

Valuers' Receptiveness to the Application of Artificial Intelligence to Property Valuation

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Abstract

Studies have shown that the level of valuation inaccuracy in Nigeria is higher than the international acceptable standard. This may be linked to the preference for traditional valuation approaches in practice. This study investigate the readiness of Nigerian valuers to adopt the artificial intelligence (AI) appraisal techniques, which have proven to be reliable and accurate in other property markets, both in theory and in practice. A cross-sectional study was conducted via a web-based questionnaire survey to registered estate surveyors and valuers practicing in Nigeria. The data collected was analysed and presented with descriptive statistics in percentiles and mean score. **The statistical relationships among the research variables was measured using the Chi-Square test.** The results show that more than half of the respondents are aware of the AI appraisal techniques. However, the techniques are not used in practice. The low adoption of the AI techniques is attributed to professional bodies responsible for regulation of real estate practice and tertiary educational institutions in Nigeria who were not proactive enough to promote their know-how and application. It was found that active collaboration between local professional bodies and similar international organisations on member training and development may improve the usage of AI techniques. The study highlights the need for a paradigm shift in property valuation practice within the Nigerian context.

Keywords: artificial intelligence; property valuation; valuers; appraisal techniques; Nigeria

Introduction and background

The accurate and reliable estimation of real estate property value is of vital importance to real estate stakeholders in different parts of the world. This information is usually needed by

mortgagees, mortgagors, portfolio managers, real estate buyers and sellers, government organizations and others in making informed real estate investment decisions (Do & Grudnitski, 1992). It has been found that property price and the demand for construction works are positively related (Zheng et al., 2012). Similarly, empirical evidence shows that investments in real estate properties stimulate economic growth (Chiang et al., 2015). Based on the foregoing, it is reasonable to suggest that the ability to accurately estimate property value could influence the economy. This clearly highlights the fundamental place of accurate and reliable property valuation to stakeholders in the real estate sector and the economy at large.

Several property valuation techniques can be found in the literature and in the real estate practice. Traditionally, property valuation methods utilized in practice in different real estate markets around the globe include direct comparison, multiple regression analysis, indexation, cost method, investment method, amongst others (McCluskey et al., 1997). However, there are some weaknesses (subjective, imprecise, inaccurate and unreliable) associated with these approaches (McGreal et al., 1998; Zurada et al., 2006). There has been constant effort to achieve a sustainable property valuation practice that will meet the sophisticated need of the 21st century property valuation estimate end-users (Adegoke, 2014). Consequently, artificial intelligence (AI) predicting and forecasting techniques such as fuzzy logic system (FLS), expert system and artificial neural network (ANN), among others, were adopted purposely to address the shortcoming of most traditional valuation approaches (Tay & Ho, 1992; Bagnoli & Smith, 1998; Amri & Tularam, 2012). These AI techniques have been applied in real estate valuation both in theory and in practice in some developed countries (see, Schwartz, 1995; McCluskey et al., 1997).

Among the AI techniques, ANN is one of the most widely applied modeling approaches in the real estate valuation research (Mora-Esperanza, 2004), and has produced encouraging and excellent results in different property markets of the world (Pagourtzi et al., 2007). This

has been documented in numerous publications including but not limited to Singapore (Tay & Ho, 1992); United States (Borst, 1995); Ireland (McCluskey, 1996); Switzerland (Din et al., 2001); Hong Kong (Lam et al., 2008); Greece (Pagourtzi et al., 2007); Turkey (Selim, 2009); Spain (Tabales et al., 2013) and other economies. **Although some scholars reported otherwise (for instance Worzala et al., 1995; Rossini, 1997; Kontrimas & Verikas, 2011).** The information gleaned from the literature shows that AI models outperform traditional techniques, in terms of accuracy. However, a critical look at these studies shows that the AI techniques have been applied to property valuation largely in the context of developed countries.

Previous studies (for instance, Ogunba & Ajayi, 1998; Ayedun et al., 2010; Babawale & Ajayi, 2011) conducted in Nigeria have reported that the level of valuation inaccuracy prevalent in the Nigerian property appraisal landscape, is far beyond industry acceptable standard. Abidoeye and Chan (2016) assert that the inaccuracy is due to **the** lack of know-how in utilizing AI modeling techniques in property valuation. In order to achieve a sustainable property appraisal in Nigeria, the present study aims to (a) examine the level of awareness of the AI appraisal techniques; (b) evaluate the willingness **of Nigerian valuers to adopt the AI** techniques in practice; (c) assess measures that will enhance the adoption of the AI techniques and (d) examine the potential benefits of adopting AI techniques to property valuation in the Nigerian real estate industry.

Artificial intelligence techniques in property valuation

AI techniques (advanced valuation approaches) are models that learn from property market data in estimating valuation figures (Özkan et al., 2007). The techniques process sample data fed into them through a mathematical process that is more rigorous than that of the traditional valuation methods (Mora-Esperanza, 2004). Rossini (1999) affirms that the advanced approaches are more likely to produce on average more accurate valuation estimates than the traditional valuation methods. In the same vein, Waziri (2010) posits that AI techniques

produce reliable and accurate valuation figures with speed. These advanced approaches include ANN, hedonic pricing model (HPM), Autoregressive Integrated Moving Average (ARIMA), spatial analysis and FLS (Pagourtzi et al., 2003). For the purpose of this study, AI appraisal techniques to be considered are limited to HPM, ANN and FLS. These approaches have widely gained much more attention by real estate researchers around the world and have also been adopted in practice in some developed countries (see, Schwartz, 1995; McCluskey et al., 1997).

It is worth mentioning that none of the valuation approaches can address all real-life property valuation exercises (Tse, 1997). Property valuation approaches (both traditional and advanced) are not meant to replace a valuer in the valuation process (Lenk et al., 1997), they are tools to be adopted in achieving the desired result (Mora-Esperanza, 2004). The valuation figures produced by valuation approaches could be influenced by variations in the microeconomic factors of a subject property market (Witten, 1987). As more accurate and reliable property valuation estimates could be obtained in a stable property market (Shapiro et al., 2012). However, the expert knowledge of a valuer cannot be underestimated in estimating more accurate property figures (Kummerow, 2003). A brief description of these techniques (considered in this study) are presented below. However, readers can see Pagourtzi et al. (2003) for a detailed process of the application of both the traditional and the advanced approaches in property valuation process. Also, the strengths and weaknesses of some property valuation approaches are provided in Lam et al. (2008).

Hedonic pricing model

The principle of HPM is based on the regression analysis (Lentz & Wang, 1998; Selim, 2009). Regression analysis could be in the form of simple regression or multiple regression. In the case of simple regression, the analysis is geared towards evaluating the relationship between one independent variable and a dependent variable. Whereas, when the relationship under consideration is between a dependent variable and more than one independent variable, then it

is referred to as multiple regression analysis (MRA). MRA is largely employed for the analysis of real estate property price because the value of a real estate property is dependent on more than one attribute (Selim, 2008). The technique has been adopted widely across different real estate markets around the world. Table 1 shows a number of the studies reported.

Table 1. Application of HPM in the global real estate markets.

Study	Country
Adair et al. (1996)	Northern Ireland
Tse and Love (2000)	Hong Kong
Janssen et al. (2001)	Sweden
Paz (2003)	Spain
Mbachu and Lenono (2005)	South Africa
Jim and Chen (2006)	China
Cebula (2009)	United States
Ge (2009)	New Zealand
Selim (2011)	Turkey
Owusu-Ansah (2012)	Ghana
Ong (2013)	Malaysia
Famuyiwa and Babawale (2014)	Nigeria
Mallick and Mahalik (2014)	India

Fuzzy logic system

The vagueness and ambiguity associated with property price analysis may render property price modeling estimates unreliable (González & Formoso, 2006). The FLS technique is an advanced valuation approach that has been designed to handle this vagueness - ambiguous, inaccurate market data in real estate price modeling. Zadeh (1965) introduced FLS technique and argued that the fuzzy set of an element in a group is characterized by a membership function, the value of this membership function ranges between 0 and 1. The principle of FLS is based on the translation of vague property information into meaningful numeric value, by following some defined set rules in the analysis. These rules are expressed as “if”, “or” and “then” to produce

the output. A typical example is “if a property is big and has high floors, then the value is high”. The graphical representation of the process of FLS is shown in Figure 1. Some FLS studies centered on property valuation include Dilmore (1993), Byrne (1995), Bagnoli and Smith (1998), González and Formoso (2006) and Kuşan et al. (2010), amongst others.

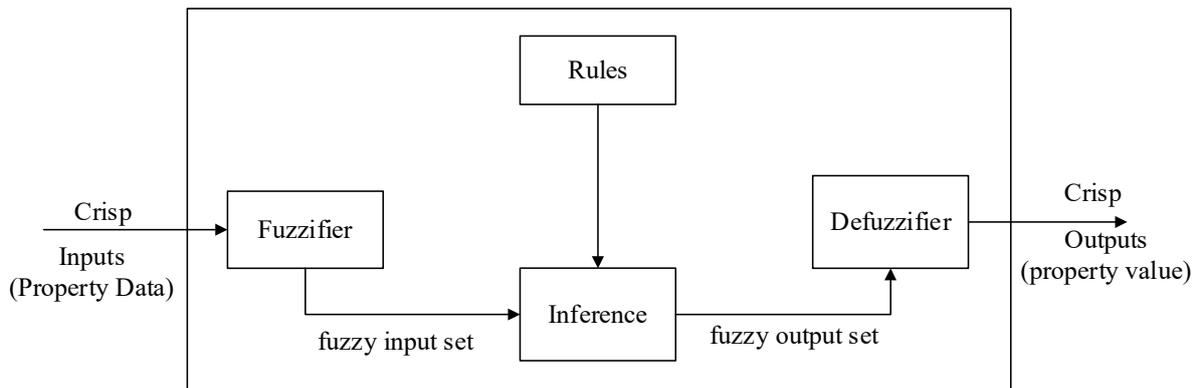


Figure 1. A fuzzy logic system.
Adopted from: Mendel (1995, p. 347).

Artificial neural network

Mora-Esperanza (2004, p. 257) described ANN as a “computer system whose microprocessors, rather than laid out in series as in traditional computers, are connected in parallel, forming layers and making multiple connections, imitating the way the neuronal network is organized in the brain”. The ANN model is suitable for property price prediction because the model mimics humans and hence, the output produced by it could be close to the estimation of a real estate valuer (Borst, 1991). Its ability to capture the nonlinear relationship between property attributes and property value (Ge, 2004), which makes it more suitable for property valuation than other appraisal techniques (Cechin et al., 2000).

The ANN model is made up of three layers, namely input, hidden and output layer. Property attributes are fed from the input layer into the network, the mathematical processing takes place in the hidden layer(s) and the result of the transformation is produced at the output

layer, which is where the **predicted** property value is obtained. Figure 2 shows an example of ANN structure with five inputs, one hidden neuron and one output neuron. Some of the studies that have applied ANN in property price prediction are Borst (1991), Do and Grudnitski (1992), Nguyen and Cripps (2001), Selim (2009) and McCluskey et al. (2013), amongst others.

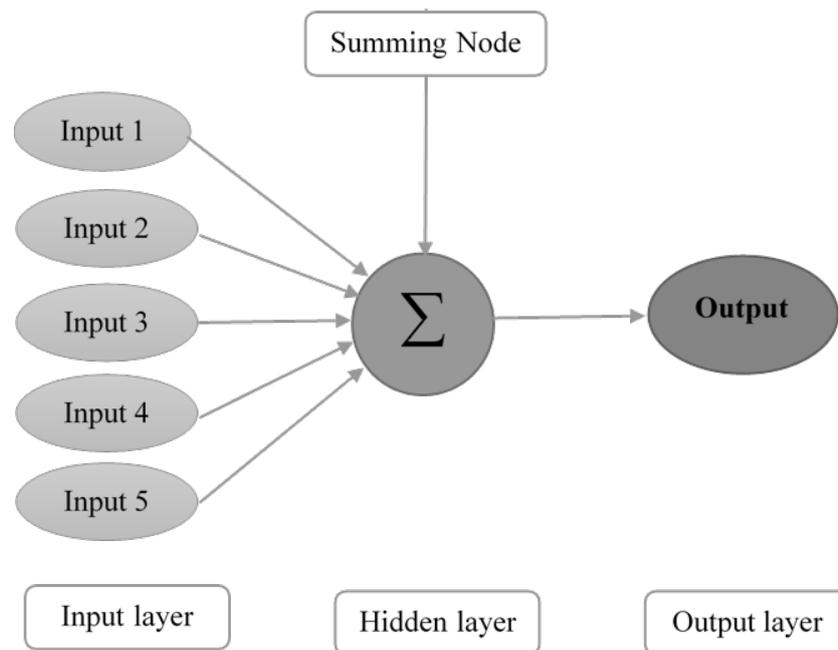


Figure 2. Structure of ANN architecture.
Adopted from: McGreal et al. (1998, p. 59).

Methodology

The main focus of this paper is to evaluate valuers' willingness to embrace AI in property valuation in Nigeria. Quantitative research approach which allows the coverage of a wider spectrum of respondents being studied (Dix & Anderson, 2000) is adopted in this study. A questionnaire survey is a form of quantitative research approach that is usually adopted to measure the perception of respondents in respect of the subject matter under study. It can be administered to the respondents by face-to-face, by post, over the telephone, by email or over

the internet (Hoxley, 2008). Online questionnaire approach was adopted in the present study to capture the opinion of real estate valuers on the research topic under investigation. As opined by Gillham (2000) and Mooya (2015), the survey instrument was validated by a group of real estate experts that have good knowledge of the Nigerian real estate market before the administration of questionnaire on the respondents,. After this exercise, the valuers commented that the instrument was adequately designed to capture the objectives of the study, hence, the questionnaire was rolled out for the actual survey.

Questionnaire administration

The SurveyMonkey platform was utilized to design the online questionnaire. This approach is not uncommon in similar studies (see for instance, Poon et al., 2011; Worzala et al., 2013; Mooya, 2015). The questionnaire was segmented into five parts. The first section centered on the characteristics of the respondents. Section Two to Five focused on questions on; knowledge of AI appraisal techniques, reasons for low awareness and applications of the AI appraisal techniques, measures that will enhance the adoption of AI appraisal techniques and benefits of adopting AI appraisal techniques, respectively. Responses were ranked on a five-point Likert scale (where 1 = strongly disagree, 2 = disagree, 3 = neutral, 4 = agree and 5 = strongly agree). This scale is common and appropriate for the study of this nature (Allen & Seaman, 2007; Dawes, 2008).

According to the 2014 membership directory of the Nigerian Institution of Estate Surveyors and Valuers (NIESV), there are 1794 registered estate surveyor and valuers in the country. Out of this number, only 1229 have their email recorded in the directory. Consequently, the link to the online questionnaire was sent to 300 randomly selected valuers. The respondents were expected to respond to the survey within a period of two months (February to March 2016). Furthermore, a reminder was sent to the respondents within the survey period in order to increase the response rate. At the end of the survey period, 138

responses were received, which represents a response rate of 46%, which is higher than what is obtainable in similar studies that have utilized survey research method (Akintoye & Fitzgerald, 2000). It was worth mentioning that 92 out of the 138 responses were properly completed and valid for further analysis.

Data analysis method

The collected data was analysed using the Statistical Package for the Social Sciences (SPSS) 21.0 software. This tool was used to conduct descriptive analyses in terms of percentile distribution and mean score (MS). Also, the Chi-Square (χ^2) test was done to examine the statistical relationship (if any) that exist between the valuers' profile and the factors that affect the issues under investigation. The MS was adopted in ranking the factors included in the survey instrument. This approach has been adopted in previous built environment studies, see for instance Frank et al. (2007), Babarinde (2015), Mooya (2015) and Abidoeye and Chan (2016), among others. The estimation of the MS was performed by adopting the expression in Equation 1, as adopted in Ameyaw and Chan (2015).

$$MS = \frac{5n_5 + 4n_4 + 3n_3 + 2n_2 + 1n_1}{N} \quad (1)$$

Where n is the score given by valuers based on a five-point scale of 1 to 5 and N is the number of valuers that rated a variable.

The respondents

Professional members of NIESV are the participants of this survey. Those valuers (Estate Surveyors and Valuers, as called in Nigeria) have obtained either a Probationer, Associate or Fellow membership status of NIESV and have acquired some considerable years of professional real estate practice experience. Estate Surveyors and Valuers are real estate professionals that have been empowered by the Laws of the Federal Republic of Nigeria (Decree No. 24 of 1975) to carry out real estate related services to the public. Therefore, the

responses from NIESV members are considered as the most appropriate for the present study.

The case study area

The authors decided to focus on Nigeria, which is the biggest economy in Africa and among the 25 largest economies of the world in terms of its Gross Domestic Product (GDP) (The World Bank, 2016). Its real estate sector contributed about 11% to the national GDP in 2014 (National Bureau of Statistics, 2014). Despite its relative encouraging economic outlook, its property market is still not matured (Dugeri, 2011). The findings of this study will be beneficial to both local and international real estate stakeholders.

Results and discussion

Reliability test

The reliability of the data collected was evaluated in order to ascertain the suitability of the data for the present study. The Cronbach's alpha test was carried out in order to confirm the extent of the internal consistency among all the respondents of the survey (Tavakol & Dennick, 2011). The Cronbach alpha's score ranges between 0 and 1, and a value close to 1 depicts a high reliability and internal consistency. Hair et al. (2010) claimed that a Cronbach alpha value that is above 0.70 is satisfactory. Coincidentally, a Cronbach alpha value of 0.72 was recorded in this study which signifies a satisfactory reliability and internal consistency.

Valuers' profile

It is expected that the characteristics of the valuers in terms of educational qualification, professional experience, sector of practice and the position held in their firms, among other factors, will have an influence on the subject under consideration. Some of the demographic profile of the respondents are shown in Table 2.

Table 2. Profile of the participants.

Variables	Frequency (n)	Percentage (%)	
<i>Membership status with NIESV</i>			
These	Fellow	14	15.20
	Associate	56	60.90
	Probationer	22	23.90
	Total	92	100.00
<i>Years of industry experience</i>			
	1-5 years	18	19.60
	6-10 years	28	30.40
	11-15 years	22	23.90
	16-20 years	8	8.70
	20 years and above	16	17.40
	Total	92	100.00
<i>Gender</i>			
	Male	78	84.80
	Female	14	15.20
	Total	92	100.00
<i>Sector of practice</i>			
	Private real estate firm	66	71.70
	Government parastatal	4	4.30
	Financial institution	2	2.20
	Education (lecturer)	16	17.40
	Oil and gas sector	0	0.00
	Built environment consortium	4	4.30
	Total	92	100.00

characteristics include their membership status with NIESV, the number of years of industry experience, the gender and the sector of practice. The statistics presented in Table 2 shows that about 76 percent of the valuers are either Fellow or Associate members of NIESV. This implies that majority of the respondents are committed members of the professional body. Also, Table 2 shows that about 63 percent of the valuers have acquired an industry professional experience of between 6-20 years and 17 percent possess over 20 years of experience. This indicates that the valuers are sufficiently experienced in the real estate practice. The gender distribution of the participants indicates that 85 percent are men, whereas, 15 percent are female. It fair to interpret that the profession is male dominated in Nigeria. In addition, about 72 percent of the respondents work in a private real estate firm and 17 percent are lecturers. This high percentage of valuers that are working in organizations where property valuation is either carried out or researched in is noteworthy for the present study.

The information presented in Figure 3 shows the highest educational qualification of the valuers. About 22 percent of the valuers have acquired bachelor's degree, 61 percent possess a postgraduate diploma/master's degree and 4 percent of the respondents are Doctor of Philosophy degree holder. This suggests that the valuers are much educated and are expected to be conversant with the global updates in property valuation practice.

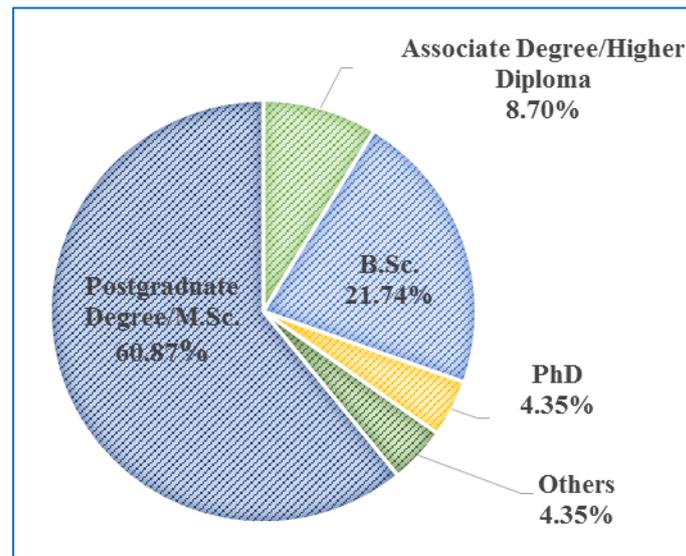


Figure 3. Valuers' highest educational qualification.

On the position held by the valuers in their firms, 44 percent are principal partners, 15 percent are managing partners and senior estate surveyors, respectively. This amounts to over 70 percent of the valuers occupying top positions in their firms, which assures the validity of the feedback of this survey. Figure 4 presents the distribution of the location of higher institutions the valuers attended. It is evident that 87 percent of the valuers attended higher institutions located in Nigeria, while meager 2 percent have experienced foreign education. **Eleven** percent of the valuers have a combination of foreign and local educational experience.

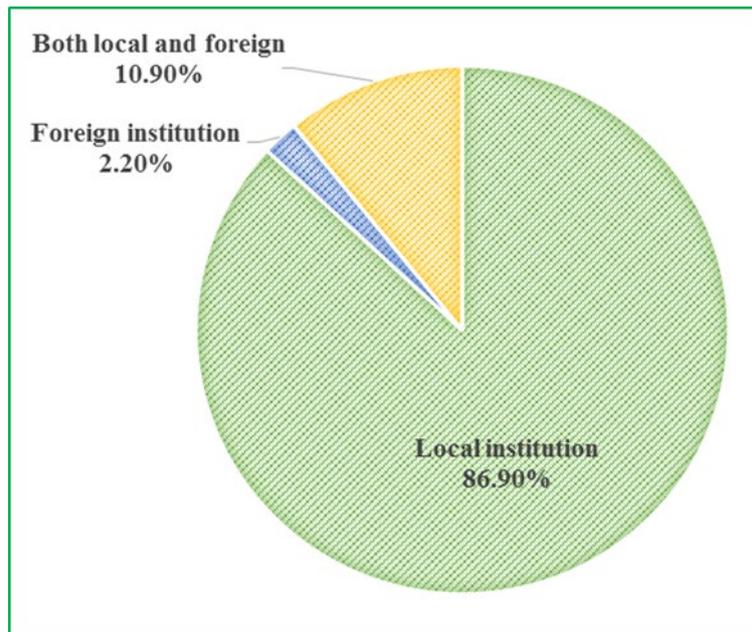


Figure 4. Location of academic institution(s) attended.

Knowledge of AI appraisal techniques

The questions contained in Table 3 was posed to the valuers in order to ascertain their level of awareness of the AI techniques and some other issues relating to the knowledge of AI techniques. Almost 60 percent of the valuers either strongly agree or agree to be aware of these techniques, while the rest are either indifferent or disagree on the issue. On the use of AI techniques in practice, only 13 percent of the valuers adopt the approaches in practice. The technique referred to here by those valuers may probably be HPM, as Abidoeye and Chan (2016) reported that this is one of the advanced approaches that the valuers operating in the Lagos metropolis (Nigeria) widely adopt in practice. The low usage may be connected to the lack of introduction to these techniques during academic training at tertiary educational (i.e. university and polytechnic), as more than half (52 percent) of the valuers indicated this.

Table 3. Knowledge of AI appraisal techniques.

Questions	Level of agreement (%)					Mean score	Standard deviation
	SA	A	N	D	SD		
Valuers are aware of the AI appraisal techniques	13.0	45.7	15.2	10.9	15.2	3.3043	1.2730
Valuers do use the AI appraisal techniques in practice	2.2	10.9	28.3	32.6	26.1	2.3043	1.0455
Valuers were introduced to AI appraisal techniques while in school (university or polytechnic)	4.2	34.8	8.7	21.7	30.4	2.6087	1.3502
NIESV or ESVARBON do organize conference, MCPD, seminar or workshop where this issue is discussed	6.5	13.0	6.5	41.3	32.6	2.1957	1.2156
The basics of AI appraisal techniques are well documented in valuation textbooks and journal articles	10.9	37.0	13.0	17.4	21.7	2.9783	1.3666
Valuers are willing to acquire the know-how of the application of AI techniques in property valuation	56.5	37.0	2.2	2.2	2.2	4.4348	0.8294
Valuers will adopt the AI techniques in practice after acquiring the know-how	41.3	41.3	10.9	2.2	4.3	4.1304	0.9968

Note: SA – Strongly agree, A – Agree, N – Neutral, D – Disagree and SD – Strongly disagree

It is expected that the basic rudiments of these techniques are to be taught to students during academic training. However, in a situation where that did not happen, the valuers have to learn on the job by attending workshops, seminars, training and conferences. Unfortunately, about 74 percent of the valuers have never received any in-house training organized by NIESV or Estate Surveyors and Valuers Registration Board of Nigeria (ESVARBON), suggesting that the valuers have not been provided with the opportunity to learn on the job through this avenue. These professional bodies that have been empowered by the Laws of the Federal Republic of Nigeria seem to have failed to sufficiently promote the awareness and adoption of these techniques in practice.

Putting all the aforementioned together, 93 percent of the valuers indicated their willingness to acquire the know-how of the application of AI techniques, while about 82 percent indicated their readiness to adopt these techniques in practice. This high receptiveness

of the valuers should be harnessed by the relevant professional bodies and other real estate stakeholders, **as this would** expose the valuers to international best appraisal practice.

Reasons for low awareness and application of the AI appraisal techniques

In order to further investigate the cause(s) of low awareness and application of AI techniques amongst valuers, responses were sought on questions addressing the issue (see Table 4). The factors were ranked in order of their importance to the awareness and application of the AI techniques that is under investigation.

Table 4. Reasons for the level of awareness and applications of the AI appraisal techniques.

Factors	Level of agreement (%)					Mean score	Standard deviation	Rank
	SA	A	N	D	SD			
NIESV and ESVARBON are responsible for the lack of awareness and adoption of the AI appraisal approaches amongst valuers	26.1	34.8	21.7	6.5	10.9	3.5870	1.2505	1 st
The educational institutions (academics) are responsible for the lack of awareness of the AI appraisal approaches amongst valuers	26.1	28.3	26.1	13.0	6.5	3.5435	1.1990	2 nd
Real estate professionals are responsible for their own lack of awareness of the AI appraisal techniques	13.0	21.7	39.1	21.7	4.3	3.1739	1.0546	3 rd
My level of education is responsible for the lack of awareness of the AI valuation techniques	10.9	6.5	26.1	21.7	34.8	2.3696	1.3153	4 th
My years of professional experience is responsible for my lack of awareness of the AI valuation techniques	4.3	6.5	23.9	28.3	37.0	2.1304	1.2139	5 th

Note: SA – Strongly agree, A – Agree, N – Neutral, D – Disagree and SD – Strongly disagree

As shown in Table 4, the professional bodies (NIESV and ESVARBON) and the educational institutions were ranked as the first and second factors, respectively, with an MS of 3.5870 and 3.5435, respectively. This corroborates the findings reported earlier (see Table 3) and implies that it is imperative that these two factors are accorded utmost attention by the concern real estate stakeholders.

Valuers' willingness to acquire and adopt AI techniques and their profile

It will be interesting to know if valuers' level of education, year of experience, sector of practice or the location of the institution(s) attended have any significant relationship with their willingness to acquire and adopt the AI appraisal techniques. As this will indicate what to focus on in order to achieve the goal of transforming the appraisal practice in Nigeria. The results of the Chi-square test performed to establish the relationship is presented in Table 5. On the willingness to acquire the know-how of AI techniques, the year of experience has a strong statistical significance with the acquisition of AI know-how at 5% level of significance. It is safe to suggest that the longer a valuer practice the real estate profession, the greater the desire to be proficient in AI appraisal. **This substantiates** the findings of Mooya (2015) in South Africa who reported that the length of professional experience of a valuer determines their professional competence. On the other side, the years of experience and the sector where a valuer practices significantly influence their readiness to adopt the AI techniques in practice. This implies that the more a valuer practice this profession, the more the eagerness to adopt the techniques in practice coupled with the sector of practice which is probably in a real estate firm, owing to the fact that most (70 percent) of the valuers work in private real estate firms.

Table 5. Chi-square test for valuers willingness to acquire and adopt AI knowledge and their profile.

Characteristics	χ^2 value	Degree of freedom (df)	P -value
<i>Willingness to acquire AI techniques know-how</i>			
Acquire higher educational qualification	5.281 ^a	16	0.994 ^a
The years of experience	32.229 ^a	16	0.009 ^a
The sector of practice	11.778 ^a	16	0.759 ^a
The location of institution(s) attended	10.282	8	0.246
<i>Willingness to adopt AI techniques in practice</i>			
Acquire higher educational qualification	24.539 ^a	16	0.078 ^a
The years of experience	41.857 ^a	16	0.000 ^a
The sector of practice	64.305 ^a	16	0.000 ^a
The location of institution(s) attended	9.926	8	0.270

Note: χ^2 means Chi-square.

Enablers of AI appraisal techniques adoption

From the perspective of introducing the AI techniques in practice in Nigeria, all real estate stakeholders have a role to play. Table 6 reflect the opinion of valuers on the measure that will enhance the adoption of the AI techniques. Of the five measures presented, a partnership between the Nigerian real estate professional bodies (NIESV and ESVARBON) and international professional bodies such as Royal Institution of Chartered Surveyors (RICS) was ranked first with an MS value of 3.8913. This implies the need for an active and sustainable collaboration between the Nigerian real estate professional bodies and their international counterparts. This partnership has been achieved in some African countries (Ghana, Kenya and South Africa) and has gone beyond mere affiliations, rather the operation of international real estate bodies such as RICS has been extended **to these real estate markets** (RICS, 2015). The second factor is the overhauling of valuation curriculum of higher institutions of learning where real estate related courses are offered. This still amount to the need for basic educational training for real estate undergraduates in order make them updated of international property valuation practice (Mooya, 2015).

Table 6. Measures that will enhance the adoption of AI appraisal techniques.

Enablers	Level of agreement (%)					Mean score	Standard deviation	Rank
	SA	A	N	D	SD			
NIESV and ESVARBON partnership with other international real estate professional bodies	30.4	45.7	10.9	8.7	4.3	3.8913	1.0737	1 st
The overhauling of valuation curriculum by ESVARBON	23.9	50.0	15.2	8.7	2.2	3.8478	0.9600	2 nd
Valuers compulsory attendance of seminar, training, workshop and conference organized by ESVARBON and NIESV	21.7	50.0	19.6	2.2	6.5	3.7826	1.0252	3 rd
The amendment of the membership code of conduct of NIESV and ESVARBON	19.6	21.7	28.3	19.6	10.9	3.1957	1.2687	4 th
Valuers mandatory acquisition of higher academic education	15.2	26.1	10.9	32.6	15.2	2.9348	1.3490	5 th

Note: SA – Strongly agree, A – Agree, N – Neutral, D – Disagree and SD – Strongly disagree

Prospects of adopting AI appraisal techniques

Scholars have applied successfully and reported outstanding results in the application of the AI techniques under investigation in the **present** study (see for instance Tay & Ho, 1992; Adair et al., 1996; Tse & Love, 2000; Hui et al., 2009; Kuşan et al., 2010; McCluskey et al., 2013). Therefore, it is believed that if the AI techniques are employed in the Nigerian real estate market, it could bring about a paradigm shift from the present state to an international level (Babawale & Oyalowo, 2011). However, in order of importance from the view of the valuers, the adoption of the AI techniques in Nigeria real estate market will transform the real estate practice, it will be sustained when implemented and the techniques will produce reliable and accurate valuation estimates that will reduce valuation inaccuracy in the property market (see Table 7). The views of the Nigerian valuers is not estranged with that of Malaysian valuers that are optimistic that computer aided valuation (CAV) will transform the Malaysian real estate appraisal practice (Azmi et al., 2013). These benefits should not be underemphasized, because the Nigerian property market is still at the developing stage (Dugeri, 2011) and at the same time, it is highly imperative to regain end-users' confidence of valuation reports in Nigeria (Adegoke et al., 2013), in order for Nigerian real estate professionals to remain competitive and respectful (Babawale & Ajayi, 2011).

Table 7. Benefits of adopting AI appraisal techniques.

Factors	Level of agreement (%)					Mean score	Standard deviation	Rank
	SA	A	N	D	SD			
This will add value and transform the Nigerian appraisal practice	23.9	47.8	19.6	4.3	4.3	3.8261	0.9901	1 st
The adoption of the AI techniques in Nigerian valuation practice will be sustained when implemented	8.7	50.0	39.1	2.2	0.0	3.6522	0.6701	2 nd
It will produce reliable estimates that will be acceptable by valuation report end-users and all stakeholders	15.2	41.3	39.1	2.2	2.2	3.6522	0.8446	2 nd
The AI appraisal techniques can reduce subjective interference in property valuation practice	17.4	34.8	39.1	6.5	2.2	3.5870	0.9276	4 th
It will reduce the time involved in carrying out valuation exercise	13.0	41.3	34.8	10.1	0.0	3.5652	0.8555	5 th

The AI appraisal techniques can replicate human skills	10.9	37.0	32.6	15.2	4.3	3.3478	1.0102	6 th
It will reduce the cost involved in carrying out valuation exercise	4.3	39.1	39.1	15.2	2.2	3.2826	0.8558	7 th
The AI appraisal approaches are more superior to the traditional valuation methods	10.9	17.4	39.1	26.1	6.5	3.0000	1.0690	8 th

Note: SA – Strongly agree, A – Agree, N – Neutral, D – Disagree and SD – Strongly disagree

Conclusion and further research

The current immature state of the Nigerian real estate practice, in terms of its appraisal practice motivated the present study. Howbeit, the receptiveness of Nigerian valuers to adopt the AI appraisal techniques was investigated. An online questionnaire was administered to professional members of NIESV. The analyses of the collected data revealed that a little bit above half of the valuers are aware of the AI appraisal techniques, but do not adopt them in practice. This is largely due to the little or no continuous professional training and non-inclusion of the AI techniques in the current curriculum of real estate programmes at university and polytechnics. Valuers' length of professional experience and the sector where valuers work was found to influence their willingness to adopt these AI techniques. Meaningful collaboration and affiliation with international real estate professional bodies and the overhauling valuation curriculum at universities and polytechnics will aid the adoption of the techniques across the nation. This will add value to the appraisal practice, in terms of estimating and reporting reliable and accurate valuation estimates that will be a good representation of market value. The subjective interference of valuers in appraisal exercise can be reduced and then lessen the level of valuation inaccuracy prevalent in the property market to the lowest minimum. The findings of the present study should serve as a wake-up call to all real estate stakeholders in Nigeria, especially the main drivers of the issue under investigation (NIESV, ESVARBON, valuers and lecturers in higher institutions) to advocate and propagate the acquisition and adoption of the AI appraisal techniques in Nigeria. **This could be achieved by improving the current curriculum used at different level of higher institution of education. The overhauling**

should be benchmarked against international standard in order to keep the students updated with the trending international valuation theories and methodologies before the graduate and begin to practice the profession. The training of practicing estate surveyors and valuers in the proficiency of the advanced valuation approaches should be accorded an urgent attention by NIESV and ESVARBON. This trainings should be hands-on, as this would enhance the ability of the valuers to incorporation market research into property valuation exercise. Property transactions data are needed to develop property price models, therefore, NIESV and ESVARBON could direct effort in maintaining a more robust and quality property sales and purchases database, as this could improve the results. This could revolutionize the appraisal practice to attaining international standard. It is assumed that the list of valuers in the 2014 NIESV directory is not updated, therefore, valuers whose details are not in the directory or have their incomplete information (no e-mail address) captured in the directory might have been excluded from this survey. However, the high profile of the sampled surveyors ensure that meaningful inferences can be made from this study. The earnest adoption of the AI techniques in practice may be triggered with research because research drives the sustainability of a profession. Although the Nigerian real estate market has been modeled using the HPM technique, the ANN and FLS techniques have not received attention by the Nigerian real estate scholars. Therefore, to further this research, the ANN will be adopted in modeling the Nigerian real estate market, particularly the Lagos metropolis **property market**. The further study will; 1) investigate the suitability and viability of ANN in property valuation in Nigeria and 2) compare the findings with that of HPM, so as to establish the most reliable and accurate of the two techniques.

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References

- Abidoye, R. B. and Chan, A. P. C. (2016). A survey of property valuation approaches in Nigeria. *Property Management*, 34 (5), 364-382.
- Adair, A. S., Berry, J. N. and McGreal, W. S. (1996). Hedonic modelling, housing submarkets and residential valuation. *Journal of Property Research*, 13 (1), 67-83.
- Adegoke, J. O. (2014). Critical factors determining rental value of residential property in Ibadan metropolis, Nigeria. *Property Management*, 32 (3), 224-240.
- Adegoke, O., Olaleye, A. and Oloyede, S. (2013). A study of valuation clients perception on mortgage valuation reliability. *African Journal of Environmental Science and Technology*, 7 (7), 585-590.
- Akintoye, A. and Fitzgerald, E. (2000). A survey of current cost estimating practices in the UK. *Construction Management & Economics*, 18 (2), 161-172.
- Allen, I. E. and Seaman, C. A. (2007). Likert scales and data analyses. *Quality Progress*, 40 (7), 64-65.
- Ameyaw, E. E. and Chan, A. P. C. (2015). Risk ranking and analysis in PPP water supply infrastructure projects. *Facilities*, 33 (7/8), 428-453.
- Amri, S. and Tularam, G. A. (2012). Performance of multiple linear regression and nonlinear neural networks and fuzzy logic techniques in modelling house prices. *Journal of Mathematics and Statistics*, 8 (4), 419-434.
- Ayedun, C., Ogunba, O. and Oloyede, S. (2010). The accuracy of Nigerian property valuations revisited. *Built Environment Journal*, 7 (2), 1-11.
- Azmi, A. S. M., Nawawi, A. H., Ab Latif, S. N. F. and Ling, N. L. F. J. (2013). Property valuers' receptive level on knowledge of computer aided valuation (CAV) system. *Procedia-Social and Behavioral Sciences*, 105, 734-744.
- Babarinde, J. A. (2015). Asset valuation and the role of news in sub-Saharan Africa: Valuers' rationality and the hype dilemma. *Pacific Rim Property Research journal*, 21 (2), 139-159.
- Babawale, G. K. and Ajayi, C. A. (2011). Variance in residential property valuation in Lagos, Nigeria. *Property Management*, 29 (3), 222-237.
- Babawale, G. K. and Oyalowo, B. A. (2011). Incorporating sustainability into real estate valuation: The perception of Nigerian valuers. *Journal of Sustainable Development*, 4 (4), 236-248.
- Bagnoli, C. and Smith, H. C. (1998). The theory of fuzz logic and its application to real estate valuation. *Journal of Real Estate Research*, 16 (2), 169-200.
- Borst, R. A. (1991). Artificial neural networks: The next modelling/calibration technology for the assessment community. *Property Tax Journal*, 10 (1), 69-94.
- Borst, R. A. (1995). Artificial neural networks in mass appraisal. *Journal of Property Tax Assessment & Administration*, 1 (2), 5-15.
- Byrne, P. (1995). Fuzzy analysis: A vague way of dealing with uncertainty in real estate analysis? *Journal of Property Valuation and Investment*, 13 (3), 22-41.

- Cechin, A., Souto, A. and Gonzalez, A. M. (2000, 22-25 November). *Real estate value at Porto Alegre city using artificial neural networks*. Paper presented at the 6th Brazilian Symposium on Neural Networks, Rio de Janeiro, Brazil.
- Chiang, Y., Tao, L. and Wong, F. K. (2015). Causal relationship between construction activities, employment and GDP: The case of Hong Kong. *Habitat International*, 46, 1-12.
- Dawes, J. G. (2008). Do data characteristics change according to the number of scale points used? An experiment using 5 point, 7 point and 10 point scales. *International Journal of Market Research*, 51 (1), 61-77.
- Dilmore, G. (1993). *Fuzzy set theory: An introduction to its application for real estate analysts*. Paper presented at the Annual conference of the American Real Estate Society, Key West, Florida.
- Din, A., Hoesli, M. and Bender, A. (2001). Environmental variables and real estate prices. *Urban Studies*, 38 (11), 1989-2000.
- Dix, K. and Anderson, J. (2000). Distance no longer a barrier: Using the internet as a survey tool in educational research. *International Education Journal*, 1 (2), 83-93.
- Do, A. Q. and Grudnitski, G. (1992). A neural network approach to residential property appraisal. *The Real Estate Appraiser*, 58 (3), 38-45.
- Dugeri, T. T. (2011). *An evaluation of the maturity of the Nigerian property market*. (Doctoral dissertation), University of Lagos, Lagos. Retrieved from <http://www.afrr.org/docs/pdf/dugeri.pdf>
- Frank, L. D., Saelens, B. E., Powell, K. E. and Chapman, J. E. (2007). Stepping towards causation: Do built environments or neighborhood and travel preferences explain physical activity, driving, and obesity? *Social Science & Medicine*, 65 (9), 1898-1914.
- Ge, J. X. (2004). *Housing price models for Hong Kong*. (Doctoral dissertation), University of Newcastle, Australia.
- Gillham, B. (2000). *Developing a questionnaire*. London: Continuum
- González, M. A. S. and Formoso, C. T. (2006). Mass appraisal with genetic fuzzy rule-based systems. *Property Management*, 24 (1), 20-30.
- Hair, J., Black, W., Babin, B., Anderson, R. and Tatham, R. (2010). *Multivariate data analysis* (7th ed.). New Jersey: Prentice-Hall.
- Hoxley, M. (2008). Questionnaire design and factor analysis. In A. Knight & L. Ruddock (Eds.), *Advanced research methods in the built environment* (pp. 122-134). Chichester, UK: Wiley-Blackwell.
- Hui, C. M. E., Lau, M. F. O. and Lo, K. K. T. (2009). Deciphering real estate investment decisions through fuzzy logic systems. *Property Management*, 27 (3), 163-177.
- Kontrimas, V. and Verikas, A. (2011). The mass appraisal of the real estate by computational intelligence. *Applied Soft Computing*, 11 (1), 443-448.
- Kummerow, M. (2003). *Theory for real estate valuation: An alternative way to teach real estate price estimation methods*. Perth: Department of Land Economy and Valuation, Curtin University.
- Kuşan, H., Aytekin, O. and Özdemir, I. (2010). The use of fuzzy logic in predicting house selling price. *Expert Systems with Applications*, 37 (3), 1808-1813.
- Lam, K. C., Yu, C. Y. and Lam, K. Y. (2008). An artificial neural network and entropy model for residential property price forecasting in Hong Kong. *Journal of Property Research*, 25 (4), 321-342.
- Lenk, M. M., Worzala, E. M. and Silva, A. (1997). High-tech valuation: Should artificial neural networks bypass the human valuer? *Journal of Property Valuation and Investment*, 15 (1), 8-26.

- Lentz, G. and Wang, K. (1998). Residential appraisal and the lending process: A survey of issues. *Journal of Real Estate Research*, 15 (1), 11-39.
- McCluskey, W. (1996). Predictive accuracy of machine learning models for the mass appraisal of residential property. *New Zealand Valuers Journal*, 16 (1), 41-47.
- McCluskey, W., Deddis, W., Mannis, A., McBurney, D. and Borst, R. (1997). Interactive application of computer assisted mass appraisal and geographic information systems. *Journal of Property Valuation and Investment*, 15 (5), 448-465.
- McCluskey, W. J., McCord, M., Davis, P., Haran, M. and McIlhatton, D. (2013). Prediction accuracy in mass appraisal: A comparison of modern approaches. *Journal of Property Research*, 30 (4), 239-265.
- McGreal, S., Adair, A., McBurney, D. and Patterson, D. (1998). Neural networks: The prediction of residential values. *Journal of Property Valuation and Investment*, 16 (1), 57-70.
- Mooya, M. M. (2015). The education and professional practice of valuers in South Africa: A critical review. *Property Management*, 33 (3), 245 - 274.
- Mora-Esperanza, J. G. (2004). Artificial intelligence applied to real estate valuation: An example for the appraisal of Madrid. *CATASTRO*, April (1), 255-265.
- National Bureau of Statistics. (2014). Nigerian Gross Domestic Product Report. *Quarter four*, (04).
- Nguyen, N. and Cripps, A. (2001). Predicting housing value: A comparison of multiple regression analysis and artificial neural networks. *Journal of Real Estate Research*, 22 (3), 313-336.
- Ogunba, O. and Ajayi, C. (1998). An assessment of the accuracy of valuations in the residential property market of Lagos. *The Estate Surveyor and Valuer*, 21 (2), 19-23.
- Özkan, G., Yalpir, Ş. and Uygunol, O. (2007, May 29 - June 1). *An investigation on the price estimation of residable real-estates by using artificial neural network and regression methods*. Paper presented at the 12th Applied Stochastic Models and Data Analysis International conference (ASMDA), Chania, Crete, Greece.
- Pagourtzi, E., Assimakopoulos, V., Hatzichristos, T. and French, N. (2003). Real estate appraisal: A review of valuation methods. *Journal of Property Investment & Finance*, 21 (4), 383-401.
- Pagourtzi, E., Metaxiotis, K., Nikolopoulos, K., Giannelos, K. and Assimakopoulos, V. (2007). Real estate valuation with artificial intelligence approaches. *International journal of intelligent systems technologies and applications*, 2 (1), 50-57.
- Poon, J., Hoxley, M. and Fuchs, W. (2011). Real estate education: An investigation of multiple stakeholders. *Property Management*, 29 (5), 468-487.
- RICS. (2015). Unleashing sub-Saharan African property markets. Retrieved on 1 May 2015, from Royal Institution of Chartered Surveyors <http://www.rics.org/hk/knowledge/research/research-reports/unleashing-sub-saharan-african-property-markets/>
- Rossini, P. (1997). Artificial neural networks versus multiple regression in the valuation of residential property. *Australian Land Economics Review*, 3 (1), 1-12.
- Rossini, P. (1999, 26-30 January, 1999). *Accuracy issues for automated and artificial intelligent residential valuation systems*. Paper presented at the International Real Estate Society Conference, Kuala Lumpur.
- Schwartz, T. J. (1995). Automating appraisal. *Wall Street & Technology*, 12 (13), 64-66.
- Selim, H. (2009). Determinants of house prices in Turkey: Hedonic regression versus artificial neural network. *Expert Systems with Applications*, 36 (2), 2843-2852.
- Selim, S. (2008). Determinants of house prices in Turkey: A hedonic regression model. *Doğuş Üniversitesi Dergisi*, 9 (1), 65-76.

- Shapiro, E., Mackmin, D. and Sams, G. (2012). *Modern methods of valuation* (11th ed.). London: Estates Gazette.
- Tabales, J. N. M., Ocerin, C. J. M. and Carmona, F. J. R. (2013). Artificial neural networks for predicting real estate prices. *Revista de Metodos Cuantitativos para la Economia y la Empresa*, 15, 29-44.
- Tavakol, M. and Dennick, R. (2011). Making sense of Cronbach's alpha. *International Journal of Medical Education*, 2 (1), 53-55.
- Tay, D. P. and Ho, D. K. (1992). Artificial intelligence and the mass appraisal of residential apartments. *Journal of Property Valuation and Investment*, 10 (2), 525-540.
- The World Bank. (2016). Gross domestic product 2015. Retrieved on 22nd July 2016, from World Bank <http://databank.worldbank.org/data/download/GDP.pdf>
- Tse, R. Y. (1997). An application of the ARIMA model to real-estate prices in Hong Kong. *Journal of Property Finance*, 8 (2), 152-163.
- Tse, R. Y. and Love, P. E. (2000). Measuring residential property values in Hong Kong. *Property Management*, 18 (5), 366-374.
- Waziri, B. S. (2010, 27-28, July). *An artificial neural network model for predicting construction costs of institutional building projects in Nigeria*. Paper presented at the West Africa Built Environment Research (WABER) Conference, Accra, Ghana.
- Witten, R. G. (1987). Riding the real estate cycle. *Real Estate Today*, 42-48.
- Worzala, E., Lenk, M. and Silva, A. (1995). An exploration of neural networks and its application to real estate valuation. *Journal of Real Estate Research*, 10 (2), 185-201.
- Worzala, E., Tu, C., Benedict, R. and Matthews, A. (2013). A graduate real estate program survey: Careers and compensation. *Journal of Real Estate Practice and Education*, 16 (1), 29-40.
- Zadeh, L. A. (1965). Fuzzy sets. *Information and control*, 8 (3), 338-353.
- Zheng, X., Chau, K. W. and Hui, E. C.-M. (2012). The impact of property price on construction output. *Construction Management and Economics*, 30 (12), 1025-1037.
- Zurada, J. M., Levitan, A. S. and Guan, J. (2006). Non-conventional approaches to property value assessment. *Journal of Applied Business Research*, 22 (3), 1-14.