



Gulf Organisation for Research and Development
International Journal of Sustainable Built Environment

ScienceDirect
www.sciencedirect.com



Review Article

Critical review of hedonic pricing model application in property price appraisal: A case of Nigeria

Rotimi Boluwatife Abidoye*, Albert P.C. Chan

Department of Building and Real Estate, The Hong Kong Polytechnic University, Hung Hom, Hong Kong

Received 2 March 2016; accepted 8 February 2017

Abstract

The hedonic pricing model (HPM) technique has been widely adopted for property price appraisal by scholars and professionals in different real estate markets around the world. Despite its popularity in this research domain, the trend of the application of HPM in Nigeria, being the largest economy in Africa, is unknown and has not been documented. This study, therefore, aims to critically review the extant literature of the HPM property price appraisal related articles published in Nigeria. Papers published in this research area were retrieved from online databases and search engines. The authors' contributions, authors' affiliations, the focused study areas and the annual publication trend of the articles were reviewed. The first application of HPM in Nigeria was recorded in 1986. Thereafter, there have been fluctuations in the number of annual publications. However, there have been a considerable number of articles published since 2010. The authors have largely focused on the Lagos metropolis property market as a study area. It was also found that most of the authors were university scholars and on the other side, real estate professionals have not contributed significantly to this research topic. In order to achieve a sustainable real estate practice in Nigeria, the gap between theory and practice should be bridged.

© 2017 The Gulf Organisation for Research and Development. Production and hosting by Elsevier B.V.

This is an open access article under CC BY-NC-ND license. (<http://creativecommons.org/licenses/by-nc-nd/4.0/>)

Keywords: Hedonic pricing model; Real estate research; Property price; The Lagos metropolis; Nigeria

Contents

1. Introduction	251
2. Hedonic pricing model: Application in property appraisal	251
3. Applications of modeling techniques in property pricing: Review of the literature	252
4. Research method	253
5. Results and discussion	254
5.1. Authors' affiliations.	254
5.2. Active authors	255

* Corresponding author.

E-mail address: rotimi.abidoye@connect.polyu.hk (R.B. Abidoye).

Peer review under responsibility of The Gulf Organisation for Research and Development.

5.3. Annual publications	255
5.4. Focus study areas	256
6. Conclusion and further research	257
Acknowledgement	257
References	257

1. Introduction

Real estate property is a composite goods. This is because the value attached to a property is dependent on many unique bundles of attributes (Rosen, 1974; Sirmans et al., 2005). The uniqueness of the stakeholders that interact in the real estate market, as well as the heterogeneous nature of real estate properties, could be attributed to the differences in the value ascribed to real estate property interest by different stakeholders (Chin and Chau, 2002; Sirmans et al., 2005). This has led to the development of a model that generates the contributory power of each of these variables to the value formation and hence, the emergence of the hedonic pricing model (HPM).

The HPM technique has been largely adopted for property appraisal in different real estate markets around the world to measure the contribution of property attributes, as well as other external factors that could affect the value of a property (Jim and Chen, 2006; Selim, 2008). The nature of real estate property warrants the quantification of the value of each property variable to property value formation. The multiple regression analysis (MRA) which is also referred to as HPM (Lentz and Wang, 1998), can be employed to analyse the property transaction data of a submarket. By this, the utility of each of these variables is being priced by the property buyer (Malpezzi et al., 1980). The general form of HPM gives the regression estimate of each independent variable, in other words, property value is a function of the sum of both the internal and external property attributes as presented in Eq. (1) (Chin and Chau, 2002; Sirmans et al., 2005).

$$\text{Price} = f(\text{structural, locational and neighbourhood factors}) \quad (1)$$

Other analytical techniques are employed in the property price appraisal domain, however, HPM is widely used by real estate researchers (Bender et al., 2000; Babawale et al., 2012). Probably because the approach is straightforward and versatile (Chin and Chau, 2002).

Nigeria has been acknowledged as the largest economy in Africa, with a relative active real estate market (PwC, 2014). Scholars (for example, Megbolugbe, 1989; Babawale et al., 2012; Adegoke, 2014; Famuyiwa and Babawale, 2014) have conducted research in its real estate market using the HPM technique to model the property price in different submarkets. To the best of the authors' knowledge, no effort has been directed at investigating the trend and gaps in the application of HPM in published real estate studies focused on Nigeria. Therefore, this study

aims at investigating the historical development of the adoption of HPM in the Nigeria's property price appraisal domain. By this, the objectives to be pursued are to (1) ascertain the first study that adopted HPM in Nigerian for property price appraisal and subsequently the annual publications up to date (2) establish the organisations or institutions which the studies emanated from (3) establish the contribution of the authors by presenting the highest publishing authors and (4) determine the focus (in terms of study areas) of the HPM publications in Nigeria.

Apart from this introductory part, the remaining of this paper is structured into five sections. The next section presents the historical background and the application of HPM in the real estate research environment, while the second section reports the review of related studies. The third part deals with the research method adopted for the current study, whereas, the following section discusses the results of the data analysis. The conclusion and further research direction is presented in the last section.

2. Hedonic pricing model: Application in property appraisal

The first application of HPM in property price appraisal could be traced back to early 1920s. Although, there is no consensus as to the actual date of introduction. For instance, Colwell and Dilmore (1999) reported that Haas (1922) is the first study to employed HPM in the property price appraisal research, by adopting it to value a farmland in Minnesota (United States). Similarly, Bruce and Sundell (1977) argued that the HPM technique was firstly introduced in the real estate pricing research in 1924. Besides, Wallace (1926) adopted the HPM technique in appraising farmlands in the US. Ridker and Henning (1967) employed HPM for the estimation of the effect of air quality on residential property values, suggesting that this is the first application of HPM in property pricing appraisal research (Chin and Chau, 2003). However, Freeman (1979) provided a theoretical justification for HPM application in property pricing appraisal research (Chin and Chau, 2003).

Scholars mostly refer to Court (1939) as the pioneer of HPM. Court (1939) developed a pricing index for automobiles, which illustrate that the demand for automobiles can be explained by numerous variables which include wheel-base, dry weight and horsepower of the car. Thereafter, other scholars (e.g., Muth, 1966; Oates, 1969) adopted HPM to real estate research. Subsequently, Rosen (1974) developed the theoretical support for the application of HPM in property value appraisal. After the study of Rosen (1974), scholars in different real estate markets

around the world have been adopting the HPM technique for real estate appraisal. Examples of these studies include but are not limited to [Adair et al. \(1996\)](#) (Northern Ireland), [Tse and Love \(2000\)](#) (Hong Kong), [Paz \(2003\)](#) (Spain), [Mbachu and Lenono \(2005\)](#) (South Africa), [Cebula \(2009\)](#) (United States), [Ge \(2009\)](#) (New Zealand), [Selim \(2008\)](#) (Turkey), [Ong \(2013\)](#) (Malaysia) and [Mallick and Mahalik \(2015\)](#) (India).

3. Applications of modeling techniques in property pricing: Review of the literature

There are quite a number of data analysis techniques that are being employed in the property pricing research domain and they range from econometrics (e.g., ARIMA, linear regression) to artificial intelligence (AI) (e.g., artificial neural network, fuzzy logic) ([Pagourtzi et al., 2003](#); [Brooks and Tsolacos, 2010](#)). Researchers have investigated the applications of these techniques in different research fields and also in real estate.

The fuzzy logic system (FLS) is one of such technique, a multi-criteria decision making tool. The application of FLS in articles published between 1994 and 2014 was reviewed by [Mardani et al. \(2015\)](#). It was established that the technique is being employed in the engineering, management and business and science and technology fields of studies. However, it was found that the majority of the articles were published in 2013, the authors of the articles reviewed adopted a hybrid form of the technique and the analytic hierarchy process (AHP) is the most combined technique. In addition, the results of the study show that a majority of the authors are engineers, while most of the articles originated from Taiwan (for instance, [Lee et al., 2008](#); [Lu and Wang, 2011](#); [Chou and Cheng, 2012](#)).

The AHP technique is another multi-criteria decision making technique that has been in the real estate research domain for a while. The study of [Zahedi \(1986\)](#) established that AHP is applicable in different fields which include economic and planning, conflict resolution, manufacturing, portfolio selection, accounting and auditing. Others are auditing, education, politics and environment marketing, amongst others. [Vaidya and Kumar \(2006\)](#) examined 150 articles that adopted AHP, but eventually reviewed 27 of these articles. In addition to the exposition of the applications of the technique that is similar to that of [Zahedi \(1986\)](#), it was discovered that most of the authors adopted the technique for variable selections. The United States was identified as the country where most of the articles emanated from, while a continuous trend of application of the techniques was noticed in developing countries, especially in India.

The artificial neural network (ANN) is an AI technique that has gained widespread popularity in different research areas as well, and has proven to be highly efficient for property pricing appraisal research ([Mora-Esperanza, 2004](#)). [Widrow et al. \(1994\)](#) reviewed the applications of the tool

in industry, business and science disciplines. The authors presented the classification of the technique in the areas of linear applications (telecommunications, sound and vibration control), multi-element nonlinear applications (credit card fraud detection, cursive hand writing recognition, loan approval, real estate analysis and marketing analysis, amongst others) and nonlinear applications on the horizon (automotive, speech recognition and mass spectra classification, amongst others). This is similar to the study of [Paliwal and Kumar \(2009\)](#) who reviewed and classified articles that applied the ANN technique in accounting and finance, health and medicine, marketing, engineering and manufacturing and general application fields.

[Bruce and Sundell \(1977\)](#) conducted a review of studies that adopted HPM in real estate appraisal before 1954, between 1954 and 1964, and between 1964 and 1977. The authors claimed that during the study period, the technique has been applied to four classes of real estate properties, namely, rural bare land, urban bare land, single-family residences and multiple-family residences. The authors attributed the non-popularity of the approach in these early days to unavailability of computers to handle the mathematical calculations involved. A review and detailed theoretical development of the HPM approach is presented by [Chin and Chau \(2002\)](#) and [Malpezzi \(2003\)](#). Also, [Sirmans et al. \(2005\)](#) conducted a meta-analysis of articles that have adopted HPM to measure the marginal contribution of variables that determine property values. [Sirmans et al. \(2005\)](#) analysed 125 articles published in the United States between 1995 and 2004 to establish the major property features that are frequently valued by property buyers. A total of 360 independent variables were identified from the 125 articles reviewed. Further, the variables are classified into eight categories, including construction & structure, house internal features, house external amenities, environmental (natural), environmental (neighbourhood & location), environmental (public service), marketing, occupancy & selling and financial issues.

Most of these studies were conducted on other property price analysis techniques and the studies that centred on HPM, were conducted in the US and other economies that have different socio-economic and research environment from that of Nigeria. The choice of studying HPM is attributed to the fact that the technique has been widely used in real estate research domain and has the ability to produce the contributory power of property value determinants that may be of interest to real estate investors and other real estate stakeholders. Nigeria is the largest economy in Africa and the 26th in the world, this was established by the rebasing of Nigeria's gross domestic product (GDP) that was estimated to be US\$ 510 billion ([National Bureau of Statistics, 2014](#); [PricewaterhouseCoopers, 2014](#)). Thus, it is imperative for real estate researchers, investors and stakeholders to gain valuable insights into the Nigerian real estate market. This will be achieved by

reviewing published studies that applied HPM in property value research in Nigeria.

4. Research method

The subjects that constitute data for this study are published articles that adopted the HPM technique in property pricing researches conducted in Nigeria. This scope necessitated the retrieval of articles from online databases and search engines – Springer, Science Direct, ProQuest, Taylor & Francis, Scopus and Google Scholar. It is worth mentioning that most of the articles were retrieved from Google Scholar. This may be due to the fact that it indexes a wide-ranging field of studies and also help to retrieve the most oblique material (Falagas et al., 2008). The search keywords used for the search exercise were; ‘hedonic pricing model’, ‘multiple regression analysis’, ‘Nigeria’, ‘real estate’, ‘property’ ‘property value’ and ‘willingness-to-pay’. Articles published in journals and conference proceedings were the publications that met the selection criteria for this review. Thesis, dissertations and other unpublished articles were not selected for the present study. The selection criteria and process used in this study have been slightly modified when compared with Ke et al. (2009). See Fig. 1 for the research framework adopted for the study.

On the range of years used for the search, the start year was left open so as to achieve one of the objectives of the current study – to establish the evolution or point of introduction of HPM to the Nigeria’s property price appraisal research domain. Conversely, the end date was put at 2014. At the end of the search exercise, 48 articles were eventually retrieved and thus, subjected to analysis. Out of these, 46 are journal articles, while only two are conference proceedings. The characteristics of these articles in terms of their authors, authors’ affiliations, annual publication trend and study areas were extracted and analysed using descriptive statistics and a contribution assessment approach. The trend and patterns that emerged are being reported in this study. The papers included in this study examined residential properties and analysed both capital and rental property values.

In order to assess the contributions of the authors and the authors’ affiliations to the research topic, the approach adopted in previous studies (Howard et al., 1987; Darko and Chan, 2016) was adopted. The contribution was estimated by awarding a score of 1 to an author of a sole authored paper, 0.60 and 0.40 to the first and second authors, respectively, for an article published by two authors and in that order for other multi-authored paper (see Table 1).

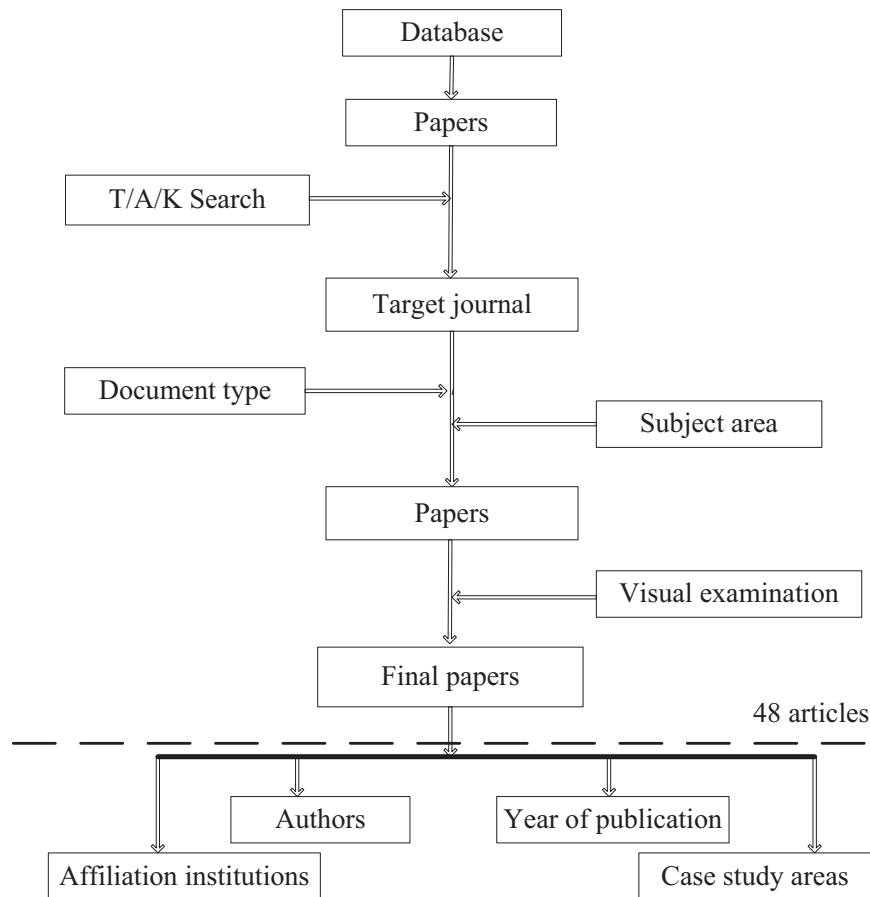


Fig. 1. Research framework for this study. Note: T/A/K – title/abstract/keywords Adapted from: Ke et al. (2009).

Table 1
Score matrix for multi-authored papers.

Number of authors	Order of specific author				
	1	2	3	4	5
1	1.00				
2	0.60	0.40			
3	0.47	0.32	0.21		
4	0.42	0.28	0.18	0.12	
5	0.38	0.26	0.17	0.11	0.08

5. Results and discussion

As mentioned earlier, the establishment of the maiden and subsequent applications of HPM in the Nigerian real estate pricing research is one of the objectives of this study. Hence, the pool of authors that published these articles, their affiliations, the years in which they published them and also the study areas in which they applied them were analysed and the results are discussed in this section.

5.1. Authors' affiliations

Table 2 shows the details of the affiliations of the authors that published the articles reviewed in this study. These affiliations are universities, polytechnics and government bodies, in which 77 percent, 9 percent and 14 percent of the authors, respectively, were affiliated to. On the contrary, none of the authors was affiliated to any real estate firm. This corroborates the findings of Adewunmi and Olaleye (2011) that reported that university scholars are the main contributors to real estate research in Nigeria. This suggests that real estate professionals in Nigeria have

not been engaging in research activities in order to contribute significantly to this research topic. A likely reason for this might be that the real estate professionals lack the know-how of the application of HPM. From Table 2, it is evident that some authors were affiliated to three universities in the US and one in Malaysia. It could be suggested that those authors were either on study or working in these foreign institutions when they conducted the research.

On the Nigerian universities' affiliations, 11 are government owned, while the remaining two are private universities. A simple explanation for this statistics is that only three Nigerian universities were accredited by the regulatory body (Estate Surveyors and Valuers Registration Board of Nigeria (ESVARBON)) responsible for the accreditation of estate management programme in Nigeria (ESVARBON, 2015). Considering the contributions that emanated from each affiliation based on the number of articles published, the number of authors affiliated and their contribution assessment score, University of Lagos, University of Ibadan, Federal University of Technology, Akure and Covenant University were the top four affiliations (universities). These universities have contributed immensely to this research topic, by having over five publications each to their credit and quite a number of scholars were affiliated to them. On the overall, in terms of their contribution assessment, they scored 10.00, 7.00, 6.60 and 4.92, respectively. It may be reasonable to conclude that these four universities are the leaders of property pricing appraisal research in Nigeria.

It is worth clarifying that the total number of publications in Table 2 is 52 as against the 48 articles retrieved,

Table 2
Authors' affiliations.

Affiliations	Class of Institution	No. of publications	No. of authors	Score
University of Lagos	University	10	17	10.00
University of Ibadan	University	7	10	7.00
Federal University of Technology, Akure	University	7	11	6.60
Covenant University	University	6	18	4.92
Obafemi Awolowo University	University	3	3	2.40
Federal University of Technology, Minna	University	2	7	2.00
Universiti Tun Hussein Onn	University	2	6	2.00
Abubakar Tafawa Balewa University	University	1	1	1.00
American University	University	1	1	1.00
Bayero University	University	1	1	1.00
Bells University of Technology	University	1	2	1.00
Central Bank of Nigeria	Government body	1	5	1.00
Florida State University	University	1	1	1.00
Lagos State Polytechnic	Polytechnic	1	1	1.00
Nasarawa State University	University	1	2	1.00
National Association of Home Builders (NAHB)	Government body	1	1	1.00
Nigerian Institute of Socio Economic Research	Government body	1	1	1.00
University of West Alabama	University	1	1	1.00
Modibbo Adama University of Technology	University	1	2	0.79
Nnamdi Azikiwe University	University	1	2	0.68
Rufus Giwa Polytechnic	Polytechnic	1	1	0.40
Ekiti State University	University	1	1	0.21

Note: the total number of citations of all the authors under an affiliation sum up to the number of authors.

the reason being that, some research collaborative effort existed between authors from two different affiliations. This made some affiliations to appear with just one publication credited to them. These instances are the joint effort between researchers in Covenant University and one colleague in Rufus Giwa Polytechnic and also the collaboration with a colleague in Nnamdi Azikiwe University. Others are collaboration between two authors from the Federal University of Technology, Akure and Obafemi Awolowo University and lastly, partnership between authors from Modibbo Adama University of Technology and their colleague in Ekiti State University. In addition, a collaborative effort between scholars was evident in this research area. This is evident with about 63 percent articles being multiple authored papers, while 37 percent was sole authored. This information shows that real estate scholars in Nigeria have been collaborating with their colleagues both within and outside their institutions. This collaboration amongst the Nigerian real estate scholars if sustained, it could result in effective research outputs (Bozeman et al., 2016).

5.2. Active authors

A total of 58 authors were identified to have contributed to this research topic. However, Table 3 shows the list of the authors that have published at least three articles (irrespective of their authorship position on the paper). Based on the number of publications and contribution scores, Arimah B. C. and Babawale G. K. are the most active authors with five articles each to their credit and scored 4.60 and 3.07, respectively. Other authors have three to four articles to their credit, with a score ranging between 1.01 and 3.00.

It can also be deduced from Table 3 that all the listed authors with the exception of Megbolugbe I. F., were affiliated to the four universities shown in Table 2 as the affiliations where considerable number of articles have

emanated. This suggests that there is a relationship between a scholar's affiliation and their research output. This is probably because they are being provided with a work environment that aids research (Lee and Bozeman, 2005).

5.3. Annual publications

Fig. 2 shows the trend of the annual publications of articles in this research topic. From the search exercise, it was found that Megbolugbe (1986) was the first study that adopted the HPM technique in property price appraisal in the Jos metropolis, Nigeria. Thereafter, real estate scholars have been adopting this technique, although there have been fluctuations in the annual publication output. It may be safe to conclude that Megbolugbe I. F. is a pioneer of HPM in real estate research in Nigeria. This effort could be attributed to the affiliation to a foreign university, where the know-how of state-of-the-art research tools could have been acquired.

Between 1986 and 2006, only 10 articles were published in this research area. This amounts to about 0.47 articles published annually. This is because in some years no article was published. The scanty publications recorded in the 1990s and early 2000s could be attributed to the lack of know-how in the application of HPM by the Nigerian real estate researchers, unavailability of data and also the immature state of the Nigerian property market during these periods (Dugeri, 2011). However, from 2007 to 2014, there have been consistent yearly publications with a considerable amount being recorded since 2010 and the highest number (11 articles) published in 2011. Hence, it is reasonable to suggest that the application of HPM in real estate appraisal gained prominence amongst Nigerian real estate researchers in 2010. Since 2011, there has been a decline in the annual publications. The reason for this decline could be that the real estate scholars have been exploring other property price analysis research tools.

Table 3
Authors' contributions.

Authors	Studies	Affiliations	No. of publications	Score
Arimah B. C.	Arimah (1992a,b,1996,1997), Arimah & Adinnu (1995)	University of Ibadan	5	4.60
Babawale G. K.	Babawale and Adewunmi (2011), Babawale and Johnson (2012), Babawale et al. (2012), Babawale (2013), Famuyiwa and Babawale (2014)	University of Lagos	5	3.07
Aluko O. E.	Aluko (2000, 2011b,a)	University of Lagos	3	3.00
Megbolugbe I. F.	Megbolugbe (1986, 1989, 1991)	NAHB, Florida State University and American University	3	3.00
Bello V. A.	Bello & Bello (2007, 2008), Bello & Ajayi (2010), Bello (2011)	Federal University of Technology Akure	4	2.40
Bello M. O.	Bello & Bello (2007, 2008), Olujimi & Bello (2009), Bello & Yacim (2014)	Federal University of Technology Akure	4	2.20
Otegbulu A. C.	Otegbulu & Johnson (2011), Babawale et al. (2012), Otegbulu & Odu (2011)	University of Lagos	3	1.41
Iroham C. O.	Akinjare et al. (2011), Iroham et al. (2011, 2014)	Covenant University	3	1.01

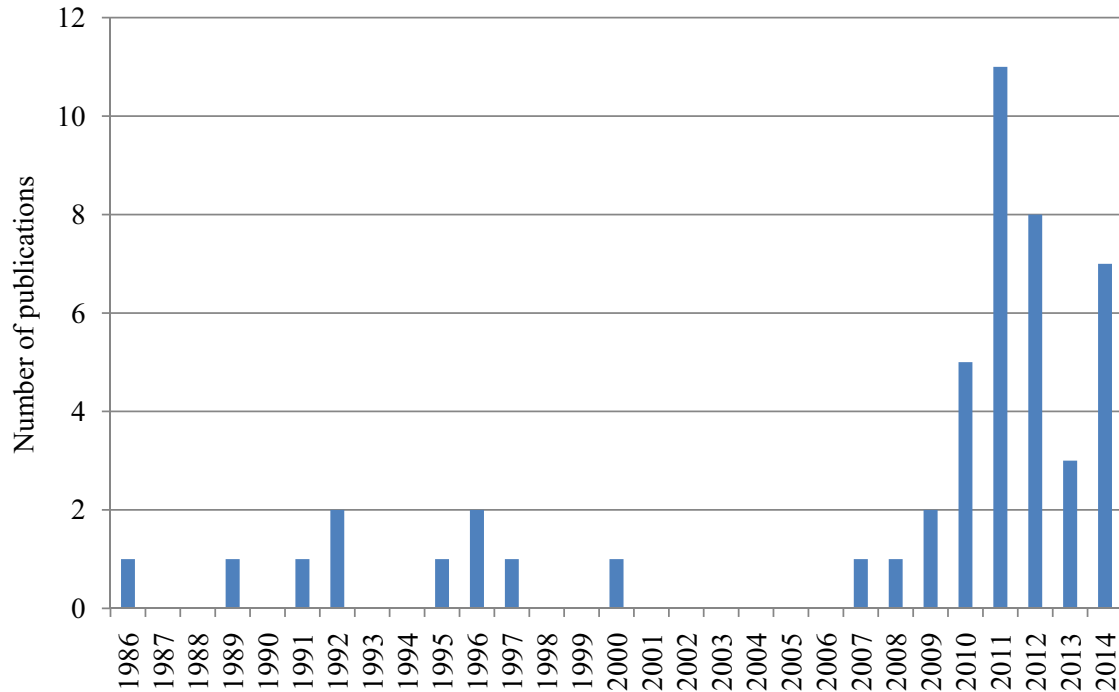


Fig. 2. Year of publication of the articles.

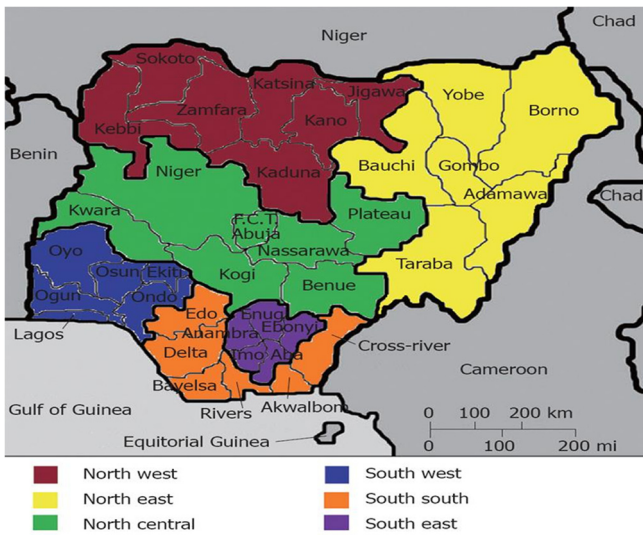


Fig. 3. The map of Nigeria. Source: <http://www.wjgnet.com/1949-8462/full/v4/i12/327.htm>.

5.4. Focus study areas

The population of Nigeria is estimated to be 173.6 million (2013 figure) and it is made up of 36 states and the Federal Capital Territory (FCT) (The World Bank, 2014). The geographical Map of Nigeria showing the 36 states divided along the six geopolitical zones is shown in Fig. 3.

Regarding the focus study areas, 26 articles focused on the Lagos metropolis property market, four examined Ibadan and Jos property markets, respectively. On the overall,

Table 4
Study area focus.

Study area	State	Geopolitical zone	Number of articles
Lagos	Lagos	South-west	26
Ibadan	Oyo	South-west	4
Jos	Plateau	North-central	4
Akure	Ondo	South-west	3
Bauchi	Bauchi	North-east	2
Ota and Ewekoro	Ogun	South-west	2
Abuja	FCT	North-central	1
Kano	Kano	North-west	1
Maiduguri	Borno	North-east	1
Minna	Niger	North-central	1
Nigeria	Nigeria	Nigeria	1
Onitsha	Anambra	South-east	1
Yola	Adamawa	North-east	1

35 articles centered on the South-western states’ property markets. This amounts to about 73 percent of all the articles reviewed as shown in Table 4. This shows that other real estate markets in Nigeria have not received more attention by real estate researchers.

The much attention given to the Lagos metropolis property market could be attributed to the large number of real estate transactions being completed in the property market, probably because of its robustness and the high number of well-informed real state stakeholders that interact in the metropolis (Oni, 2010).

The little attention accorded to other property markets apart from the Lagos metropolis could be as a result of the non-availability of transaction data that are needed for the construction of HPM in these real estate markets. Also, the few number of real estate firms, as well as regis-

tered estate surveyors and valuers operating outside the Lagos metropolis property market (Ibiyemi and Tella, 2013), could also be responsible for the low attention on these property markets.

6. Conclusion and further research

A state-of-the-art review of the applications of HPM in property price appraisal research in Nigeria was conducted and reported in this study. Megbolugbe (1986) published paper was found to be the first study to apply HPM in property appraisal research in Nigeria, by deciphering the Jos property market. The findings of this study shows that the main contributors to this research topic are scholars affiliated with universities, predominantly University of Lagos, University of Ibadan, Federal University of Technology, Akure and Covenant University. This corroborates the argument of Laryea and Leiringer (2012) that demonstrated that built environment research is domiciled in universities and research institutes. Whereas, real estate professionals affiliated with real estate firms did not contribute to the research topic. This gap between theory and practice of property pricing aspect of the real estate profession in Nigeria should be filled so as to transform the real estate practice. The Lagos metropolis was the focus of most of the studies reviewed, due to its being the most vibrant real estate market in the Nigerian property market. In all, the findings of this study provide important insights into the trend in the current knowledge about the application of HPM in property price appraisal studies in Nigeria. This can serve as guidance for new researchers interested in this field of study, by showing what has been done, who did them and where they were done. The search for the articles reviewed was limited to online databases and search engines. However, articles that are not indexed in the sources searched might have been missed out. Despite this limitation, the adoption and explicitly of search and selection criteria ensures that the current study is replicable and valid inferences can be drawn from the findings. The findings of this study imply that the HPM technique has not been widely adopted in other real estate markets in Nigeria. Such studies when holistically conducted will fill this research gap and at the same time provide an overview of the property price mechanism in Nigeria. This paper is a preliminary study to a larger-scoped study that aims to compare the predictive accuracy of the widely adopted HPM with the novel ANN technique. This exploration will reveal if ANN can actually serve as a substitute for HPM in the Nigerian real estate market.

Acknowledgement

The authors sincerely acknowledge the Research Grants Council of Hong Kong (SAR) and the Department of Building and Real Estate, The Hong Kong Polytechnic University, Hong Kong for providing the financial and

material support toward this research. An earlier draft of this paper was presented at the CRIOCM 2016 International Conference in Hong Kong. The authors will like to appreciate the constructive comments of the anonymous reviewers during the review process.

References

- Adair, A.S., Berry, J.N., McGreal, W.S., 1996. Hedonic modelling, housing submarkets and residential valuation. *J. Property Res.* 13 (1), 67–83.
- Adegoke, J.O., 2014. Critical factors determining rental value of residential property in Ibadan metropolis, Nigeria. *Property Manage.* 32 (3), 224–240.
- Adewunmi, Y.A., Olaleye, A., 2011. Real estate research directions and priorities for Nigerian institutions. *J. Real Estate Pract. Educ.* 14 (2), 125–140.
- Akinjare, O., Ayedun, C., Oluwatobi, A., Iroham, O., 2011. Impact of sanitary landfills on urban residential property value in Lagos state, Nigeria. *J. Sustainable Dev.* 4 (2), 48–60.
- Aluko, O.E., 2000. Urban market segmentation and house values in metropolitan Lagos. *Niger. Geog. J.* 3 (4), 148–168.
- Aluko, O., 2011a. The effects of location and neighbourhood attributes on housing values in metropolitan Lagos. *Ethiopian J. Environ. Stud. Manage.* 4 (2), 69–82.
- Aluko, O., 2011b. Spatial scales and measurement of housing values in Nigeria: the case of metropolitan Lagos. *Ethiopian J. Environ. Stud. Manage.* 4 (4), 27–38.
- Arimah, B.C., 1992a. An empirical analysis of the demand for housing attributes in a third world city. *Land Econ.* 68 (4), 366–379.
- Arimah, B.C., 1992b. Hedonic prices and the demand for housing attributes in a third world city: the case of Ibadan, Nigeria. *Urban Stud.* 29 (5), 639–651.
- Arimah, B.C., 1996. Willingness to pay for improved environmental sanitation in a Nigerian city. *J. Environ. Manage.* 48 (2), 127–138.
- Arimah, B.C., 1997. The determinants of housing tenure choice in Ibadan, Nigeria. *Urban Stud.* 34 (1), 105–124.
- Arimah, B.C., Adinnu, F.I., 1995. Market segmentation and the impact of landfills on residential property values: empirical evidence from an African city. *Neth. J. Hous. Built Environ.* 10 (2), 157–171.
- Babawale, G.K., 2013. Measuring the impact of church externalities on house prices. *Khazar J. Humanities Social Sci.* 16 (4), 53–68.
- Babawale, G.K., Adewunmi, Y., 2011. The impact of neighbourhood churches on house prices. *J. Sustainable Dev.* 4 (1), 246–253.
- Babawale, G.K., Johnson, O., 2012. The specification of hedonic indexes for duplexes in Lekki peninsular area of Lagos metropolis. *Elixir Social Sci.* 45 (1), 7689–7698.
- Babawale, G.K., Koleoso, H.A., Otegbulu, A.C., 2012. A hedonic model for apartment rentals in Ikeja area of Lagos metropolis. *Mediterr. J. Social Sci.* 3 (3), 109–120.
- Bello, V., 2011. “The impact of urban crime on property values in Akure, Nigeria”, Paper presented at the FIG Working Week, 18–22 May. Marrakech, Morocco.
- Bello, V.A., Ajayi, C.A., 2010. Occupants’ satisfaction and rent paid for residential properties close to waste dump sites in Nigeria. *J. Sustainable Dev.* 3 (1), 98–103.
- Bello, M.O., Bello, V.A., 2007. The influence of consumers behavior on the variables determining residential property values in Lagos, Nigeria. *Am. J. Appl. Sci.* 4 (10), 774–778.
- Bello, M.O., Bello, V.A., 2008. Willingness to pay for better environmental services: evidence from the Nigerian real estate market. *J. Afr. Real Estate Res.* 1 (1), 19–27.
- Bello, O.M., Yacim, A.J., 2014. Impact of tree shade on rental value of residential property in Maiduguri, Paper presented at the FIG Congress, 16–21 June, Kuala Lumpur, Malaysia.

- Bender, A., Din, A., Hoesli, M., Brocher, S., 2000. Environmental preferences of homeowners: further evidence using the AHP method. *J. Property Investment Finance* 18 (4), 445–455.
- Bozeman, B., Gaughan, M., Youtie, J., Slade, C.P., Rimes, H., 2016. Research collaboration experiences, good and bad: dispatches from the front lines. *Sci. Public Policy* 43 (2), 226–244.
- Brooks, C., Tsolacos, S., 2010. *Real Estate Modelling And Forecasting*. Cambridge University Press, United States of America.
- Bruce, R.W., Sundell, D.J., 1977. Multiple regression analysis: history and applications in the appraisal profession. *Real Estate Appraiser* 43 (1), 37–44.
- Cebula, R.J., 2009. The hedonic pricing model applied to the housing market of the city of Savannah and its Savannah historic landmark district. *Rev. Reg. Stud.* 39 (1), 9–22.
- Chin, T.L., Chau, K.W., 2002. A critical review of literature on the hedonic price model. *Int. J. Hous. Sci. Appl.* 27 (2), 145–165.
- Chin, T., Chau, K., 2003. A critical review of literature on the hedonic price model. *Int. J. Hous. Sci. Appl.* 27 (2), 145–165.
- Chou, W.-C., Cheng, Y.-P., 2012. A hybrid fuzzy MCDM approach for evaluating website quality of professional accounting firms. *Expert Syst. Appl.* 39 (3), 2783–2793.
- Colwell, P.F., Dilmore, G., 1999. Who was first? An examination of an early hedonic study. *Land Econ.* 75 (4), 620–626.
- Court, A.T., 1939. Hedonic price indexes with automobile examples. The dynamics of the automobile demand, General Motors, New York.
- Darko, A., Chan, A.P., 2016. Critical analysis of green building research trend in construction journals. *Habitat Int.* 57 (1), 53–63.
- Dugeri, T.T., 2011. An evaluation of the maturity of the Nigerian property market (doctoral dissertation). Department of Estate Management, University of Lagos, Lagos, Retrieved from <<http://www.afrr.org/docs/pdf/dugeri.pdf>>.
- ESVARBON, 2015. Accredited universities <http://www.esvarbon.gov.ng/Accredited-Institutions/Accredited-Universities>, accessed 1st May, 2015.
- Falagas, M.E., Pitsouni, E.I., Malietzis, G.A., Pappas, G., 2008. Comparison of pubmed, scopus, web of science, and google scholar: strengths and weaknesses. *FASEB J.* 22 (2), 338–342.
- Famuyiwa, F., Babawale, G.K., 2014. Hedonic values of physical infrastructure in house rentals. *J. Facil. Manage.* 12 (3), 211–230.
- Freeman, A.M., 1979. Hedonic prices, property values and measuring environmental benefits: a survey of the issues. *Scand. J. Econ.* 81 (2), 154–173.
- Ge, J., 2009. Determinants of house prices in New Zealand. *Pac. Rim Property Res. J.* 15 (1), 90–112.
- Haas, G.C., 1922. A statistical analysis of farm sales in blue earth county, Minnesota, as a basis for farm land appraisal (Masters thesis). Applied Economics, University of Minnesota, United States of America, Retrieved from <http://ageconsearch.umn.edu/handle/184329>.
- Howard, G.S., Cole, D.A., Maxwell, S.E., 1987. Research productivity in psychology based on publication in the journals of the American Psychological Association. *Am. Psychol.* 42 (11), 975–986.
- Ibiyemi, A., Tella, E., 2013. Critical issues in economic risks consideration by commercial property investors and valuers in Nigeria: the case of Lagos. *Int. J. Emerging Sci. Eng.* 1 (12), 35–43.
- Irohah, C.O., Oloyede, S.A., Oluwunmi, A.O., 2011. An analysis of the location of worship centers on residential property values in Ota, Nigeria. *J. Sustainable Dev. Afr.* 13 (1), 13–22.
- Irohah, C.O., Oluwunmi, A., Simon, R.F., Akerele, B.A., 2014. Assessing the trend in rental values of commercial properties along Oyemekun road, Akure, Nigeria. *Covenant J. Res. Built Environ.* 1 (1), 10–29.
- Jim, C., Chen, W.Y., 2006. Impacts of urban environmental elements on residential housing prices in Guangzhou (China). *Landscape Urban Plann.* 78 (4), 422–434.
- Ke, Y., Wang, S., Chan, A.P., Cheung, E., 2009. Research trend of public-private partnership in construction journals. *J. Constr. Eng. Manage.* 135 (10), 1076–1086.
- Laryea, S., Leiringer, R.T.F., 2012. Built environment research in west Africa: current trends and future directions, proceedings of West Africa Built Environment Research (WABER) Conference, Abuja, Nigeria, 24–26 July, pp. 797–804.
- Lee, S., Bozeman, B., 2005. The impact of research collaboration on scientific productivity. *Soc. Stud. Sci.* 35 (5), 673–702.
- Lee, A.H., Chen, W.-C., Chang, C.-J., 2008. A fuzzy AHP and BSC approach for evaluating performance of IT department in the manufacturing industry in Taiwan. *Expert Syst. Appl.* 34 (1), 96–107.
- Lentz, G., Wang, K., 1998. Residential appraisal and the lending process: a survey of issues. *J. Real Estate Res.* 15 (1), 11–39.
- Lu, W.-M., Wang, T.-C., 2011. A fuzzy multi-criteria model for the industrial cooperation program transaction strategies: a case in Taiwan. *Expert Syst. Appl.* 38 (3), 1490–1500.
- Mallick, H., Mahalik, M.K., 2015. Factors determining regional housing prices: Evidence from major cities in India. *J. Property Res.* 32 (2), 123–146.
- Malpezzi, S., 2003. Hedonic pricing models: a selective and applied review. In: O'Sullivan, T., Gibb, K. (Eds.), *Housing Economics and Public Policy*. Blackwell Science Ltd, Oxford, UK, pp. 67–89.
- Malpezzi, S., Ozanne, L., Thibodeau, T., 1980. *Characteristic Prices Of Housing In Fifty-Nine Metropolitan Areas*. The Urban Institute, Washington DC.
- Mardani, A., Jusoh, A., Zavadskas, E.K., 2015. Fuzzy multiple criteria decision-making techniques and applications—Two decades review from 1994 to 2014, *Expert Systems with Applications*, vol. 42 No., pp. 4126–4148.
- Mbachu, J.I., Lenono, N., 2005. Factors influencing market values of residential properties, Proceedings of Queensland University of Technology Research Week International Conference, Brisbane, Australia, 4–8 July, pp. 1–12.
- Megbolugbe, I.F., 1986. Econometric analysis of housing trait prices in a third world city. *J. Reg. Sci.* 26 (3), 533–547.
- Megbolugbe, I.F., 1989. A hedonic index model: the housing market of Jos, Nigeria. *Urban Stud.* 26 (5), 486–494.
- Megbolugbe, I.F., 1991. Hedonic indices and housing programme benefits. *Urban Stud.* 28 (5), 773–781.
- Mora-Esperanza, J.G., 2004. Artificial Intelligence Applied To Real Estate Valuation: An Example For The Appraisal of Madrid, *CATASTRO*, vol. April No., pp. 255–256.
- Muth, R.F., 1966. Household production and consumer demand functions. *Econometrica* 34 (3), 699–708.
- National Bureau of Statistics, 2014. Nigeria's revised and final GDP rebasing results by output approach. National Bureau of Statistics, Abuja, Nigeria.
- Oates, W.E., 1969. The effects of property taxes and local public spending on property values: An empirical study of tax capitalization and the tiebout hypothesis. *J. Political Economy* 77 (6), 957–971.
- Olujimi, J.A., Bello, M.O., 2009. Effects of infrastructural facilities on the rental values of residential property. *J. Social Sci.* 5 (4), 332–341.
- Ong, T.S., 2013. Factors affecting the price of housing in Malaysia. *J. Emerging Issues Econ. Finance Banking* 1 (5), 414–429.
- Oni, A.O., 2010. Harnessing real estate investment through decision process for selecting tenants in Nigeria, Proceedings of 10th African Real Estate Society Conference, Naivasha, Kenya, 26th–29th, October, pp. 1–19.
- Otegbulu, A., Johnson, O., 2011. The impact of Jacuzzi bathtubs on house prices. *J. Sustainable Dev.* 4 (3), 199–209.
- Otegbulu, A.C., Odu, T., 2011. An assessment of lodgers' value perception of hotel facilities and services. *J. Sustainable Dev.* 4 (4), 91–100.
- Pagourtzi, E., Assimakopoulos, V., Hatzichristos, T., French, N., 2003. Real estate appraisal: a review of valuation methods. *J. Property Investment Finance* 21 (4), 383–401.
- Paliwal, M., Kumar, U.A., 2009. Neural networks and statistical techniques: a review of applications. *Expert Syst. Appl.* 36 (1), 2–17.
- Paz, T.P., 2003. Determinants of housing prices in Spanish cities. *J. Property Investment Finance* 21 (2), 109–135.
- PricewaterhouseCoopers, 2014. Economic and fiscal implications of Nigeria's rebased GDP <http://www.pwc.com/ng/en/publications/>

- [gross-domestic-product-does-size-really-matter.jhtml](#), accessed 1 May 2015.
- PwC, 2014. Economic and Fiscal Implications of Nigeria. PricewaterhouseCoopers, Abuja, Nigeria.
- Ridker, R.G., Henning, J.A., 1967. The determinants of residential property values with special reference to air pollution. *Rev. Econ. Stat.* 49 (2), 246–257.
- Rosen, S., 1974. Hedonic prices and implicit markets: product differentiation in pure competition. *J. Political Econ.* 82 (1), 34–55.
- Selim, S., 2008. Determinants of house prices in Turkey: A hedonic regression model. *Doğuş Üniversitesi Dergisi* 9 (1), 65–76.
- Sirmans, S.G., Macpherson, D.A., Zietz, E.N., 2005. The composition of hedonic pricing models. *J. Real Estate Lit.* 13 (1), 1–44.
- The World Bank., 2014. Project Performance Assessment Report Federal Republic Of Nigeria State Education Sector Project, pp. 69, The World Bank IEG Public Sector Evaluation.
- Tse, R.Y., Love, P.E., 2000. Measuring residential property values in Hong Kong. *Property Manage.* 18 (5), 366–374.
- Vaidya, O.S., Kumar, S., 2006. Analytic hierarchy process: an overview of applications. *Eur. J. Oper. Res.* 169 (1), 1–29.
- Wallace, H.A., 1926. Comparative farm-land values in Iowa. *J. Land Public Util. Econ.* 2 (4), 385–392.
- Widrow, B., Rumelhart, D.E., Lehr, M.A., 1994. Neural networks: applications in industry, business and science. *Commun. ACM* 37 (3), 93–105.
- Zahedi, F., 1986. The analytic hierarchy process—a survey of the method and its applications. *Interfaces* 16 (4), 96–108.