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Analysis of Spatial Factors Affecting Rental House Prices: A Case Study of Nyeri Town Constituency, Kenya

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Abstract Rental properties transactions have steadily increased annually by 2.7% globally since 2017. For a developing country like Kenya the transactions contributes 8.1% of Kenya's gross domestic product according to 2019 national accounts statistics as it forms the basis of basic human need, shelter. It is projected to increase to 22% by 2020 in line with Government's 'big four' agenda among them affordable housing, thus attracting investors constructing both commercial and residential houses. Investors in the real estate sector use a range of methods to determine rental house prices. Diverse factors have been noted to influence rental house prices some having higher effect than others. This research endeavors to analyze the spatial factors that affect rental houses prices in Nyeri town constituency, Kenya and determine their relationship to their current respective prices. Primary data was collected from rental house owners and assigned managing estate agents via structured questionnaires distributed through purposive sampling method. Guided by literature and data collected, roads, land value, houses and population data alongside secondary data was acquired and analyzed using the spatial hedonic model. Through GIS technologies, spatial factors identified from the data collected affecting rental house prices are analyzed and their relationship with rental house prices was determined. Regression and multicriteria analysis assigned different weights to the various factors as they were noted to influence the prices differently. From analytic hierarchy process, varying percentages were deduced on all the factors. Study results indicates different indices as seen from various spatial factors identified and analyzed having varying coefficients from which a predictive rental house price formula is generated. Maps were generated showing relationship of spatial factors with rental house prices. Investors or agencies can know the influence of the factors and may peg their decisions on the results of this research. This research is paramount in decision making procedures of investors as they eye on setting up developments within the constituency. The county government may benefit heavily as they may be able to work on certain areas that may increase revenue in the sector.

Keywords: *real estate, rental houses, GIS, spatial hedonic model*

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1. Introduction

Every investment is in some way or another dependent on land and property [1]. Housing being a basic need has attracted 22.8% of Kenya's real estate developers to offer safe and comfortable living spaces for dwellers [2]. It has translated to a booming business in most parts of the country leading to 80 million dollars income on rental properties collected from the sector by the Kenya Revenue Authority [3]. This is by the close of the 2018/2019 financial year having a notable increase of 42% revenue growth [4] from the close of 2015/2016 financial year. Real estate sector has experienced significant growth in the last decade [5]. Kenya has attracted worldwide investors who set up residential and commercial apartments leading to a 4.2% increase in gross domestic product in 2019 [4]. The Kenyan government under its four pillar agenda whereby housing is one of them plans to offer 500,000 affordable housing to all Kenyans across the 47 counties by 2022 [6,7]. Real estate remains to be one of the market leaders contributing 8.1% (2019) of Kenya's gross domestic product [8].

Determining appropriate rental house prices has been a major challenge due to lack of rental houses pricing criteria [9]. Property valuation reports indicate that many house owners have been either undercharging or overcharging. In other cases there have been varying prices for houses of similar nature and quality. Investors and house owners lack a tool that guide them towards their pricing criteria same case to house seekers who fall

for the mercies of the real estate players in determining the prices. Across the constituency lies several undeveloped parcels that lay bare since their owners lack a tool that can guide them on the nature of investment they can put up according to February 2019 Cytonn report [10].

Real estate sector is appreciating at an average rate of 11% per decade [4] with commercial and residential building being set up in every estate [8]. This situation is not different in Nyeri town constituency in Kenya [11] which is a fast growing constituency. This is majorly due to 10 educational institutions [12] in the area, host of key government offices coupled with diverse agribusiness activities from all the other wards. It thus acts as the central hub of all business activities [13] with a population of 119,276 people [14]. This brings a very high demand for houses.

There is a general trend of houses near significant infrastructures and amenities fetching a higher house rent amount than the ones which are not [1]. This has also been observed for houses built on flat surfaces and areas not near watershed regions which attract a higher rental value than ones on a slope. However these relationships have not been determined nor researched on.

Traditional methods are being used to model prices some of them use regression, comparative analysis and others econometric pricing leaving out very key spatial information in their modelling [15,16]. Lack of information on the relationship of land surface features and location leads to poor decision making for house owners hence 19% of real estate investors end up stalling their investment after high dues demanded from potential tenants rendering houses vacant according to global property guide [17].

Determining prices of rental house globally is mostly done through indices given by real estate players [18]. Models such as econometric based models [19] which uses native forces of demand and supply, comparative based models [20]which relies on matching similar characters of specific rental properties and traditional based models [21] have been used to estimate rental house prices. Traditional hedonic models [20], [22] of house rent valuation uses the classical ordinary least squares [23]. The accuracy of the widely used spatial hedonic model [19,24,25,26] has been improving as it uses spatial autoregressive coefficient [27] and uses various input parameters to determine prices of houses. Real estate markets are heterogeneous [28], with a series of geographical and sectoral submarkets that lack a central trading market [9]. Every property is usually unique and information on the market transactions is often not available [29]. The pricing process is usually negotiated and the market is characterized by large transaction costs [30]. The prices of an existing property should theoretically be equal to discounted present value of the expected stream of future income (rents), which depend on expected growth in income, anticipated real interest rates, taxes, geographical features, neighborhood features, land surface features and other structural factors [1,31].

Spatial hedonic model assumes that a rental house price is determined by variety of independent characteristics [30]. This model has been widespread and became a notable tool in rental house price assessment [32]. The specific bundle of characteristics can be classified into four heterogeneous dimensions; structural and physical attributes, spatial and locational features, neighborhood environmental qualities and socio-demographics characteristics [33]. The resulting predictive rental house predictive spatial hedonic model can be defined by a vector of continuous and dummy variables as in equation 1:

$$\begin{aligned} Rental\ value = {} & b0 + b1(room) + b2(condition) \\ & + b3(water) + b4(wall) + b5(toilet) \\ & + b_6(size) + b_7(location) + b_8(age) + \varepsilon \end{aligned} \quad (1)$$

Equation 1: Spatial hedonic model rental house price predictive formulae

Where, $b0$ is the regression constant, ε is the error term and $b1$, $b2$, …, $b10$ are regression coefficients as derived by Lancaster [26]. The rental values, numbers of room, size and age of properties are continuous variables while all other variables (location of properties, sources of water supply to the property, type of toilets, walling materials) are dummy variables [34]. The accuracy of the model has been increasing over time. As noted myriad of both non spatial which are mostly preferential and spatial factors come into play. This research focuses on the spatial factors within Nyeri town constituency, Kenya.

This research aims at determining spatial factors affecting prices of rental houses within Nyeri town constituency, Nyeri County, Kenya as well as evaluating their relationship.

2. Methods

2.1. Study Area

The research was conducted in Nyeri town constituency in Nyeri County situated in the central region of Kenya. Nyeri Town Constituency is one of the six constituencies in Nyeri County (Figure 1). It has five (5) administrative wards [11]. It is situated in central Kenya bordering Kirinyaga and Meru to the east, Laikipia to the North, Nyandarua to the west and Murang'a to the south [13], having an area of 183.1 square kilometers.

Nyeri town constituency is the most developed constituency with about 38.2% built up area and being the main business hub of the county due to factors such as its strategic location within the county, host of major public and administrative offices and also Nyeri town which is the capital of the county thereby the best for this research. There exist other five shopping centers within the constituency. There has been an increase in demand for houses since 2010 due to many educational institutions and rural-urban migration leading to significant developments in the real estate sector [12].

The population of constituency works in the formal and informal sectors as well as in small-scale urban agriculture and livestock production. There have been an upsurge of many residential and commercial homes as investors try to fill the housing gap with an approximate **population of** 119,276 people [4,14].

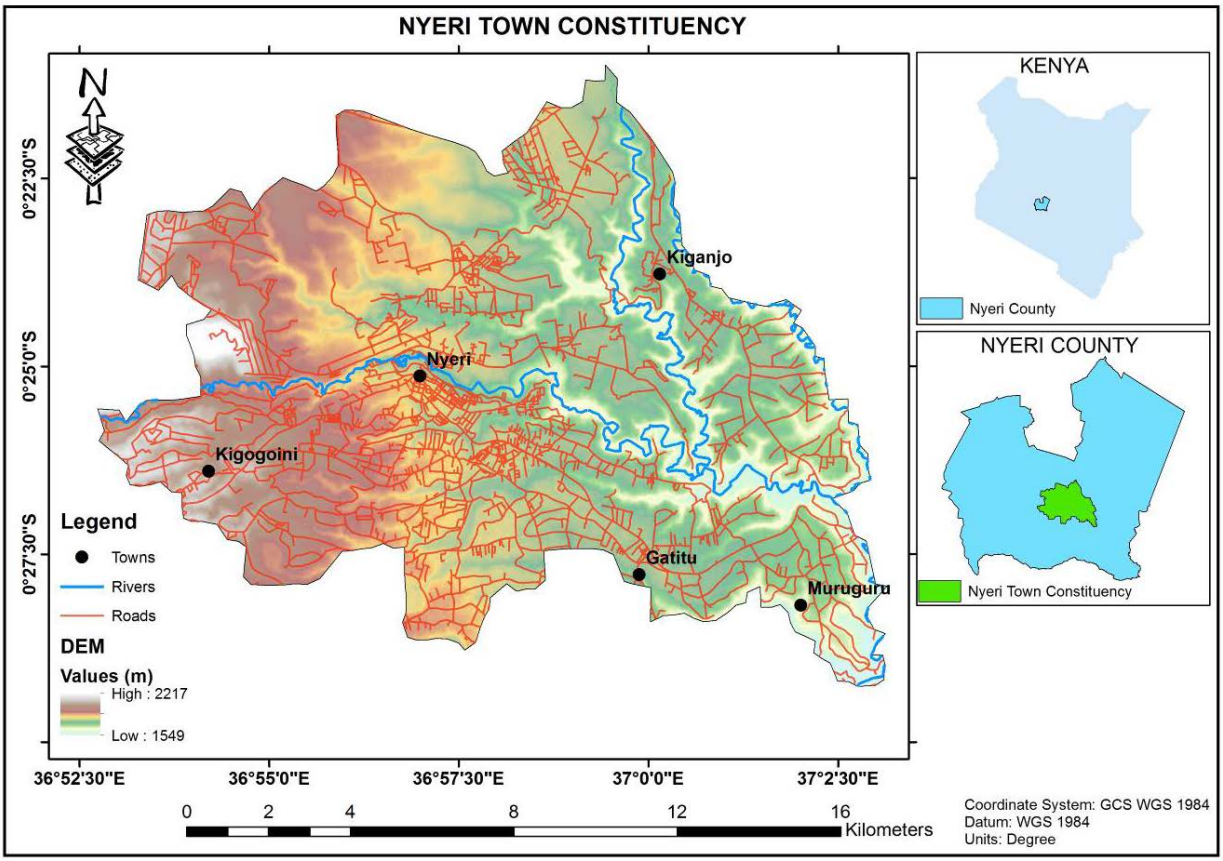

Figure 1. Nyeri Town Constituency, Kenya and the major towns. Data Source: Kenya Open Data [35]

2.2. Methodology

The research adopted a general workflow as depicted in Figure 2 in its endeavor to achieve its objectives. Structured questionnaires coupled with ground observations and personal interviews were issued to house owners and assigned managing agents in the various wards as selected and the information stored in a database. The assigned managing agents of the given rental houses bear complete database pertaining to the property and may also act as the representative of house owners.

The base spatial hedonic model which has been used in other areas was used to furnish the research on the main input spatial factors that have been noted globally to influence rental house price as well as provide a regression model formula used in the study. Other input spatial factors were gathered from the structured questionnaires distributed though purposive sampling method within the study area and literature. The input factors were then analyzed in relation to the area deducing regression coefficient for each. A total of six spatial factors were analyzed based on the analysis of the data collected of the significant spatial factors affecting rental house prices. These factors include land value, population density, proximity to towns, slope, security and distance to roads.

Using handheld GPS ground truth data of the selected sites and ground control points was collected, this data assisted in the calibration process and importantly the exact location of the houses. Land value data was collected showing value of land for various zones within the constituency then added as attributes in the various parcels of land together with rental house prices collected from house owners and estate agents. Digital Elevation Model (DEM) was used to deduce important land form features like slope from which were used for further analysis of relationship with the factors noted from the research.

Population data was joined using spatial join tool with the rental house prices which were used to derive coefficient for the predictive formulae after their relationship was deduced. Near analysis tool was used to deduce relational information between the location of the houses in respect to roads and towns. A multicriteria approach was deployed so as to analyze all the factors determined.

Extract multi value to point tool was used for roads, towns, population density and land value datasets after rasterizations so as to obtain a uniform dataset incorporating rental house prices from the sample houses before conducting regression analysis.

A successful regression analysis was conducted on all the factors so as to deduce various coefficients of the rental house prices in respect to the outlined factors coming up with predictive formulas.

Analytical hierarchy process was deployed so as to analyze all the factors assigning different weights to the factors determined. The weights were incorporated in the predictive formulas deduced from the regression analysis. A total of 8 non-spatial factors deduced from base spatial models and literature were then incorporated in the final model thus achieving results of the study. The model gives predicted rent values given floor sizes in square feet (Ft^2) at different locations in the study area. Validation of the model was conducted using 50 sample rental houses from Mathira constituency which is the second most developed constituency within Nyeri County.

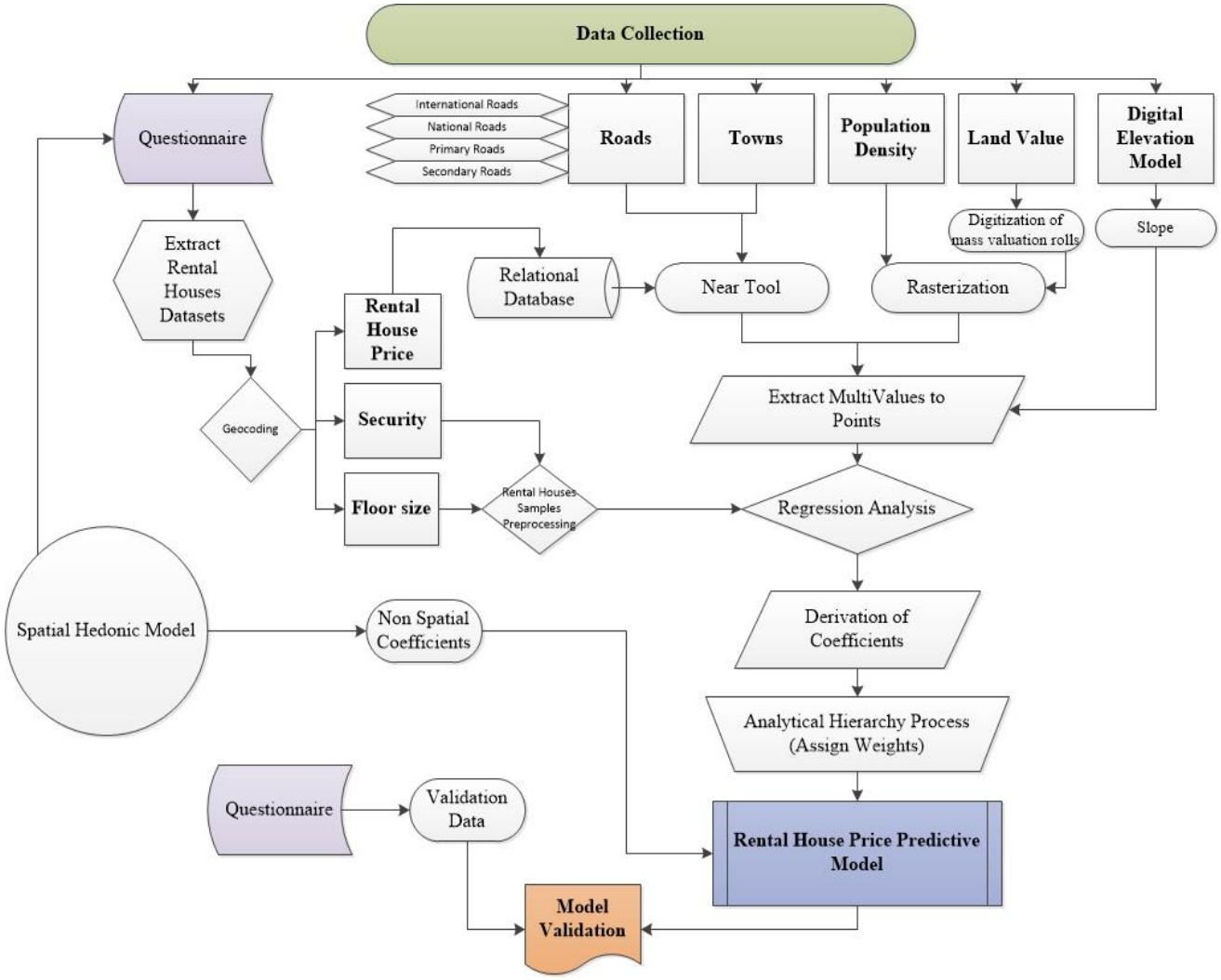

Figure 2. Flow chart of research methodology

2.3. Data Collection

Primary and secondary data was collected to help in this research. Roads data was obtained from Kenya National Highway Authority [36] and Kenya Rural Roads Authority useful in determining the roads network and condition for modelling purposes and relationship determination. Registry Index Maps (RIM) obtained from the Cartography Department in the Ministry of Land Nyeri were used to show the demarcations of various parcels of land within the constituency. This was integrated with the land value data collected from the government valuer in the ministry of lands Nyeri whereby land values from the mass valuation rolls were added as attributes. Value of parcels within the constituency is noted to have a huge impact on its prevailing developments.

Population data gathered from Kenya National Bureau of Statistics [14] was very important in determining the demographic pattern of the area as well as determination of population density of various estates, shopping centers and towns within the constituency.

From the local estate agents, the current rental house pricing data was collected, very beneficial in determination of the relationship between the values obtained and various datasets collected pertaining that house. This was key data pertaining to this study.

Town data within the constituency was collected from the Kenya Open Data platform. Digital Elevation Model (DEM) was downloaded from Alaska Satellite Facility with a 12.5m spatial resolution (Table 1).

Structured questionnaires were used to collect data from the field having both closed and open questions as borrowed from base spatial hedonic model and literature. They were issued to selected house owners in the wards through a non-probabilistic sampling method elaborated through the next subheading. This samples were used in the analysis process. Rental house data was collected from assigned managing agents like Samtech commercial Agents, Jesma investments, Mwalimu agents, Tylers Property Agents (www.tylers.co.ke) and others within the constituency.

Ground truth data was collected using a handheld GPS (Table 1) which came in handy in capturing coordinates of certain houses and features. Real Time Kinematic (RTK) survey data which yield nearly absolute positions (sub-centimeters position accuracy) was collected. These points were used as GCPs to improve the accuracy of X, Y, and Z positions of the resulted DEM.

The software packages used was Microsoft Access and ArcGIS software used for mapping, editing maps, data processing, analysis and visualization.

Table 1. Data used in the study

S/N	Data Type	Source
1	Roads	Kenya Open Data
2	Land Value(Kenyan Shillings)	Ministry of Lands and Physical Planning
3	Population Density	KNBS
4	Digital Elevation Model (12.5m resolution)	Alaska Satellite Facility
5	Towns	Kenya Open Data
6	Infrastructure	Kenya Open Data
7	Rental house prices (Kenyan Shillings)	Estate Agents, House owners

2.4. Sampling Strategy

Primary data for the study was based on the sample of 250 houses collected from the five wards namely; Rware, Rurin'gu, Gatitu/Muruguru, Kamakwa/ Mukaro and Kiganjo/Mathari each having 50 houses distributed across the wards extent collected within 11 months prior to the survey. Using purposive sampling which is a non-probabilistic sampling technique, primary data were elicited through a questionnaire survey which sought information on housing attributes and the corresponding rental house prices from apartment owners and managers in the study area [37]. This is complemented with selective interviews and personal observations. The questionnaires consisting of three main parts which are background of the respondent, information of the house and factors influencing house prices were administered to house owners or their representatives who are 18 years of age or above.

Key information on the first part of the questionnaire, background of the respondent includes: name of the respondent, affiliation to the building, gender, age, highest level of education and occupation. The second part, information of the house consisted of: location of the house (coordinates), type of the house, average size of the siting room, rental value, occupancy of the house and if the house is being managed by a managing agent. The last part, factors influencing houses prices consisted of; consideration made by the owner to decide on the rental price, insecurity cases within the area and whether the rental price has been revised over time.

The sample size of 250 tenants is considered adequate given of cross sectional homogeneity of the respondents. Furthermore, the socio-economic profile of occupiers of houses in the study area and its environs is comparable as occupiers of apartments usually belong to the upper middle segment and the lower upper segment of the population income brackets that are supposed to have homogenous tastes such that the net effects of neighborhood attributes are similar.

2.5. Data Processing

Every parcel was assigned attributes of its land value generated from the zonal valuation from the ministry of land and rental prices as collected from the local managing agents and house owners. Using ArcGIS software, several layers were created which includes roads, population, slope, house type, parcels, land value. A database was created for storage and retrieval of information.

Primary data gathered directly from the respondents by use of questionnaires gave factors that house owners consider when setting their rental house prices together with the type and conditions of the house. Relationships were determined on all factors identified and spatial relationship defined through multicriteria analysis and regression analysis. With the help of a spatial hedonic model all the factors with various coefficients were denoted and a predictive surface model generated.

2.6. Data Analysis

The data analysis has been structured into two sections. In the first section is the analysis of the data on the characteristics of the respondents and housing characteristics which were presented using descriptive statistics. The second is the analysis of the relationship between locational, neighborhood, and structural attributes on the one hand, and apartment rentals on the other which are presented inferentially.

Data analysis was carried out using ArcGIS software which is a cross-platform desktop geographic information system application that supports viewing, editing, and analysis of geospatial data complemented by Microsoft Excel for further regression analysis [38]. Multivariate analysis techniques was used to develop the model as well as determine relationship of location and land surface features with rental house pricing.

Hotspot analysis was conducted for further analysis whereby hotspot map were created through use of ArcGIS. They were able to classify the rental rates of various houses and categorizing them with confidence levels whereby hotspot with the highest significance level signifies the areas with highest rental rates.

Regression analysis was used to assign different weight to the various factors noted to influence house rental prices. This was necessary since each factor affected the price differently others having a higher impact than the rest. The coefficients deduced were used to form a rental house price predictive formula.

2.7. Logical and Ethical Considerations

The exercise of data collection through use of questionnaires was done after seeking permit for research from National Commission for Science, Technology and Innovation (NACOSTI) [39] which is a state corporation established under the Science, Technology and Innovation Act, 2013 (Revised 2014). The questionnaires distributed to various house owners were treated with maximum confidentiality ensuring no leakage to any third party.

This is because they contain crucial data regarding the owners' investment as well as biodata. The data was purely used for research purposes. Ethics were observed while distributed them whereby the judgement of the participants were well respected. Unwilling participants were excused.

3. Results and Discussion

Table 2. Major characteristics of respondent's variable frequency percentage (%)

(a) Gender Distribution of the Respondents		
Male	196	78
Female	54	22
Total	250	100%
(b) Distribution of the Respondents by Educational Qualification		
National Diploma or below	35	14
Tertiary (BSc./HND)	142	57
Post graduate	68	27
Others	5	10
Total	250	100%
(c) Distribution of Respondents by Job Classification		
Traders	17	42
Civil Servants	45	18
Corporate Organizations	67	27
Private Consultancy	60	24
Students	25	10
Others	11	4
Total	250	100%

Housing is a multi-attribute commodity, accessibility to work, transport and amenities, and its neighboring properties are routinely considered by housing buyers. This was demonstrated by this research as it pinned out various factors that affect rental house prices away from the buildings attribute. Spatial factors were notice to play a big role in the pricing. Of the independent variables measured and tested in the regression analysis, the following proved statistically significant: availability of night guard, sewer line accessibility, private outdoor space, security systems, Continuous electricity and water supply, tiled sitting room.

Table 2 summarises certain characteristics of the respondents. From Table 2 (a), 78% of the respondents are male, 84% are university or polytechnic graduates (Table 2b), about 70% are either civil servants or white-collar workers.

Respondents are mainly professionals and civil servants with a minimum academic qualification of secondary school certificate which guarantee a measure of rationality, objectivity and reliability in their responses.

3.1. Relationship of Spatial Factors Influencing Rental Price and Rental House Prices

Relationship between Rental House Prices and Land Value

From the analysis it was found out that land value played a great role in rental price determination (Figure 3) whereby the areas with the highest land value were noted to have houses with the highest rental prices.

Following regression analysis (Figure 4), the relationship between rental house prices and land value was found to be:

$$House\ Rent = 0.0002\left(Land\ Value\right) + 5360.7$$

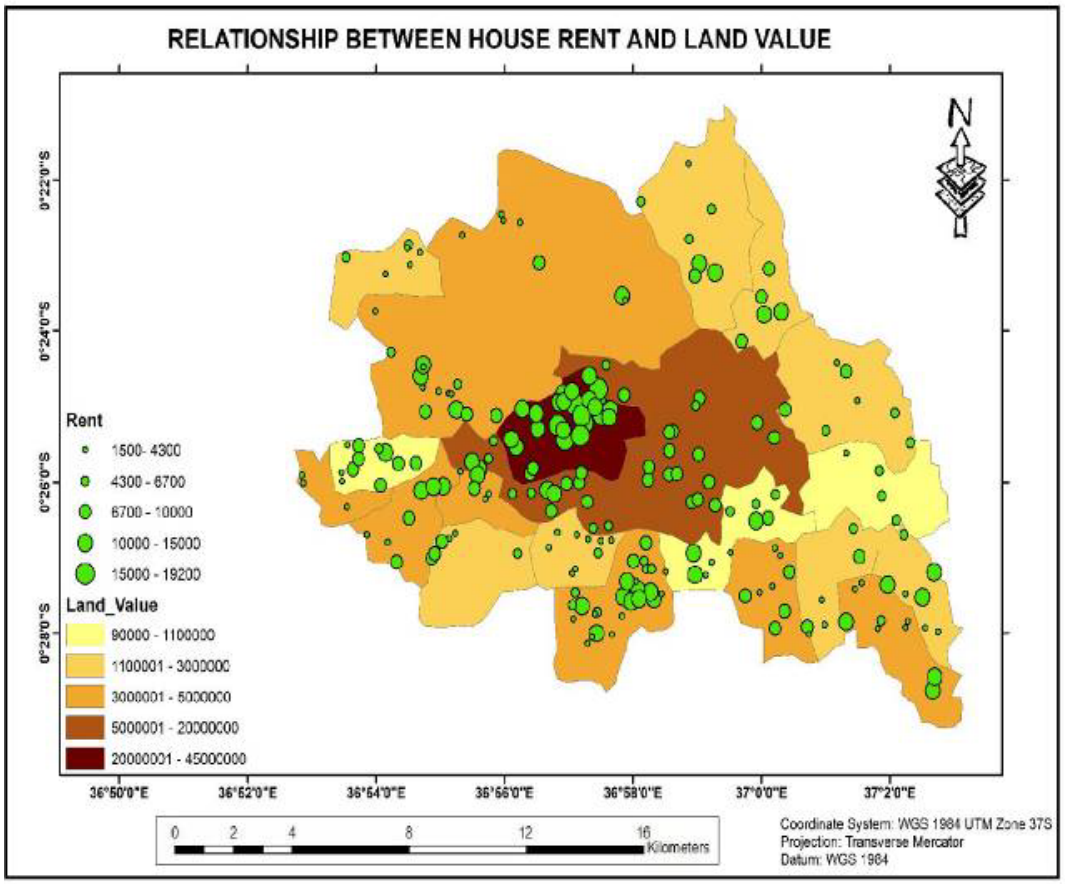

Figure 3. Relationship between rental house prices and land value

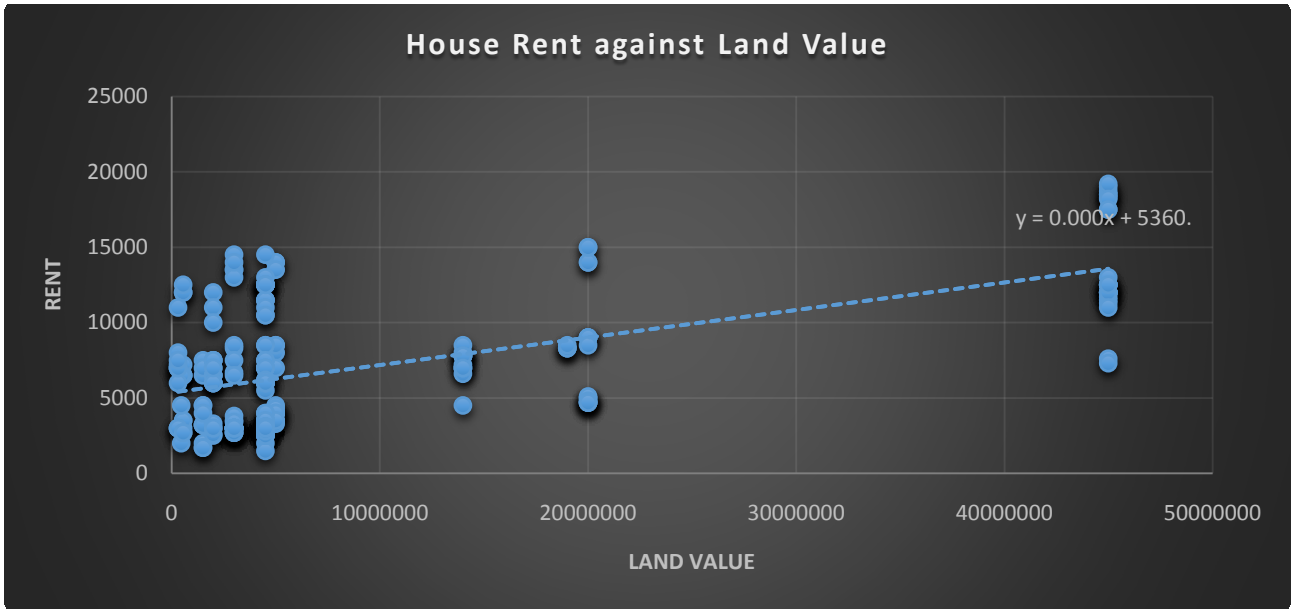

Figure 4. Rental house prices and land value predictive equation

Relationship between Rental House Prices and Population Density

Population density was noticed to be directly proportional to rental house prices. This was due to the forces of demand and supply whereby the dense areas had a high demand of houses thereby owners increasing the rental prices (Figure 5).

The relationship between rental house prices and population density (Figure 6) was found to be;

$$Rental\ price = -7.1833\left(pop\ density\right)+10327$$

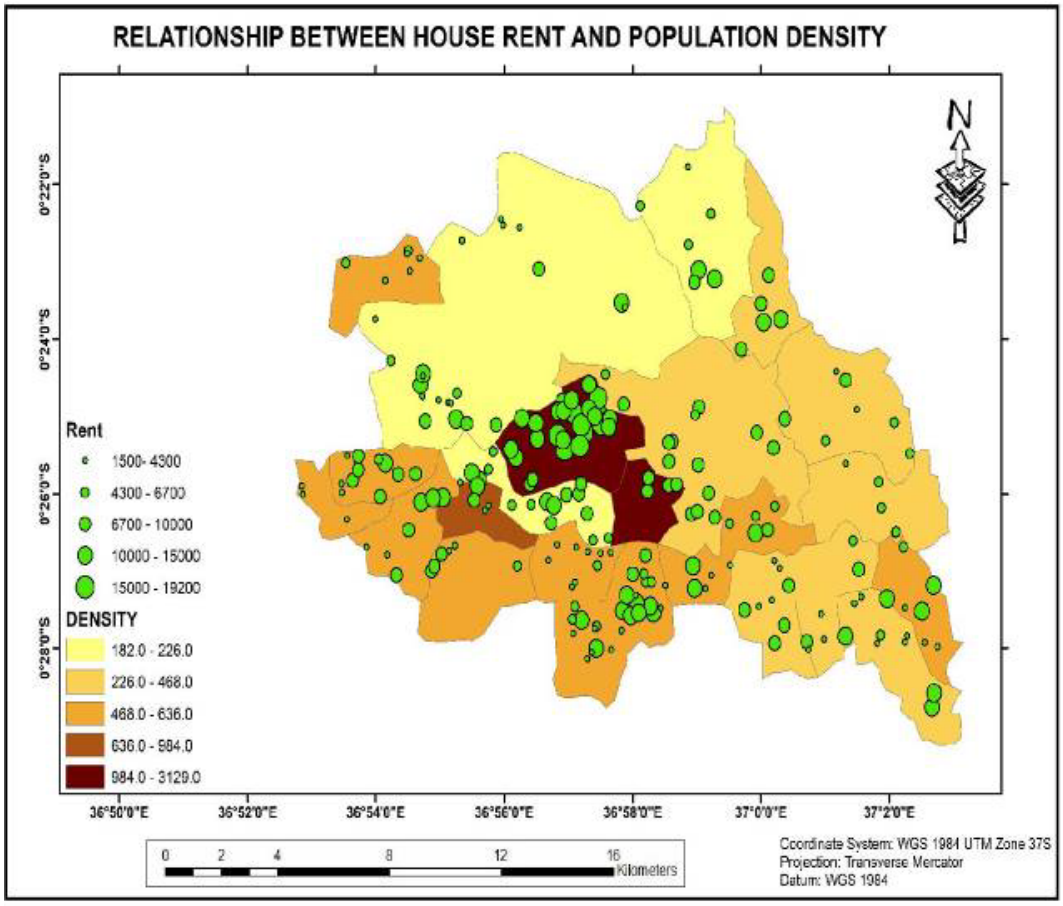

Figure 5. Relationship between rental house prices and population density

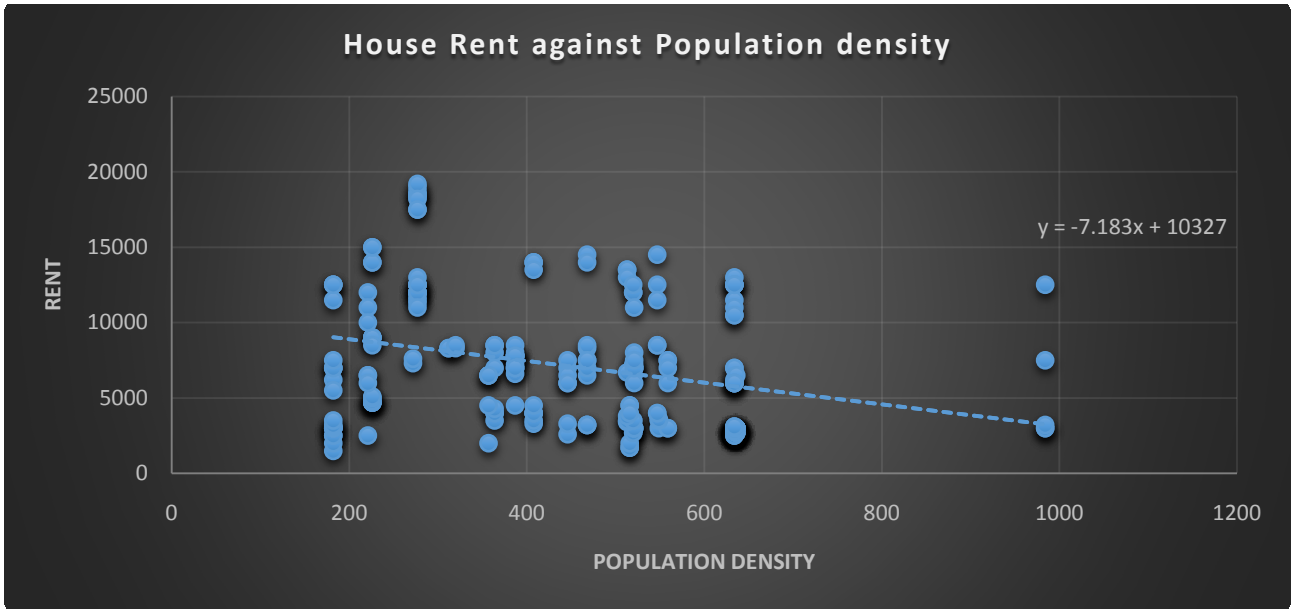

Figure 6. Rental house prices and population density predictive equation

Relationship between Rental House Prices and Proximity to Nyeri Towns

Nyeri town which is the main town in the study area is located in Rware ward. This was noted to have a great impact on the rental prices in that the closer a house is to Nyeri town the more its rental price was. This was created after creating a centroid in the Rware ward polygon and creating a buffer related to the largest extent from the centroid. Through Euclidean distances created from other small towns in within the constituency, there was a direct proportional relationship (Figure 7). There exist a similar relationship between other towns in the constituency namely Kiganjo, Muruguru, Gatitu and Kigogoini and rental house price.

The relationship between rental house prices and proximity to Nyeri towns (Figure 8) was found to be:

$$Rental\ Price = -1.5174\left(distance\ from\ towns\right)+11095$$

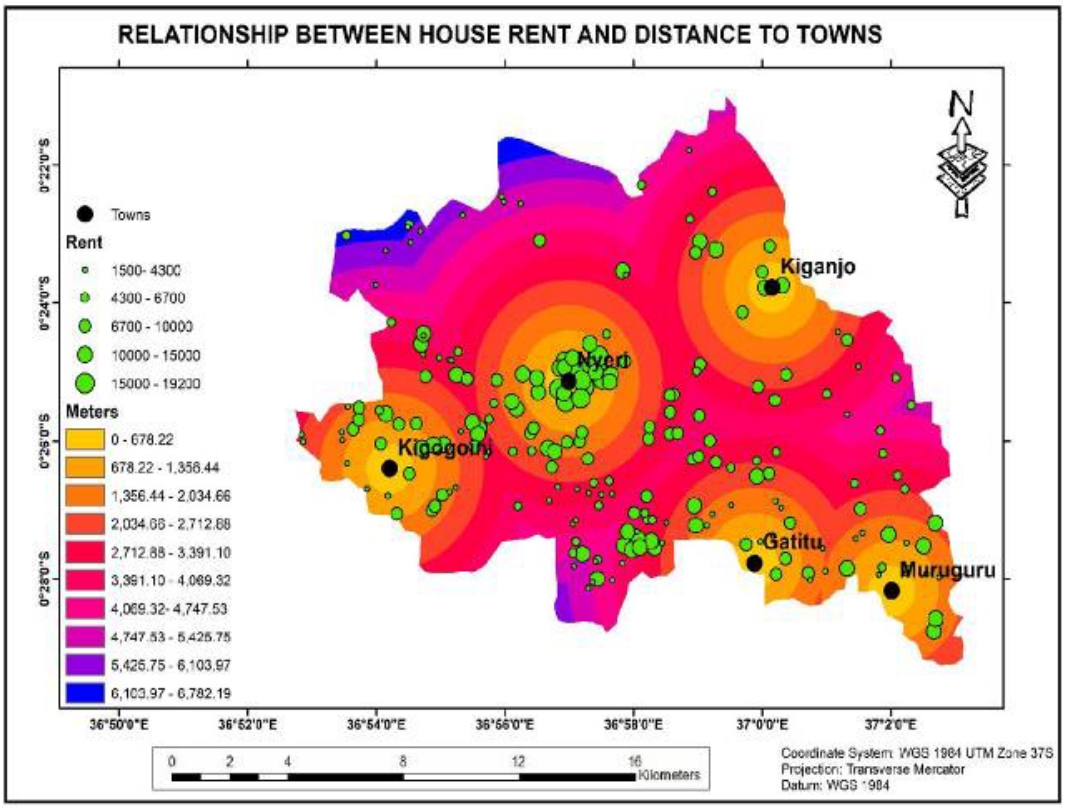

Figure 7. Relationship between rental house prices and proximity to Nyeri towns

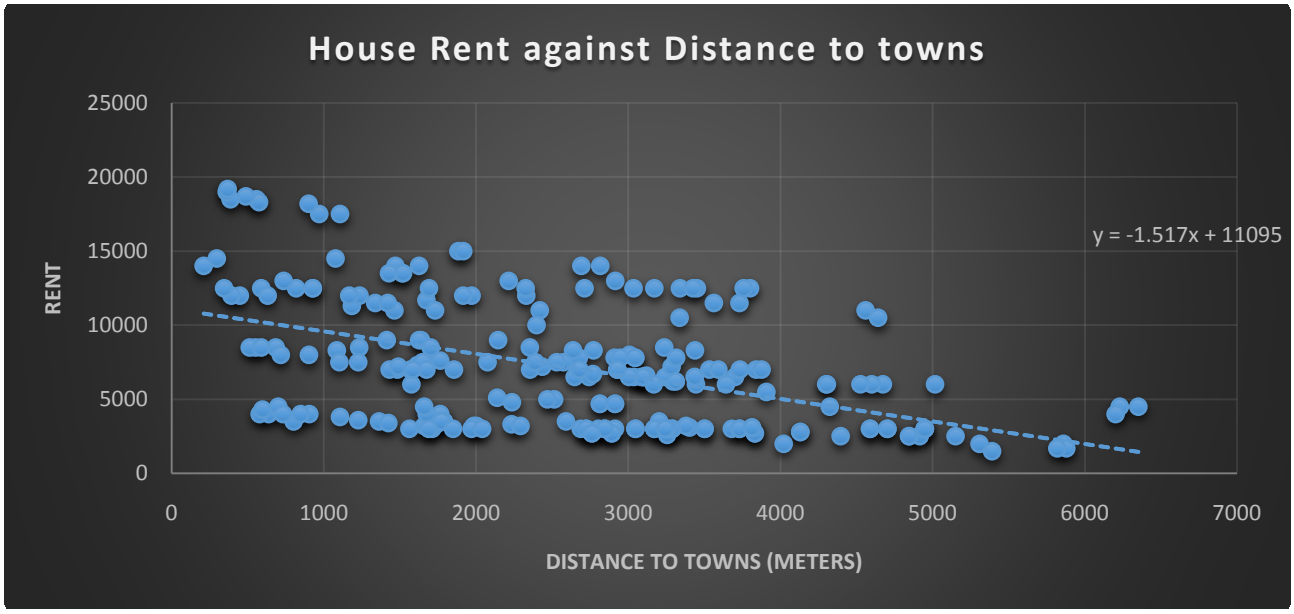

Figure 8. Rental house prices and proximity to Nyeri towns predictive formulae

Relationship between Rental House Prices and Slope

From the DEM, land form features derived included slope which was seen to have an impact on the rental house prices. It was noted that the houses constructed on the a slope of 15% gradient or less had a 19% higher margin of rental prices than their counterpart build in areas in relatively sloppy areas (Figure 9).

This relationship between rental house prices and slope (Figure 10) after regression analysis was fond to be;

$$Rent = 52.531(slope) + 6844.4$$

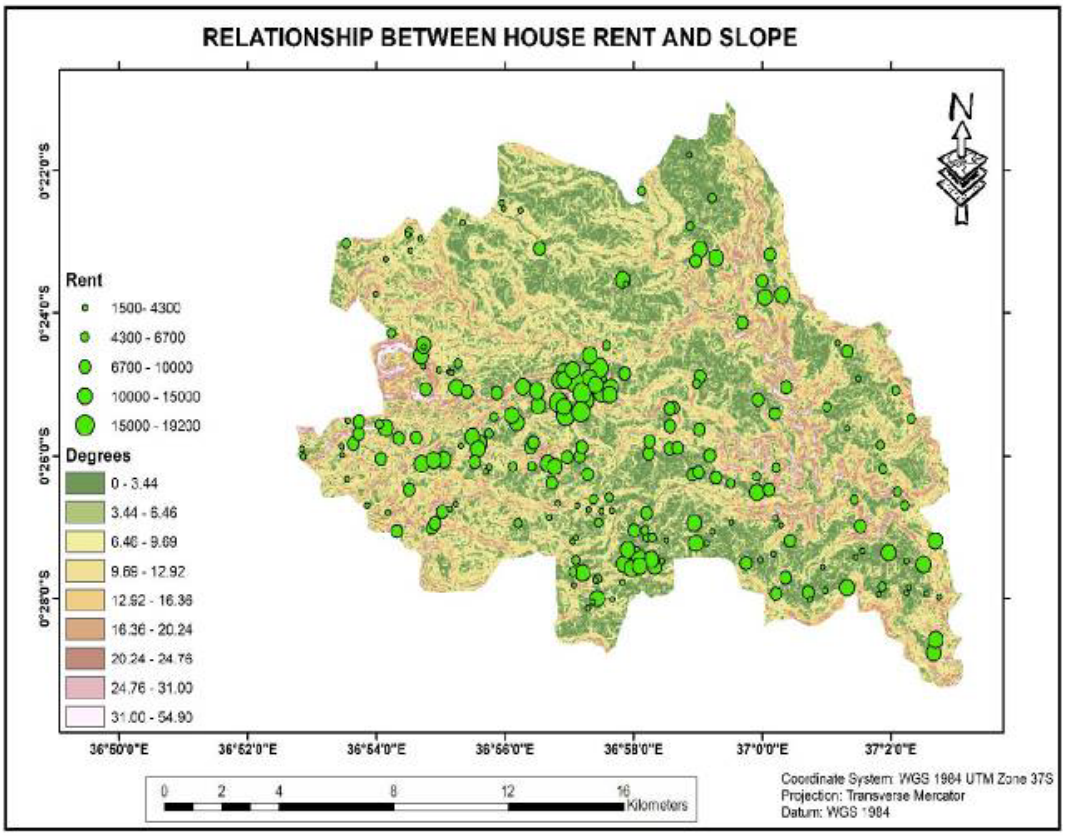

Figure 9. Relationship between rental house prices and slope

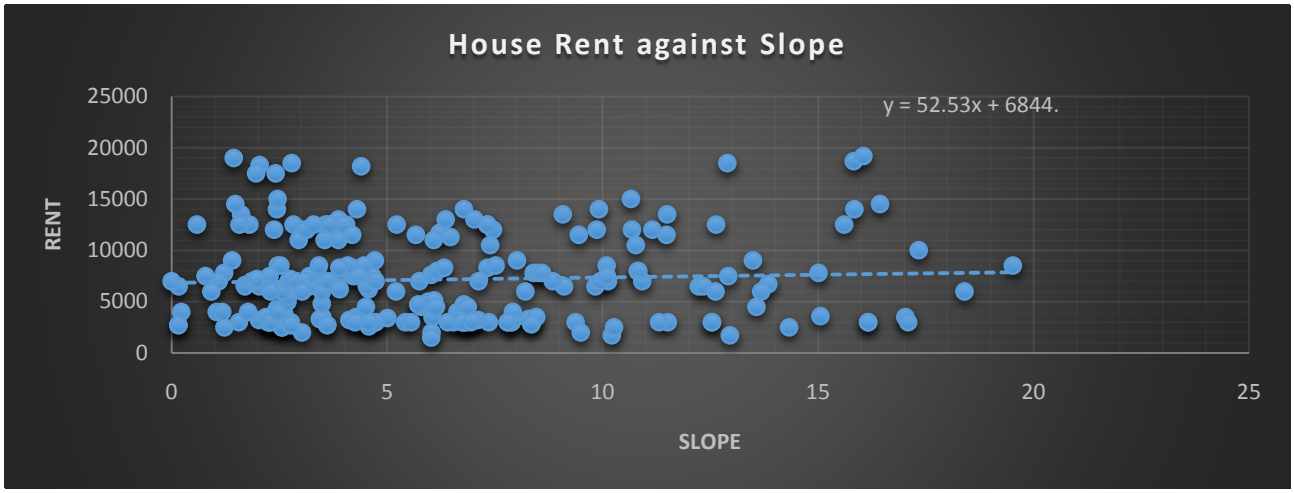

Figure 10. Rental house prices and slope predictive formulae

Relationship between Rental House Prices and Classes of Roads

There were three classes or roads identified in the area. This included; class A: international trunk roads class B: national trunk roads, class C: primary roads, class D: secondary roads.

The houses built in a buffer of 80m from class B road were noted to have a higher rental rates followed by class C then D (Figure 11). Nearness to main infrastructure plays a big roles in rental house price determination. International road did not have much influence on the rental house prices as it appears passes through a small section on the west of the research area and more than 40 kilometers from the main town.

The relationship between the various classes of roads was found to be:

$$Rent = -0.1726(dist\_international) + 8324.3$$
$$Rent = -0.6566(dist\_national) + 8204.9$$
$$Rent = -0.3707(dist\_primary) + 8240.4$$
$$Rent = -0.8707(dist\_secondary) + 9118.7$$

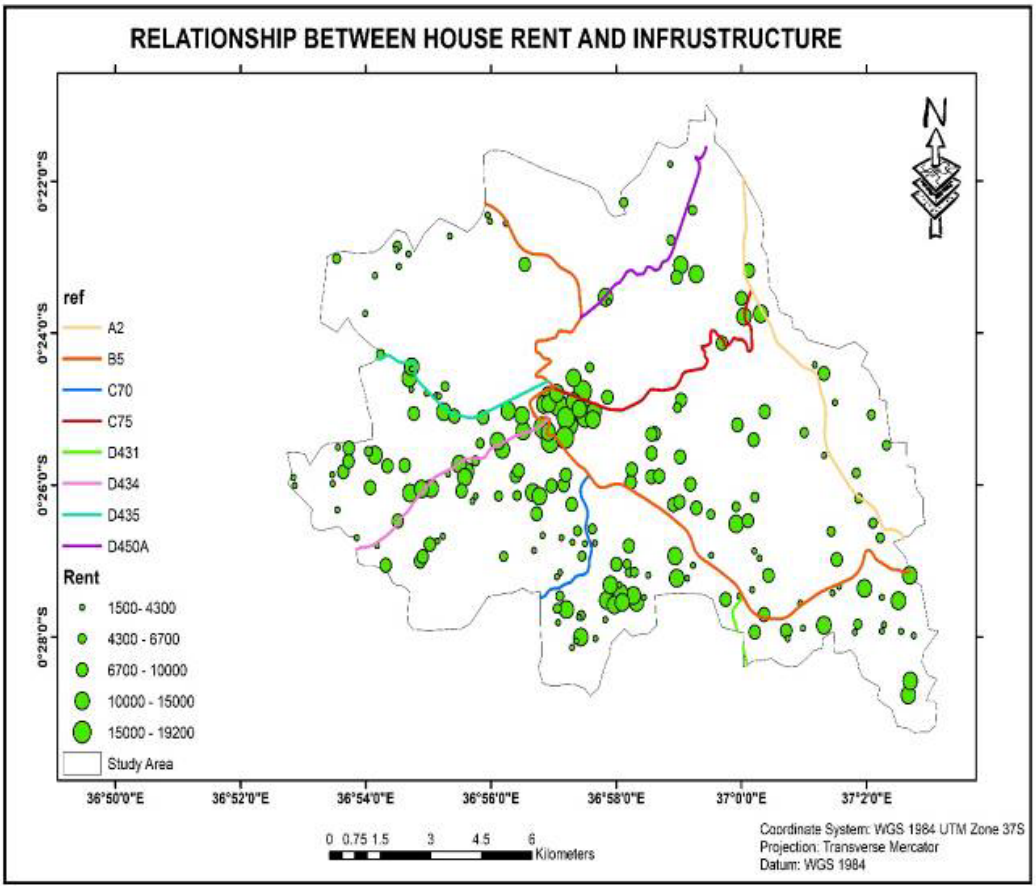

Figure 11. Relationship between rental house prices and road classes

Relationship between Rental House Prices and Security

From the structured questionnaires, it was noted that presence of a police station had an impact in security of the surrounding area. The areas that were far from police station were noted to have had previous insecurity incidences as compared to houses near the police station. Rware ward has only one police station. The more secure area denoted by lack of any insecurity incidences before were seen to have a higher rental price margin that the other areas. Nearness to slum contributed too areas insecurity as seen in Kiawara and Majengo slums. The security levels were denoted using a scale of 1-5 whereby the 1 denoted low security and vice versa (Figure 12).

This relationship between rental house prices and slope (Figure 13) after regression analysis was fond to be;

$$Rent = 963.46\ (security) + 5746.6$$

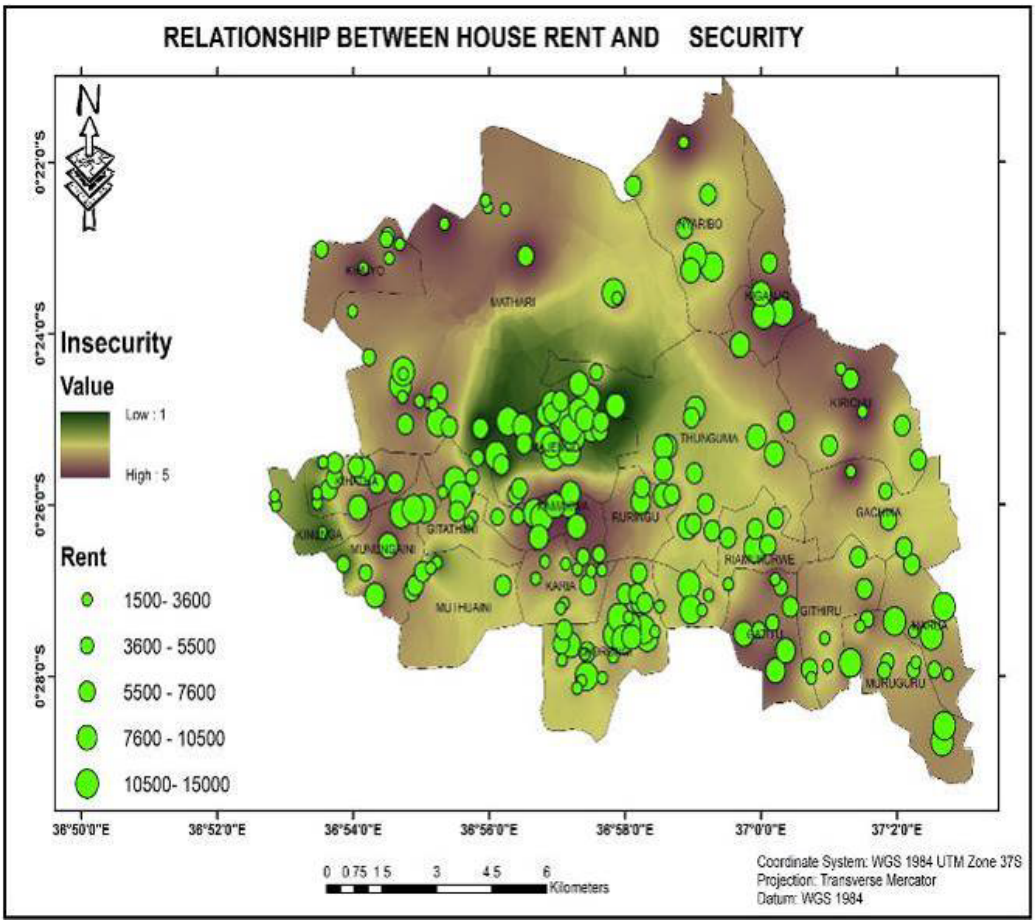

Figure 12. Relationship between rental house prices and security

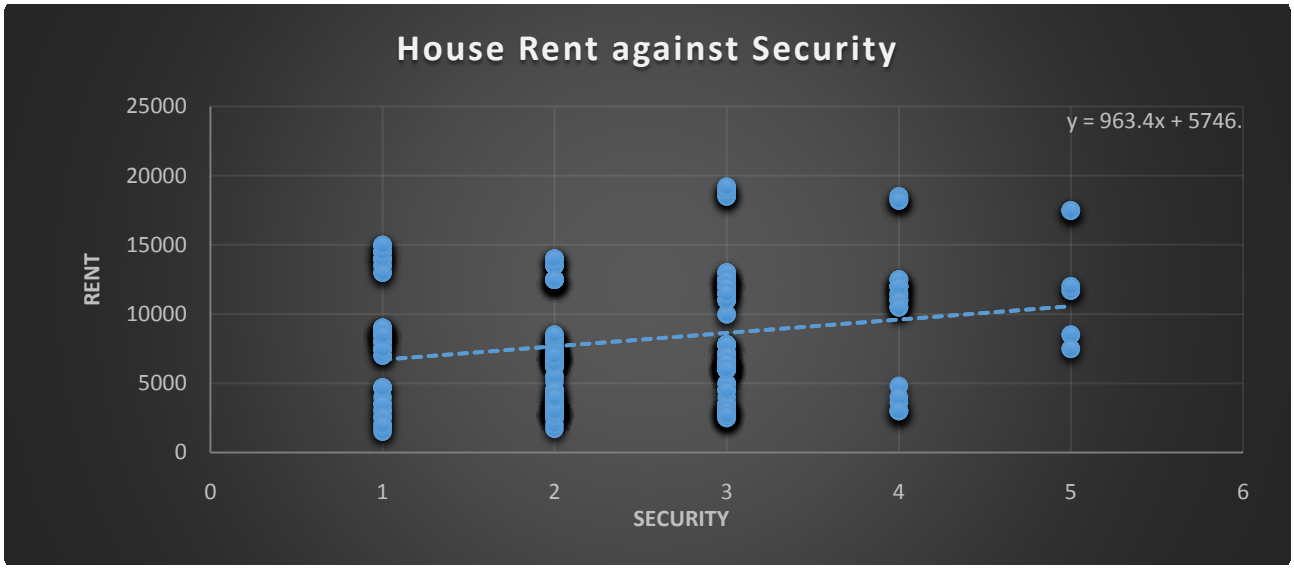

Figure 13. Rental house prices and security predictive formulae

3.2. Combined Rental House Price Predictive Formula

Rental house predictive formula was generated after consideration of all the factors. Different weights was assigned through a regression analysis of all the different types of houses identified within the area as demonstrated.

Rental house predictive formulae:

1. Rent= 0.0002(Land Value) + 5360.7
2. Rent= -7.1833(pop density) + 10327
3. Rent= 963.46 (security) + 5746.6
4. Rent= 52.531(slope) + 6844.4
5. Rent= -1.5174(towns) + 11095
6. Rent= 0.0988 (floor size) + 209.12
7. Rent= -0.1726(dist_international) + 8324.3
8. Rent=-0.6566 (dist_national) + 8204.9
9. Rent=-0.3707(dist_primary) + 8240.4
10. Rent= -0.8707(dist_secondary) + 9118.7

Rent/10 = 73471.12 + 0.0002(Land Value) -7.1833 ***(pop density)*** + 963.46 ***(security)*** + 52.531 ***(slope)*** -1.5174 ***(towns)*** +0.0988 ***(floor size)*** -0.1726 ***(dist_international)*** -0.6566 ***(dist_national)*** -0.3707 ***(dist_primary)*** -0.8707 ***(dist_secondary)***

3.2.1. Multicriteria Analysis

From the result of multi criteria analysis, the factors examined were noted to affect the rental house price with varying percentages (Table 3). Analytic Hierarchy Process (AHP) is based on a hierarchical structuring of the elements that are involved in a decision problem. The evaluation of the hierarchy is based on pairwise comparisons.

The Decision Maker's (DM's) judgment may not be consistent with one another, so AHP measures the inconsistency of judgments by calculating the consistency index CI of the matrix. The CI is in turn divided by the average random consistency index RI to obtain the consistency ratio CR. The RI index is a constant value for an n × n matrix, which has resulted from a computer simulation of matrices with random values from the 0- 8.

Table 3. Percentage influence of the factors affecting rental house prices

CLASSES	%
Dist to Towns	11.93
Dist to Roads	10.09
Floor size	33.81
Land Value	19.27
Pop Density	4.73
Security	12.97
Slope	7.22

3.2.2. Final Combined Spatial Hedonic Rental Houses Predictive Formula

With the application of spatial hedonic model having incorporated both spatial and non-spatial factors, the resultant combined hedonic regression equation is therefore:

RENTAL HOUSE PRICE = 73471.12 + 0.0002(**Land Value**) -7.1833 (**pop density**) + 963.46 (**security**) + 52.531 (**slope**) -1.5174 (**towns**) +0.0988 (**floor size**) -0.1726 (**dist_international**) -0.6566 (**Dist_National**) -0.3707 (**dist_primary**) -0.8707 (**dist_secondary**) -0.02(**Noise**) + 0.094(**Scenic Beauty**) + 0.053(**tiles**) + 0.0001(**Fence**) + 0.025 (**Garage**) - 0.050(**Pollution**) -0.074(**Night Guard**) + 0.0001(**Parking**) – 0.0003(**House Age**)

3.3. Model Validation

With a total of 50 houses gathered from the second most developed constituency in Nyeri County, Mathira Constituency, validation data was prepared and analysed. The data was overlaid in Google earth pro for visualization with the combine spatial model. Rental values from the model were extracted into the collected points and exported in an excel spreadsheet. A correlation between the house rent and collected data rent values gave a mean R^2 of 0.9767 from the statistical description (Figure 14).

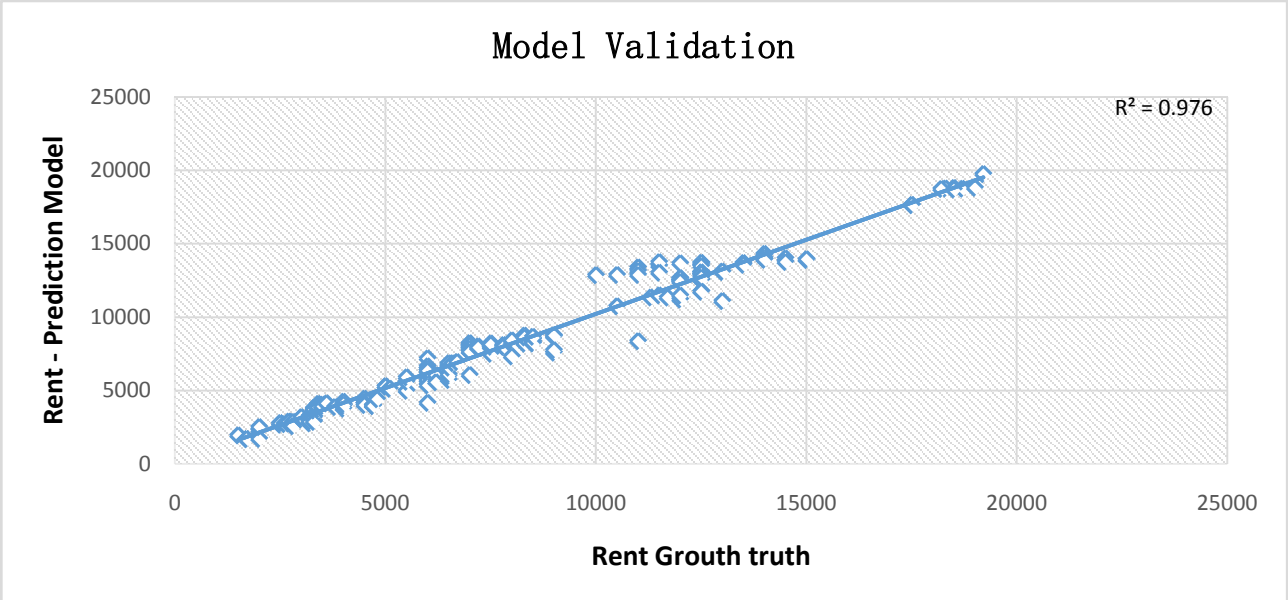

Figure 14. Model validation

4. Conclusion

The spatial factors which were noted to influence rental house prices include; land Value, population density, proximity to towns, slope, security and distance to roads.

Regression analysis and spatial hedonic modelling are valuable tools for real estate professionals in determining the correlation between building characteristics and the transaction price, as well as to predict future transaction pricing. Using these techniques can facilitate building valuation when traditional discounted cash flow models cannot be populated, which can often be the case if an asset is located in a remote location and/ or its structure is unique to other building assets. The results from this study can also produce answers to development decisions such as what building attributes to include in an effort to generate the highest value on a parcel of land.

GIS and real estate technologies have proven to be powerful tools in the analysis of real estate dynamic market if well adopted. With well laid down framework, decision making tools can be made which will enable users to make informed decisions in regards to possible investments and house type well knowing the various factors that will affect prices and how. More research should go to development of predictive models.

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