

# Developing a Mass Appraisal Approach for Residential Properties in Minna Metropolis

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## Abstract

Mass appraisal has become a standard approach of valuing large groups of properties especially for taxation purpose. It is widely used in developed countries including the US, UK and other European countries as well as in some developing countries such as Malaysia. In this paper, the application of mass appraisal model in Nigeria was examined. Hedonic based multiple regression analysis was used to analyse a set of 91 transaction data recorded between 2009 and 2013. The regression results revealed the contributory effect of the different housing attributes on the house price. Based on these results, a mass appraisal model for residential property valuation was developed. The performance of the model was evaluated using ratio study and the model was found to be adequate. It was discovered that a good mass appraisal model can bring about improvement in property tax administration in the study area by reducing cost and ensuring fairness and equity, which are very crucial in any property tax assessment process. The paper recommends that future studies should incorporate GIS, more explanatory variables as well as larger sample size to improve the accuracy of the model.

**Keywords:** Mass Appraisal, Residential Property Price, Hedonic Model, Ratio Study

## Introduction

The significance of housing to both the society and economy cannot be overemphasised. It provides for one of the basic human needs and also constitutes a substantial proportion of the wealth of many households as stated by Forensic Technologies International (FTI Consulting, 2012). This wealth also accrues to government as most countries of the world use different forms of taxes levied on homeowners as revenues to carry out developmental projects. These projects will in turn offer direct or indirect social benefits to the property occupants and in most cases lead to increase in values of their properties. Property tax therefore is one of the major and important sources of revenue to the local government, the arm of government mainly charged with the administration of property taxes (Harris and Moore, 2013; Owuso-Ansah, 2012; Sipan, *et al.*, 2012).

However, this potential of property tax as a source of revenue has not been fully realised particularly in Minna, despite the city's economic importance. Therefore, the selection of Minna for this study is due to the importance of the city as the capital of Niger State, which shares boundary with Nigeria's capital city, Abuja. Minna has over the years experienced continuous influx of people which has led to rapid increase in its population. However, this rise in population has not been accompanied by adequate infrastructural development.

Real property tax is thus seen as one of the avenues through which the local government can generate more revenues to finance its activities especially in terms of infrastructural development for the benefit of the populace. Consequently, there is need for a systematic real property tax administration system that will serve the

interest of the government and people. It becomes very important to propose a more efficient way of assessing house prices by the local governments for the purpose of tax administration. This will ensure equity and uniformity, as well as effectiveness in the assessment process, which will be advantageous both to the taxpayers and the local authorities. It will also lead to reduction in costs of property assessment as well as time saving. This has necessitated the recommendation of mass appraisal for taxation purposes, which will serve as a starting point to providing an effective tax system in Minna.

Property valuation is required for different purposes including taxation. This implies that before tax is levied on a property, the property has to be properly assessed to know its value. The accuracy of this valuation is very paramount for a good tax system and also very important to property market players especially the real estate professionals (Sipan and Ab Rahman, 1996). The valuation of real estate has been carried out using the traditional methods of valuation which are comparison, cost, investment, profit and residual methods (Selim, 2008). These approaches are still useful for single property valuation. It is however argued in the literature that they are not efficient for valuing large group of properties especially for the purpose of taxation, which requires a certain level of equity and fairness across all the assessed properties. This is because these traditional methods have some level of subjectivity and also bring about inconsistencies of assessed values (see Sipan *et al.*, 2012). Apart from the inconsistencies, errors involved and the lack of evidence to be used by valuers in adopting the traditional sales comparison approach also makes the valuation process difficult, thereby resulting in inaccuracy of valuation opinion (Bozic *et al.*, 2013). Due to lack of any standardized procedure for

determining residential property value in Minna, people may tend to resort to personal judgement to arrive at an estimated value. There is therefore need for a shift in paradigm to more reliable methods of valuing properties. Thus, mass appraisal, an approach for valuing large group of properties was introduced.

The purpose of this paper therefore is to employ a hedonic regression approach in estimating house prices in Minna, Nigeria, with the aim of applying a mass appraisal model for residential property taxation which will ensure equity, fairness and cost effectiveness that will be at the advantage of the taxpayers and the local government.

## **Literature Review**

### **Mass appraisal**

According to International Association of Assessing Officers (IAAO), mass appraisal is “the process of valuing a group of properties as of a given date and using common data, standardized methods, and statistical testing (IAAO, 2013a).” It usually involves large group of properties as against individual property (Kauko and d'Amato, 2008). Mass appraisal started in the United States in the 1920s, and has since then continued to evolve (Florida Department of Revenue, 2002). It has been adopted in developed countries like America, the UK and other European countries. Research in the field of mass appraisal is also gaining more prevalence in some developing countries such as Malaysia. There is however no evidence of the application of mass appraisal model for property taxation in the Minna property market.

### **Mass appraisal performance evaluation**

In mass appraisal, the performance of the model has to be evaluated to ensure that the model is capable of replicating the forces of demand and supply in the whole tax jurisdiction fairly and equitably. According

to IAAO (1990), the primary tool used to evaluate the performance of mass appraisal models is ratio study. For the purpose of equity, there are two major aspects of mass appraisal accuracy measured in a ratio study which are appraisal level and appraisal uniformity.

### ***Appraisal level***

Appraisal level measures the proximity between assessment values and actual sales prices on an overall basis (IAAO, 2013a). This is because in mass appraisal, appraised values do not usually equal market prices. The principle however is that *overappraisals* should balance *underappraisals* such that the typical ratio is near 1 or 100 percent. The four measures of appraisal level in a ratio study are the median, arithmetic mean, weighted mean and geometric mean, each of which has its pros and cons. It is thus recommended that all the measures be calculated and compared for proper guidance (IAAO, 1990). Note that wide variations among the different measures of appraisal level may be indicative of poor appraisal performance. The Standard for Ratio Study (IAAO, 2013b) stipulates that while the theoretically desired level of appraisal is 1.00, a level between 0.90 and 1.10 is acceptable for any class of property with the exception of cases where stipulated local standards must be followed.

### ***Appraisal uniformity***

The second tool used in measuring the performance of mass appraisal is the appraisal uniformity. It basically looks at the consistency and equity of values. First, it considers uniformity between property groups, for example, “that residential and commercial properties are appraised at similar percentages of market value and that residential assessment levels are consistent among neighbourhoods, construction classes, age groups, and size groups.

Secondly, it also considers the consistency of assessment levels within property groups” (IAAO 2013a). The typical measures of uniformity used in ratio study are the Coefficient of Dispersion (COD) and the Price-Related Differential (PRD). The standards for COD have been outlined in details in the Standard on Ratio Studies (IAAO 2013b). Generally, a COD between 5 – 20 is acceptable depending on the type of property being appraised. It should be noted however that Low CODs (15 or less) tend to be associated with good appraisal uniformity (IAAO, 1990).

The PRD on the other hand is used to measure assessment’s progressivity or regressivity. It provides a simple gauge of price-related bias, which shows the extent of bias between low- and high-value properties in the sample used. The Standard on Ratio Studies (IAAO, 2013b) specified an acceptable PRD of 0.98 to 1.03. PRD below 1.00 is an indication of assessment progressivity, whereby the assessment ratios increase with price. It implies that the high-value properties are over-appraised. Conversely, PRDs above 1.00 tend to indicate assessment regressivity, in which case the assessment ratios decline with price, indicating that the high-value properties may be under-appraised (IAAO, 1990).

### **Hedonic price model**

Alternative methods of assessing values of properties have sprung up lately such as econometric models which are useful approaches in estimating home prices to buyers and local authorities (Tabales *et al.*, 2013). More so, the authors noted that over the years, classical hedonic models in real estate appraisal have been used as a procedure to estimate prices of such complex goods as housing. The hedonic model posits that “a good possesses a myriad of attributes that combine to form

bundles of utility-affecting attributes that the consumer values (Ching and Chan, 2003).” The hedonic model based on micro economic theory has been widely used in real estate valuation and housing market studies, particularly in analysing residential property prices and rental values (Selim, 2008). The hedonic approach is particularly useful when there is no enough statistical information especially the property transaction details (Tabales *et al.*, 2013). It also has the advantages of easy-to-use, easy-to-understand and high accuracy of results (Tian, 2013). In the case of a house, the model tends to estimate the price or rental value of the house as a function of its attributes. Other advanced techniques that are used in mass appraisal include artificial neural networks, spatial analysis, fuzzy logic, kriging, autoregressive integrated moving average, spatial autoregression, geographically weighted regression, moving window regression, time trend analysis and feedback (Jahanshiri *et al.*, 2011; Mohamad, 2012). The literature has shown that the Ordinary Least Square regression is the most common model used in property assessment ratings (Sipan *et al.*, 2012).

There are two types of variables that are usually included in a house price hedonic regression model. They are dependent variable (also called regressand or measured variable) and independent variable (also called regressor or predictor variable) (Ismail, 2005). According to the researcher, the dependent variable is a measure of house value, which is represented by rents, sales price, asking price, or even owner's estimated price as the case may be. The researcher noted that the use of each of these different measures of house value is evident in previous studies, adding that rents are normally adopted in case of studies that involve rented properties while the other measures of value are adopted in

studies that involve owner occupied properties.

The second type of variable, which is the independent variable includes all significant factors that are likely to affect the measure of value. In the housing market literature, these factors have been broadly grouped into three namely the structural, locational and neighbourhood attributes. Focusing on property-specific attributes, Wyatt (2007) submitted that “the principal physical qualities of the building are size, age, condition, external appearance (including aspect and visibility), internal specification and configuration.” He argues that these qualities are hypothesized to have effect on the level of “performance of the building to varying degrees depending on the use to which it is put.”

#### **Factors for mass appraisal approach in residential neighbourhoods**

Residential real estate prices can be influenced by a diverse number of attributes or factors. These factors can be broadly classified under micro and macro determinants. The macro determinants of house prices are those macroeconomic factors such as inflation, exchange rate, unemployment rate and GDP that affect the entire economy of a country. The micro factors on the other hand, which are property specific factors and are of relevance in hedonic price analysis, have been classified into three by Watkins (2001) as physical, neighbourhood and locational characteristics. For the purpose of this study which focuses on developing a mass appraisal model, only the micro determinants of house price will be considered because mass appraisal is based on local property markets.

Sirmans and Macpherson (2005) listed out the top twenty housing attributes (micro house price determinants) that are most

frequently included in previous studies on hedonic house price modelling. Table 1 shows details of the appearances of the variables from the previous studies.

It is worthy of note that not all of these variables can be found in the present study area. The absence of some variable in the current study may be attributed to differences in contextual, idiosyncratic and cultural settings as noted by Ching and Chan (2003) or as a result of variation in the nature of the property market characteristics as noted by Bello and Bello (2008). In addition, the unavailability of data on some variables has equally limited the number of variables to be included in the study.

## Methodology

### Data

Data used in this research are property attributes/ characteristics and sales transaction data. The attribute data cover the three aspects of structural, locational and neighbourhood attributes earlier mentioned and they include house type, size, number

of rooms, number of bathrooms/toilets, age, condition, location, distance to the central business district and neighbourhood facilities available. The sales transaction data is basically the price at which the residential properties in question were sold and the respective year each property was sold. These attributes were identified from previous studies through literature review. Table 2 shows the list of variables included in this study and their units of measurement. They are variables for which data were obtained by the researcher. Macroeconomic factors were not included since they are variables that are more concerned with the larger economy of the country as a whole rather the local property market as applicable to this study.

Due to the unavailability of much residential transaction records in the study area, data for this study is made up of 91 house sales transaction cases in Minna, recorded between 2009 and 2013.

**Table 1: Variables often included in most hedonic models**

Independent Variables	Number of (Times):			
	Appearances	Positive	Negative	Not Significant
Lot Size	52	45	0	7
Ln Lot Size	12	9	0	3
Square Feet	69	62	4	3
Ln Square Feet	12	12	0	0
Brick	13	9	0	4
Age	78	7	63	8
No. of Stories	13	4	7	2
No. of Bathrooms	40	34	1	5
No. of Rooms	14	10	1	3
Bedrooms	40	21	9	10
Full Baths	37	31	1	5
Fireplace	57	43	3	11
Air Conditioning	37	34	1	2
Basement	21	15	1	5
Garage Spaces	61	48	0	13
Deck	12	10	0	2
Pool	31	27	0	4
Distance	15	5	5	5
Time On Market	18	1	8	9
Time Trend	13	2	3	8

**Source:** Adopted from Sirmans and Macpherson (2005)

The data were sourced from six of the registered estate surveying and valuation firms that are practicing in Minna. The firms provided data on residential property transactions, particularly the sales prices and corresponding property attributes. Note that in a ratio study that utilizes sales data only (as in the case of this research), there is limited extent of control that the researcher has over sample size (IAAO, 1990). This implies that the sample size will be limited

by the amount of data available. Other secondary data used in this research were sourced from published materials and documents that contain discussions about the subject matter of research and the research trend. These sources include textbooks, reports, journals, conference proceedings, gazette materials, internet and other electronic sources.

**Table 2: List of variables and their descriptions**

Variable	Variable Name	Measurement of Variable	Variable Description
Y	Price	Nigerian Naira (₦)	Price of the House: Actual Sales price of the house in Naira
X <sub>1</sub>	Type	Nominal	Type of House: Whether the house is a Tenement, Flat, Semi-Detached or Detached Bungalow or a Duplex
X <sub>2</sub>	Size	Scale (Sqm)	Total Size of the house in square meters
X <sub>3</sub>	Rooms	Scale	Number of rooms in the house
X <sub>4</sub>	Bathrooms	Scale	Number of bathrooms or toilets in the house
X <sub>5</sub>	Age	Scale (Years)	Age of the house since it was built
X <sub>6</sub>	Condition	Nominal	Physical condition of the house: Whether the house is Very Poor, Poor, Fair, Good or New.
X <sub>7</sub>	Year	Scale	Year the house was sold: 2009, 2010, 2011, 2012 or 2013
X <sub>8</sub>	Location	Nominal	Location of the house: Area in which the house is located – low, medium or high income area.
X <sub>9</sub>	Distance	Scale (KM)	Distance of the house to the Central Business District (Mobil)
X <sub>10</sub>	Facilities	Nominal	Number of facilities available in the neighbourhood the house is located such as School, Hospital/ clinic, Police Post.

A representation of the proposed model is given as:

$$P = a + \beta x + e \quad (1)$$

In the equation 1, **P** is the House prices, **a** is the constant, **β** is the coefficient matrix, **x** is the set of independent variables and **e**, the error term. Substituting for the variables, we will have the equation re-written thus:

$$\begin{aligned} \text{House Price} = & \text{Constant} + \beta_1 (\text{Type}) + \beta_2 (\text{Size}) \\ & + \beta_3 (\text{Rooms}) - \beta_4 (\text{Baths}) + \beta_5 (\text{Age}) \\ & + \beta_6 (\text{Year}) + \beta_7 (\text{Condition}) - \beta_8 (\text{Location}) \\ & + \beta_9 (\text{Distance}) + \beta_{10} (\text{Facilities}) + \text{error term} \end{aligned} \quad (2)$$

**Table 3: Descriptive statistics**

Variables	Mean	Std. Deviation
Price	4349450.54	2711923.206
Type	3.14	1.644
Size	171.7	54.453
Rooms	5.88	5.625
Bathrooms	2.79	1.197
Age	12.58	8.694
Condition	3.23	1.034
Year	3.67	1.491
Location	2.40	.728
Distance	2.9398	1.28924
Facilities	3.13	.957

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Five types of houses were sampled in the study. They are detached bungalows, semi-detached, flats, tenements and duplexes. The number of rooms in a house ranges from 2 to 21 rooms depending on the house type. The prices of these houses range from ₦1,200,000 for tenements, which are the cheapest types, up to ₦10,000,000 for duplexes, with the average price being about ₦4,349,450. Most of the recorded transactions within the sample period of 5 years took place in 2013 with the other samples almost evenly distributed throughout the previous year. This is an indication of improved record keeping by the estate firms. Data on the condition of the houses revealed that 32 of the houses are in fair condition, 25 are in good conditions while 20 were said to be in poor state of repairs as at the time they were sold.

### Method of analysis

The study employed the use of statistical technique particularly the hedonic price modelling approach base on multiple regression analysis (MRA) to empirically identify the significant factors that affect house prices in the study area and the level of effect exerted by each of the factors. The selection of this method of analysis is based on the evidence from literature that MRA performs better when small samples are used for analysis (see Kauko and d'Amato, 2008). The coefficients from the regression result showed the marginal contribution of each of the variables included in the regression model to the overall price of a house in the study area. The significant factors identified from the regression results were then used to propose a model. The model was then evaluated to test its suitability for the purpose of mass appraisal. The model evaluation was done with the aid of the mass appraisal evaluation technique known as ratio study. The two aspects of mass appraisal accuracy in a ratio study

namely appraisal level and appraisal uniformity were measured to ascertain the adequacy of the model. There are four measures of appraisal level in a ratio study which are the median, the arithmetic mean, the weighted mean and the geometric mean, each of which is expected to be at a level between 0.90 and 1.10. On the other hand, appraisal uniformity is typically measured using Coefficient of Dispersion (COD) and the Price-Related Differential (PRD). While the COD should normally fall between 5 and 20, the PRD is expected to be between 0.98 and 1.03.

### Results

A regression analysis was obtained using all the variables and it was found that the number of rooms did not pass the check, having a P-Value of 0.272 which is above 0.05. Consequently, the variable was excluded and a second regression model was obtained which is shown in table 4. The model has a coefficient of determination ( $R^2$ ) of 0.923. This shows that about 92% of variation in house price can be explained by the independent variables. The F-statistics (F-value – 107.57 and F-sig. – 0.000) indicate that the independent variables when put together are statistically significant in determining house prices in Minna. While the F-statistics show the significance of the variables as a whole, the significance of the individual variables is indicated by their respective P-Values (sig.) and the results shows that all the variables are individually significant (p-values less than 0.05).

Further evaluation of the results reveals that the problem of multicollinearity does not exist in the model as all the variables have a tolerance that is greater than 0.1 and VIF that is below 5. The contributory effect of each variable can be observed from the B coefficients of the variables. A look at the signs of the coefficients of the independent variables will reveal that all the variables

included in the model except age of a house and its distance to the CBD are positively correlated with house prices. This implies that a unit increase in each of the variables with positive coefficients (type of house, size, bathroom, condition, year, location and facilities) will bring about corresponding increase in price of a house. On the other hand, the negative signs on the coefficient of age implies that the older a house is, the lesser the price of the house. Likewise, the farther a house is from the CBD, the lower the price of the house.

A mass appraisal model was therefore obtained using the coefficients from the regression results. The equation for the model is presented as follows:

$$\text{House Price} = -5721793.178 + 255441.430(\text{Type}) + 5942.767(\text{Size}) + 722872.168(\text{Baths}) - 30191.112(\text{Age}) + 1035230.685$$

$$(\text{Condition}) + 146506.912(\text{Year}) + 675543.323(\text{Location}) - 189033.094(\text{Distance}) + 531602.035(\text{Facilities}) \quad (3)$$

The model presents house price as a function of the different attributes of the house, each of which affects the price at varying degrees as indicated by the coefficients

### Mass appraisal performance evaluation

As earlier stated, every mass appraisal model has to be evaluated. The essence of the evaluation is to compare the appraised values with the actual sales prices to see if the model can be accepted. Evaluation of the model in this study was done using ratio study. The results of the ratio study are presented in table 5.

**Table 4: Regression coefficients**

Model	Unstandardized Coefficients		Standardized Coefficients Beta	t	Sig.	Collinearity Statistics	
	B	Std. Error				Tolerance	VIF
(Constant)	-5721793.178	719275.614		-7.955	.000	-	-
Type	255441.430	68010.869	.155	3.756	.000	.561	1.783
Size	5942.767	1904.560	.119	3.120	.003	.652	1.534
Bathroom	722872.168	97761.689	.319	7.394	.000	.512	1.955
Age	-30191.112	12335.514	-.097	-2.447	.017	.610	1.641
Condition	1035230.685	124791.713	.395	8.296	.000	.421	2.373
Year	146506.912	76315.623	.081	1.920	.048	.541	1.847
Location	675543.323	176636.993	.181	3.824	.000	.423	2.362
Distance	-189033.094	87677.689	-.090	-2.156	.034	.549	1.823
Facilities	531602.035	169577.230	.188	3.135	.002	.266	3.757



**Table 5: Measure of appraisal level and appraisal uniformity**

S/N o.	Measure of Appraisal Level	Required*	Result
1	Median	0.9 – 1.1	1.0024
2	Mean	0.9 – 1.1	1.0091
3	Weighted Mean	0.9 – 1.1	1
4	Geometric Mean	0.9 – 1.1	0.94
	<b>Measure of Appraisal Uniformity</b>		
5	Coefficient of Dispersion (COD)	5 – 20	20.91
6	Price-Related Differential (PRD)	0.98– 1.03	1.009

\*Note: The requirements for each of the measures as stipulated in The Standard on Ratio Studies (IAAO 2013b) have been discussed in the previous sections.

All the measure of appraisal level computed, that is, the median, arithmetic mean, weighted mean and geometric mean fall within the acceptable standard of 0.90 – 1.10. In addition, two measures of appraisal uniformity were computed. While the PRD has fallen within the acceptable of standard of 0.98 – 1.03, the COD is a bit above 20 (20.91), the researchers deem the model still acceptable considering the sample size utilized in the research as well as the fact that all the five other measures are within the acceptable standards.

## Conclusion

The paper made attempt to develop a symbolic Mass Appraisal model to undertake valuation of residential properties in Minna. The research established that house prices in Minna are significantly influenced by type of the house, its size, age, condition, the number of bathrooms, year the house was sold, location of the house, its distance to the CBD as well as the availability of neighbourhood facilities. The age of a house and its distance to the CBD have negative effect on prices, meaning that as the two variables increase, house prices tend to decrease. The study has used these significant variables to develop a model for

mass appraisals of residential properties for taxation purpose. The model was evaluated using ratio study; a mass appraisal evaluation technique. After evaluation, the model was found to be suitable and is therefore recommended for mass appraisal of residential properties in Minna. The study further recommends that in the future, more explanatory variables and larger samples should be used and Geographic Information Systems (GIS) should be incorporated to accurately capture the locational attributes of the properties, as it has been noted in previous studies like Tian (2013) that the adoption of GIS has helped to produce more accurate assessment values.

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