Multiple regression analysis to predict the value of a residential building and to compare with the conventional method values

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Abstract: Valuation is an art which has found various use in different sectors. But it is seldom restricted to the boundaries of engineers and architects when it comes to property valuation. In the present study, the market value of a residential building situated in Udupi, Karnataka State, India is predicted using Multiple Regression Analysis (MRA) based on the factors affecting the value of the property. This value is then compared with the values obtained by the conventional approaches of valuation like Land and Building method, Rental Income Approach, Composite Rate method and by detailed estimation approach. The property under valuation has a plinth area of 2545.42 square feet standing on a free hold land of 4207.896 square feet. The market value predicted by Multiple Regression Analysis (MRA) shows a variation of 14.10% in comparison with Land and Building method, a variation of -22.17% in comparison with Rental Income approach, a variation of 4.90% in comparison with Composite Rate method and a variation of 8.81% in comparison with detailed estimate method. The advantage of using MRA is that it uses statistical modelling and reduces the chance of human bias and error.

1. INTRODUCTION

Valuation is an art of estimating meaningful present worth of any commodity or property based on experience, logical approach, relevant statistical data and certain common sense at a stated time. It only attempts at suggesting the fair prices. Valuation is not an arbitrary process. It is based on certain facts and only after a judicious processing of such facts and indications, we can suggest value or fair price of the property. Rise and fall of the fair price can occur in a very short span of time. It follows all valuations must clearly state the date to which valuation relates, since time is the essence of all valuations. It is the estimate of the worth of a particular item in terms of money. It is based on certain facts and factors. For various purposes the valuation of different types of assets is required to be carried out. The person who is valuing must have a clear idea about the cost, price, value and the purpose of valuation. Valuation is very important to determine, from time to time or at a given specific time, the value of a specific asset. The importance of property valuation to stakeholders varies according to the purpose for which valuation is done. Property valuation is traditionally done through Land and Building method, Rental Income Approach, Composite Rate method or by detailed estimation. These approaches give a fair idea of the market value but the effect of human bias and
error is a constant hindrance.

2. LITERATURE REVIEW

Zurada J et al. [1] illustrated a comparative study of four regression based methods including Multiple Regression Analysis (MRA) and three Artificial Intelligence (AI)-based methods under various simulation scenarios. It was observed that the performance of non-traditional regression-based methods were better in all simulation conditions, particularly with homogeneous data sets. The performance of AI-based methods was impressive with less homogeneous data sets. Chaphalkar N B and Dhatunde M [2] studied the valuation of properties using Multiple Regression Analysis (MRA). The method is advantageous as it models relationship between market value and property characteristics and the effect of changes in house attributes on value and gives better accuracy & efficiency in predicting value of property as compared with the traditional approach. Bunyan Unel F and Yalpir S [3] used analytic hierarchy process (AHP) and reproduced coefficients that serve as the basis for real estate valuation. Comparison and performance analyses was also made using a multiple regression analysis (MRA) valuation model. Benjamin J D et al. [4] illustrated about the application of Multiple Regression Analysis in real estate valuation for mass property tax assessment. The advantage of this process is that appraiser bias towards the choice of comparables will be eliminated and the adjustments in magnitude and direction is statistically estimated by the software using regression coefficients. Also, by using MRA chances of error by human interference and the problems of small sample sizes can be eliminated. Nallathiga et al. [5] reported distribution of the stigma effect on property value depreciation across various regions of India and discussed about the types of stigma and their characteristics and the approaches to quantify sigma. The paper also analyses on which aspect of the property value can the stigma impact can be seen most i.e., income yield (Y) or capital value(C). The distribution of the stigma effect is demonstrated by the Y-C matrix. Myers [6] discussed about the impact of sustainability on the market value and the role of the valuer in incorporating the value of sustainable features. The author reports that valuers are identifying a value relationship between sustainability and market value but tend to prevent further investment in sustainability due to inaccurate assessments and lack of knowledge about sustainability in valuations. Parmar et al. [7] illustrated the general field practice of valuation of real estate property based on systematic research in the field of valuation. This study covers the methodology verified by the government approved valuer and concerned field expert. Achu K [8] reported about the influence of client pressure on property valuation, influences related to client characteristics and influences related to specific valuation purposes which can be a major source of judgmental bias on part of the value. Pagourtzi E et.al.[9] reviewed the traditional methods of valuation like comparable, cost, income, profit, regression and contractor’s method and advanced methods like ANN’s, hedonic pricing, spatial analysis, fuzzy logic and ARIMA model methods.

3. MULTIPLE REGRESSION ANALYSIS

Multiple Regression Analysis (MRA) has found increasing application in property valuation because of less human bias and error. MRA method is widely accepted by most practitioners and academicians due to established methodology from a long time. [1]. MRA relies on econometric modelling i.e. fluctuation in market value which reproduces the market behavior based on probability framework [2]. Estimate of the unknown parameters can be arrived at using regression analysis. There are many factors affecting the valuation of real estate, each of which has a different effect on the value [3].

3.1. Identification of Independent Variables/ Factors

In regression modelling there are two types of variables involved i.e. the dependent variables and independent variables. The dependent variable is the factor depending on the impact of several other factors which here is the market value of the property. The other type of variables are the independent
variables consisting of quantitative and qualitative factors. In quantitative attributes, variables such as size of plot, floor area, age of building, number of rooms, number of storeys, level of unit are considered. Variables such as accessibility to amenities or facilities, view from property, shape, zoning etc. which cannot be numerically measured are identified as qualitative factors.

Table 1. Independent Variables

| Sl. No | Variable          | Type         | Code |
|--------|-------------------|--------------|------|
| 1      | Built up area     | Quantitative | X1   |
| 2      | Number of Floors  | Quantitative | X2   |
| 3      | Age of Building   | Quantitative | X3   |
| 4      | No. of Rooms      | Quantitative | X4   |
| 5      | No. of Parking Spaces | Quantitative | X5 |
| 6      | Plot Shape        | Qualitative  | X6   |
| 7      | Location          | Qualitative  | X7   |
| 8      | Access Road       | Qualitative  | X8   |
| 9      | Nearness to amenities | Qualitative  | X9   |

There are obstacles and risks associated with property valuation as it is matter of subjective opinion and opinions vary. The market value of a property depends on various factors which may be broadly classified into quantitative and qualitative factors. For analysis of variables through MRA it is necessary to quantify each independent variable. For the purpose of this study, the qualitative factors as quantified in the following manner.

In case of shape traits, a plot of rectangular shape with clearly distinguishable boundaries is assigned 1, plot of other regular shapes is assigned 2 and plots of irregular shape is assigned 3. For location traits localities of superior, good and average quality of facilities are assigned 1, 2 & 3 respectively. Similarly, a property with a 2-lane access road with concrete or asphalt finish is assigned 1, a property with a single lane access road with concrete or asphalt finish is assigned 2 and a property with unfinished access road is assigned 3. The properties having access to amenities within a range of 0-3 km are assigned 1, range of 3-6 km are assigned 2 and 6-10 km are assigned 3. These details are entered in Table 2.

3.2. Application of Multiple Regression Analysis

The dependent variable is subjected to the impact of independent variables. Regression analysis uses statistical modelling to assess the impact of variables on each other. Multiple Regression Analysis (MRA) is used to identify the impact of multiple variables/ factors on the dependent variable individually as well as the combined effect of all the factors on the dependent variable. For the purpose of this study, data of 20 comparable residential properties are collected in and around Kundapura town which are shown in Table 2 and are denoted as P1, P2, P3, through P20. The regression analysis is done through the data collected from these twenty properties with recent valuation based on the 9 independent variables chosen as shown in Table 1. The regression equation for the chosen 9 independent variables is as follows

\[ Z = A_0 + A_1X_1 + A_2X_2 + A_3X_3 + A_4X_4 + A_5X_5 + A_6X_6 + A_7X_7 + A_8X_8 + A_9X_9 + E \]

Z is the dependent variable which here represents the market value, A0 is the regression constant which is the Y-intercept. The terms X1, X2, X3…X9 represents the independent variables as shown in Table 1. A1, A2, A3…A9 represents the regression coefficients which signify the change in value of the dependent variable for unit change in the individual independent variable, when other variables
remain constant. E is the error term which represents the impact of all factors other than the independent variables which have an effect on the dependent variable [4]. Multiple Regression Analysis (MRA) is done through Microsoft Excel and data is fed into the software. The regression data is shown in Table 2.

### Table 2. Regression Data

| Property | Market Value | Area(Sft) | No. of Floors | Age of Building (years) | No. of Rooms | No. of Rooms | Shape | Location | Access road | Nearness to amenities |
|----------|--------------|-----------|---------------|-------------------------|--------------|--------------|-------|-----------|-------------|-----------------------|
| P1       | 13,03,000    | 931       | 1             | 4                       | 2            | 1            | 3     | 3         | 3           | 1                     |
| P2       | 17,79,375    | 975       | 1             | 6                       | 1            | 0            | 2     | 3         | 3           | 1                     |
| P3       | 20,71,375    | 1135      | 1             | 3                       | 2            | 0            | 3     | 2         | 1           | 1                     |
| P4       | 21,25,750    | 1140      | 1             | 10                      | 2            | 1            | 1     | 3         | 2           | 1                     |
| P5       | 26,61,750    | 1365      | 1             | 4                       | 2            | 1            | 1     | 2         | 2           | 1                     |
| P6       | 27,43,000    | 1443      | 2             | 14                      | 3            | 1            | 2     | 2         | 1           | 1                     |
| P7       | 28,53,265    | 1453      | 2             | 1                       | 4            | 1            | 2     | 2         | 1           | 2                     |
| P8       | 31,67,250    | 1545      | 1             | 11                      | 3            | 1            | 1     | 2         | 2           | 2                     |
| P9       | 32,63,000    | 1776      | 2             | 8                       | 3            | 1            | 1     | 2         | 1           | 1                     |
| P10      | 37,11,300    | 1780      | 2             | 8                       | 3            | 2            | 2     | 2         | 1           | 1                     |
| P11      | 41,16,000    | 1960      | 2             | 7                       | 3            | 2            | 2     | 1         | 1           | 1                     |
| P12      | 46,43,125    | 2185      | 2             | 13                      | 4            | 2            | 2     | 2         | 2           | 3                     |
| P13      | 50,52,500    | 2350      | 2             | 4                       | 4            | 2            | 1     | 1         | 1           | 1                     |
| P14      | 53,80,025    | 2485      | 2             | 2                       | 5            | 2            | 1     | 1         | 1           | 2                     |
| P15      | 59,63,000    | 2680      | 2             | 1.5                     | 5            | 3            | 1     | 1         | 1           | 2                     |
| P16      | 61,44,875    | 2725      | 2             | 3                       | 5            | 3            | 1     | 1         | 1           | 1                     |
| P17      | 6580,800     | 2880      | 2             | 5                       | 6            | 3            | 1     | 1         | 1           | 2                     |
| P18      | 68,73,500    | 2950      | 3             | 6                       | 6            | 3            | 1     | 1         | 1           | 3                     |
| P19      | 72,96,875    | 3125      | 3             | 4                       | 7            | 3            | 2     | 1         | 1           | 2                     |
| P20      | 78,72,500    | 3350      | 3             | 2                       | 7            | 3            | 1     | 1         | 1           | 3                     |

### Table 3. Regression Statistics

| Regression Statistics                  |       |
|---------------------------------------|-------|
| Multiple R                            | 0.99802 |
| R Square                              | 0.99605 |
| Adjusted R Square                     | 0.99249 |
| Standard Error                        | 173937.09 |
| Observations                          | 20    |

### Table 4. ANOVA Analysis

| ANOVA | df | SS         | MS         | F          | Significance F  |
|-------|----|------------|------------|------------|----------------|
| Regression | 9 | 76247855253060.00 | 8471983917006.66 | 280.0275402 | 8.14626E-11 |
| Residual   | 10 | 302541096903.79 | 30254109690 |            |               |
| Total      | 19 | 76550396349963.70 |            |            |               |

From Table 3, the value of multiple regression is 0.998 which implies that there is positive correlation between the dependent variable and independent variables. The R square value which is the coefficient of determination is 0.996, shows that the combined effect of 9 independent variables explains 99.6% of the variation in market value. The standard error is 173937.09 which signifies the variation in market value.

ANOVA analysis is shown in Table 4. The F statistic is the ratio of Mean Square (MS) Regression to Mean Square Residual which is 280.027. The value of Significance F must be lower than F statistic.
for the test to be significant. Here from ANOVA table we see that the value of Significance F is lower than F statistic. Hence the test is significant. Final regression table is shown in Table 5.

Table 5. Final Regression Table

| Coefficients | Standard Error | t Stat |
|--------------|----------------|-------|
| Intercept    | -1176197.46    | 493810.7187 | -2.381879167 |
| Area (Sft)   | 2539.599451    | 341.3092835 | 7.440757031 |
| No. of Floors| 32584.98187    | 222073.7461 | 0.146730455 |
| Age of Building (years) | -3064.67011 | 12378.04051 | -0.247589278 |
| No. of Rooms | 26186.62719    | 94813.73948 | 0.276190216 |
| No. of Parking Spaces | 26449.98096 | 124961.6412 | 0.211664801 |
| Shape        | -41113.3591    | 111070.2884 | -0.370156229 |
| Location     | 34497.49399    | 154812.1091 | 0.222834597 |
| Access road  | 78694.98295    | 132734.0527 | 0.592877121 |
| Nearness to amenities | 26610.27989 | 75555.10611 | 0.352196976 |

From the Final Regression Table 5, the regression equation would be

\[ Z = -1176197.46 + (2539.599\times X_1) + (32584.98\times X_2) - (3064.67\times X_3) + (26186.63\times X_4) + (26449.98\times X_5) - (41113.36\times X_6) + (34497.49\times X_7) + (78694.98\times X_8) + (26610.28\times X_9) \]

4. VALUATION BY CONVENTIONAL APPROACHES AND MRA

A residential building in Udupi is chosen (P0) and value is worked out by using conventional approaches like Land and Building method, Rental Income Approach, Composite Rate method and by detailed estimation. MRA is applied to the same property and the value is found out. The details of the property (P0) are shown in Table 6.

Table 6. Details of Property (P0)

| Land Extent = 4207.8960 sft | Plinth area constructed = 2545.42 sft |
| Age of Building = 1 year | No. of floors = 2 |
| No. of Rooms = 5 | No. of parking spaces = 2 |
| Plot Shape - Regular Shape | Location - Good |
| Access Road - 2 lane with asphalt finish | Nearness to amenities = 5 km |

4.1 Land and Building Method

In this method the property is valued separately in terms of land, building and amenities and the final valuation amount is equal to the sum of land, building and amenities after accounting for depreciation of the building and amenities. In the present scenario, the total value of the subject property (P0) by land and building method is Indian Rupees (INR) 6450000/- (Rupees Sixty-Four Lakh Fifty Thousand Only)

Note: As of 27th MAY 2020, 1 USD = 75 INR

4.2 Rental Income Approach

In this method, valuation is done by calculating the total income that can be fetched by the property based on prevailing market rent and capitalizing it based on the rate of return. In the present scenario, the total value of the subject property (P0) by rental income method is INR 4400000/- (Rupees Forty-Four Lakh Only)

4.3 Composite Rate Method

In this method, valuation is done by working out the composite rate of the building. This composite
rate is calculated in relation with a nearby similar building under comparison. Due consideration is also given to depreciation. The value of the subject property (P0) by composite rate method is INR 5930000/- (Rupees Fifty-Nine Lakh Thirty Thousand Only).

4.4 Valuation by Detailed Estimation
Here valuation is done by working out the quantities of the various items of work. The present rate analysis for each item is made. All the items of work having value are worked out and the total valuation is equal to the sum of worth of all individual items of work. Depreciation is considered wherever applicable. Then land value component is also added. The value of the property (P0) by detailed estimation method is INR 6151000/- (Rupees Sixty-One Lakh Fifty-One Thousand Only).

4.5. Valuation by Multiple Regression Analysis (MRA)
Making use of the regression equation obtained from Table 5,

\[ Z = -1176197.46 + (2539.599 \times X_1) + (32584.98 \times X_2) - (3064.67 \times X_3) + (26186.63 \times X_4) + (26449.98 \times X_5) - (41113.36 \times X_6) + (34497.49 \times X_7) + (78694.98 \times X_8) + (26610.28 \times X_9) \]

\[ Z = -1176197.46 + (2539.599 \times 2545.42) + (32584.98 \times 2) - (3064.67 \times 1) + (26186.63 \times 5) + (26449.98 \times 2) - (41113.36 \times 2) + (34497.49 \times 2) + (78694.98 \times 1) + (26610.28 \times 2) \]

\[ Z = 5652770.287 \approx 5653000 \] (Rupees Fifty-Six Lakh Fifty-Three Thousand Only)

The values obtained by various methods of valuation are tabulated in Table 7.

| Valuation approach       | Market Value (INR) | Variation w.r.t MRA (INR) | % Variation |
|--------------------------|--------------------|---------------------------|-------------|
| Multiple Regression Analysis (MRA) | 5653000 | 0 | 0 |
| Land and Building method | 6450000 | 797000 | 14.10 |
| Rental Income Approach   | 4400000 | 1253000 | -22.17 |
| Composite Rate method    | 5930000 | 277000 | 4.90 |
| Detailed estimation      | 6151000 | 498000 | 8.81 |

5. CONCLUSION
From the results shown above in Table 7 it can be seen that the market value predicted by Multiple Regression Analysis (MRA) shows a variation of 14.10% in comparison with Land and Building method, a variation of -22.17% in comparison with Rental Income approach, a variation of 4.90% in comparison with Composite Rate method and a variation of 8.81% in comparison with detailed estimate method. The fair market value of the property is around Rs 6500000/- which is close to the values obtained by Land and Building method, Composite Rate method and detailed estimation method. The value obtained by Rental method is much below the fair market value. This is due to the fact that the rental return for the building is very low. The property under valuation is situated in the outskirts of a small town and hence rent potentiality is also less in that locality for residential buildings. However the value obtained by rental method nearly approaches to fair market value in certain localities of cities where the demand for rental buildings is high. It is tedious to quantify the qualitative attributes as opinions are subjective and may vary from person to person. MRA aides in identifying the effect of each attribute on the dependent variable and the combined effect of all the attributes. The reliability factor in case of results obtained from Multiple Regression Analysis (MRA) can be increased by analyzing more sets of data. Also, in case of conventional approaches the valuer’s perception is of great importance and is again subjective. So, the percentage variation may also change depending upon the circumstances.
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