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Analysis of the characteristics of residential function in the mountainous cities (Case study: Rwandz city – Erbil Governorate – Iraq)

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Abstract

House is the haven that keeps people from natural and human conditions, it gives them trust, safety, and steadiness. It is one of the most basic human needs this became a serious function which cities offer, and became one of the most important aspects which caught urban researchers interest, they take into consideration a wide range of architectural, social, and economic indicators. The study aims to provide an overall conception of Rwandz residential functions, using a collection of parameters and some GIS and statistical techniques, to help establish plans and future projects to improve the growth of this city and other towns and cities in that area. The study found that the old parts of Rwandz city which are located in the core, differ from the outer parts which are relatively newer in many properties, generally, the core is more densely populated than the outer, bigger family size, more illiteracy, and unemployment, few incomes, older houses, smaller houses, in the opposite of the outer parts. Besides, the study tested the correlation coefficient between the criteria; it found some strong statistical relationships between them, which reflected some real-life properties of the residential function. Lastly, the study designed a regression model to predict the main residential function criteria.

Keywords

Rwandz, residential function, GIS, correlation, regression

1. Introduction

House is the shelter that protects people from natural and human conditions, and it gives people confidence, safety, and stability, also it has become part of the human happiness elements. So the availability of shelter is a basic human need (Pacione, 2005), it has become an important function which cities offer. The importance of the housing increases constantly, e.g. only in China, there are about 3.5 million housing units being built every year (CHEN *et al*., 2007).

The city of Rwandz is one of the best-known ancient cities in the mountain territory in Iraq, which geographers, in particular urban geographers, ignored. It has now become an administrative center and

tourism center. It receives a large number of tourists each year, helping both the city and the Kurdistan region to increase employment opportunities, and boost economic activity. So every investment in this town is in the best interest of the whole country, hence, the attention to residential function is given to the importance of this study.

The study aims to provide a comprehensive understanding of the residential function in the city of Rwandz through a set of criteria and some GIS and statistical techniques, to contribute to the development of plans and future projects to evolve this city and the other cities of the region.

The urban residential function is one of the most significant aspects that urban researchers take it into consideration, they rely on many criteria reflecting urban residents' lifestyle, and in which explain the properties of the residential function. It must be observed that these criteria differ in terms of economics and civilization from one country to another and from time to time within one nation. Also, these criteria established by States are the minimum standards that should be accessible in housing to be socially acceptable and fit for human habitation.

By studying these criteria, researchers can know the status of the cities and their population, and find out its characteristics, as to solve the problems related to it. Some studies such as (Senior, 1973) tried to find out a way to diagnosis the problems of urban dwellers by creating the residential subsystem model. While others looked for the reasons for residents' choices, some of them pointed to lifestyles (Pisman *et al*., 2011), while others refer to accessibility (Zondag & Pieters, 2005). Furthermore, (Usman & Ibrahim, 2017) researched residential satisfaction according to some basic services in the poor countries, they concluded that there is a strong relationship between residential satisfaction and access to basic needs such as potable water and sanitation, this relation effects on both housing quality and housing physical and social environments. Several researchers used modern technology to determine some residential features, for example (Sun *et al*., 2017), studied the differentiation of the seven residential types in Xiamen in China, by using tools like GIS, remote sensing, One-Way ANOVA and Least significant Difference (LSD), they deduced that residential differentiation affected by some factors such as size, type, and the distribution of residential land in the city, which it has to be controlled powerfully by the planners, so as to avoid conglomerate of particular residential types.

Iraqi researchers have addressed the residential function in several cities through some indicators or criteria, such as architectural, population, public services, and socio-economic criteria. They used a number of strategies like factor analysis, cluster analysis, and GIS spatial analysis. Besides, some of them divided their study areas into a group of residential regions, depending on specific criteria like

house age, morphology, and their qualities (Atia & Hassan, 2014). This study tried to identify and evaluate the main properties of the residential function of the city of Rwandz through several criteria, and to develop a model for predicting these features using statistical techniques.

2. Study area

According to historical resources, the history of Rwandz city extends to thousands of years. In 1548 the city was occupied by Ottoman Empire. Rwandz city had a great role in the area throughout all these times; it was the capital of the Emirate of Soran during the rule of Prince Muhammad, who's named Pashay Gwara -The Great King 1813-1835, the emirate authority reached to many territories such as Erbil and Amedi (McDowall, 1996). Now the city is the center of Rwandz district, which manages two sub-districts with 38 villages (Soran_Statistics_Department, 2019).

Rwandz city is located on 44° 31″ 30′ east and 36° 36″ 45′ north, as shown in Figure 1, about 110 kilometers from Erbil city, it is located in the complicated torsion of the mountainous region and rounded several mounts like Korakh - 2115m, Armusha - 1824m, Handren - 2584m, Zozig - 1863m and Bradost -2058m (ASF, 2020).

As for the site of the city of Rwandz, it has been built on a barrow, between 650 meters above sea level in the northeast especially in the city gate, and about 820 meters above sea level particularly at the outer limits of the city west and southwest. The city overlooks on two deep canyons, one called "*kharand*" the other called "*khara-rash*" Figure 2, the depth of these canyons is between 20 – 300 meters (ASF, 2020), which approaching each other in the northern parts of the city.

Table 1 reveals that in Iraq's first census in 1947, the town of Rwandz was being settled with over 300 people, increased to 8237 people after 10 years. Due to the bad political situation, mountain people were leaving their places and immigrating to major cities, such as Erbil, and in 1965 the population was down to 5411, but in 1977 the situation started to settle after the agreement of March between the Iraqi government and the Kurds, which lead to rising the population to 8583. According to the estimations of (Soran_Statistics_Department, 2019), the study area has about 13934 people in 2019, which has grown approximately 2% annually from 1947 to 2019. The population of the city has distributed in 13 neighborhoods, as it's pointed in Figure 2.

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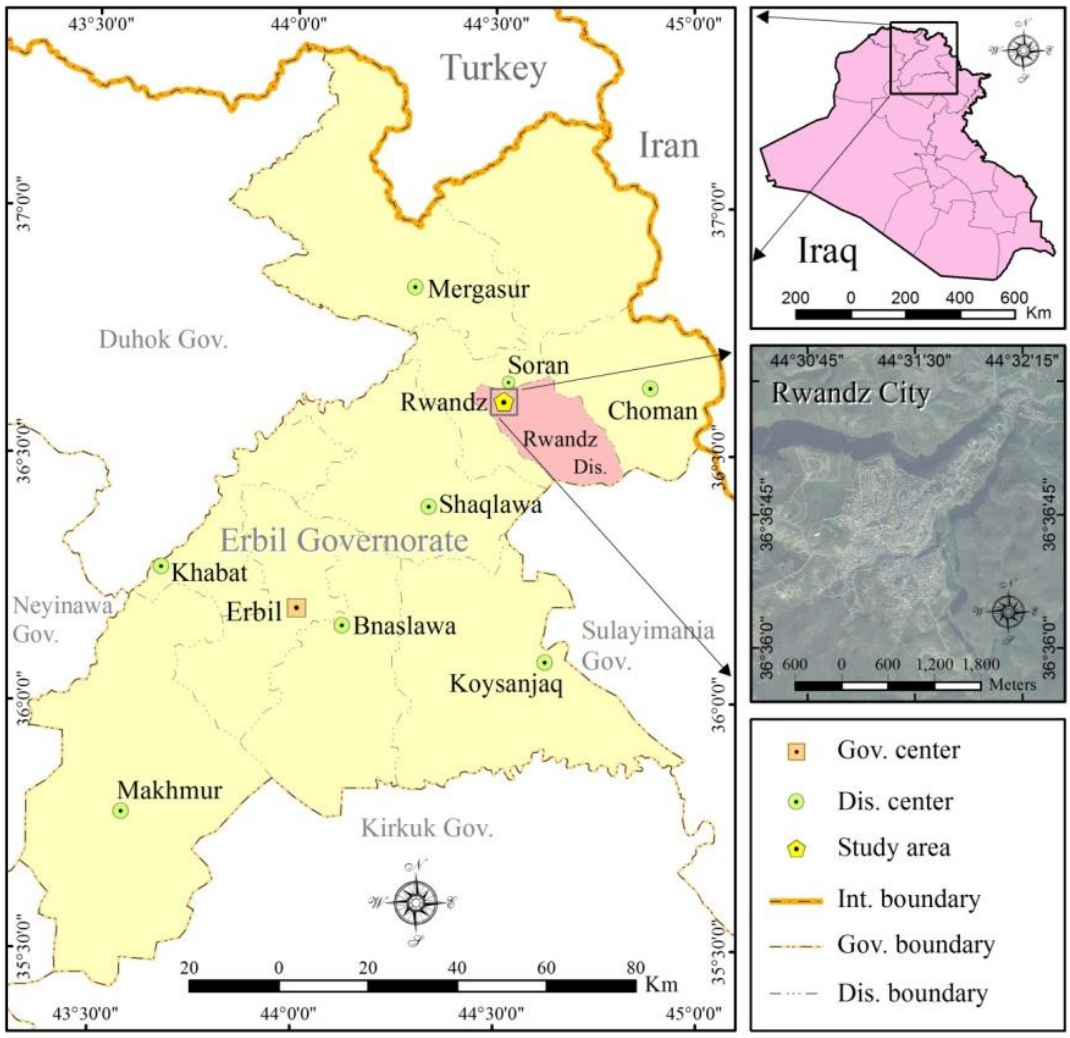

Figure 1. Study area

Table 1. Population number of Rwandz city 1947-2019

year	population
1947	3320
1957	8237
1965	5411
1977	8583
1987	8616
2009	10992
2019	13934

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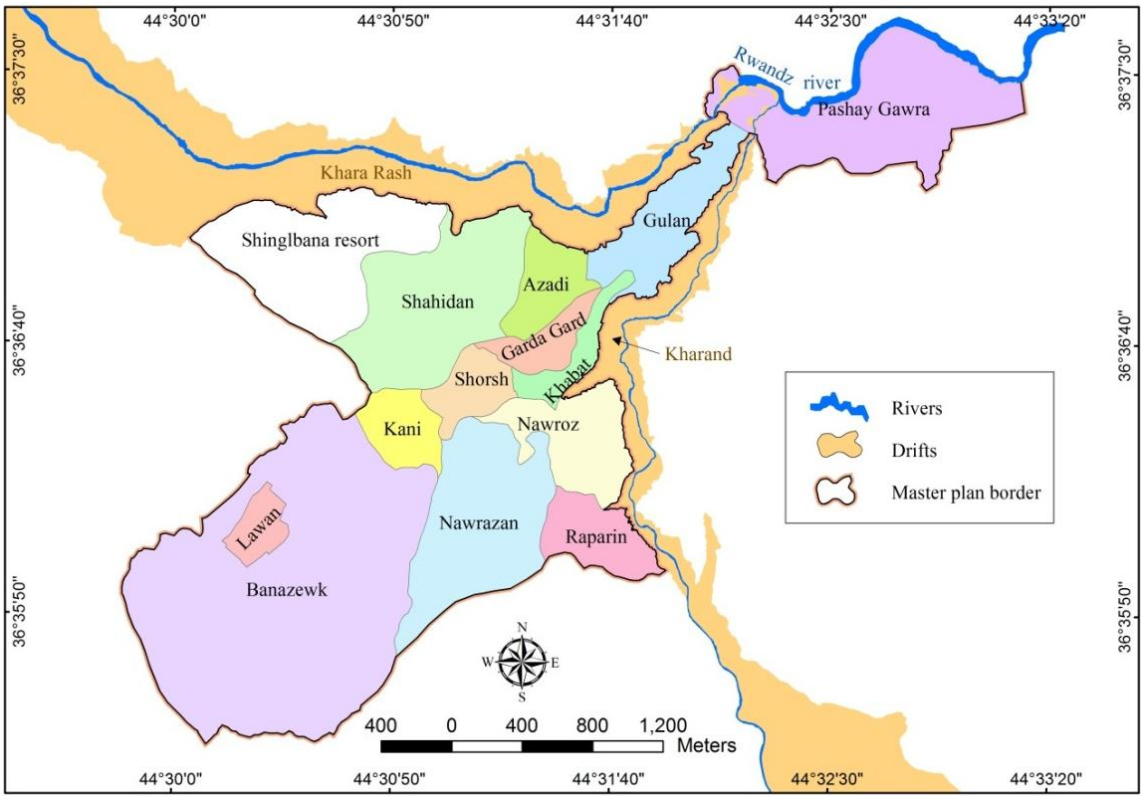

Figure 2. Rwandz city in 2019

2. Methods

2.1 Materials

The data used in the study is divided into two groups, official data, and fieldwork data. Official data includes two types, office data type, such as population data of Iraqi censuses for the period 1947-2009, and some governmental office data like municipal and statistic departments, the other kind is raster data which collected from (ASF, 2020) and the master plan map of the study area which set by (Rwandz_Municipal_Department, 2019).

On the other hand, there is fieldwork data, which fills a large part of this study and there are no such data from government agencies. In order to collect data from the field, the questionnaire was designed, which focused on the characteristics of urban housing in the city of Rwandz, such as: *population number*, *family size*, *residential movement*, *illiteracy*, *house ownership*, *unemployment*, *family annual income ($)*, *house area (sq. meter)*, *age*, *and style*, *number of rooms and floors*, *building materials*, *and existing garden*. The questionnaire forms were distributed by the simple random way on the entire quarters depending of the number of houses. The study extracted the sample size based on 80% of *Z*-value by relying of these two equations (Israel, 2003):

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- 1st equation: if the community size is large (n_0) (10,000):

$$n_0 = \frac{Z^2(1-p)}{e^2}$$

Where (p) is the estimated proportion from previous studies which is usually 30% and (e) is the desired level of precision which is 5%.

- 2nd equation: if the community size is small (n) (1000):

$$n = \frac{n_0}{1 + \frac{(n_0 - 1)}{N}}$$

The number of houses in Rwandz city (N) is estimated by 4,696 units (Soran_Statistics_Department, 2019), thus, the sample size (n) became 134, but the study agreed to allocate 10 questionnaire forms per neighborhood and decreased the sample size of houses to 130 due to the lack of housing numbers on the neighborhood level. Figure 3 illustrates the entire framework of the study.

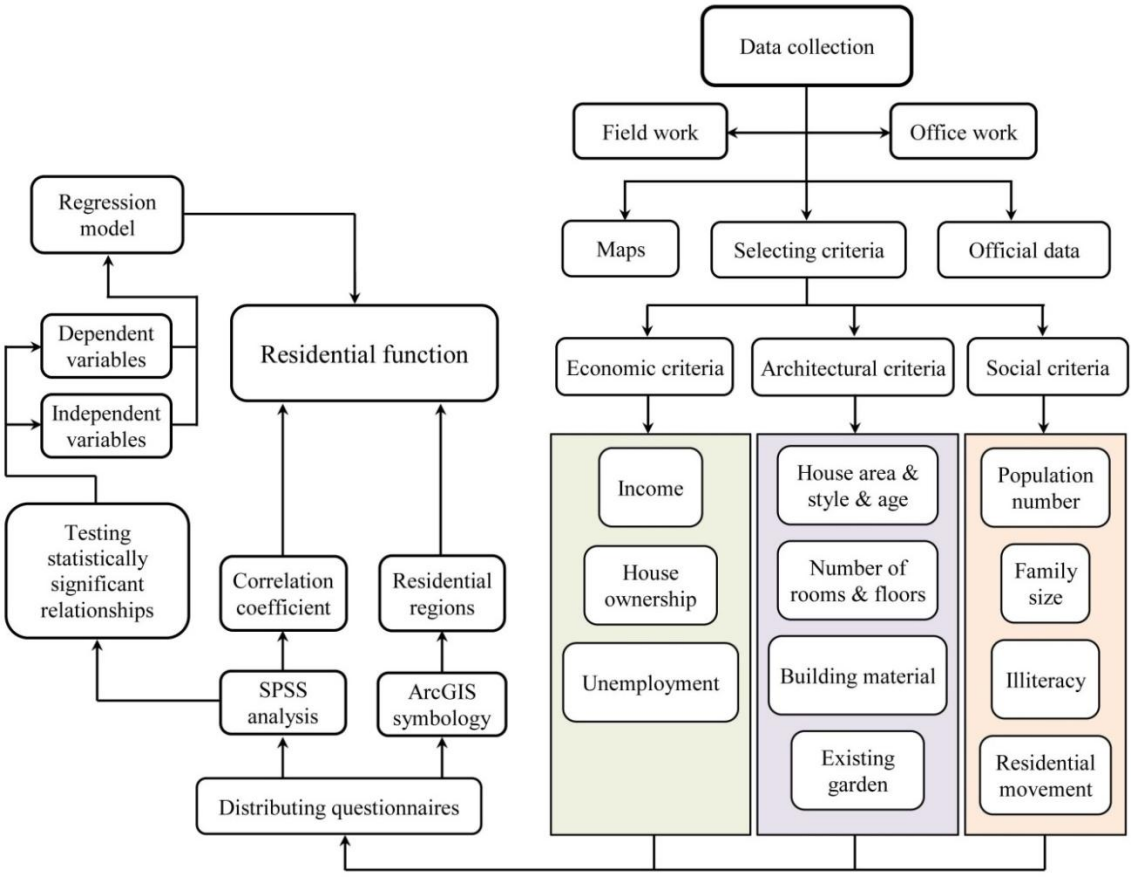

Figure 3. Flowchart of the main processes of the study

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2.2 Correlation coefficient

In the study of the Earth's phenomena, with their relationships, distribution and locations, the researcher is interested in. These phenomena are related to each other in different correlations, linear or non-linear, direct or inverse, strong or weak. The measurement scale is called (correlation coefficient). There are three popular types of correlation coefficients, Pearson product-moment correlation, Spearman's rank-order correlation, and Kendall's tau correlation. Pearson's correlation coefficient is a measure of the relationship between two continuous variables, while Spearman's and Kendal's correlation coefficients are used to measuring the correlation of data consisting of ordinary variables (Chok, 2010). The correlation result is usually between (+1) and (-1), while direct and inverse are indicated with positive and negative signs, besides, the relation becomes more complete, whether positive or negative when becomes closer to +1 or -1 (Gogtay & Thatte, 2017); (Taylor, 1990).

The classification of the relationships between causal and non-cause variables is usually based on a purely scientific basis, rather than on a statistical basis. As regards the role of statistical methods, the aim is to quantify the relationship, to report it digitally, and to determine whether it is statistically significant or not, in addition to excluding the possibility of chance in the occurrence of correlations (Chok, 2010). This paper has used the Two-tailed Pearson correlation coefficient which is shown below:

- 3rd equation: Pearson correlation coefficient (Mukaka, 2012); (Chok, 2010):

$$r_{xy} = \frac{\sum_i^n (x_i - x^-)(y_i - y^-)}{\sqrt{\sum_{i=1}^n (x_i - x^-)^2}\sqrt{(y_i - y^-)^2}}$$

Where: *r* is correlation, *xi* and *yi* are the values of *x* and *y* for the i^{th} individual

2.2 Regression analysis

In analyzing the relationship between variables, researchers are not satisfied with the degree of their correlation but predict a variable through the others by using the regression. The significance of the regression is that it leads to summarizing the complex and dynamic relations of the real world. Regression analysis is a statistical way to determine the relationship of cause-effect between variables (Uyanik & Guler, 2013). In other words, the regression provides information about the link between the reaction variable (dependent) and one or more independent (predictor) variables. There are two types of regression, linear regression and non-linear regression. In linear regression, the variables' power equal to one, while in non-linear regression the variables appear with different powers or in a logarithmic

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form. The linear regression appears in two forms, simple linear regression which concerns the relationship between only two variables, and multiple linear regression which analyzing the relationship between more than two variables, which is expressed through the equation below (Rawlings *et al*., 2001); (Uyanik & Guler, 2013):

4th equation: Multiple linear regression coefficient:

$$y = \beta_0 + \beta_1 X_1 + \cdots + \beta n X n + \varepsilon$$

Where: y = dependent variable, X_1 = independent variable, β_1 = parameter, ε = error

3. Results and Discussion

This paper used some techniques to assess the features of Rwandz city's residential function, such as GIS symbology used to differentiate residential regions and SPSS analysis to determine the relationships between housing criteria with setting a predictive model for those criteria.

3.1 Residential regions

In this part of the study, there have been focused on the most important criteria which collected in the fieldwork and illustrated in Figure 4, 5, 6, 7, 8, 9, and 10; as mentioned below:

3.1.1 Population number

The fieldwork has achieved in distributing the population differently between city locations, some of them have a lot of people particularly in the old part of the city near the commercial area as in Gulan, Shorsh, Kani, Raparin and Pashy Gawra which have more than 60 persons while other places have less than 50 persons like Lawan, Shahidan and Nawrazan in the sample size.

3.1.2 Illiteracy

UNESCO classifies an illiterate as someone aged 15 and above, who can't read and write a brief, easy phrase about his or her daily lives, or someone without formal education (Vagvolgyi *et al*., 2016); (Harman, 1970), Figure 5 shows that the illiteracy varies from one place to another in the city of Rwandz. There are neighborhoods with high illiteracy, such as Kani, Shorsh, and Azadi, which are more than 20 people, while there are neighborhoods where illiteracy drops to less than 7 people, as in Lawan and Banazewk.

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3.1.3 Unemployment

According to the International Labor Organization, People who are jobless, looking for work, and they are ready to take a job, are unemployed (Byrne & Strobl, 2004). In developing countries, conducting surveys for unemployment faces major difficulties, because people do not know the concept of this social phenomenon sufficiently, some believe that unemployment only means someone is not appointed in the government offices or companies, others think that unemployment comprises all the age categories, including retirees also, thus data gathered in the sample size might not be reflected with the real status.

Concerning the city of Rwandz, certain quarters are characterized by elevated unemployment as in Shorsh, Gulan and Pashy Gawra (Figure 6); while other quarters such as Lawan, Banazewk, Nawrazan, Shahidan, and Azadi have little joblessness.

3.1.4 Family annual income ($)

The high-class income neighborhoods are scattered among the city sites (Figure 7), Pashay Gawra in the northeast, Raparin in the south, Lawan in the southwest, and Shorsh in the middle of the city are high-income neighborhoods (over $10,000). Gulan, Banazewk, and Shahidan are in second place. While there are places in the city that have few income (Under $7,500) like Azadi, Garda Gard and Nawroz.

3.1.5 Age of the house

This indicator facilitates the study of the spatial growth of the city over time. Regarding Rwandz, Gulan and Khabat are the oldest part of the city (more than 15 years old), and this fact was emphasized in that study sample (Figure 8). On the other hand, the southwestern outer sections of the city such as Raparin, Nawrazan, Banazewk, and Lawan are the contemporary neighborhoods newly constructed.

3.1.6 House area (square meter)

House is a physical structure that a household has to occupy (Herbert & Stevens, 1960). In another word it can be said that a house is a place where residents do their tasks like living, sitting, talking, sleeping, and so forth. These tasks vary in economic, social, and cultural situations from family to family and reflect on residential characteristics, such as house area, number of floors, number of rooms, construction materials, and gardens. As far as the house area in Rwandz is concerned, it is generally not more than 300 m^2 as it is shown in Figure 9, except for neighborhoods of Khabat and Raparin which have more than this extent and Azadi quarter with over 400 m^2.

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3.1.7 Number of rooms

As mentioned above, the number of rooms considers as one of the residential characteristics, which means dividing the house to a group of sections, each section is allocated to do certain duties, hence the more family members, the more need for rooms. The average number of rooms in Rwandz is over 5.5 in Gulan, Khabat and Nawroz quarters, whereas Shahidan quarter is at or below 4.5 (Figure 10).

After making overlay between the above mentioned residential regions, it can be discussed that old territories over the age of 15 years are generally characterized by elevated population and low-income leading to widespread socio-economic problems such as illiteracy and unemployment, despite the tiny area, housing is defined by a high rate of room number due to congestion caused by population increase. In contrast, the newly-developed regions with homes under 15 years of age have a small population, high income, low unemployment, low analphabetism and a small number of rooms.

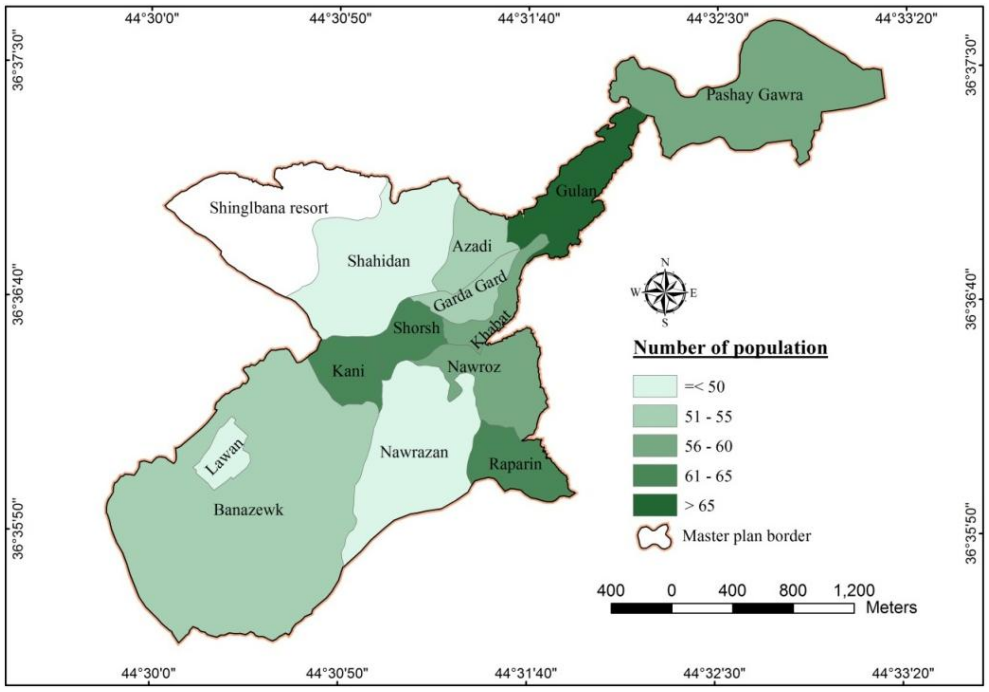

Figure 4. Population number

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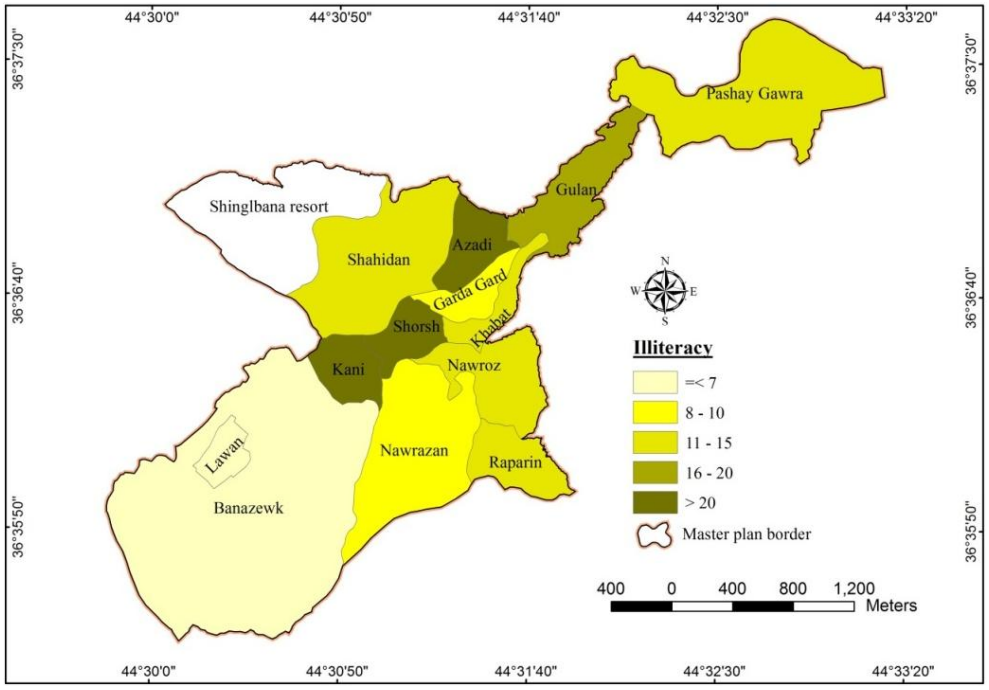

Figure 5. Illiteracy

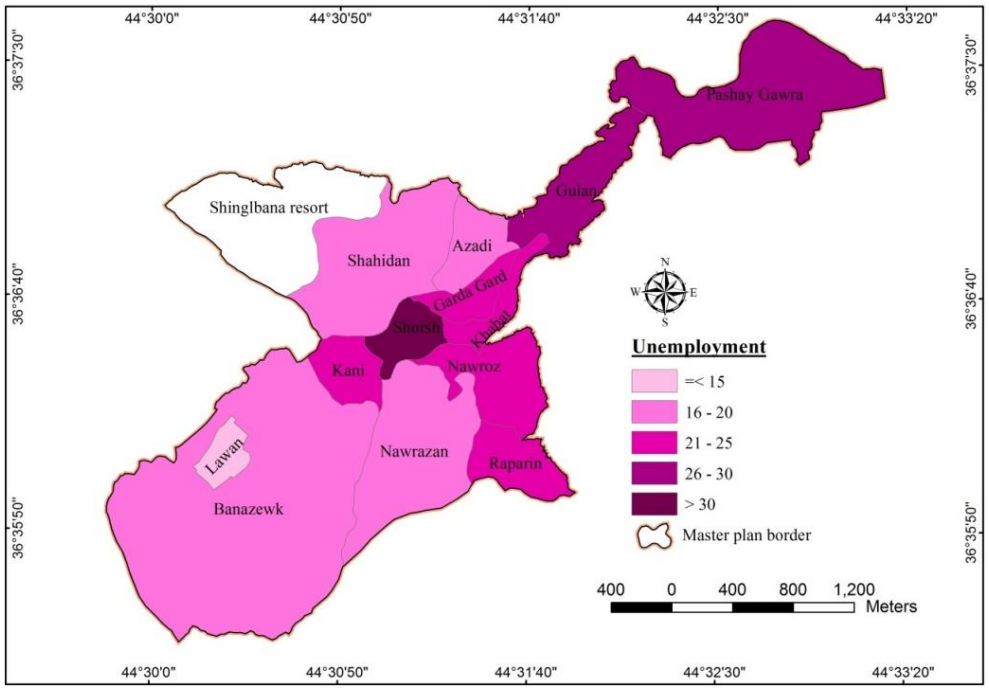

Figure 6. Unemployment

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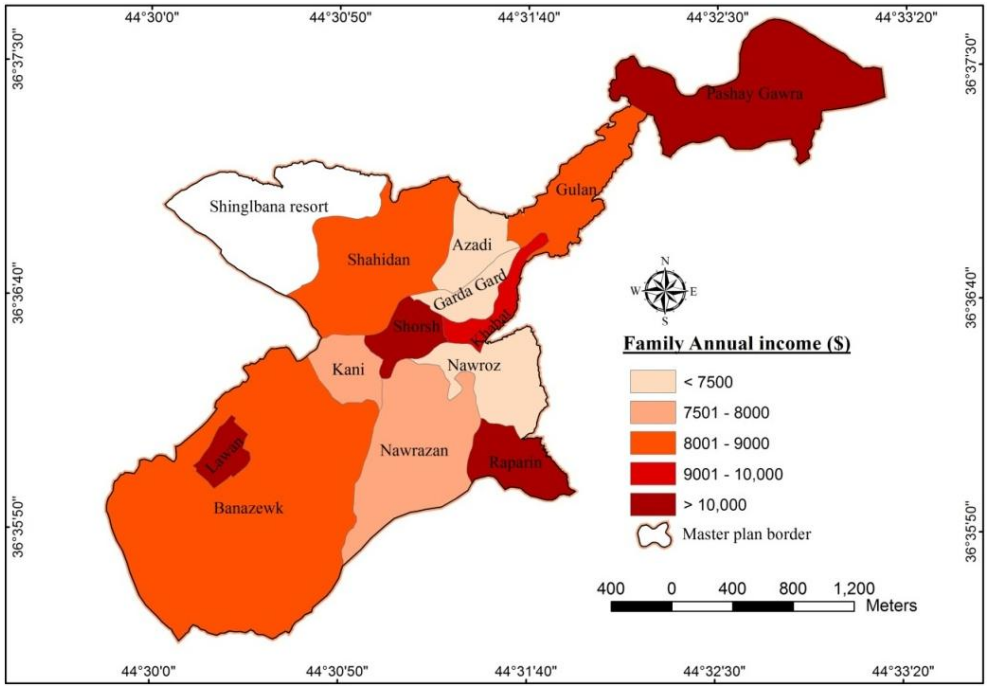

Figure 7. Family annual income ($)

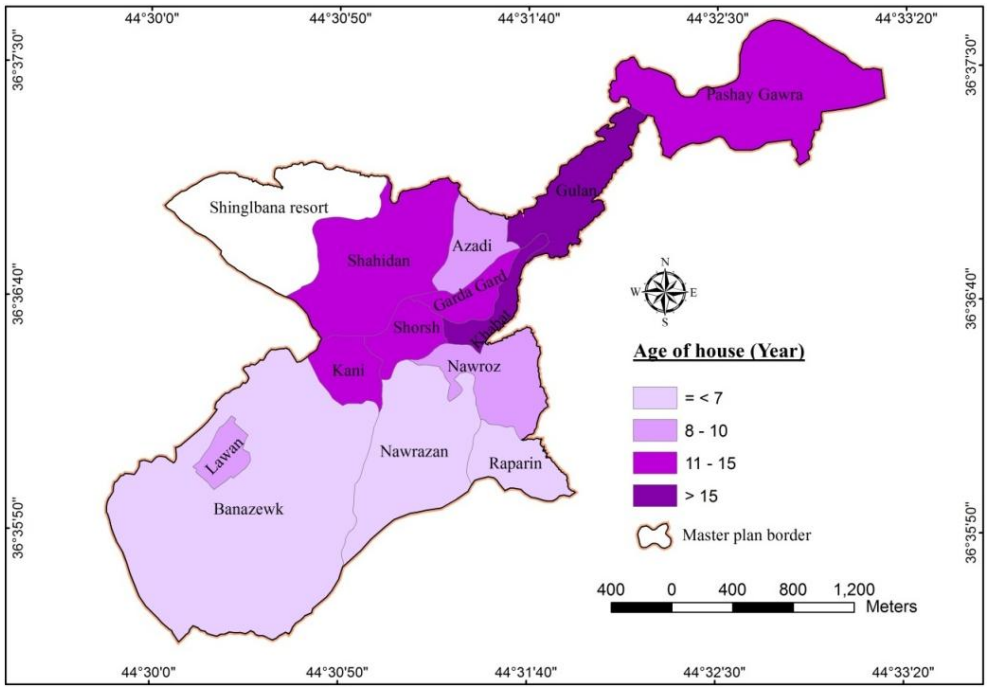

Figure 8. Age of the house

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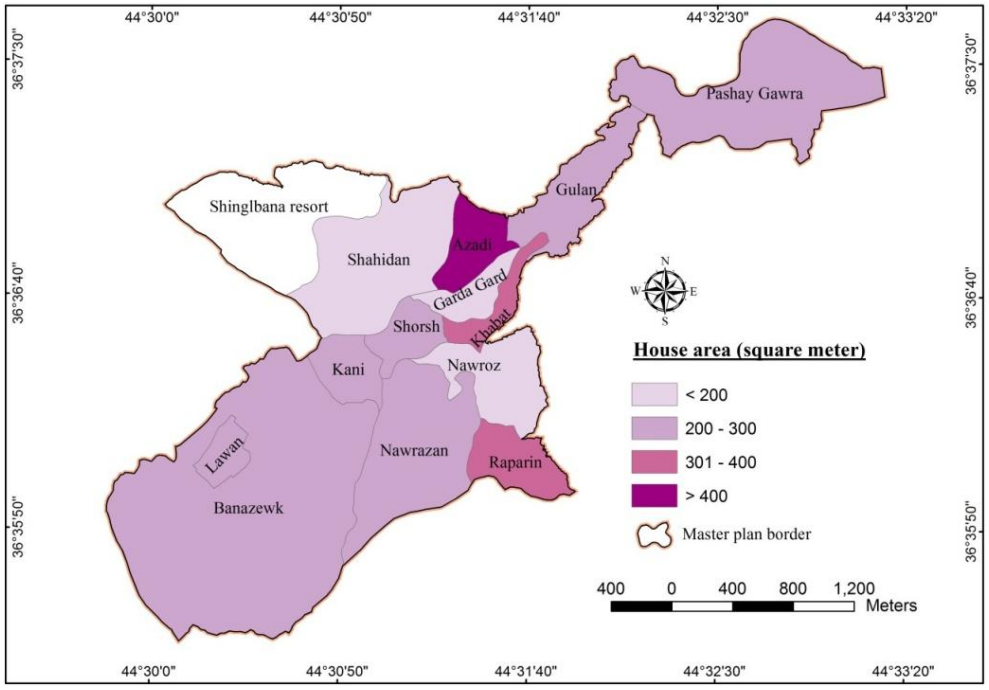

Figure 9. House area (square meter)

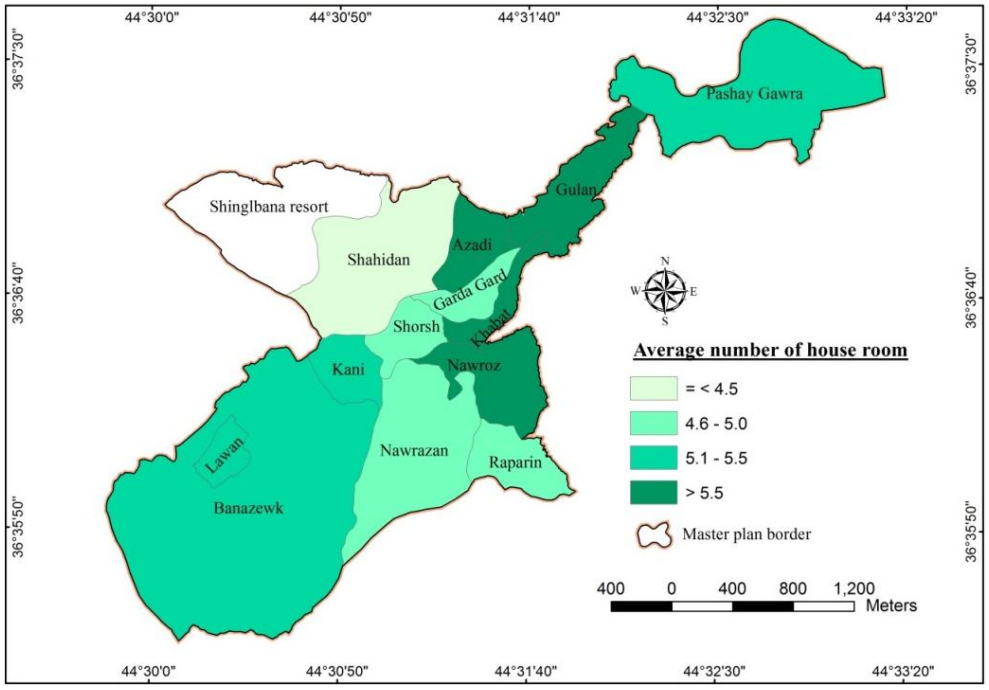

Figure 10. Number of rooms

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3.2 Correlation analysis

In this section, the Two-tailed Pearson correlation analysis in SPSS is used to find out the strength and direction of the statistical relationships between 15 criteria of residential function in the city of Rwandz, as illustrated in Table.2 which shows statistically significant powerful correlations besides non-significant correlations between these criteria, as it is discussed below:

- Concerning population and family size, it is normal that they both have strong relationships with other criteria such as illiteracy, unemployment, number of floors and number of the room.
- The inverse relationship between homeownership and residential mobility explains why rental residents desire to leave their homes and move elsewhere in the city more than owned house dwellers. Besides the positive correlation between homeownership and house area explicates that people try to rent small houses to avoid expensive big houses.
- Illiteracy has significant relationships to unemployment, income, house age, house style, material of wall and roofing. These correlations illustrate that illiteracy, which has an inverse relationship to income, is found mainly in poor households, besides a powerful relationship to unemployment because more illiteracy leads to more joblessness. Moreover, illiteracy exists to a large extent in the aged neighborhoods characterized by old-fashioned houses, more than the new ones.
- Residential mobility has negative relationships to homeownership, house age, house style, and house wall material. These correlations have some explanations, for example in the older quarters with old-fashioned houses individuals want to leave their homes more than others in the new quarters with contemporary buildings.
- The powerful relations between house age with house style, wall material, and roofing material, explain why old-fashioned houses feature ancient traditional architectural materials such as clay and wood.
- House area describes some residential characteristics, e. g. the big houses are featured by a lot of rooms and floors, furthermore, the more area, the more chances for home gardens.

It must be said that there are some difficulties when distributing questionnaires, which related to economic life because people do not write correct information about the quantity of how many they get money in a certain period. This is due to people's bad impression of any type of survey process. If we return to the history of Iraq, particularly in the years of Ottoman occupation, when the authority was taking taxes from people and needed youths for military service, for this reason, they did not like to

give the correct information to any formal employee. Therefore the study sees that there were weak statistically significant correlations between the criterion of family annual income and the other criteria.

Table 2. Two-tailed Pearson correlation analysis matrix

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O
A	1														
B	.412**	1													
C	-.111	-.051	1												
D	.519**	.198*	.004	1											
E	.015	.050	-.262**	-.155	1										
F	.691**	.175*	-.119	.508**	.101	1									
G	-.008	-.015	-.093	-.208*	.047	-.096	1								
H	.027	.058	.098	.232**	-.186*	.121	-.059	1							
I	-.037	.010	.352**	.023	-.121	.029	.009	.277**	1						
J	-.007	-.052	.152	.180*	-.221*	.054	-.091	.339**	.278**	1					
K	.309**	.376**	.009	.097	.067	.170	-.059	-.056	.188*	-.100	1				
L	.217*	.347**	.064	.051	.073	.047	-.051	.060	.558**	.077	.599**	1			
M	.161	.038	.050	.422**	-.219*	.164	-.142	.556**	.285**	.518**	-.058	.153	1		
N	.091	-.080	.023	.236**	-.159	.121	-.038	.484**	-.053	.590**	-.092	-.031	.545**	1	
O	.007	.143	.020	-.003	-.039	-.031	-.106	.048	-.248**	.014	.215*	-.001	-.010	.172*	1

A: Number of population B: Family size C: House ownership D: Illiteracy E: Residential movement F: Unemployment G: Family annual income ($) H: Age of the house I: House area (sq. meter) J: House style K: Number of floors L: Number of rooms M: Material of house wall N: Material of house roof O: Existing garden

3.3 Prediction model

To predict five significant residential functions called dependent variables, such as (house area, number of rooms, number of floors, the material of house wall, the material of house roof), the manner of Multiple Linear Regression has been used in this paper, through some social, economic, and building variables called independent variables, such as (number of population, family number, house ownership, illiteracy, unemployment, family annual income, and age of the house), using the SPSS program, after testing the statistically significant relationships between the variables. Below is the prediction models resulted in this study:

1 - *House area (sq. meter) = (-103.264) + (Number of population × -7.891) + (Family number× 16.492) + (House ownership × 217.984) + (Illiteracy × -8.888) + (Unemployment× 18.294) + (Family annual income ×.003) + (Age of the house ×6.423)*

2 - *Number of rooms = (3.196) + (Number of population ×.175) + (Family number ×.911) + (House ownership ×.330) + (Illiteracy ×-.109) + (Unemployment ×-.133) + (Family annual income ×-2.372E-5) + (Age of the house ×.011)*

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3 - *Number of floors = (.778) + (Number of population × .060) + (Family number × .353) + (House ownership × .080) + (Illiteracy × -.035) + (Unemployment × .004) + (Family annual income× -8.968E-6) + (Age of the house × -.004)*

4 - *Material of house wall = (.786) + (Number of population × .020) + (Family number × -.074)+ (House ownership × -.018) + (Illiteracy × .117) + (Unemployment × -.038) + (Family annual income × -6.625E-6) + (Age of the house × .027)*

5 - *Material of house roof = (.904) + (Number of population × .026) + (Family number × -.171)+ (House ownership × -.033) + (Illiteracy × .045) + (Unemployment × -.017) + (Family annual income × 8.423E-7) + (Age of the house × .025)*

These prediction equations can be largely helpful when the future development plans will be set to the city of Rwandz, because the architectural characteristics of the house represent the reality of the life of the inhabitants of the cities, and in designing these properties, it may contribute to the growth of the social and economic life closely related to the architectural features.

Conclusions

The study has focused on the characteristics of the residential function in the city of Rwandz, as a living example of the mountainous cities, through several techniques such as map symbology in ArcGIS, correlation, and regression in SPSS. The most important work of this study was the fieldwork, which distributed 130 forms of the questionnaire asked a lot of questions about the architectural, social, and economic properties of the housing units within the sample size. It has found a set of conclusions related to the reality of the city and its dwellers. It found that the architectural, social, and economic properties have strong relationships with each other. The study reached to design maps of residential regions, each of them has certain features, the most significant is that the old sides of the city which are located in the core, differ from the outer parts which are relatively newer in many properties, generally, the core is densely populated more than the outer, bigger family size, more illiteracy, and unemployment, modest income, older houses, smaller houses, in the opposite of the outer parts.

Besides, the study analyzed the statistically significant relationships between the criteria of residential function and concluded that the population and the family size have strong ties with the other criteria, that residents of leased, older and old-designed houses wish to move to other places than residents of the houses owned, new and modernly designed. People try to rent small houses to evade costly large houses. Poor households are marked by high analphabetism, greater unemployment, older districts, and old-fashioned design styles. Old-fashioned houses characterize old traditional architectural materials such as clay and wood. Finally, the study tried to find a way to predict certain distinct residential

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functions via the coefficient of multiple linear regression, particularly when the future outlines for the development of the city of Rwandz are defined.

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References

ASF, 2020. *Data of Digital Elevation Model (DEM) - 15 meters*. Alaska Satellite Facility. (online) Available at: https://search.asf.alaska.edu/ (Accessed: March 2020).

Atia, N.H. & Hassan, A.J., 2014. Analysis of residential function of the city of Kirkuk. *Journal of Al-Frahids Arts*, 2(19), pp.293-336. (http://jaa.tu.edu.iq/index.php/art/article/view/436).

Byrne, D. & Strobl, E., 2004. Defining unemployment in developing countries: evidence from Trinidad and Tobago. *Journal of Development Economics*, 73(1), pp.456-76.

CHEN, Q., GLICKSMAN, L., LIN, J. & SCOTT, A., 2007. Sustainable Urban Housing in China. *Journal of Harbin Institute of Technology*, 14.

Chok, N.S., 2010. *Pearson's versus Spearman's and Kendall's correlation coefficients for continuous data*. Master of Science, University of Pittsburgh.

Gogtay, N.J. & Thatte, U.M., 2017. Principles of correlation analysis. *Journal of Association of Physicians of India*, 65, pp.78-81.

Harman, D., 1970. Illiteracy: An Overview. *Harvard Educational Review*, 40(2), pp.226-43.

Herbert, J.D. & Stevens, B.H., 1960. A MODEL FOR THE DISTRIBUTION OF RESIDENTIAL ACTIVITY IN URBAN AREAS. *JOURNAL OF REGIONAL SCIENCE*, 2(2), pp.21-36.

Israel, G.D., 2003. *Determining Sample Size*. University of Florida. (online) Available at: www.tarleton.edu/academicassessment/documents/Samplesize.pdf (Accessed: 15 March 2017).

McDowall, D., 1996. *A modern history of the Kurds*. London: IB Tauris.

Mukaka, M.M., 2012. A guide to appropriate use of correlation coefficient in medical research. *Malawi Medical Journal*, 24(3), pp.69-71.

Pacione, M., 2005. *URBAN GEOGRAPHY - A GLOBAL PERSPECTIVE*. 2nd ed. London: Taylor & Francis e-Library.

Pisman, A., Allaert, G. & Lombaerde, P., 2011. Urban and suburban lifestyles and residential preferences in a highly urbanized society Experiences from a case study in Ghent (Flanders, Belgium). *Belgeo*, 1(2), pp.89-104.

Rawlings, J.O., Pantula, S.G. & Dickey, D.A., 2001. *Applied regression analysis: a research tool*. 2nd ed. Springer Science & Business Media.

Rwandz_Municipal_Department, 2019. *Master plan of Rwandz city of 2013, map scale 1:20,000*.

Senior, M.L., 1973. Approaches to residential location modelling 1: Urban ecological and spatial interaction models (A review). *Environment and Planning*, 5, pp.165-97.

Soran_Statistics_Department, 2019. *Estimates of population and housing units of Soran and Rwandz districts in 2018*. Soran.

Sun, C. et al., 2017. Residential Spatial Differentiation Based on Urban Housing Types—An Empirical Study of Xiamen Island, China. *Sustainability*, 9(10).

Taylor, R., 1990. Interpretation of the Correlation Coefficient: A Basic Review. *Journal of Diagnostic Medical Sonography*, 6(1), pp.35-39.

Usman, M.K. & Ibrahim, H., 2017. URBAN HOUSING AND SENSATIONAL INTERPRETATION FOR EXPERIENCE. *Journal of Education and Social Sciences*, 6(2), pp.278-86.

Uyanik, G.K. & Guler, N., 2013. A study on multiple linear regression analysis. In *4th International Conference on New Horizons in Education*., 2013. Procedia - Social and Behavioral Sciences.

Vagvolgyi, R. et al., 2016. A Review about Functional Illiteracy: Definition, Cognitive, Linguistic, and Numerical Aspects. *Frontiers in psychology*, 7, p.p.1617.

Zondag, B. & Pieters, M., 2005. *Influence of accessibility on residential location choice*. Paper. Washington: Transportation Research Record, The 84th Annual Meeting of The Transportation Research Board.