bring to the lime light the surge in growth of land prices in the peak places of Pondicherry.

TABLE OF CONTENTS

CHAPTER No.	TITLE	PAGE No.
	ABSTRACT	v
	LIST OF TABLES	viii
	LIST OF FIGURES	ix
1	INTRODUCTION	1
	1.1 General	1
	1.2 Assessment of Indian Real Estate	1
	1.3 Real Estate Scenario of Pondicherry	2
	1.4 Limitations of the study	3
2	AIM AND LITERATURE	4
	2.1 Aim	4
	2.2 Objective	4
	2.3 Description of the Research Work	3
	2.4 Review of Literature	5
	2.5 Literature Based on Modelling and forecast of Land price using Influencing factors	5

3	METHODOLOGY	11
	3.1 Methodology	11
4	INFLUENCING FACTOR	12
	4.1 General	12
	4.2 Selected Factors	12
5	STUDY AREA	18
	5.1 General	18
	5.2 Details of Study Area	18
6	ANALYSIS AND MODELLING OF LAND PRICE	21
	6.1 General	21
	6.2 Data Collection	21
	6.3 Analysis of Land Price Using Study Period	21
	6.4 Land Price Modelling	28
	6.5 Validation of Land Price Modelling	43
7	Forecasting of Land Price In Pondicherry	47
	7.1 General	47
	7.2 Forecasting of Land Price	48

	7.3 Analysis of Forecasting Results from 2021 to 2025	56
	7.4 Influence of Selected Factors On Forecasted Land Price	57
8	Summary and Conclusion	58
	8.1 Summary	58
	8.2 Conclusion	58
	8.3 Application of the Study	59
	References	61

LIST OF TABLES

Table No.	Description of tables	Page No.
4.1	Dependent and Independent Variables in Land Price	17
5.1	Study Area	18
5.2	Geographical Position of the Study Area	20
6.1	Land Price per Ground in Study Areas	22
6.2	GLV per Ground in Study Areas	23
6.3	Average Value of Selected Factors	24
6.4	Interaction of Selected Factors on Land Price in study Area	35
6.5	Interaction among Selected Factors	36
6.7	Model Summary and Analysis of Variance (ANOVA) of Four Study Locations	36
7.1	Linear Prediction Values of GLV (in Lakhs)	47
7.2	Factor Prediction Values	48

LIST OF FIGURES

Fig.No	TITLE OF FIGURES	PAGE No.
3.1	Methodology	11
4.1	Rural Urban Population Percentage	13
5.1	Study Area in Pondicherry	19
6.1	Rise of Land Price at Ariyankuppam in Pondicherry	25
6.2	Rise of Land Price at Pillaichavadi in Pondicherry	26
6.3	Rise of Land Price at Saram in Pondicherry	26
6.4	Rise of Land Price at Kalapet in Pondicherry	27
6.5	Rise of Land Price at Pondicherry	27
6.6	Average Annual Rise of Land Price in Study Area	28
6.7	Multilayer Neural Network Technology	31
6.8	Neural Network Architecture	34
6.9	Ranking factors by NN method at Kalapet in Pondicherry	37
6.10	Ranking factors by NN method at Pillaichavadi in Pondicherry	37
6.11	Ranking factors by NN method at Ariyankuppam in Pondicherry	38
6.12	Ranking factors by NN method at Saram in Pondicherry	38
6.13	Ranking factors by NN method at Pondicherry	39
6.14	Histogram of Land Price In Pondicherry	41

6.15	Dendrogram using ward's Method for Pondicherry	42
6.16	Validation of Model at Kalapet in Pondicherry	43
6.17	Validation of Model at Pillaichavadi in Pondicherry	44
6.18	Validation of Model at Saram in Pondicherry	44
6.19	Validation of Model at Ariyankuppam in Pondicherry	45
6.20	Validation of Model at Pondicherry	45
7.1	Prediction Pattern of Gold upto 2025	49
7.2	Prediction Pattern of Silver upto 2025	49
7.3	Prediction Pattern of BSE Index upto 2025	50
7.4	Prediction Pattern of Crude Oil upto 2025	50
7.5	Prediction Pattern of NSE Index upto 2025	51
7.6	Prediction Pattern of Dollar Equivalence upto 2025	51
7.7	Prediction Pattern of Home Loan upto 2025	52
7.8	Prediction Pattern of Construction Cost upto 2025	52
7.9	Prediction Pattern of GDP upto 2025	53
7.10	Prediction Pattern of Inflation upto 2025	53
7.11	Predicted Price Model at Ariyankuppam in Pondicherry	54
7.12	Predicted Price Model at Pillaichavadi in Pondicherry	54

7.13	Predicted Price Model at Kalapet in Pondicherry	55
7.14	Predicted Price Model at Saram in Pondicherry	55
7.15	Predicted Price Model at Pondicherry	56

List of Variable names and its Abbreviations

Variable Names	Abbreviations
Year	Year
Silver price/gm (Rs)	Sil
Gold Price/gm (Rs)	Gold
BSE index	BSE
NSE index	NSE
Crude oil/barrel (Rs)	Croil
Dollar Equivalence (Rs)	Doll
Home loan (%)	HL
Construction cost (Rs)	Cc
GDP (%)	GDP
Inflation (%)	Infla
Population	Pop
GuideLineValue (Rs)	GLV

CHAPTER 1

INTRODUCTION

1.1 GENERAL

Shelter, one of the fundamental requirements of human race forms the basis for the need for land. The desire to acquire and own a piece of land for ones comfortable living opened the flood gates of the Real Estate Industry across the globe. With the steady upsurge in population over the years, the industry has thrived and continues to flourish thereby catering to the demand of the end users. The real estate industry is prevalent in every sector like commercial, industrial, retail, residential, hospitality, healthcare etc. to name a few. Nevertheless, it has now become an indicator of a nation's economical growth. Hence a healthy development of this industry plays a vital role in stimulating the economy, adjusting the industrial structure and improving the living standard.

1.2 ASSESSMENT OF INDIAN REAL ESTATE

The real estate industry in India offers promising and exciting investment opportunities not only for Indian residents but also for those Indians spread across the world. Real estate as an asset class is gaining preference among investors since it minimizes the risk of short term fluctuations and is also less volatile and tangible in nature. The country's economy is on track and there is an urban transformation that is fuelling an increased demand in this sector. It has been estimated that there is a huge potential for investments by 25 million Non Resident Indians (NRI) in housing alone in India. The forecast suggests that most sought cities for investment in housing includes Bangalore, Hyderabad and Chennai followed by Delhi, Mumbai, Pune, Goa and Nagpur. From the data on NRI investments, it has been found that investment on real estate has increased from six million United States Dollars (USD) in the year 1995 to 8.90 billion USD in 2011. An estimated investment of 180 billion USD by NRI's is predicted in the year 2020. These statistics reveal that the real estate business has come to stay and is poised for phenomenal growth in the forthcoming years.

The real estate industry in India has been booming and has emerged as a dynamic sector in the recent decades. Many educational institutions are offering specialized courses in real estate related subjects due to its importance. Real estate sector is second only to agriculture, in generating employment in the country and continue well in the coming years. It covers property management, land development, mortgage banking and urban planning, counselling and consultancy etc. The real estate has achieved a huge growth in the past years and it is expected to continue in the forthcoming years. Indian real estate is expanding in all parts. Favourable demographics, rising purchasing power, availability of finance, reforms initiated by the Government, a buoyant economy, cosmopolitan atmosphere and improved life style are instrumental in driving the demand towards high end. With this the Indian real estate sector has been expanding at an exponential rate. With the booming economy and a strong Gross Domestic Product (GDP) growth, the industry is expanding in all segments such as commercial, residential and retail segment.

1.3 REAL ESTATE SCENARIO OF PONDICHERRY

Pondicherry , officially known as **Puducherry** is the capital and the most-populous city of the Union Territory of Puducherry in India. The city is in the Puducherry district on the southeast coast of India and is surrounded by the state of Tamil Nadu, with which it shares most of its culture and language. Pondicherry Municipality consists of 42 wards. Wards 1–10 are north of the city. Wards 11–19 are in Boulevard Town and remaining wards are southwest of the city centre. The latitude of Puducherry, Pondicherry, India is 11.916064, and the longitude is 79.812325. Puducherry, Pondicherry, India is located at India country in the Districts place category with the gps coordinates of 11° 54' 57.8304" N and 79° 48' 44.3700" E. Latitude and longitude of Kalapet (Land 1) 12.0370° N, 79.8552° E. Land 2, Pillaichavady whose latitude and longitude are 12.0096°N, 79.8549° E. For Saram, Land 3, 11.9408°N and 79.8121°E are the latitude and longitude values. Ariyankuppam which is land 4 whose latitude and longitude are 11.8958°N and 79.8046°E

1.4 LIMITATIONS OF THIS STUDY

Due to inherent and unpredictable variables, the study contemplates the following limitations:

- Residential land prices alone are taken up for forecasting. Other types of land usage like commercial, institutional, industrial, recreational, healthcare etc shall also have an impact on the accuracy of the results of the study.
- No scientific sampling technique has been adopted while selecting the thirteen study locations. In this context, the inclusion of data for all the locations would be a pragmatic approach to the study.
- Environmental factors like climatic conditions, rainfall, pollution levels etc. also have impact on the land price trend which is not considered in this study.
- No provision has been made in the study to absorb the impact of natural calamities like earthquake, tsunami, storm etc.
- Change in policies of Government and new infrastructural development may also affect the outcome of this study.

CHAPTER 2

AIM AND LITERATURE

2.1 AIM

To estimate the price of land in Pondicherry for the next 5 years with the help of economic factors and SPSS Data Analysis.

2.2 OBJECTIVE

The objective of this study is to determine the distribution of land prices in Pondicherry union territory, by deriving an accurate model for predicting their trends. It is anticipated that the model will become an useful tool for professionals in view of the uncertainties and risks in property development. The study focuses on the following:

- To Assess the Present Market Rate of The Land at Study Area in Pondicherry
- To Collect the Factor Values For past 20 Years
- To Forecast the Price of The Land for Next 5 Years Using NN and Regression Technique

2.3 DESCRIPTION OF THE RESEARCH WORK

Research Problem: Land prices in cities change over a period of time. The unstable and nonlinear price variation makes it difficult to predict the future price movements accurately. The problem becomes more pronounced since the underlying functional relationship between input and output is unknown. Furthermore, the actual input variables are hardly detectable. Hence, it becomes an inherently complicated task to determine the underlying nonlinear structure of the property price time series. A reliable modelling technique will reduce the uncertainty borne by market participants so that the number of informed agents increases. Thus, a practical and reliable methodology for modelling and forecasting the trend of land price is necessary.

REVIEW OF LITERATURE

2.4 GENERAL

Over the last two decades there have been a large number of empirical studies analyzing land prices. This chapter reviews the selected literatures on land price modelling and forecasting in different countries. Advantages and inherent shortcomings of different models on land price are discussed. Attributes used in previous studies on the land price model are examined to establish influencing attributes that are pertinent and applicable to Pondicherry union territory.

2.5 LITERATURE BASED ON MODELING AND FORECASTING OF LAND PRICE USING INFLUENCING FACTORS

John (1983) compared the annual increase in land price in Illinois with the Consumer Price Index (CPI) and found that the increase in the land price was approximately twice than the increase in CPI. Expected ratio of return from land, reasonable size of plot, rate of inflation, rental value, and increase in income and decline in interest rate were identified as responsible for the trend.

Isakson (1997) developed a regression model to value urban land that included explanatory variables such as sale date, distance from interstate corridor, zoning, and buyer and seller character. From 1985 to 1992, his model statistically clarified about 43% of reality in Denver. Environmental setting, accessibility, transportation facility, school network, shopping facilities, and regional characteristics were defined as variables affecting housing price by Tam et al (1999). According to his research, accessibility has no impact on housing prices, as shown by the R^2 of 0.62.

Kilpatrick (2000) showed the usefulness of time-series regression model which used economic data to provide more accurate forecast of 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 regression co-efficient. He identified the population growth, economic development, infrastructure, agriculture, location, nearby developments, limited supply and increasing demand on land as factors, which contribute to appreciation of land value.

Mark and John (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. Poniewozik (2003) explained the factors affecting market value of rural land in New Mexico due to booming computer industry. Moreover expectation of capital gain, income earning potential, appreciation of land value, rural life style, recreational attitude of people, family tradition, profit maximization and disposable income also had influence on land price trend. The model explained about 93 % of the variations per acre sale price and found that elevation of land had positive effect and whereas increase in distance to major trade centre had negative influence on land price.

Davis and Healthcote (2004) studied home values in 46 largest US metropolitan areas. Land is relatively inelastic in supply and its market value should be determined by demand-side factors, such as household income, interest rates or speculative activity. Moreover, substantial differences in residential land values across metropolitan areas, cycles in home prices continue to drive real estate.

Buday (2005) developed the land price model for Slovakia. Five districts were studied in Slovakia and the land price in 2001 and 2002 were compared. The area of sales were also compared and concluded that the price of agricultural land had sustained growth. Nagarajan (2005) explained that the value of property was determined by supply and demand. In the market, the supply of property was fixed at a spot time. Aspects such as exposure to service, weather, and accessibility to good transport link, to school, to nearby railway station, proximity to motor way junctions and access to employment had more

effect on property. New Zealand property price trends (2005) compared floating and two years fixed mortgage interest rates with the land price. If interest rate increases land price decreases and if inflation increases land price increases and it is concluded that the increase in land price will be close to 10 % a year for the forthcoming years and in long term with reasonable confidence the land price will steadily increase. Anthony et al (2006) examined the expected price appreciation of distressed property and compared it to the prevailing metropolitan area appreciation rate whether due to individual property or local area heterogeneity in appreciation of 50 states and the District of Columbia in the US.

Chunwang (2007) found that the fluctuation in real estate market price in Taiwan was affected by its economic situation. The case study focused on the integration between the public tender data over the years of lands in Kaohsiung City and economic factors. Maximum likelihood estimation used as a tool and the study found that the land value had negative correlation with interest rate and positive correlation with GDP and exchange rate.

David and Paavo (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.

Roic (2009) showed that the affordability, holding power, rental yield, capital gain, financing of property investment, vacancy rate as the factors of Singapore property buyers. Floor Space Index (FSI) specified by the development authority had the influence on the value of land and the increase in FSI without providing adequate infrastructure facilities might deteriorate the living standard of people..

Richard (2010) estimated the impact of landfills on nearby property values for three landfills in Pennsylvania. Analysis showed that the landfills which accept high volumes of waste (500 tons per day or more) decrease adjacent residential property values by 13.7 %, on average. This impact diminishes with distance at a gradient of 5.9 % per mile.

Wilson et al (2002) studied the residential property market accounts for a substantial proportion of United Kingdom (UK) economic activity. Professional valuers, estimate property values based on current bid prices (open market values). In this paper, Artificial Neural Networks (ANN) trained using national housing transaction time series data, which forecasts future trends within the housing market was presented.

John and Carmelo (2003) said that house prices, unlike stock prices, appear to be predictable with some degree of accuracy. They used an autoregressive process to model the time series behavior of a city-wide house price index in Florida, and then produce one-quarter ahead forecasts for individual properties. The decision-making framework is fitted with housing transactions from Dade County, Florida, from 1976 through the second quarter of 1997.

Marko (2005) analyzed the spatial-temporal variation of land prices in two localities by means of structural time series modeling formalism that combines the flexibility of a time series model with that of the interpretation of a regression analysis. In predictive testing, for most model formulations the unobserved component approach generated only a marginal average prediction error when compared to the orthodox hedonic models, which, in contrast, yielded to a considerable amount of systematic prediction error.

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 traditional NN. The approaches in the fitting precision and the forecast precision aspect had the good effect by using Matlab software to simulate the fitting and forecasting process. The result indicated that, in the big sampled data situation, using the wavelet NN to forecast the real estate index was able to obtain with a good effect.

Newell and Macfarlane (2006) used six-monthly survey amongst independent property forecasters in Australia which was used to compare property forecasts with actual property performance to assess the accuracy of property forecasting in Australia over 1999 -2005. The accuracy of this property forecasting was also benchmarked against a number of alternative naïve property forecasting strategies to assess the “added-value” of property forecasting in Australia. Zhangming (2006) forecasted the real estate price index by using the Back Propagation (BP) NN.

Kurnow (2007) studied the land value trend in the US to trace the cyclic fluctuations in the distribution of land price among the states since 1922. There the market value of a real property was derived by adding value of land with value of improvement. Tinghao (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.

Yoon et al (2007) created a set of multivariate statistical regression models for testing the consistency of observed Japanese land market prices with present value market fundamentals. Flui (2008) described the application on nonlinear complex system's analysis methods were the nonlinear regression, the NN, the grey theory, the wavelet arithmetic, Bayesian method, the misalignment time series and the stochastic process, the misalignment dynamic model and so on among which the NN method was accepted and applied by the numerous researchers.

Khan et al (2009) used real GDP, real quantity of import, implicit GDP deflator, unit value index of imports and consumption expenditure, standard error of regression adjusted R^2 0.52. Correlation matrices were computed. It revealed that there is enough correlation to go ahead for factor analysis and negative loading indicates that the variable has an inverse relationship with the rest of the factors.

Steven and Albert (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 is functionally equivalent to ordinary least square, multiple layered ANNs are capable of modeling complex nonlinearities. Moreover, because 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.

Rangan and Kabundi (2010) compared the forecasting ability of five alternative types of models in predicting four key macroeconomic variables, namely, per capita growth rate, the CPI inflation, the money market rate, and the growth rate of the nominal effective exchange rate for the South African economy. Keynesian dynamic stochastic general equilibrium, the unrestricted variance regressive, and the small-scale Bayesian vector autoregressive models, were used in estimation based on four variables. Dynamic factor models and the large-scale Bi Variance Regressive models (BVAR) use information from a data containing 266 macroeconomic time series observed over the period 1983 to 2002. The results, based on root mean square errors show that except for the growth rate of the of nominal effective exchange rate, large-scale BVARs outperform the other four types of models consistently and, generally, significantly.

Many studies have been done on land prices and factors determining them. Most of these studies were done laying emphasis on physical factors and that too in American, Australian, Japan, China and New Zealand cities. Not much attention has been paid on modelling and forecasting the land price using economic attributes as influencing factors in these studies. The scope of research was not extended to economic factors in the analysis and modelling and this is considered to be a limitation in these studies. In order to overcome these limitations an attempt has been made to incorporate the economic factors also in the analysis and modelling. The present study aims to bring out the significance of economic attributes pertaining to the modelling and forecasting of land price in Pondicherry union territory.

CHAPTER 3

METHODOLOGY

3.1 METHODOLOGY

The present study mainly focuses on the evaluation of interaction effects of economic attributes on land price and, modelling and forecasting of land price at thirteen different locations in Pondicherry union territory. The relationship between the economic factors and their effects on land price are investigated by correlation analysis. The factors are ranked based on the magnitude of influence on the land price. The land price in the study areas is modelled and forecasted using Multiple Regression analysis and NN technique. Figure 1.1 shows the flow chart of research methodology.

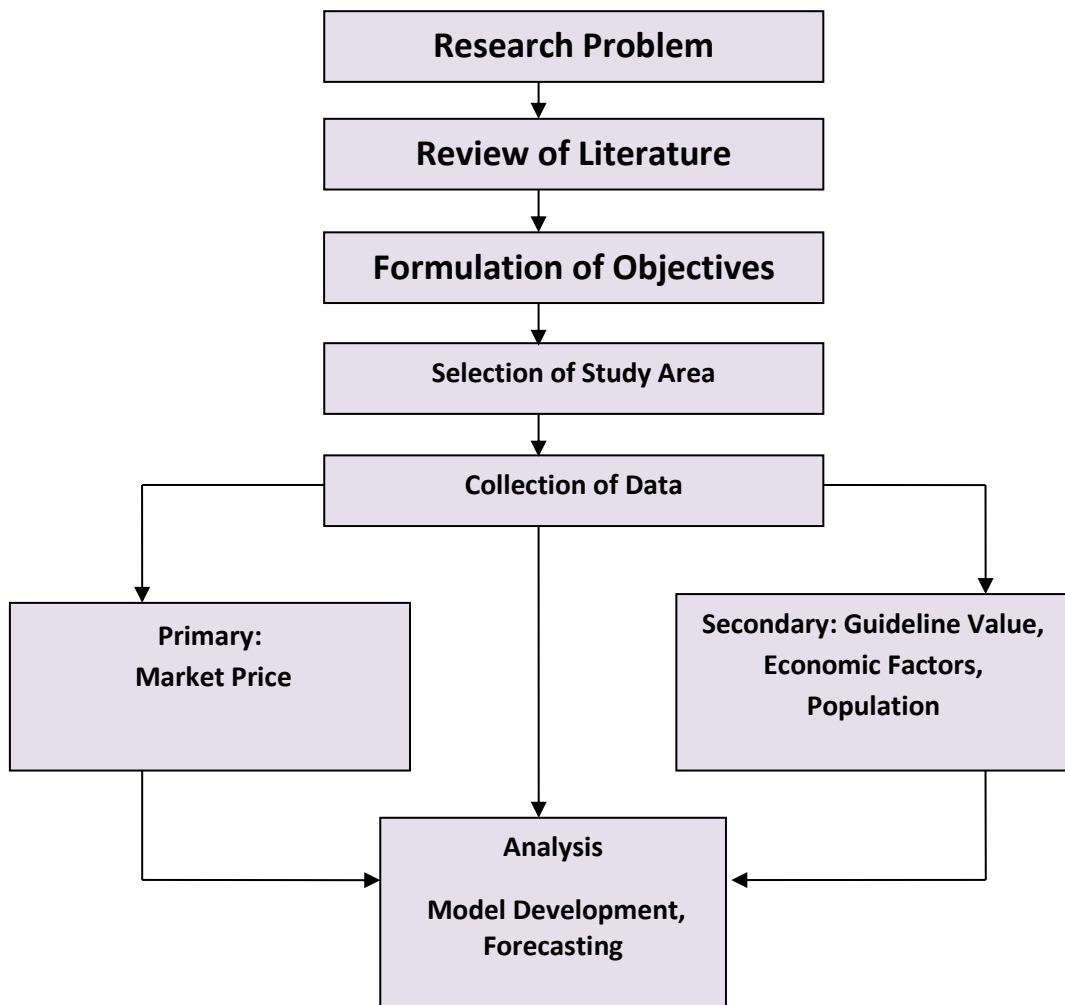


Figure 3.1 Methodology

CHAPTER 4

INFLUENCING FACTORS

4.1 GENERAL

Land price trend gets affected by geometric, social and Economical factors. Population growth combined with migration towards metro areas, better employment with high income, rise in affordability of youth, wide road, location close to city centre and major junctions have rising effect on land price. On the other hand high rise in Guide Line Value (GLV), congestion by heavy traffic, air and noise pollution, minimum width of road, location of land away from centre have their own downturn effect on land price. From the intensive literature survey, social and economical factors have been selected as influencing factors on land price trend. This chapter deals with the characteristics of influencing factors and their impacts on each other.

4.2 SELECTED FACTORS

The significant attributes that influence the land price trend that are used to create the models are shown in Table 4.1. Modelling is based on the relationship between the indicators and the price of land (dependent variable).

4.2.1 Social Factor

Population is used as a social factor. The importance of population in land price prediction have already been studied and highlighted by many authors viz. David E.D (2008), Dianqing (2008), John (2007), Musings (2000) and William C (2008). infrastructure such as proximity to schools, hospitals and retail stores also tends to increase property rates.

For those looking for a home, infrastructure is a big factor to consider. A buyer would place a higher value on a location with reasonable infrastructure. As a result, property prices rise as well. Accessible road and rail transportation have been shown to dramatically raise real estate prices. When metro rail projects are announced, for example, the neighbourhoods along the route benefit greatly.

According to the 2011 census, 69.16 percent of Puducherry's population resides in the district's urban areas. In urban areas, there are a total of 657,209 inhabitants, with males accounting for 323,489 and females accounting for 333,720. According to 2011 census results, the sex ratio in Puducherry's urban area is 1032. In the 2011 census, the child sex ratio in Puducherry district was 978. In the metropolitan area, there were 66,835 children aged 0 to 6, with 33,792 males and 33,043 females. Puducherry district's child population is 10.45 percent of the total urban population. According to census 2011, the average literacy rate in Puducherry district is 88.57 percent, with males and females literates at 93.43 percent and 83.88 percent, respectively.

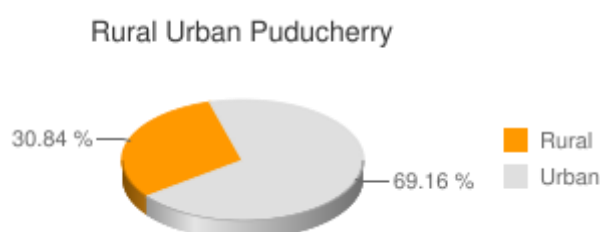


Fig 4.1(Rural-Urban Population Percentage)

(source:<https://www.census2011.co.in/census/district/482-puducherry.html>)

4.2.2 Economic Factors

Economic Factors are play an important Role in the Land Price Trend. In 2016, the Demonetisation directly affects the land. People are mostly invested in Gold, at that time, the GLV goes down. So, it is witnessed that Land price was also depend on Economic factors.

- i. Silver Price/Gm (Rs)
- ii. Gross Domestic Product (%)
- iii. Crude oil cost (Rs)
- iv. Dollar equivalence (in Rs)
- v. Rate of inflation (%)
- vi. Gold Price

- vii. BSE share index
- viii. Home loan (%)
- ix. Construction Cost/sq.ft in (Rs)
- x. Guide line value
- xi. Time

Let's see the brief description about the factors:

(i) METAL (GOLD AND SILVER)

The most common precious metal in which people invest is gold. Investment market falls, currency collapse, inflation, war, and social instability are all examples of economic, political, social, or currency-based crises. Gold prices are set in US dollars, British pounds, and European euros. The fortunes of metals are determined by a number of factors, including stock market performance, dollar gyrations, and the essence of economic data.

(ii) Inflation

According to the Indian Ministry of Statistics and Programme Implementation, India's inflation rate was 5.5 percent in May 2019. This is a slight decrease from the previous annual figure of 9.6 percent in June 2011. For all commodities, inflation rates in India are generally expressed as changes in the Wholesale Price Index.

(iii) Gross Domestic Product

India's real **GDP** (Gross Domestic Product) is estimated to contract by 7.7% in **2020-21**, compared to a **growth rate** of 4.2% in 2019-20, with Real GVA (Gross Valued added) shrinking by 7.2%, as per advance estimates released by the National Statistical Office (NSO) on Thursday (Source: thehindu.com dated 07/01/21)

(iv) BSE and NSE index

The Bombay Stock Exchange (BSE) is Asia's oldest stock exchange, with over 6000 companies listed, including large, medium-sized, and small businesses. In 2007, the BSE became the tenth largest stock exchange in the world, with a market capitalization of USD 1.8 trillion, bringing it closer to industrialized economies in terms of market capitalization to GDP. The BSE, which was established in 1875 and has been completely electronic since 1995, finds electronic trading to be an important part of its long-term growth strategy. In 1994, the National Stock Exchange (NSE) was created. The BSE and NSE indices are used to determine the country's economic condition, and as a result, they have become significant indicators.

(v) Crude oil

In the financial year 2019, the average price of crude oil from the Indian basket was about 70 dollars per barrel. About the end of fiscal year 2012, the average price of crude oil increased slightly, reaching about 112 dollars per barrel. Since the sharp inflation in 2004, the increase in crude oil prices and market instability have become a source of concern for international markets.

(vi) GLV

The government sets the value of a property as a guideline value. Property buyers are not permitted to apply for a property that is less than the Guideline Value. However, there is no restriction against reporting the property at Market Value, which may be higher than the Guideline Value. The primary goal of establishing the Guideline Value is to prevent Stamp Duty evasion.

(vii) Construction cost

The cost of construction materials varies by location; for example, the cost of construction in a village is not the same as the cost of construction in a city. It also varies depending on the availability of labor, surrounding materials, sand, and raw materials, among other factors. Brick & hollow brick, Cement, Steel rod, hard stone small, River Sand, Imported Sand, Crushed stone powder, various types of wood, Tiles or granite, House Wiring and Switches, plumbing, water tank fixing, and so on are the main construction materials used in the construction of houses or buildings. So, before we start constructing a house, we need to know the price / prices of construction materials on a regular basis.

(viii) Time

The data cover a 20 years span over which the level of land prices may have increased. Hence, in an effort to standardize the observations over the 20 years period, time is introduced as a proxy for these dynamic influences

Variable Type	Variable Name
Dependent Variable	Market Price per Ground (Rs)
Independent Variables	Gross Domestic Product (%)
	Cost of Crude oil (Rs)
	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 (Rs)
	Guide Line Value per ground (Rs)
	Time factor (Year and Month)

TABLE 4.1 DEPENDENT AND INDEPENDENT VARIABLES IN LAND PRICE

CHAPTER 5

STUDY AREA

5.1 General

Economics is a philosophy that deals with day-to-day problems. It needs to be written in everyday language.

However, it gives them their own definition, which is sometimes narrow and sometimes wide.

For example, the term "value" has a very specific meaning, while "land" has a very broad one. Land management is the method of efficiently using the land's resources. Land management includes the making and execution of land-related decisions. If waste is to be absolutely avoided, land resources are set in character and must be carefully handled. Land price information is a crucial and basic resource.

5.2 Details of Study Area

Table 5.1 STUDY AREA

REGION	PLACE	RE-SURVEY NUMBER
PONDICHERRY	KALAPET	144
PONDICHERRY	PILLAICHAVADI	214
PONDICHERRY	SARAM	31
PONDICHERRY	ARIYANKUPPAM	212

To Predict the Future Price Trend of Land, we have chosen the land as shown in (Table 5.1).

The Lands are chosen, such that each land present in urban and developing Regions of Pondicherry.

FIG 5.1 STUDY AREAS IN PONDICHERRY

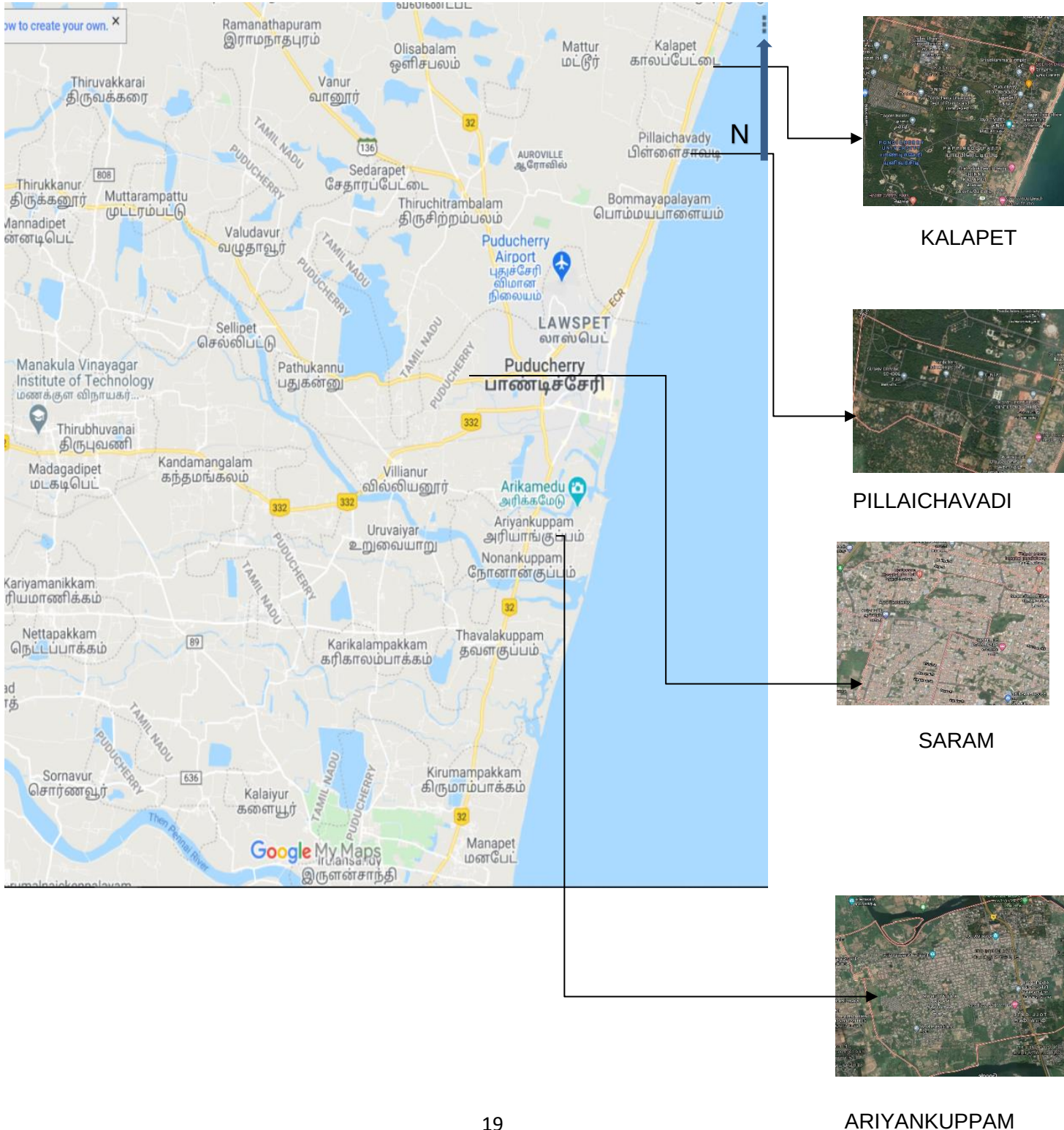


TABLE 5.2 GEOGRAPHICAL POSITION OF THE STUDY AREA IN
PONDICHERRY

LOCATION	LATITUDE	LONGITUDE
KALAPET	12.0370° N	79.8552° E
PILLAICHAVADI	12.0096° N	79.8549° E
SARAM	11.9408° N	79.8121° E
ARIYANKUPPAM	11.8958° N	79.8046° E

CHAPTER 6

ANALYSIS AND MODELLING OF LAND PRICE

6.1 GENERAL

In this chapter, the complete details of the Analyzing land trend is discussed. The development of Multiple Regression and NN models are described in detail.

6.2 DATA COLLECTION

This study involves both primary and Secondary data. Primary data has been collected through personal visits to the real estate agencies and owners of the land taken for the study. Secondary data are collected through Internet, Newspapers and the articles. The data between January 2000 and December 2020 are used in the analysis. The thirteen variables are useful for assessing the performance of property as a key to future investment. The thirteen selected economical and social factors in macro and micro level are collected since 2000 in monthly basis.

The study locations' transacted land prices in lakhs of rupees per 5.5 cents (or) a Ground (or) 2400 Square feet are gathered as primary data via a questionnaire survey. Other economic factors' monthly averages were gathered from secondary sources such as journals, magazines, and the RBI's open data source.

6.3 ANALYSIS OF LAND PRICE DURING STUDY PERIOD

The distribution of land prices in PONDICHERRY is studied by collecting market prices of land from reliable sources at all the study locations. The cumulative increase of land price from the year 2000 to 2020 is presented in the Figures from 6.1 to 6.13.

Locations					
Year	ARIYANKUPPAM	PILLAICHAVADI	SARAM	KALAPET	PONDICHERRY
2000	10.8	2.1	21.6	3.6	9.5
2001	11.7	2.2	24	4	10.4
2002	12.7	2.2	26.4	4.4	11.4
2003	13.6	2.3	28.8	4.8	12.4
2004	14.6	2.4	31.2	5.2	13.3
2005	15.6	2.5	33.6	5.6	14.3
2006	17	3.4	36	6	15.6
2007	18.4	4.3	38.4	6.4	16.9
2008	19.8	5.2	45.6	8.3	19.7
2009	21.2	6.1	52.8	10.2	22.5
2010	22.6	7	60	12	25.4
2011	24	7.9	67	13.9	28.2
2012	25.4	8.8	70.5	14.5	29.8
2013	28.6	10.3	73.9	15.2	32
2014	31.9	11.8	77.2	15.9	34.2
2015	35.1	13.3	80.6	16.6	36.4
2016	38.4	14.8	84	17.2	38.6
2017	41.4	16.7	94	18.7	42.7
2018	44.4	18.5	104.2	20.2	46.8
2019	47.4	20.4	114.3	21.7	50.9
2020	50.4	22.4	124.4	23.8	54.6

**TABLE 6.1 Land Market Price per Ground (Rs. In Lakhs) in
Pondicherry**

Locations	ARIYANKUPPAM	PILLAICHAVADI	SARAM	KALAPET	PONDICHERY
Year					
2000	3.6	0.5	11	0.4	3.9
2001	3.6	0.5	11	0.4	3.9
2002	3.6	0.5	11	0.4	3.9
2003	3.6	0.5	11	0.4	3.9
2004	3.6	0.5	11	0.4	3.9
2005	6.4	0.8	11	0.4	4.7
2006	6.4	0.8	11	0.4	4.7
2007	6.4	0.8	21.3	1	7.4
2008	6.4	0.8	21.3	1	7.4
2009	6.4	0.8	21.3	1	7.4
2010	6.4	0.8	21.3	1	7.4
2011	6.4	0.8	26.2	2.4	9
2012	13.9	3.8	26.2	2.4	11.6
2013	13.9	3.8	26.2	2.4	11.6
2014	13.9	3.8	26.2	2.4	11.6
2015	13.9	3.8	26.2	2.4	11.6
2016	17.2	7.7	30	6.2	15.3
2017	17.2	7.7	30	6.2	15.3
2018	17.2	7.7	30	6.2	15.3
2019	17.2	11.5	30	6.2	16.2
2020	23.2	11.5	36.7	9.1	20.1

TABLE 6.2 GLV per Ground (Rs. In Lakhs)

(Source: Sub register offices and <http://nilamagal.py.gov.in/glr>)

Table 6.3 Average Value of Factors

Time	GOLD	SIL	BSE	NSE	CROIL	DOL	HL	CC	GDP	INFLA
2000	424	9	4502	1429	1271	44.61	12.02	600	3.84	3.8
2001	411	11	3476	1145	1148	47.03	12.00	636	4.82	4.3
2002	484	13	3228	1047	1211	48.47	10.44	674	3.8	4.0
2003	544	15	3968	1216	1347	46.44	8.71	714	7.86	3.9
2004	596	18	5552	1760	1711	45.17	7.75	756	7.92	3.8
2005	631	21	7506	2263	2685	44.05	8.00	801	8.06	4.4
2006	875	23	11664	3364	2915	45.39	8.67	849	7.66	6.7
2007	924	25	15901	4524	2922	41.22	10.38	899	3.09	6.2
2008	1214	23	14029	4471	4157	42.92	10.10	952	7.86	9.1
2009	1511	23	13941	4029	2976	48.04	8.88	1009	8.5	12.3
2010	1798	27	18208	5444	3610	45.88	8.75	1069	5.24	10.5
2011	2360	28	17724	5454	4850	46.18	10.04	1133	5.46	10.0
2012	2864	29	17835	5325	5595	53.31	10.17	1272	6.39	9.4
2013	2644	31	19727	5873	6105	58.29	10.08	1348	7.41	5.8
2014	2482	32	24941	7300	5865	60.92	10.10	1428	8	4.9
2015	2391	35	27383	8327	3331	64.33	9.76	1513	8.26	4.5
2016	2697	37	26506	8116	2876	66.88	9.38	1603	7.04	3.6
2017	2632	41	31163	9504	3440	65.23	8.50	1699	6.12	3.4
2018	2798	42	35684	10763	4680	68.26	8.48	1800	4.18	4.8
2019	3590	45	38716	11405	4323	70.17	8.69	1908	3.1	5.0
2020	4453	56	37705	10945	3045	74.22	7.33	1908	6.34	6.4

(Source: Internet and SBI)

In Saram at Pondicherry, the cost of land was very high at Rs. 21.6 lakhs per ground even during the year 2000. At the end of 2020, the land Price Price 124.4 lakhs. The sudden increase in Land was due to urbanization and Proper Infrastructure. The average annual increase was observed at 20%.

In Pillaichavadi at Pondicherry, the land price was observed too low. The Price is Gradually increasing. Since it is located at outer region of Pondicherry, rate of increase in price was weak.

In terms of the value of land, thePrice of land in Pillaichavadi in Pondicherry was the cheapest during 2000 followed by Kalapet. Saram was the costliest area followed by Ariyankuppam. This shows the Central Zone of Pondicherry has experienced much growth compared to areas in other zones.

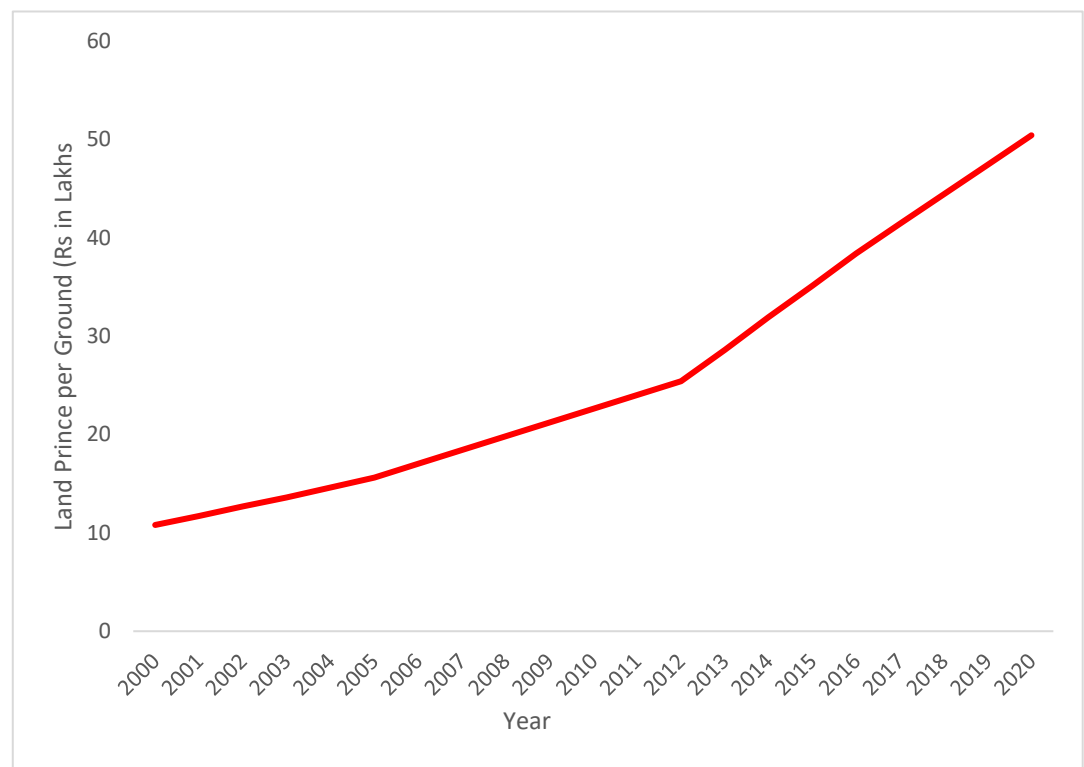


Figure 6.1 Rise of Land Price at Ariyankuppam in Pondicherry

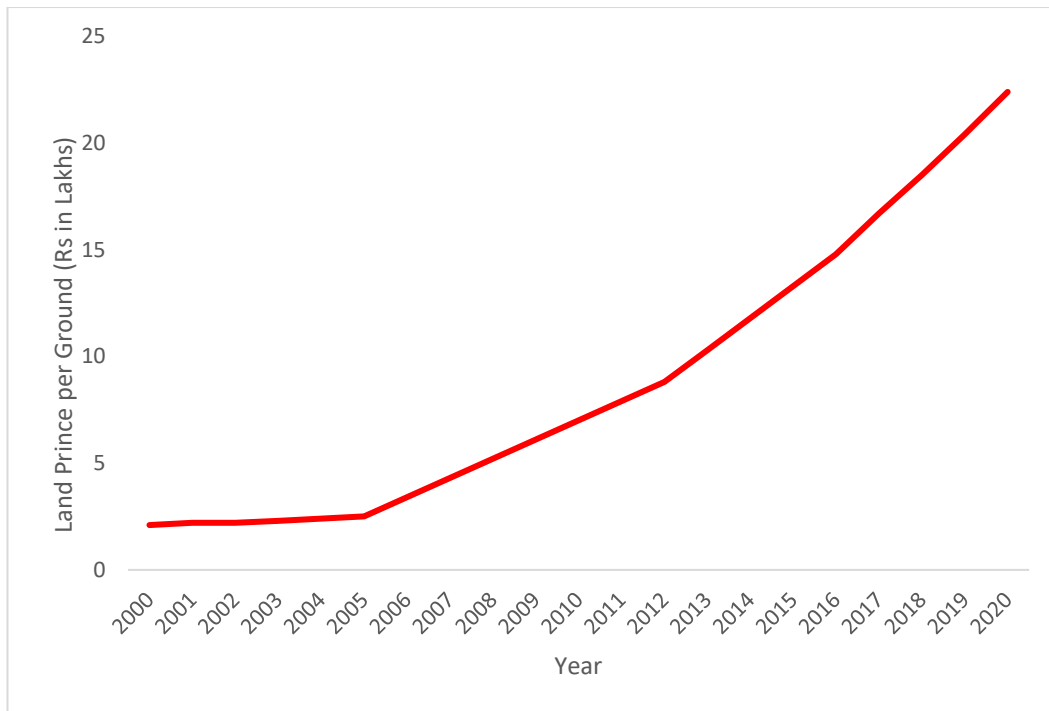


Figure 6.2 Rise of Land Price at Pillaichavadi in Pondicherry

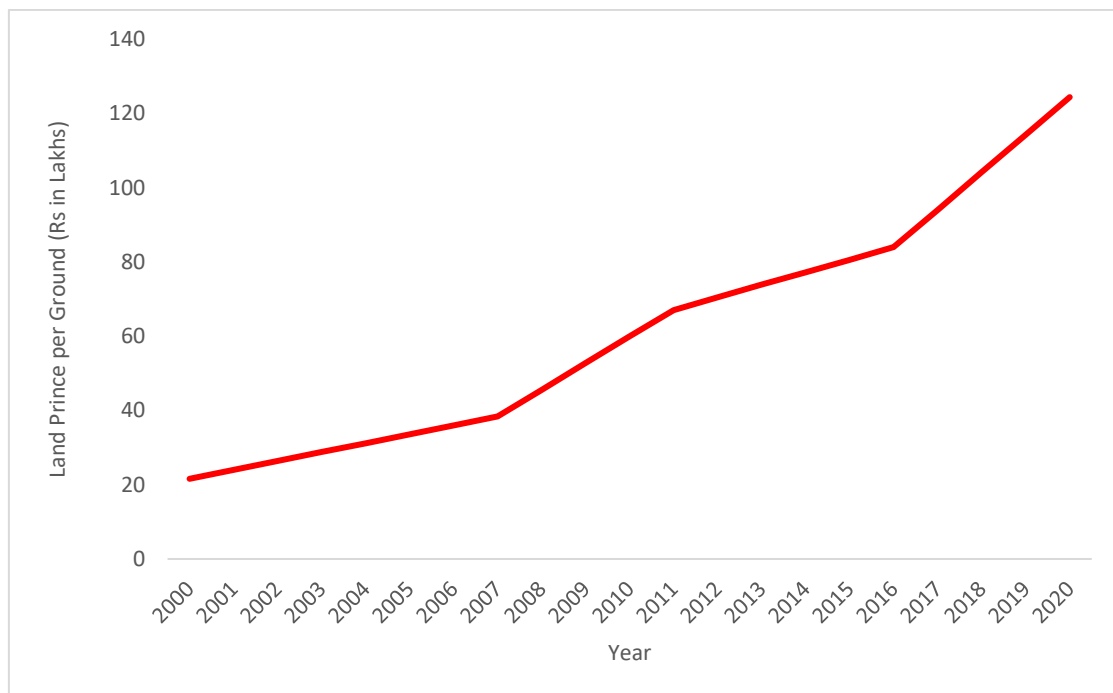


Figure 6.3 Rise of Land Price at Saram in Pondicherry

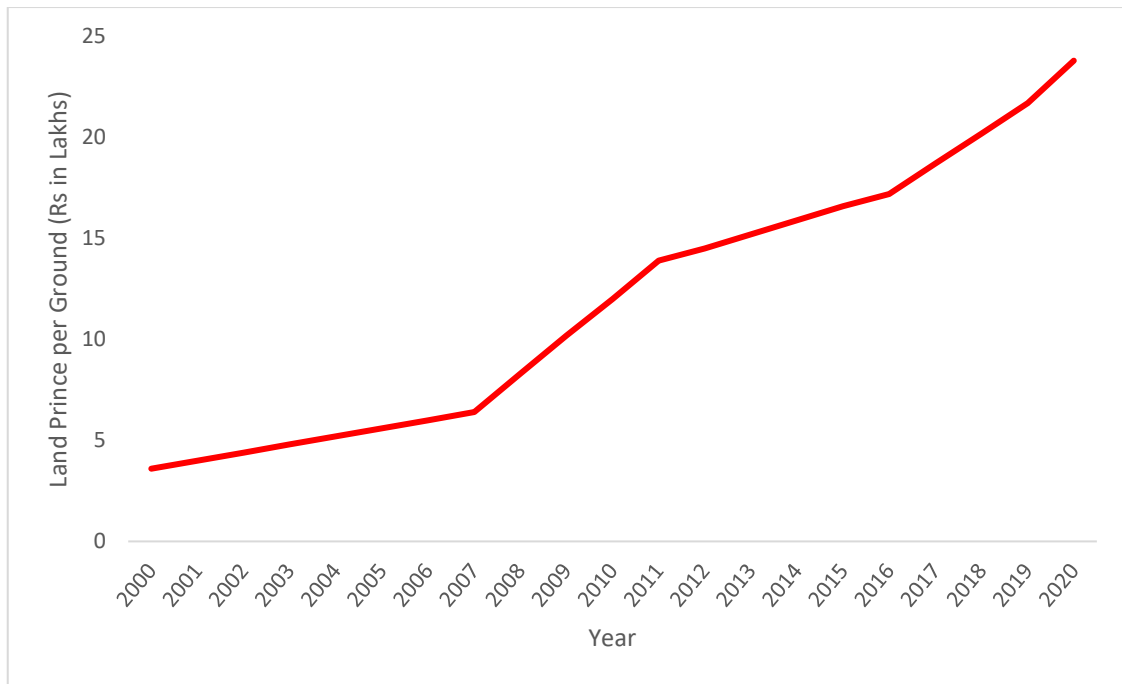


Figure 6.4 Rise of Land Price at Kalapet in Pondicherry

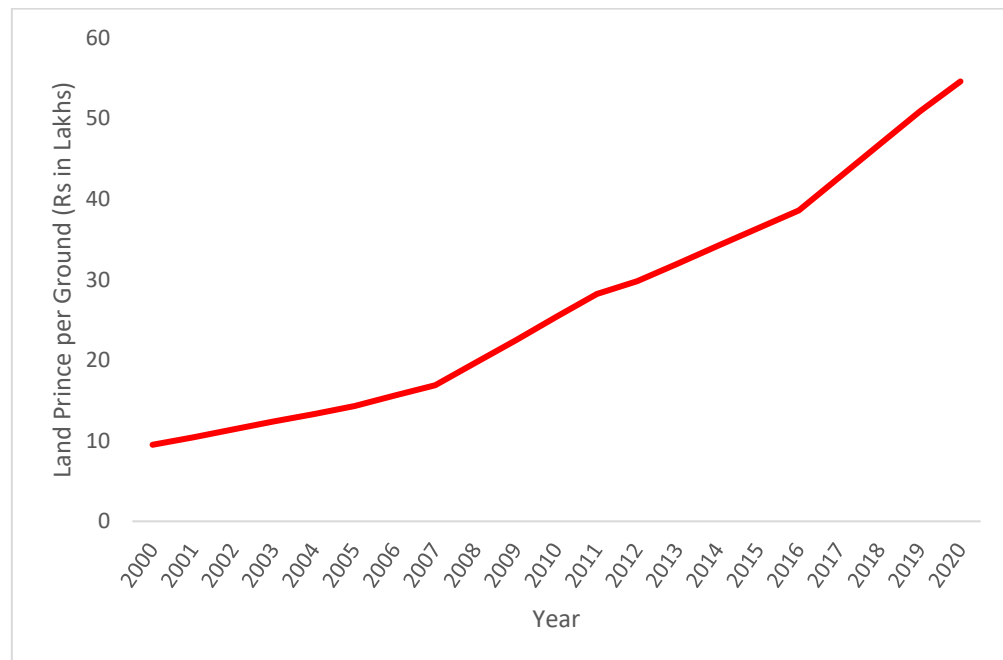


Figure 6.5 Rise of Land Price at Pondicherry

The average annual rise of land price for the study period in the selected locations is presented in the Figure 6.5. It can be seen that the highest Average price rise of 61 LAKHS in 20 years is observed in Saram. The next higher average price rise was observed in Ariyankuppam area 26 Lakhs in 20 Years. The price rise was almost uniform in Kalapet and Pillaichavadi.

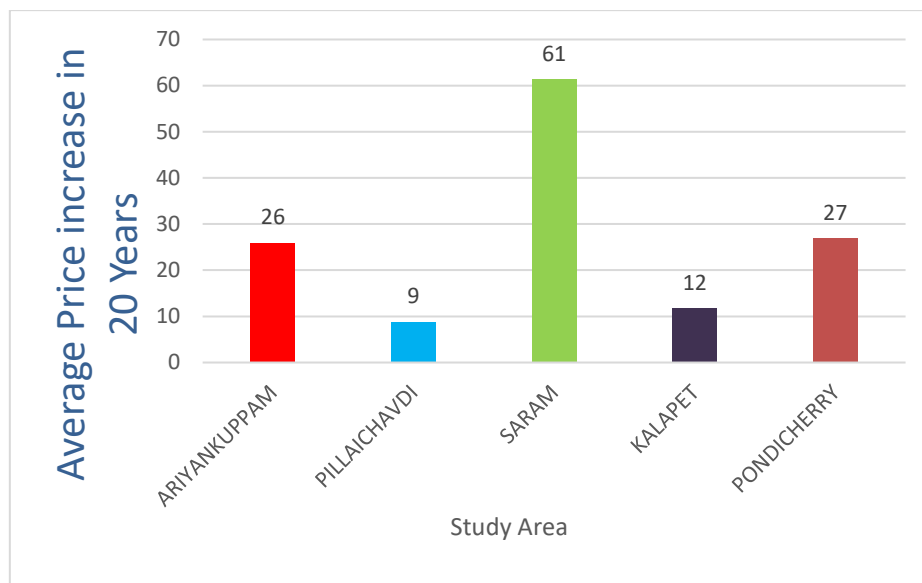


Figure 6.6 Average Annual Rise of Land Price

6.4 LAND PRICE MODELING

The monthly average of all thirteen factors of each location from the year 2000 to 2020 (310 sets) and simultaneous form of equations with known factor values are entered in SPSS software for regression modeling. The factors are trained against land price in BP method of NN in MATLAB software with desired learning rate. The data from the year 2000 to 2020 (176 sets) are used to develop model and remaining data (76 sets) have been reserved for validating the obtained models. The influence of each factor on land price is derived by performing correlation analysis. The interaction effect among each factor is also performed to know the co-movement of factors. Regression and NN equations for all locations and a common model for Pondicherry are

developed with a minimum error level and the models are validated with the available land price data of 2000 and 2020.

The models are evaluated by standard tests to examine their acceptable level and the tested models are used to forecast the land price for the forthcoming five years from 2021 to 2025. The theory of multiple regression and NN technique are described below.

6.4.1 MULTIPLE REGRESSION TECHNIQUE

Regression analysis is the statistical technique in which observational data are modeled by a function which is a nonlinear combination of the model parameters and depends on one or more independent variables. The data are fitted by a method of successive approximations. Regression analysis is widely used for modelling and forecasting the land prices [Jason (2008); Flui(2008)]. 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. In this study the multiple regression analysis is carried out by using SPSS software.

The general multiple regression equation is

$$Y = b_0 + b_1x_1 + b_2x_2 + \dots + b_nx_n$$

Where, Y = Estimated value corresponding to the dependent variable

b_0 = y intercept

$x_1, x_2 \dots x_n$ = values of n independent variable

x_1 = Time (Year & Month), x_2 = Gold price per gram (Rs) , x_3 = Silver price per gram (Rs), x_4 = BSE Index, x_5 = NSE Index, x_6 = Inflation (%), x_7 = Crude oil price per barrel (Rs), x_8 = Dollar equivalence (Rs), x_9 = Gross Domestic Product, x_{10} = Cost of construction per Square foot x_{11} = Home loan interest (%), x_{12} = Population and x_{13} = Guideline value (Rs)

$b_1, b_2 \dots b_n$ = Slopes associated with $x_1, x_2 \dots x_n$ respectively.

6.4.2 NEURAL NETWORK TECHNIQUE

NN is also commonly used for land price modelling and forecasting. [Steven (2009); Zhangming (2006)]. NN is computationally powerful and well-suited to modelling complex mapping relationships. NN is a computing system composed of a large number of simple and interconnected processing elements that process data based on their dynamic state responses to external inputs. The analysis of the NN model has gained rapid and growing popularity due to its ability to provide solutions to some of the problems in computer science and artificial intelligence that have previously been intractable by regular serial computers.

NN is a computational framework based on knowledge of biological neural cells (neurons) in the brain for its architecture and function. NNs are mathematical and computational models for nonlinear function approximation, data classification, clustering, and nonparametric regression, as well as simulations of the behaviour of collections of model biological neurons (Sudeer, 2011). NN, which is known as artificial intelligence, is a paradigm that is supposed to resemble biological neural networks..The key benefit of the NN methodology for price forecasting over traditional approaches is that it offers a standardised approach and reduces the time spent in model preparation. NN is a statistical model of human cognition or neural biology that has been generalised.

6.4.2.1 MULTILAYER NEURAL NETWORK

Figure 6.7 shows the schematic representation of a feed forward network, which is commonly used in NN model. Neurons are the processing components of the NN. These neurons are linked by information channels. There are several inputs but

only one output for each neuron. External stimulation or the output of other neurons may be used as inputs to the neuron. Each link has a weight that reflects its interconnection power. The neuron is fired and an output signal is generated when the weighted sum of the inputs to the neuron reaches a certain threshold. There are multiple layers to the neurons, including one input, one output, and some hidden layers. Between the input and output layers are these secret layers. The neurons in the input layers receive the input signal and transfer it on to the hidden layers after weighting it. Only the neurons in the output layer would have the same number of input signals as the input signals. The number of neurons in the hidden layers is determined by the accuracy and speed required, and there is no hard and fast law. Signals can only be propagated from the input layer to the hidden layer and from the hidden layer to the output layer in this type of network.

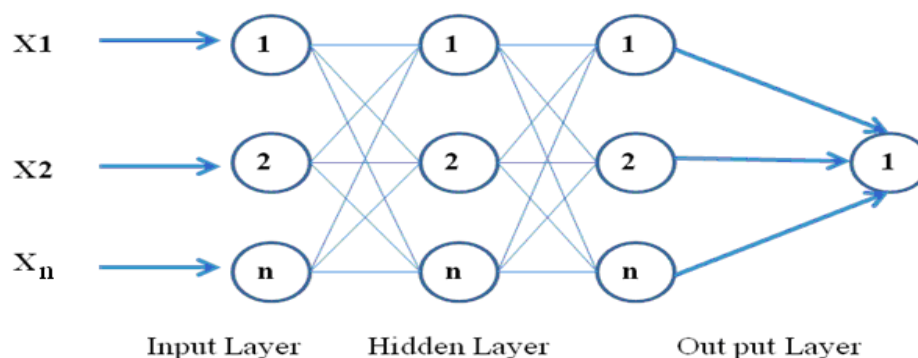


Figure 6.7 Multilayer Neural Network

Only when the weights are changed or turned through a learning method known as training will the network recognise input patterns. The sample collection is divided into subsets. One by one, these subsets are presented to the network. The method is defined as supervised training if the outputs of these samples are known. The method is known as unsupervised training when the outputs are unknown. Epoch is the name given to the span of time in which one goes through this loop. Epoch size refers to the number of training samples in a subset of the total sample. BPN and Conjugate Gradient Algorithm are two approaches for training the network. Among the two, BPN is the most commonly used approach for network preparation. The generalised delta rule is another name for this. Because of its ability to generalise data, BPN has grown

in popularity and is now widely used in defect detection and classification (Maldague and Largouet, 1998).

6.4.2.2 BACK PROPAGATION NETWORK – OVERVIEW

BPN is a multilayered NN architecture that learns from exemplars, which are input sample pairs (Nandhitha 2010). Until an output is produced, the inputs are propagated from the first layer to the next layer via the hidden layer. After that, the obtained performance is compared to the desired target. Backwards propagation of the error is determined. Each unit in the intermediate layer, on the other hand, receives only a portion of the total error signal, based on its relative contribution to the original output. The procedure is replicated layer by layer until each node in the network receives an error signal representing its relative contribution weights. Each unit then updates the network coverage to a state that allows all of the training patterns to be encoded (Yegnanarayana, 2006).

The importance of this process is that as the network matures, the intermediate layers' nodes arrange themselves in such a way that different nodes begin to identify different aspects of the total input space. When given an arbitrary noisy or incomplete input pattern after training, the units in the hidden layers of the network will respond with an active output if the new input contains a pattern that matches the feature the individual units learned to recognise during training. Hidden layer units, on the other hand, have a propensity to suppress their outputs if the input pattern lacks the feature that they were trained to recognise (Freeman and Skapura, 1997).

Data for training must be carefully chosen. In general, as much data as possible should be used. A subset of the available data set can be used to train the network, while the rest can be used to evaluate it. BPN excels at broadening its reach. The output would have scaled values if the output function is sigmoidal. The application typically determines the size of the input and output layers. The size of the hidden layer must be a balance between the necessary storage space and the accuracy of the result. Small random values should be given weights, and the bias values should be kept low. The learning parameter's value has a major impact on the

network parameter. Usually it is to be small in number in the order of 0.05 to 0.25 to ensure network convergence. It is possible to increase the number as the learning proceeds and it will help to speedy convergence. The basic procedure for training the network is

- Give the network an input vector and it will measure the output values.
- Calculate the error by comparing the outputs to real-world values.
- Calculate the sum by which each weight should be changed.
- Correct the weights with the adjustment.
- Repeat for all of the training vectors until the error for all of the vectors in the training set is satisfactory (Nandhitha 2010). The approach presents the application of NN for modeling the land price trend with the support of economic factors. NN model is constructed with 13 indicators that are Processing Elements with one bias node as input. All the input values are normalized using the MinMax table. The principle behind normalization process is:

$$\text{Normalized Value, } N = \frac{[\text{Original Value} - \text{Minimum Value}]}{[\text{Maximum Value} - \text{Minimum Value}]}$$

The Neural Network architecture, used in this study, is a multilayer feed forward network. Levenberg – Marquardt algorithm is used for training MLN. A five layered BPN has been developed with three hidden layers and one output layer. Three hidden layers and one output layer have been built in a five-layered BPN. Figure 6.16 shows a network architecture with three hidden layers and an output layer that provides the best match for the data. The secret layers have 20, 13, 13 neurons each, and the output layer has one neuron. The learning and momentum parameters are 0.6 and 0.9, respectively, and the error convergence is expected to be less than 0.1%. The hidden layers' activation function is tan sigmoid, while the output layer's function is pure linear, which represents real-time values.

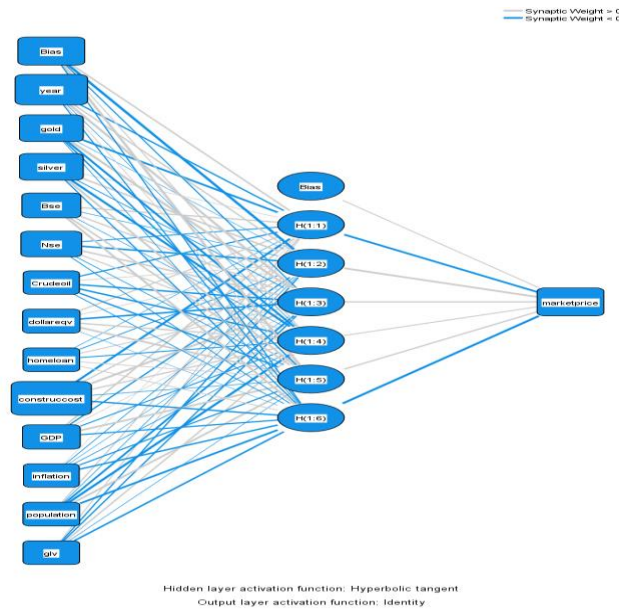


Figure 6.8 Neural Networks Architecture in Pondicherry

6.4.3 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 equation.

$$\text{Correl (X, Y)} = \frac{\sum(x - x')(y - y')}{\sqrt{\sum(x - x')^2 \sum(y - y')^2}}$$

The impact of all of the chosen factors (X) on land price (Y) is investigated. In all thirteen study places, inflation, dollar equivalence, and home loan interest show a negative association with land price. The remaining variables have a favourable relationship with the land price, as shown in Table 5.6. Table 5.7 reveals that the dollar and home loan interest have a negative relationship with the other factors, while inflation has a marginal positive relationship with the remaining factors. Multiple regression analysis was conducted with a 95% confidence level and a 5% error significance level, and it was discovered that the analysis describes the pattern very well, with R² values ranging from 0.97 to 0.99. The variables were ranked in order of their impact on the production in descending order (market price of land). Figure 5.17 indicates that the GLV and silver price alone account formore than half of total output.

Table 6.4 Interaction of the Selected Factors on Land Price

Location	ARIYANKUPPAM	PILLAICHAVADI	SARAM	KALAPET	PONDICHERRY
Factors					
Time	0.97	0.96	0.98	0.98	0.98
Gold	0.92	0.92	0.96	0.96	0.95
Silver	0.94	0.93	0.94	0.93	0.94
BSE	0.97	0.96	0.96	0.95	0.96
NSE	0.97	0.96	0.96	0.95	0.96
Croil	0.49	0.50	0.57	0.62	0.55
Dol	0.93	0.93	0.90	0.89	0.91
HL	-0.42	-0.36	-0.40	-0.36	-0.40
CC	0.99	0.99	0.99	0.98	0.99
GDP	-0.10	-0.14	-0.13	-0.10	-0.12
Infla	-0.12	-0.13	-0.01	0.03	-0.04
Pop	0.95	0.97	0.97	0.97	0.99

Table 6.5 Interaction among Selected Factors

Factors	Time	Gold	Sil	BSE	NSE	Croil	Doll	HL	CC	GDP	Infla
Time	1.000	-	-	-	-	-	-	-	-	-	-
Gold	-0.032	1.000	-	-	-	-	-	-	-	-	-
Sil	-0.042	0.969	1.000	-	-	-	-	-	-	-	-
BSE	-0.029	0.960	0.964	1.000	-	-	-	-	-	-	-
NSE	-0.028	0.958	0.961	0.998	1.000	-	-	-	-	-	-
Croil	-0.012	0.740	0.674	0.709	0.708	1.000	-	-	-	-	-
Doll	-0.049	0.942	0.952	0.934	0.933	0.596	1.000	-	-	-	-
HL	0.005	-0.460	-0.529	-0.483	-0.480	-0.209	-0.442	1.000	-	-	-
CC	-0.028	0.976	0.966	0.988	0.988	0.699	0.955	-0.511	1.000	-	-
GDP	-0.001	-0.109	-0.025	-0.046	-0.048	0.000	-0.064	-0.304	-0.056	1.000	-
Infla	0.001	0.112	0.028	0.005	0.001	0.437	-0.116	0.054	0.000	0.075	1.000

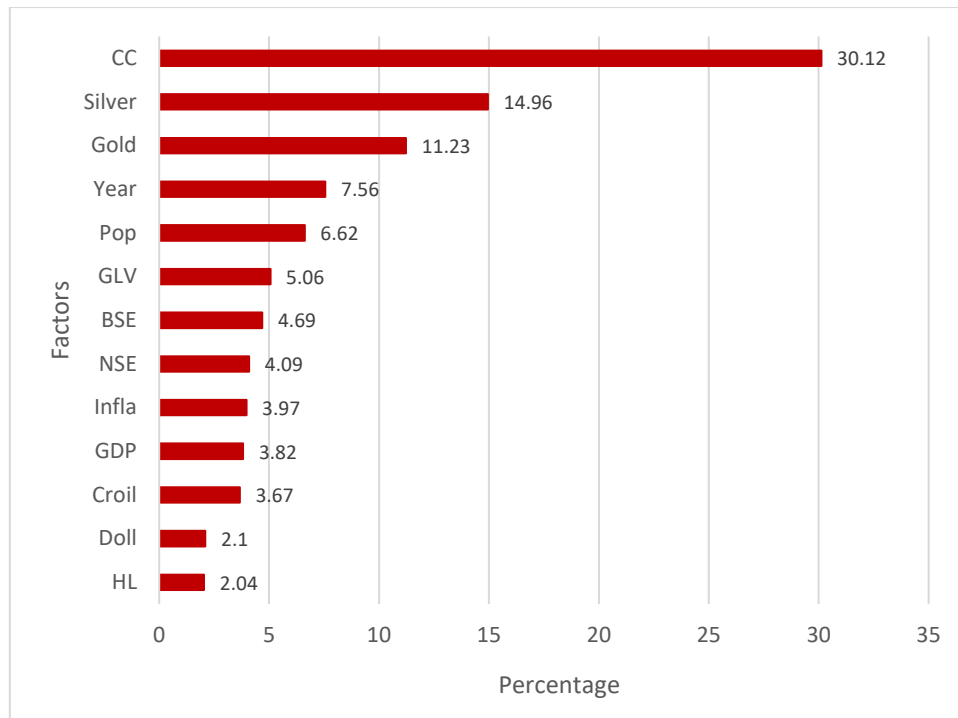


Figure 6.9 Ranking of Factors by NN Method at Kalapet in Pondicherry

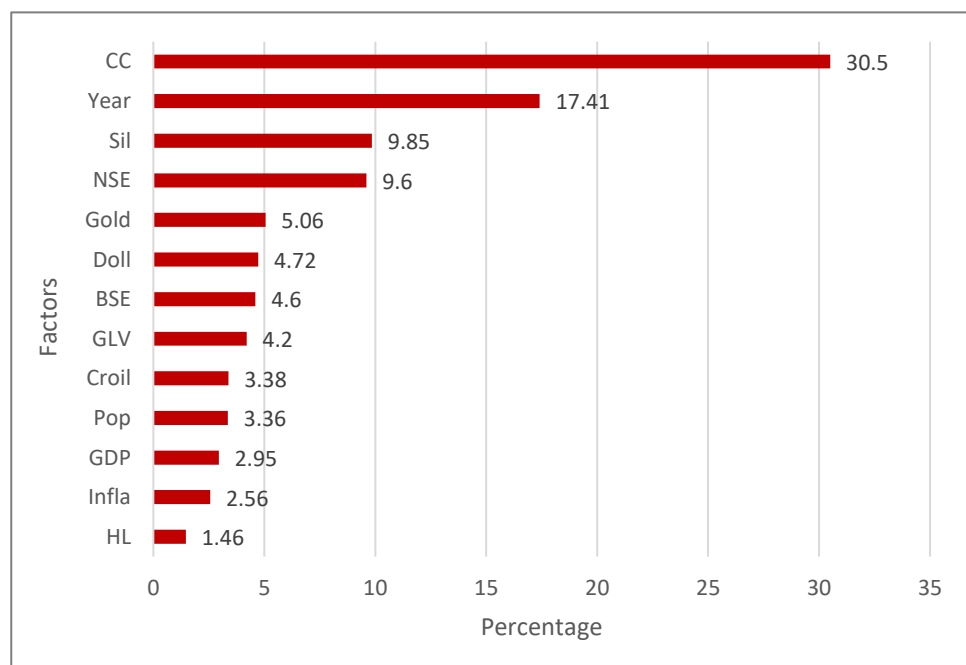


Figure 6.10 Ranking of Factors by NN Method at Pillaichavadi in Pondicherry

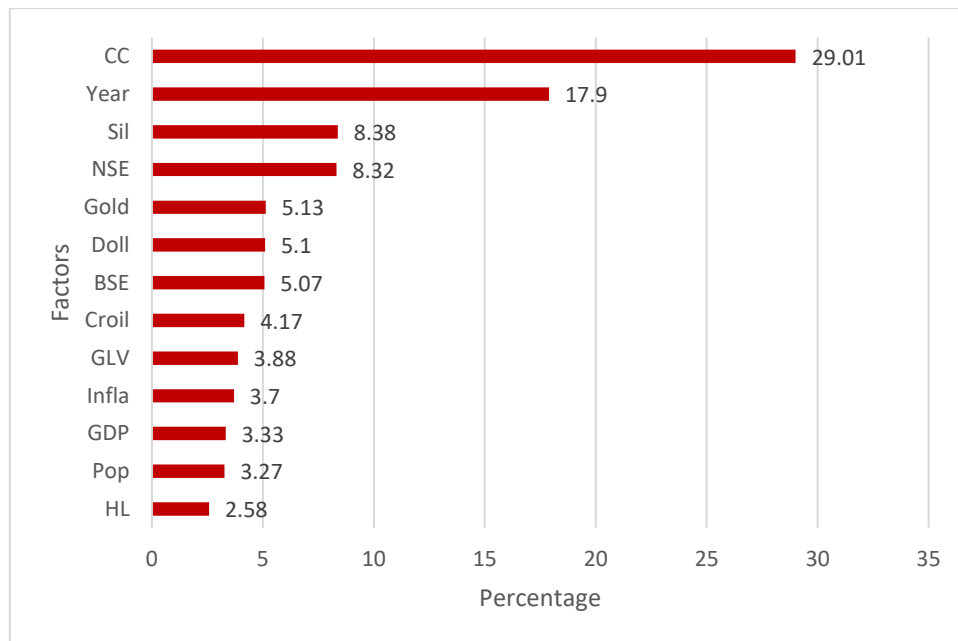


Figure 6.11 Ranking of Factors by NN Method at Ariyankuppam in Pondicherry

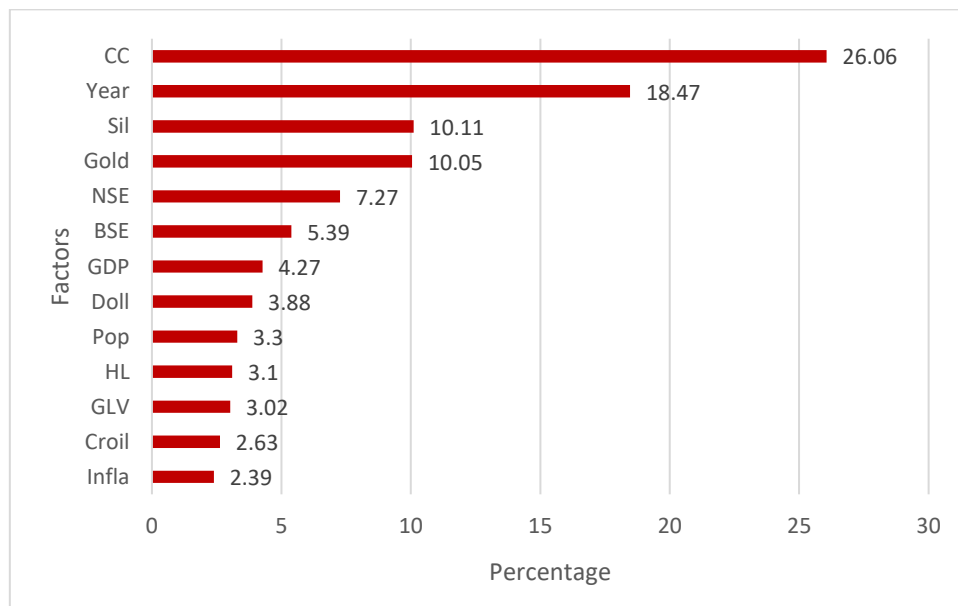


Figure 6.12 Ranking of Factors by NN Method at Saram in Pondicherry

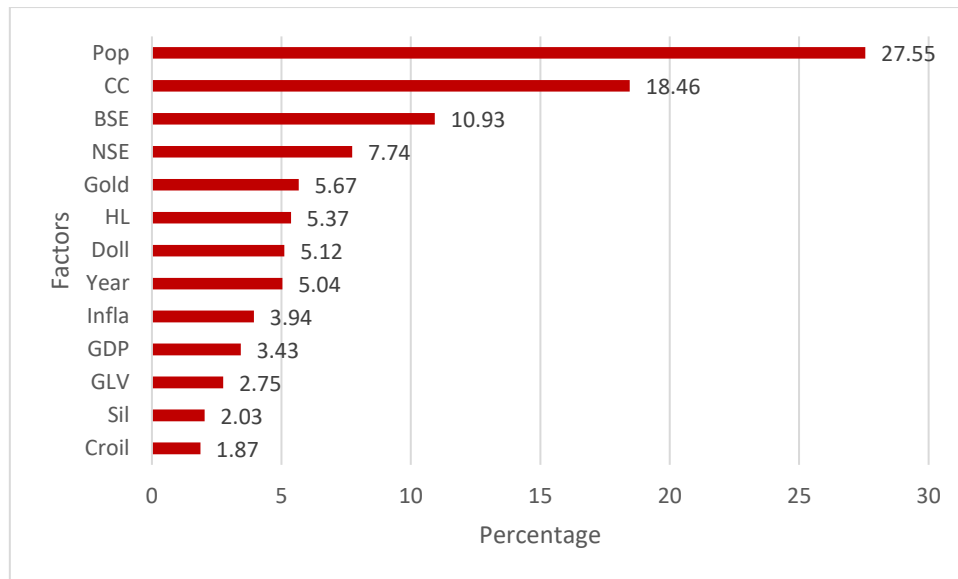


Figure 6.13 Ranking of Factors by NN Method at Pondicherry

Market Price at Kalapet in Pondicherry = $11753628.559 - (6253.537 \times x_1) - (15.199 \times x_2) + (49.933 \times x_3) + (18.754 \times x_4) + (1868.44 \times x_5) + (10979.090 \times x_6) + (1751.134 \times x_7) + (12001.859 \times x_8) + (1696.035 \times x_9) - (1.030 \times x_{10}) + (180.290 \times x_{11}) - (10171.638 \times x_{12}) - (.1408 \times x_{13})$

Market Price at Saram in Pondicherry = $288130781.9 - (145262.262 \times x_1) + (610.824 \times x_2) - (29740.174 \times x_3) - (8.886 \times x_4) + (46.889 \times x_5) + (83.446 \times x_6) - (1133.765 \times x_7) - (30013.238 \times x_8) + (10503.865 \times x_9) - (7100 \times x_{10}) + (25593.684 \times x_{11}) - (5.683 \times x_{12}) - (.189 \times x_{13})$

Market Price at PillaiChavadi in Pondicherry = $51652001.008 - (.096 \times x_1) - (26438.480 \times x_2) - (6.912 \times x_3) - (6461.275 \times x_4) - (.848 \times x_5) + (34.457 \times x_6) - (1.546 \times x_7) - (5717.609 \times x_8) + (15515.514 \times x_9) + (1804.261 \times x_{10}) - (520.091 \times x_{11}) - (2634.003 \times x_{12}) - (.338 \times x_{13})$

$$\begin{aligned} \text{Market Price at Ariyankuppam in Pondicherry} = & 335088.439 - (656.491 \times x_1) \\ & + (2403.308 \times x_2) - (94.511 \times x_3) - (1.122 \times x_4) + (9.605 \times x_5) - (16.941 \times x_6) + \\ & (4106.671 \times x_7) + (7883.470 \times x_8) + (3767.961 \times x_9) - (2256.134 \times x_{10}) - \\ & (8863.788 \times x_{11}) - (26.817 \times x_{12}) - (.073 \times x_{13}) \end{aligned}$$

$$\begin{aligned} \text{Market Price at Pondicherry} = & 53790097.23 + 156.02 \times x_1 - (8238.72 \times x_2) - \\ & (9.263 \times x_3) + 30.386 \times x_4 + (11.224 \times x_5) - (1824.115 \times x_6) + (7667.66 \times x_7) + \\ & (5729.664 \times x_8) - (522.276 \times x_9) + (9574.73 \times x_{10}) - (26624.259 \times x_{11}) - \\ & (0.374 \times x_{12}) - (5.880 \times x_{13}) \end{aligned}$$

Where x_1 = Time (Year & Month), x_2 = Gold price per gram (Rs) , x_3 = Silver price per gram (RS), x_4 = BSE Index, x_5 = NSE Index, x_6 = Inflation (%), x_7 = Crude oil price per barrel (Rs), x_8 = Dollar equivalence (Rs), x_9 = Gross Domestic Product, x_{10} = Cost of construction per Square foot x_{11} = Home loan interest (%), x_{12} = Population and x_{13} = Guideline value (Rs)

Table 6.6 Model Summary and Analysis of Variance (ANOVA) of 4 Locations

Factors	Pillaichavadi	Ariyankuppam	Saram	Kalapet	Pondicherry
R	0.999	1.000	0.999	0.997	0.999
R ²	0.997	1.000	0.998	0.994	0.999
Adjusted R ²	0.997	1.000	0.998	0.994	0.999
Sum of Square	9.820E+13	3.744E+14	2.340E+15	9.947E+13	4.767E+14
Df	13	13	13	13	13
Mean Square	7.554E+12	2.880E+13	1.800E+14	7.652E+12	3.667E+13
F	6408.642	45961.117	8302.347	3118.483	17594.843
Significance	0.001	0.000	0.000	0.001	0.000

6.4.4.1 HISTOGRAM

A histogram is a graphical representation of statistics that represents the distribution of data visually. Karl Pearson was the first to introduce it as a method of estimating the probability distribution of a continuous variable. A histogram is made up of tabular frequencies represented as adjacent rectangles that are erected over discrete intervals (bins) and have an area equal to the frequency of the observations in the interval. The frequency density of the interval, i.e. the frequency divided by the width of the interval, is also equal to the height of a rectangle. The total area of the histogram is equal to the number of data, and Figure 6.13 shows the histogram of a typical CMA model. A normalised histogram may also be used to represent relative frequencies. The proportion of cases that fall into each of several categories is then shown, along with the total area. The categories are typically described as non-overlapping, consecutive intervals of a variable. The categories (intervals) must be next to each other and of equal size.

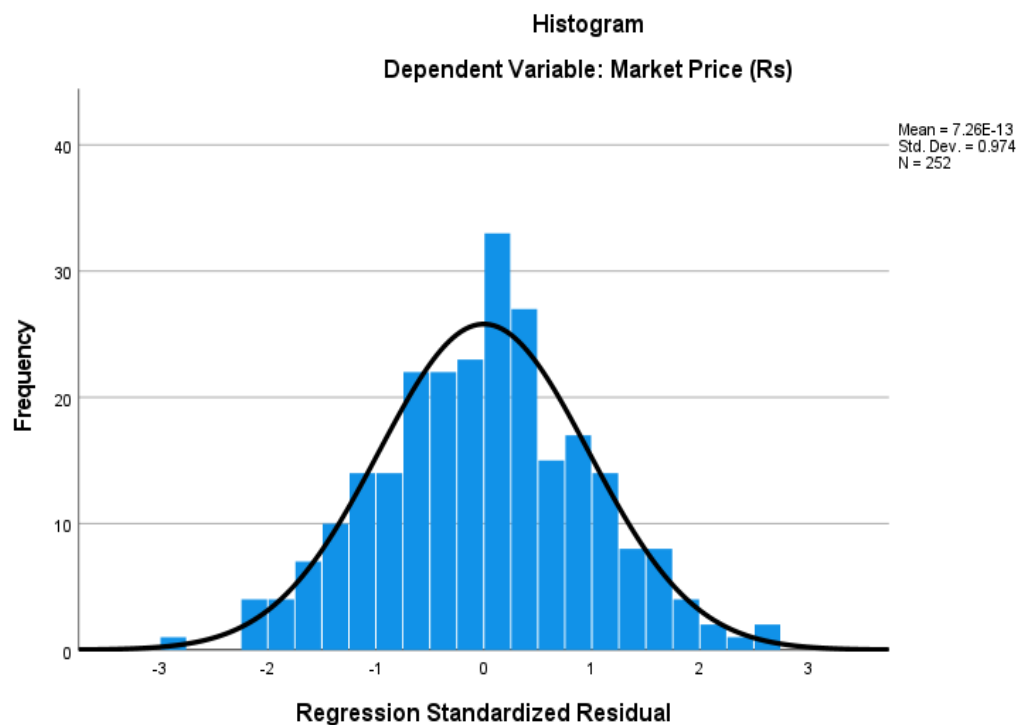


Fig 6.14 Histogram of Pondicherry

6.4.4.2 Dendrogram

The results of hierarchical cluster analysis are represented graphically in a dendrogram. Each stage of hierarchical clustering is described by the fusion of two tree branches into a single one in this tree-like plot. The branches reflect the clusters that were discovered at each stage of the hierarchical clustering process. A mathematical procedure, such as cluster analysis, is typically used to create a dendrogram. A Dendrogram's aim is to show the relationships between different units by grouping them into smaller and smaller clusters. All of the factors are grouped into two clusters in Pondicherry, with the first cluster containing only GLV and the second cluster containing the remaining twelve factors. Figure 6.14 illustrates the merger of both clusters in the direction of market value.

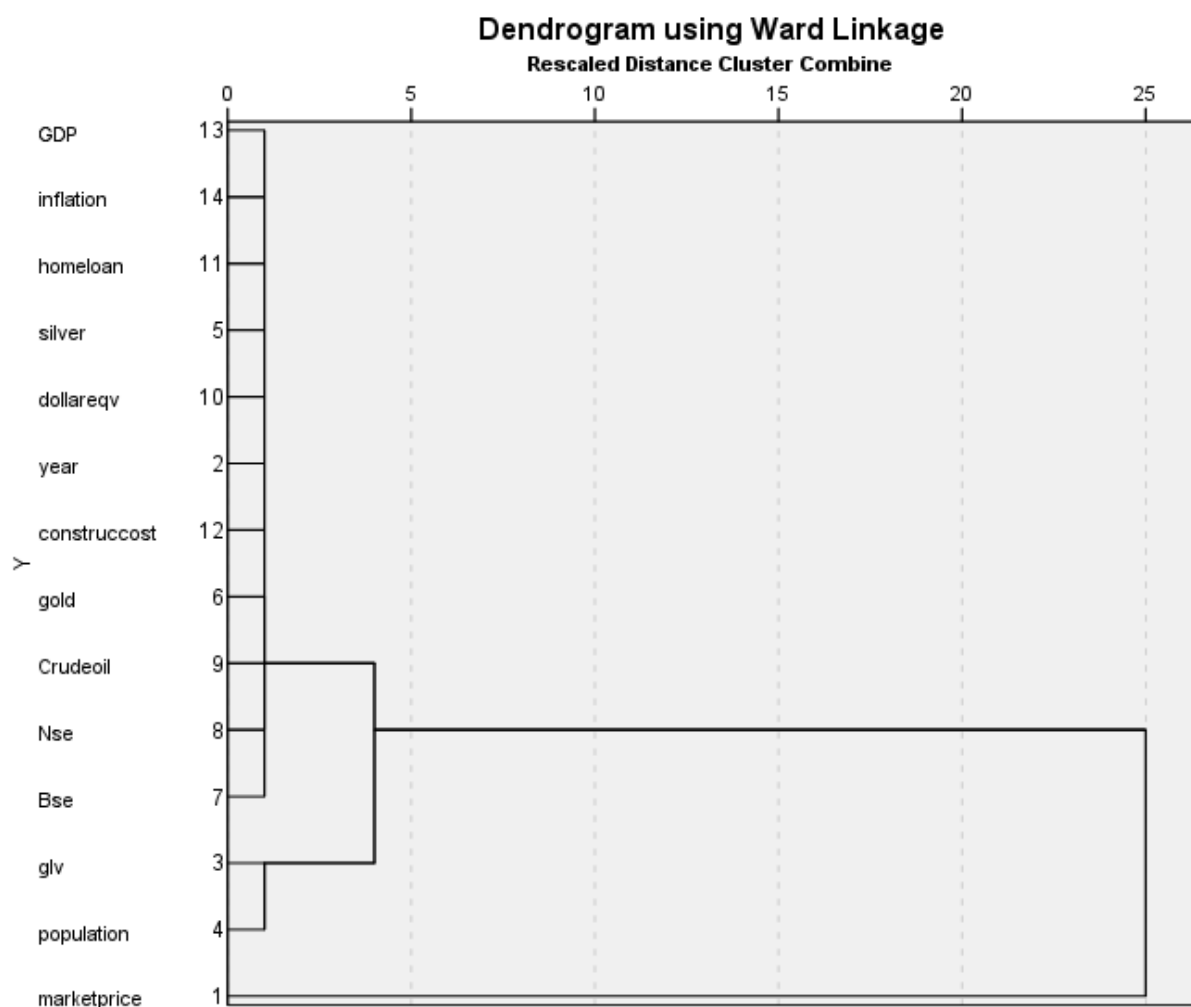


Figure 6.15 Dendrogram using Ward Method

6.5 VALIDATION OF LAND PRICE MODELING

For the years 2019 and 2020, the built models have been validated. Figures 6.15 to 5.34 show the land price output using multiple regression for the selected study areas and Pondicherry. Since the whole data can be interpreted, graphical measures are more effective than numerical measures. In Pondicherry, both models overestimated the land price. This may be attributable to the accumulation of erroneous data in different areas of the study field, as well as the investigation's small number of locations.



Figure 6.16 Validation of Model at Kalapet in Pondicherry

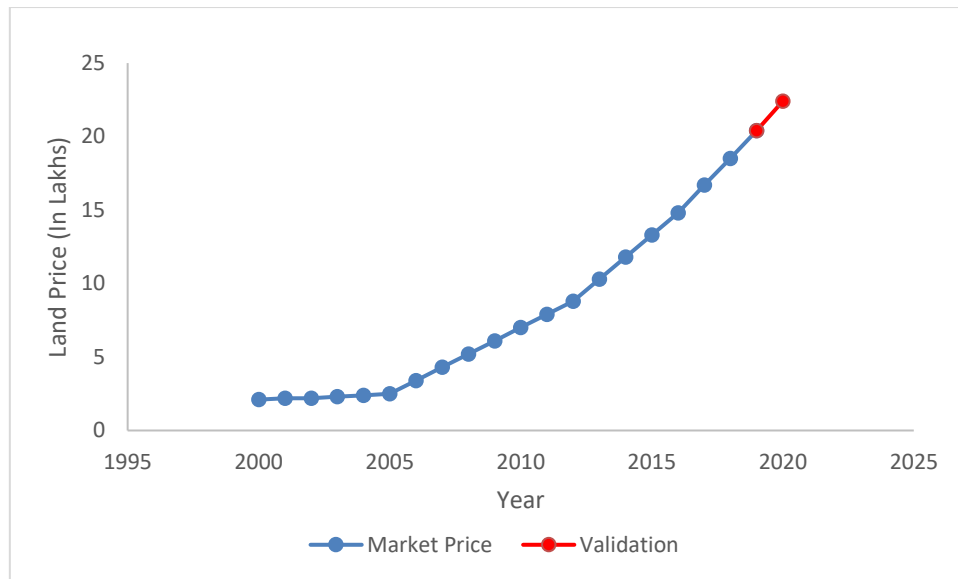


Figure 6.17 Validation of Model at Pillaichavadi in Pondicherry

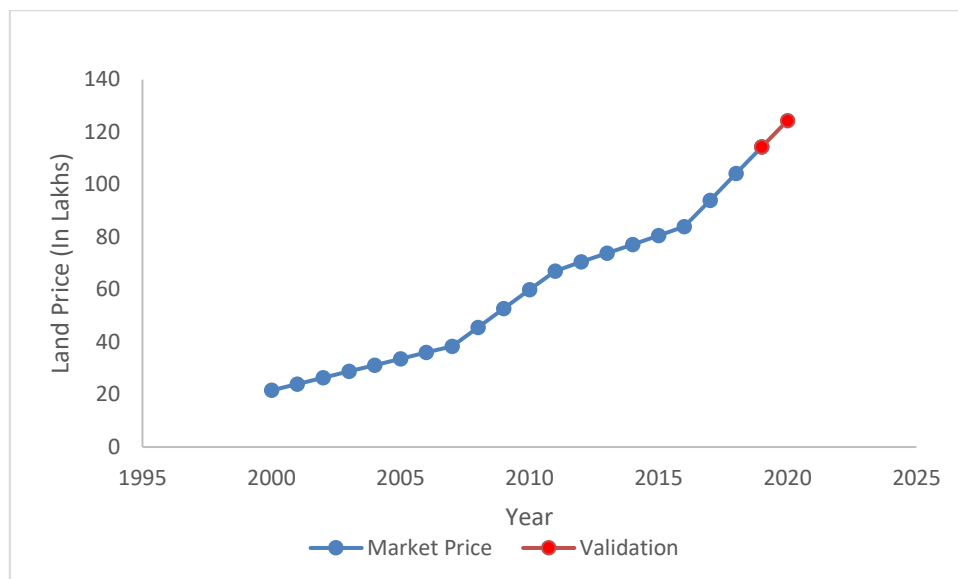


Figure 6.18 Validation of Model at Saram in Pondicherry

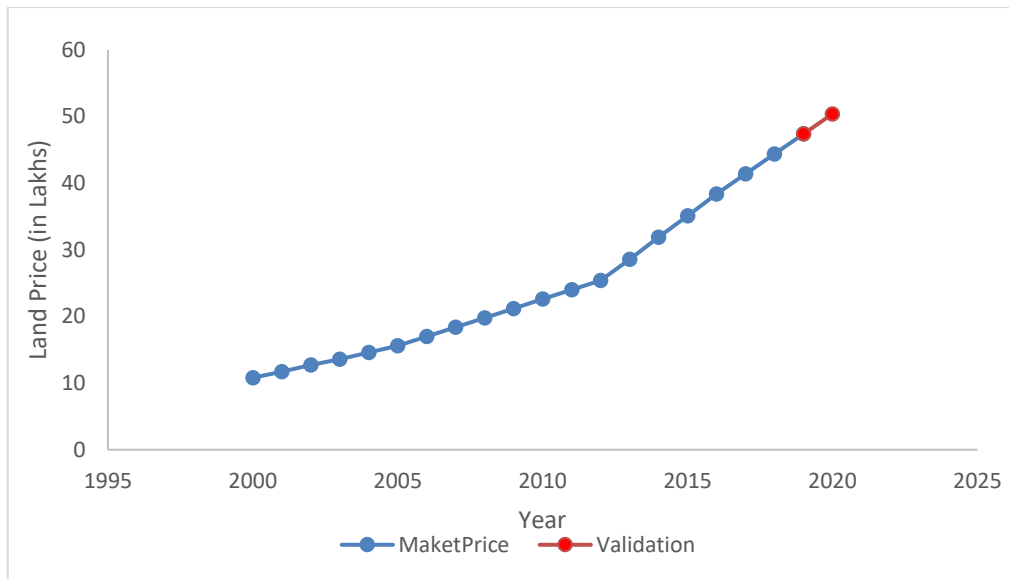


Figure 6.19 Validation of Model at Ariyankuppam in Pondicherry

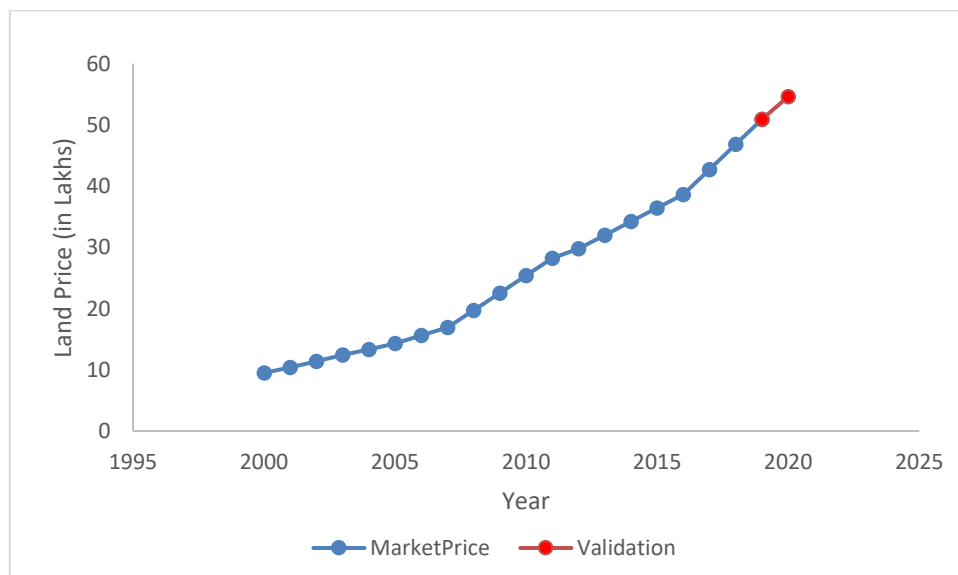


Figure 6.20 Validation of Model at Pondicherry

The Validation models implies that the Regression model perfectly fit into the Market Price. So that Market Price Market Price Can be predicted with lesser than 14% error. Kalapet Regression fit having some error but the error percentage was lesser within the evaluation limit. Other Study areas are perfect fit and error was below 5%.

CHAPTER 7

FORECASTING OF LAND PRICE IN PONDICHERRY

7.1 GENERAL

This chapter looks at how to forecast land prices in Pondicherry at various study locations using potential projected assumptions based on past patterns. The forecasted land price trend is compared to the previous trend for Twenty years (2000-2020) and five years (2021 - 2025).

7.2 FORECASTING OF LAND PRICE

Predicted values of all selected variables are plugged into the model to predict the future price of land. For the period 2021 to 2025, GLV, GDP, Dollar Equivalence, and Inflation are predicted using a linear method, while the rest of the variables are predicted using a polynomial method. Table 7.1 shows the expected GLV values in all thirteen locations from 2020 to 2025 with an R^2 value of 0.9. Table 7.2 displays the economic factors that are projected to have a high level of R^2 values between 2021 and 2025, based on their previous trend.

Table 7.1 Linear Prediction Values of GLV (Rs. in Lakhs)

Location	R^2	2021	2022	2023	2024	2025
Ariyankuppam	0.94	20.9	22.1	24	25.9	27.9
Pillaichavadi	0.91	13.2	14.7	16.2	18.1	20
Saram	0.91	35.1	36.2	37.3	38.4	39.5
Kalapet	0.95	9.3	10.3	11.3	12.5	13.8

Table 7.2 Factors Prediction Values

Factor	Type of Prediction	R²	2021	2022	2023	2024	2025
Gold	Polynomial	0.96	4692	4928	5169	5438	5714
Sil	Polynomial	0.96	68	71	74	77	80
BSE	Polynomial	0.98	42012	44659	47386	50450	53607
NSE	Polynomial	0.98	12417	13190	13985	14878	15798
Croil	Polynomial	0.65	5131	5295	5432	5597	5762
Doll	Polynomial	0.97	82.96	87.55	91.57	96.63	101.95
HL	Polynomial	0.29	8.57	8.49	8.42	8.33	8.25
CC	Polynomial	0.99	1949	2051	2138	2246	2358
GDP	Polynomial	0.07	4.07	3.47	2.82	2.06	1.24
Infla	Polynomial	0.13	6.4	6.4	6.5	6.5	6.5

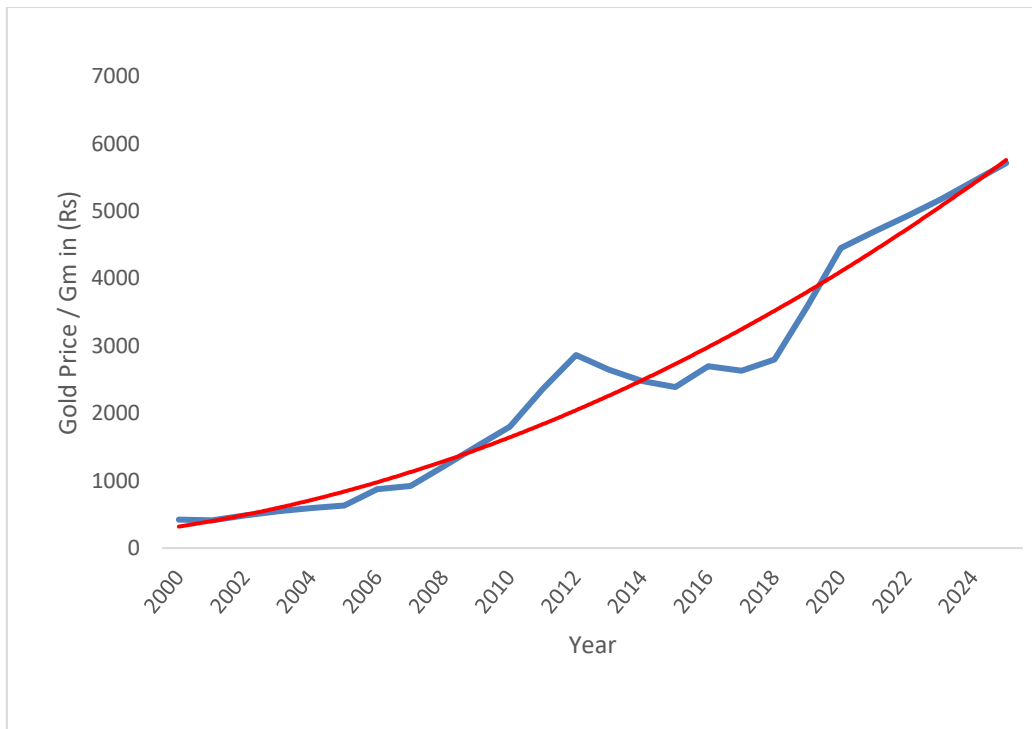


Figure 7.1 Figure Predicted Pattern of Gold Upto 2025

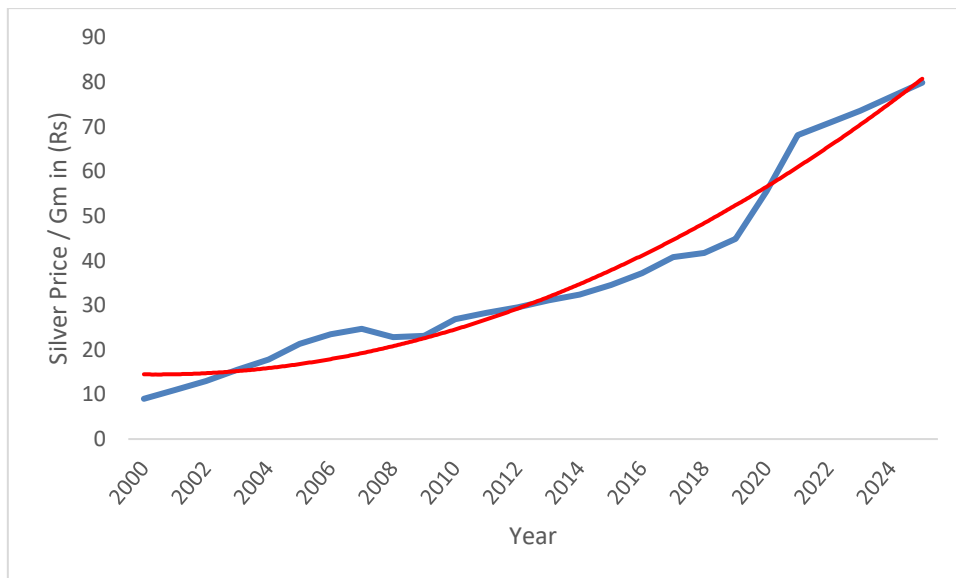


Figure 7.2 Predicted Pattern of Silver Upto 2025

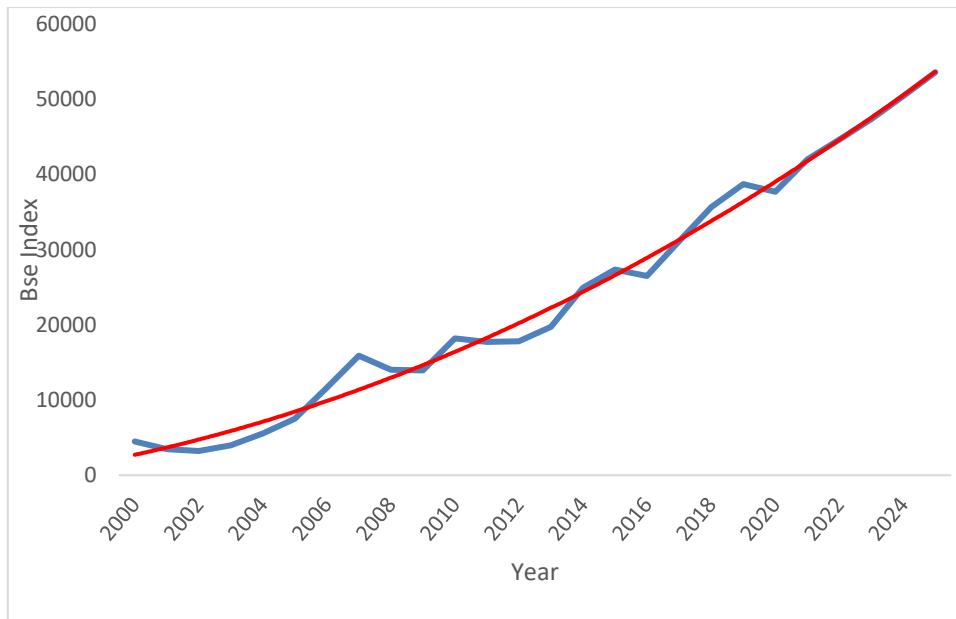


Figure 7.3 Predicted Pattern of BSE Index Upto 2025

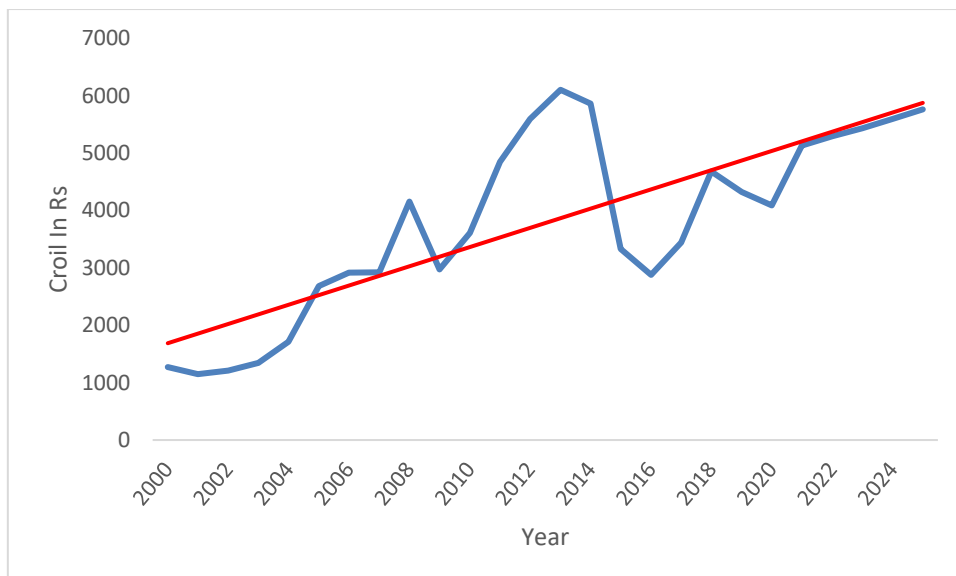


Figure 7.4 Predicted Pattern of Crude Oil Upto 2025

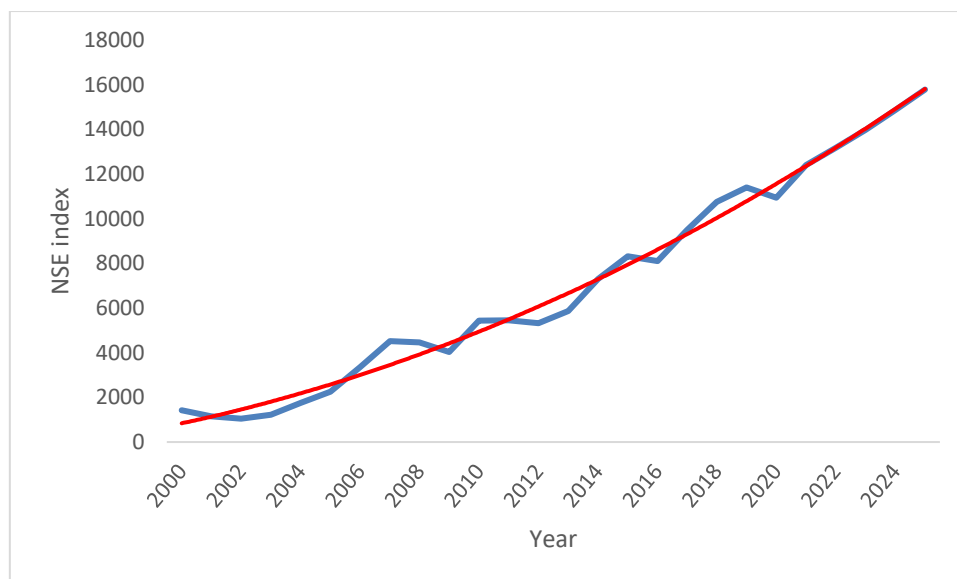


Figure 7.5 Predicted Pattern of NSE Index Upto 2025

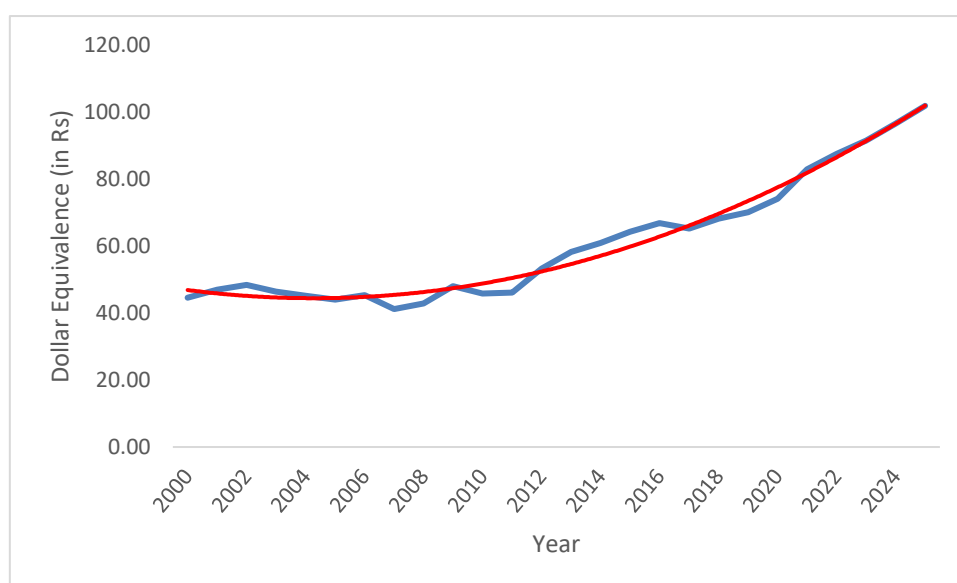


Figure 7.6 Predicted Pattern of Dollar Upto 2025

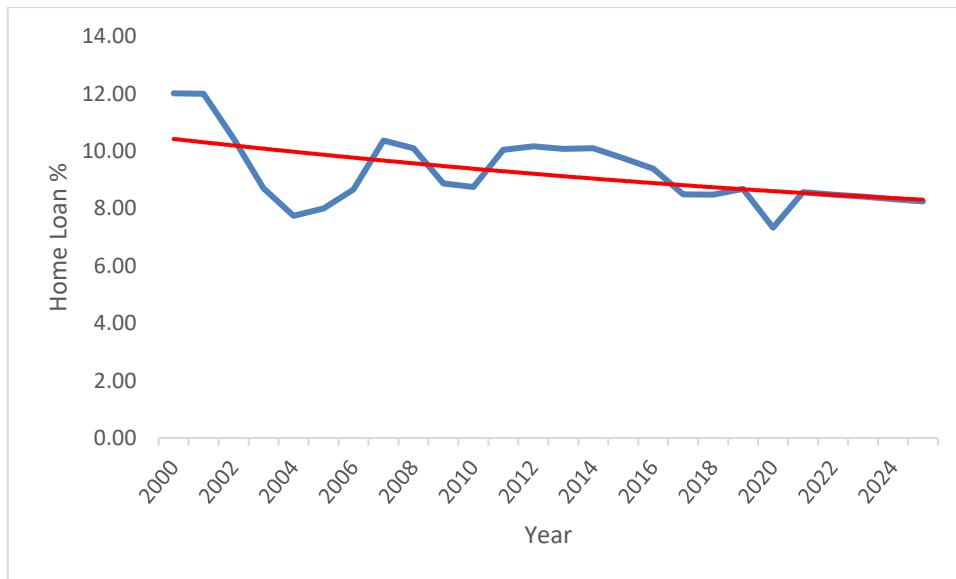


Figure 7.7 Predicted Pattern of Home Loan Upto 2025

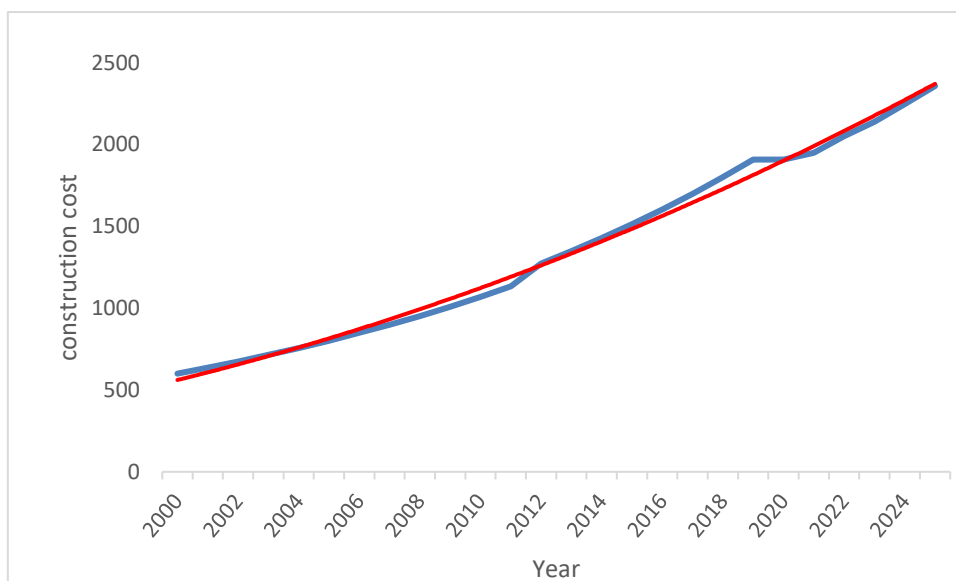


Figure7.8 Predicted Pattern of Construction cost Upto 2025

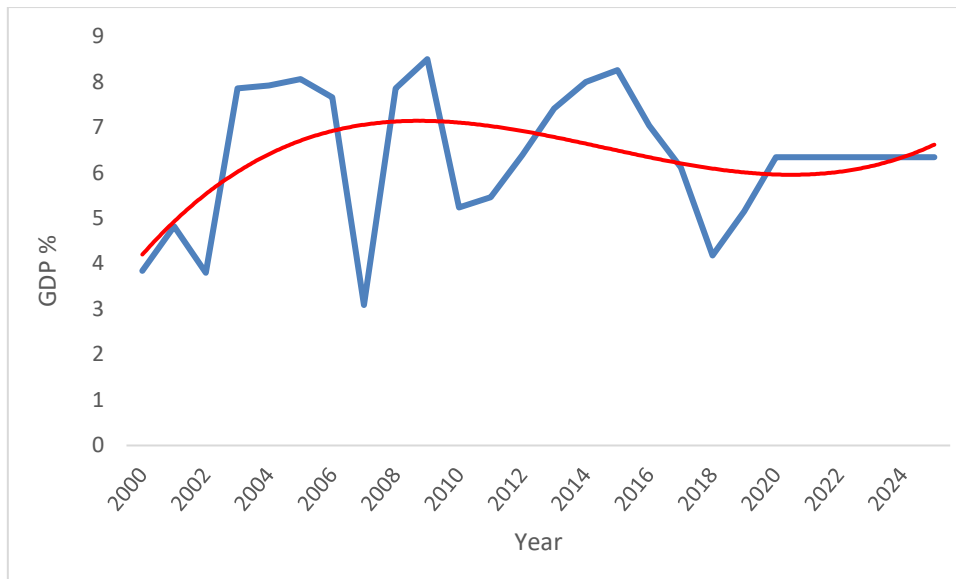


Figure 7.9 Predicted Pattern of GDP Upto 2025

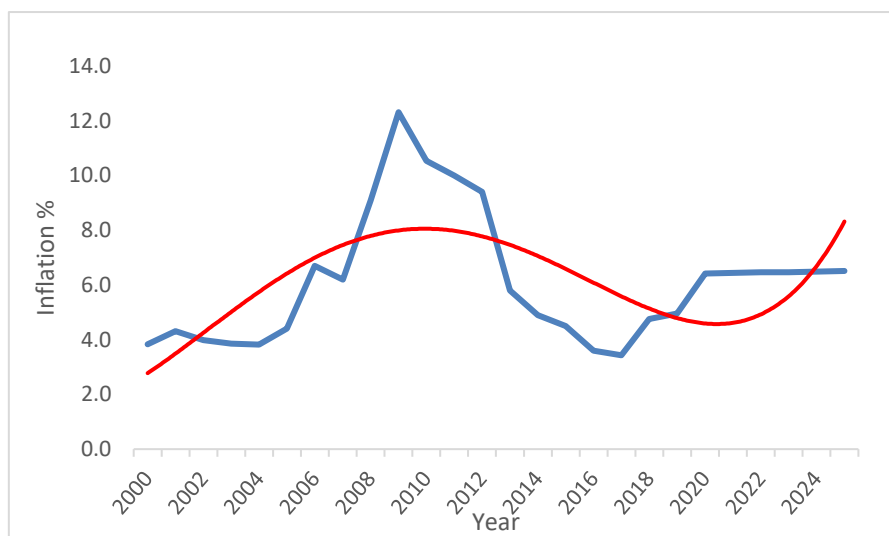


Figure 7.10 Predicted Pattern of Inflation upto 2025

The assumptions made on the factors are plugged in the regression and NN model, trained and the hypothetical data is allowed to test. The test result yields the future price of unit land and its behaviour at study locations is shown in Figures from 7.11 to 7.14. It can be seen that the price rise in all the locations will be positive. The behaviour of the common forecast model for Pondicherry is shown in Figure 7.15

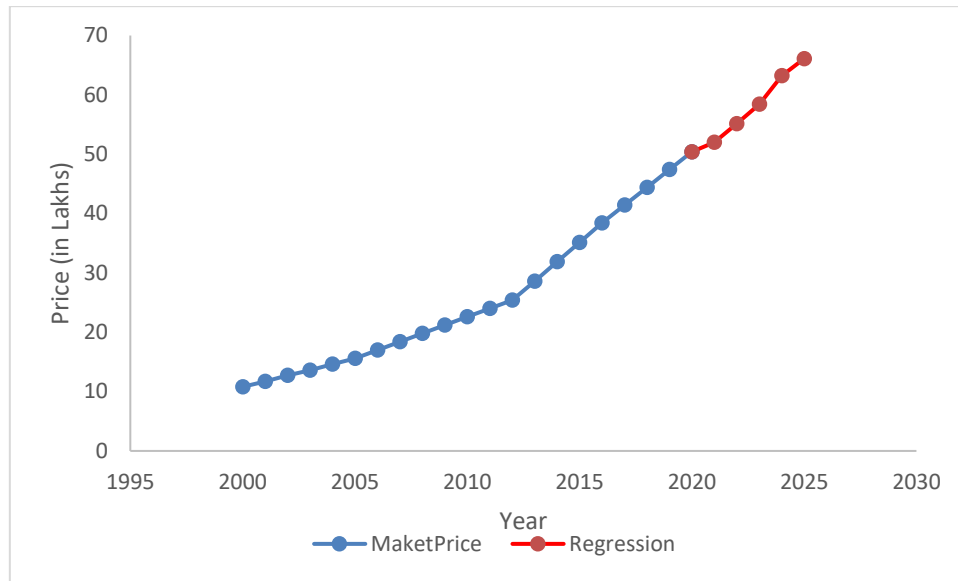


Figure 7.11 Predicted price Model at Ariyankuppam in Pondicherry

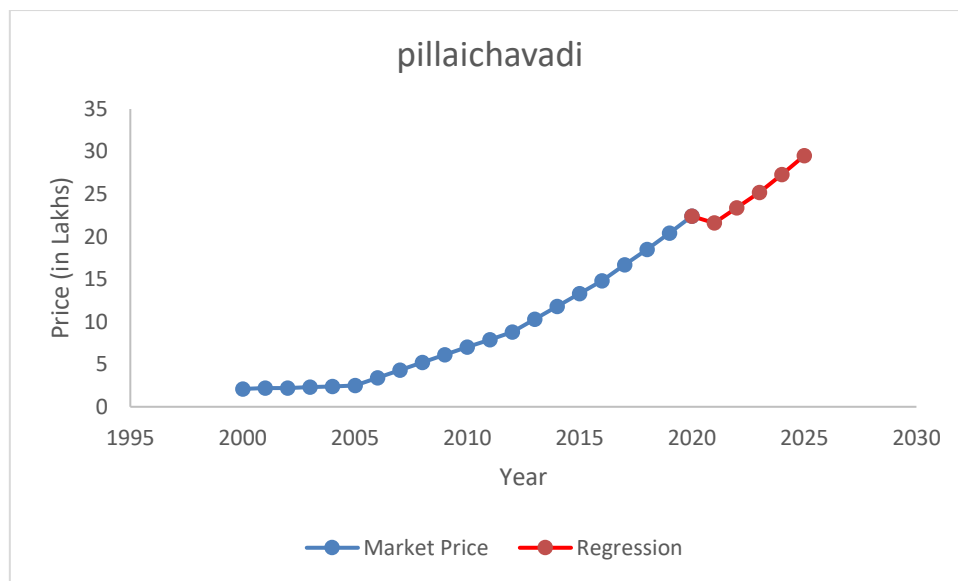


Figure 7.12 Predicted Price Model at Pillaichavadi in Pondicherry



Figure 7.13 Predicted price Model at Kalapet in Pondicherry



Figure 7.14 Predicted Price Model at Saram in Pondicherry



Figure 7.15 Predicted price Model at Pondicherry

7.3 ANALYSIS OF FORECASTING RESULTS

The average increase in land price for the next five years between 2021 and 2025 is forecasted for all the selected four locations in Pondicherry. From the forecasted figures, it can be seen that the maximum average land price rise is within 15 % in all the zones of Pondicherry. The highest percentage growth of land price is forecasted at 14 % in Saram. The next higher price rise of 11 % is predicted in Ariyankuppam. But the predicted Land Price in Pillaichavadi was little higher in compared with Kalapet. Overall, the central region of Pondicherry and South region of Pondicherry will experience heavy Price rise in Future. And the Price was Going to be more than 19% annually.

7.4 INFLUENCE OF SELECTED FACTORS ON FORECASTED LAND PRICE

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 is assumed to be suitable, inflation to be within a comfortable range of 4 to 6 percent, GDP to be within a better range of 8 to 10%, and construction costs to be within a tolerable range of Rs 1900 to 2000 per square foot area. The combination of an 8% home loan, 6% inflation, and a 10% GDP would keep the land price under control and pull it down by up to 4%. So the policy emphasis should be on lowering building costs by controlling material costs, using alternative affordable materials, and using innovative cost-effective construction methodologies on a large scale to keep land prices from rising in the future

CHAPTER 8

SUMMARY AND CONCLUSION

8.1 SUMMARY

The pattern of land prices in Pondicherry is examined by modelling and forecasting land prices at four different locations within Pondicherry, using economic and social factors as influencing factors. Data for all factors affecting land price are gathered from primary and secondary sources for the period 2000 to 2020. The models are built using these details. Multiple regression and NN techniques are used in modelling and forecasting. The predicted prices are then compared to the five-year average rise in land prices.

8.2 CONCLUSION

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

- The study shows that the land price influenced more by economic Factor in compared with Social Factor.
- The five factors construction cost, time, gold, silver and NSE have more than 65 % effect on land price in Pondicherry.
- In the analysis, all the factors other than inflation, dollar equivalence and interest on home loan show positive correlation with unit land price.
- In this analysis, the predictive and forecasting ability of regression and NN techniques on land price is compared. Despite the fact that both models are found to be well matched with the data set of land price modelling and forecasting in all locations, the model based on regression has a higher accuracy.
- The ability of regression and NN techniques to predict and forecast land price is compared in this report. Despite the fact that both models are well aligned with the land price modelling and forecasting data set in all areas, the regression model has a higher accuracy.

- A common land price model for Pondicherry is developed and is given below:

$$\begin{aligned} \text{Market Price at Pondicherry} = & 53790097.23 + 156.02 \times x_1 - \\ & (8238.72 \times x_2) - (9.263 \times x_3) + 30.386 \times x_4 + (11.224 \times x_5) - (1824.115 \times x_6) \\ & + (7667.66 \times x_7) + (5729.664 \times x_8) - (522.276 \times x_9) + (9574.73 \times x_{10}) - \\ & (26624.259 \times x_{11}) - (0.374 \times x_{12}) - (5.880 \times x_{13}). \end{aligned}$$

8.3 APPLICATION OF THE STUDY

The following are some of the study's functional applications.

- The results of this report will be included in the annual adjustment of land guideline prices, possibly drawing in more income for the state government during land transactions.
- This report would assist policymakers in considering the historical movement of the established factors in order to monitor and stabilise the increase in land prices.
- Since there is a greater need for good long-term data analysis regarding land price, general land market behaviour, and growth, the findings of this study may be very useful to government and non-government organisations involved in land administration.

Regulatory mechanisms such as on-line land registers, proper regulation and monitoring on land use transfer and taxes may be devised to promote creation of suitable areas, exert a balancing impact on the land market, and redistribute the population to receive large benefits, among other things.

REFERENCES

1. Asabere. P.K and Harvey. B (2003), "Factors Influencing the Value of Urban Land: Evidence from Halifax-Dartmouth, Canada", *Journal of Real Estate Economics*, Volume 13, Issue 4, pp. 361–377.
2. V. SampathKumar, M.Helen Santhi and J.Vanjinathan, 2015, "Evaluation of theTrend of Land Price Using Regression and Neural Network Models", *Asian Journal of Scientific Research*, ISSN 1992-1454.
3. Anthony. H., et al. (2006), "Predicting Construction Cost Using Multiple Regression Techniques", *Journal of Construction Engineering and Management*, Vol. 132, No.7, pp. 750-758.
4. Alston. J.M (1984), "An Analysis of International Land Prices", Ph.D Thesis, North Carolina State University.
5. Alston. J.M (1986), "Analysis of Growth of US Farmland Prices", *American Journal of Agricultural Economics*.
6. Burt. O.R (1986), "Econometric Modeling of the Capitalization Formula for Farmland Prices", *American Journal of Agricultural Economics*.
7. Marko. H (2005), "An Analysis of Land Prices: A Structural Time-Series Approach" *International Journal of strategic property management*, Vol. 9, No. 3, pp. 145-172.
8. Rice (1992), "Land Price Model", *Journal of Real Estate Research*, Vol. 28(3), pp. 293-320.
9. Yegnanarayana. B (2006), 'Artificial Neural Networks', Prentice Hall of India Pvt. Limited.
10. Newell. G and Macfarlane. J (2006), "The Accuracy of Property Forecasting in Australia", *Pacific Rim Real Estate Society Conference*, Auckland
11. Feldstein. M (1980b), "Inflation, Tax Rules and the Stock Market", Working Paper No. 403, Harvard University, National Bureau of Economic Research
12. Kurnow. E (2007), "Land Value Trends In The US".
13. John. M.C and Carmelo. G (2003.), "Evaluating House Price Forecasts", *Journal of Real Estate Research*.
14. Wang. J and Tian. P (2005), "Real Estate Price Indices Forecast by Using Wavelet Neural Network, Computer Simulation".

15. Philips. P.C.B (1986), "Understanding Spurious Regressions in Econometrics", Journal of Econometrics
16. Hannonen (2008), "Predicting Urban Land Prices : a Comparison of Four Approaches", International Journal of Strategic Property Management
17. John.T.S.J (1983), "Factors Affecting Land Price Decline", American Journal of agricultural economics