LHI Journal of Land, Housing, and Urban Affairs
pISSN: 2093-8829, eISSN: 2234-1765
LHI Journal 2021;12(2):13-32 | http://doi.org/10.5804/LHIJ.2021.12.2.13

Comparative Spatial Analysis Between Inner-City Socialized Housing and Private Housing Developments in Metro Manila, the Philippines*

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Abstract

Rapid urbanization has resulted in the unprecedented growth of population in Metro Manila, the Philippines and has led to a 'dual' housing crisis - vacant/unoccupied socialized housing and a chronic housing shortage or delayed housing supply. By developing two GIS-based statistical models, this study is to examine socialized housing in comparison with private housing with respect to location patterns, integration, accessibility, social and economic aspects, and vulnerability to environmental hazards. Multiple regression analysis was integrated with the GIS to identify significant variables that influence the spatial distribution of socialized housing. The comparison between the two regression models has shown that socialized housing is located in areas with inappropriate land use and poor accessibility to transportation facilities and built urban resources. Moreover, both regression models have proven the statistical significance of the vulnerability of socialized housing to environmental hazards. The finding explains how the current housing policies do not address the country's housing crisis, especially for the marginalized and low-income households. Thus, the findings provide implications for urban planners and local decision-makers in reforming the current policy interventions.

Keywords : Empty Housing Phenomenon, Housing Backlog, Socialized Housing, Multiple Regression Analysis, Power Analysis

1. Introduction

Urbanization is an inevitable phenomenon experienced globally, whether the country is developed or developing. In general, urbanization is the migration of the population from rural areas to urban areas for its prominent features for economic growth and prosperity. Anticipated to continue in the coming years and to bring unprecedented demographic problems, create new economic and social shifts, and environmental issues in the world. The major shift of population from rural to urbanized areas poses a fundamental challenge in the development of urban infrastructure and has given rise to the unprecedented growth of urban dwellers in cities that has led to inadequate provision of housing resulting in deficient urban housing policies and lack of pro-poor housing

*이 논문 또는 저서는 2017년 대한민국 교육부와 한국연구재단의 지원을 받아 수행된 연구임(NRF-2017R1D1A1B03029464).
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Received: June 15, 2021 / Revised: July 10, 2021 / Accepted: July 10, 2021

policies to be well recognized among policymakers and researchers (Dunkerley and Whitehead, 1983).

The importance of housing to the economy contrasts strongly with the housing conditions and policies that exist in developing countries. The Philippines is one of the fastest urbanizing developing countries in Asia with more than half of the population currently residing in urban areas. Based on the 2015 census data, the population of the Philippines is 101 million an increase of over 8 million from the 2010 census results. The country is expected to grow around 110 million by 2020, and 125 million by 2030 (PSA, 2019). With the significant rate of population increase in the country the growth rate has slowed slightly from the previous census data however it is still considered substantial.

From rapid population growth, urbanization, and rural-urban migration, the housing crisis of the Philippines remains a challenge. And how the impact of urbanization has resulted in spatial, political, and social change, especially on low-income urban residents. The implementation issues in the production of adequate and affordable housing to the intended beneficiaries need to be addressed and an inclusive and sustainable urban development framework to be developed.

Philippines' current private production approach of housing hardly addresses the housing issues in terms of affordability, livelihood displacement, living costs, and social service inaccessibility. It is critical to guarantee affordable and adequate socialized housing for the poorest 30% of Filipino families whose income barely allows access to basic needs. Affordable or socialized housing refers to housing programs and projects undertaken by the government or the private sector, which shall include sites and social services, long-term financing, and liberalized terms on interest payments. And the beneficiaries of the program are underprivileged and low-income Filipino citizens.

The objective of the research is to examine the Philippines' current dominant approach of a Private-Public Partnership (PPP) production of socialized housing that resulted the 'dual' housing crisis – empty housing phenomenon and housing backlog. Rather than addressing the housing backlog, the production of housing is continuously intensified by the millions of unsold, abandoned, and empty housing. And the theory behind the hypothesis is wherein large real estate companies are stimulated to maximize their resources and expertise by constructing socialized housing in unsuitable areas and securing their profits. Whereas, the government has disregarded provisions for equitable urban land distribution and housing development for the urban poor.

The study would examine and analyze the spatial distribution and characteristics of socialized housing, and its integration and relation into the following: accessibility to built urban resources and transportation, social and economic aspects, and vulnerability to environmental hazards. The spatial analysis of the socialized housing would be associated with the distribution of the general housing developments. By analyzing the distribution of the general population of each Barangay of each district and municipality of the capital region. A barangay is often defined as an inner-city or suburban neighborhood, or officially it is the smallest administrative division in the Philippines. Thus, to examine and analyze the relationship and distribution of the following housing developments to the variables proposed in the study.

2. Literature Review

2.1 'Dual' Housing Crisis in the Philippines

The Philippines housing sector has a significant gap between the demand and supply of housing. As the country is currently experiencing a 'dual' housing crisis - producing empty/unoccupied socialized housing amid a chronic housing shortage or backlog, particularly for low-income Filipino families (Arcilla, 2018). The empty housing phenomenon is the socialized housing that low-income beneficiaries refuse to occupy due to limited access to livelihood and social services and substandard and unsuitable units. Housing backlog or shortfall is often defined as housing provision that has accrued against previous development plan targets.

The Urban Development and Housing Act (UDHA) and the Local Government Code (LGC) are the two national laws that delineate the objectives of socialized housing in the Philippines. UDHA's main objective is to "to uplift the conditions of the underprivileged and homeless citizens in urban areas and resettlement areas by making available to them decent housing at affordable cost, basic services, and employment opportunities". It entails the responsibility of fund sourcing and the roles of housing agencies in socialized housing production. The LGC is responsible for engaging with local governments to be independently efficient and effective in terms of providing essential services and housing. The National Housing Authority (NHA) is one of UDHA's major key housing agencies that is tasked to provide socialized housing for the poorest 30% of urban Filipino families. NHA regulates and offers incentives to private sectors for socialized housing production and has the primary responsibility for selecting resettlement sites and beneficiaries. The concept of increasing the supply of low-valued housing units with the private sector is for the poorest 30% of urban Filipino families to afford formal housing. However, the current housing production approach is a reflection of how socialized housing development is private and supply-side focussed.

One of the Philippines' pressing issues the chronic housing backlog particularly for low-income Filipino families who involuntarily reside in unhabitual and makeshift or condemned marginal housing. According to the socio-economic report of the NEDA (2017), the Philippines' housing demand and supply profile of 2001-2011 results in a total housing backlog of 3,919,566 units, and with the new housing need of 2012-2030 is about 6,226,540 units an average of 345,941 housing need per year with an average housing production capacity of 200,000 units per year. By 2030, the estimated total housing backlog is about 6.5 million units, and if not addressed it would reach 22 million units by 2040.

Contrary to the increasing housing backlog, the housing sector primarily concentrates on a housing finance approach that is demand-driven, project-based, profit-oriented, and Private-Public Partnerships (PPP) of marketized socialized housing programs that produce unoccupied, low-valued, remote off-city housing and lack of access to urban resources. As a result of NEDA (2017) annual reports, the shelter production for the poor is monitored in terms of the number of completed housing as a primary accomplishment, rather than promoting liveability, sustainable, and resilient communities. Housing ceased to be considered as a structure built where families and communities can succeed. Rather, it became a commodity, that is produced in unsuitable sites and sold expeditiously to maximize profits. An inclusive and sustainable urban development framework is vital to be developed given the insinuation of rapid population growth, urbanization, and rural-urban migration in the Philippines.

Generally, the concept of social groups is associated with multiple factors such as income, wealth, education, employment, and status. According to the 2015 census data (PSA, 2019), slightly more than half (58.4%) belonged to lower-income groups and nearly half (40.2%) were middle-income class, and the remaining (1.4%) belonged to the upper-income class in the Philippines. In general, the middle- and upper- class predominantly reside in urban regions such as the capital region Metro Manila. The housing tenure of the middle- and upper- households majority (74%) tend to own their dwellings and about 26% rent their dwellings. The majority of the middle- and upper-households reside in areas where education, health, employment, and transportation are strategically accessible. The middle- and upper-income groups housing is usually related to income and the quality of the housing available. However, low-income groups have limited options and often rely on government housing programs to meet their living requirements.

2.2 Accessibility

The spatial distribution of housing in terms of its location to urban resources and more specifically, to services and facilities, is an unpopular explored point of angle. Studies of the neighbourhood effects on socially disadvantaged groups living in under-resourced places have also highlighted the lack of access to urban resources (such as facilities and services) as an explanatory factor of poverty (Small and Newman, 2001). From the perspective of need-based equity in planning it implies that all types of socioeconomic groups should be given equal access to urban opportunities and social resources. To examine and measure the accessibility of the locations and their integration into built urban resources will result in a better understanding of the spatial distribution of the region's housing for disadvantaged populations to ensure equitable distribution of urban resources.

Accessibility is a widely used concept of development in the fields of urban sustainable development, generally, it is defined as the ease (or difficulty) of reaching spatially separated urban resources from a given origin using one or more modes of transportation (Geurs and van Wee, 2004). It is a key indicator of the functional efficiency and spatial equity of an urban spatial structure (Gonzalez-Feliu et al., 2014). It is an indication of both the availability of an urban resource (education, health, safety, and basic needs) and the ease with which it can be reached from a given origin.

To define the approach of accessibility measurement to be applied is to consider one of the primary objectives of the study is to examine the integration of the population group occupying the in-city socialized housing to various urban services and facilities and to assess how to minimize the inequality of nearest distance between them. According to Hodgart (1978) "equity" models seek to minimize inequality by choosing a facility that reduces the distance of any origin (population group) to a minimum, the Minimum Distance approach would be applied to measure the accessibility between the in-city socialized housing and the nearest facilities.

2.3 Social, Economic, and Environmental Aspects

Land use planning serves a variety of purposes and produces benefits of considerable value, as it classifies land based on purpose and existing human activities, and as it plays a vital role in sustainable urban development wherein neighborhoods, cities, and regions develop and encourages economic growth (Shen et al., 2011). According to Oliver et al. (2007) using the line-based road network buffer principally shows land-use type characteristics greater associated with walking, the method was based on the idea that the land-use type that runs along the road network is more significant to examine the relationship between the built-up area, wherein the residents experienced walking through it, than using the conventional circular-based buffer.

The following land-use types were considered in the study: Residential Area wherein the purpose of the area is for housing and Commercial Area wherein it is designed for businesses and infrastructures related to commerce.

There is still the presence of disputes and arguments about whether the resettlement sites for low-income socioeconomic groups are allocated where they are prone and vulnerable to environmental hazards (Bullard, 1996). And less attention is given and few considerable types of research have examined the classism in environmental justice (Bullard, 1996), social aspects of vulnerability, and the relationship between the segregation of different classes of urban residential society and the landscape of urban environmental hazards and potential risks (Szasz and Meuser, 2000).

One of the objectives of this study is to examine the distribution of housing developments and its vulnerability to environmental hazards. The spatial methodological approach to consider is by selecting a threshold or buffer distance to measure the proximity of the housing locations from environmental hazards.

3. Materials and Methods

3.1 Description of the Study Area

Metropolitan Manila, officially the National Capital Region (NCR) of the Philippines, as shown in Fig. 1, the seat of government, and one of three defined metropolitan areas in the Philippines, located in the southwestern portion of Luzon. The leading urban metropolis embodies 16 cities and one municipality and has a total land area of 61.957 square kilometers approximately 0.21% of the entire Philippines with a population of 12,877,253 based on the 2015 census. It makes Metro Manila the densest, fastest-growing region and continues to attract more people from all other regions of the country. However, due to its

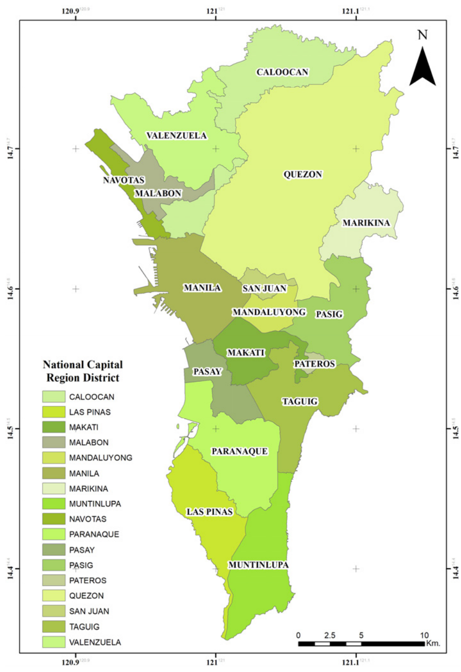

Fig. 1. National Capital Region (NCR)

unplanned growth in response to socio-economic demands and rapid population growth due to migration and births and the level of higher vulnerability to environmental hazards, increased the pressures on the capacity of the region in delivering the basic needs and resulted in unregulated development of housing problems.

3.2 Variables

The dependent variables and predictor variables for the two regression models (Model_SH and Model_GH) are grouped into the following criteria: accessibility (Transportation and Urban Resources), social and economic, and environmental aspects, as shown in Table 1, 2, and 3.

The study will comprise of two multiple regression

Table 1. Description and Units of Variables

Variables	Code	Description	Unit
Dependent Variables			
Socialized Housing	log Model_SH	Normalized no. of occupants in each site	no.
General Housing	log Model_GH	Normalized no. of occupants in each barangay	no.
Predictor Variables			
Transportation			
Bus Stop	BS	Distance to the nearest Bus stop	m
RailWay stations	RW	Distance to the nearest Railway station	m
Road Density	RD	Road Density	m per L/m^2
Built Urban Resources			
Hospital Facilities	HF	Distance to the nearest Hospital Facilities	m
Public Markets	PM	Distance to the nearest Public Markets	m
Police Station	PS	Distance to the nearest Police Stations	m
Educational institutions	Educ	Distance to the nearest Educational Institutions	m
Place Of Worship	POW	Distance to the nearest Place of Worship	m
Social and Economic			
COMmercial area	COM	Land-use type: Commercial area	m^2
RESidential area	RES	Land-use type: Residential area	m^2
Environmental Aspects			
Flood Prone areas	FP	Flood prone areas	m^2
Landslide Prone areas	LP	Landslide prone areas	m^2
Ground Shake	GS	Ground shake prone areas	m^2

Table 2. Descriptive Statistics Summary of Model_SH

Code	Unit	Obs	Mean	Std. Dev.	Min	Max
Dependent Variable						
log Model_SH	no.	36	5.60	1.20	3.00	8.11
Predictor Variables						
Transportation						
BS	m	36	1,658.02	1,196.32	143.86	5,075.42
RW	m	36	5,912.78	4,274.18	880.13	14,446.19
RD	m per l/m^2	36	19.14	6.49	6.37	34.13
Built Urban Resources						
HF	m	36	1,695.98	1,281.92	70.85	4,701.11
PM	m	36	2,953.92	1,665.69	329.25	6,127.62
PS	m	36	1,194.53	1,014.17	189.41	5,083.77
Educ	m	36	1,753.48	1,140.20	264.57	4,343.71
POW	m	36	1,061.77	707.31	201.57	2,767.92
Social and Economic						
COM	m^2	36	125,997.40	162,414.20	0.00	529,024.00
RES	m^2	36	523,922.30	389,952.90	0.00	1,241,770.00
Environmental Aspects						
FP	m^2	36	195,518.90	233,209.50	0.00	756,169.00
LP	m^2	36	59,933.78	171,291.50	0.00	747,942.00
GS	m^2	36	140,820.20	279,548.70	0.00	785,424.00

Table 3. Descriptive Statistics Summary of Model_GH

Code	Unit	Obs	Mean	Std. Dev.	Min	Max
Dependent Variable						
log Model_GH	no.	1691	7.87	1.30	1.10	12.42
Predictor Variables						
Transportation						
BS	m	1691	906.84	947.70	0.00	7,867.59
RW	m	1691	1,799.80	1,923.67	0.00	15,389.93
RD	m per l/m^2	1691	0.03	0.01	0.00	0.05
Built Urban Resources						
HF	m	1691	1,211.53	726.08	0.00	5,262.77
PM	m	1691	1,597.35	1,347.69	0.00	10,865.30
PS	m	1691	632.81	730.70	0.00	6,360.40
Educ	m	1691	576.28	452.77	0.00	6,698.82
POW	m	1691	915.37	779.80	0.00	5,907.65
Social and Economic						
COM	m^2	1691	443,948.00	358,458.90	0.00	1,575,685.00
RES	m^2	1691	484,691.90	384,366.90	0.00	2,045,174.00
Environmental Aspects						
FP	m^2	1691	112,583.50	158,172.00	0.00	785,475.00
LP	m^2	1691	35,457.50	131,226.90	0.00	785,412.00
GS	m^2	1691	528,243.00	342,221.50	0.00	785,465.00

models, the first model is the Socialized Housing Model (Model_SH), as shown in Fig. 2, composed of 36 operating socialized housing sites distributed in the region. The dependent variable, for Model_SH is the normalized total number of occupants in each site. The second model is the General Housing Model (Model_GH), as shown in Fig. 3, divided into 1,691 barangays (smallest administrative division). The dependent variable for Model_GH is the normalized total number of occupants in each barangay as per Census 2015. Unlike socialized housing, general housing uses data collected in units of batangay because the number of houses and the population are large. To illustrate the population of each barangay ArcMap Polygon to Point Tool is used to convert the polygon feature into centroid points.

ArcGIS Network Analysis' Closest facility analysis would be utilized to calculate the MD (Minimum Distance) using SND (Shortest Network Distance) between each origin (population group) and the nearest facility. Data related to independent variables were obtained from the Philippine statistics authority and the Philippine Geoportal. The closest facility analysis displays the best routes and measures the closest distance traveling between the incidents and determines which are nearest to one another as it performs multiple closest facility analyses simultaneously. The analysis can have multiple incidents and find the closest facility for each incident. Accessibility variables are assigned as facilities: bus stops, railway stations, hospital and health facilities, public markets, police stations, universities, and places of worship,

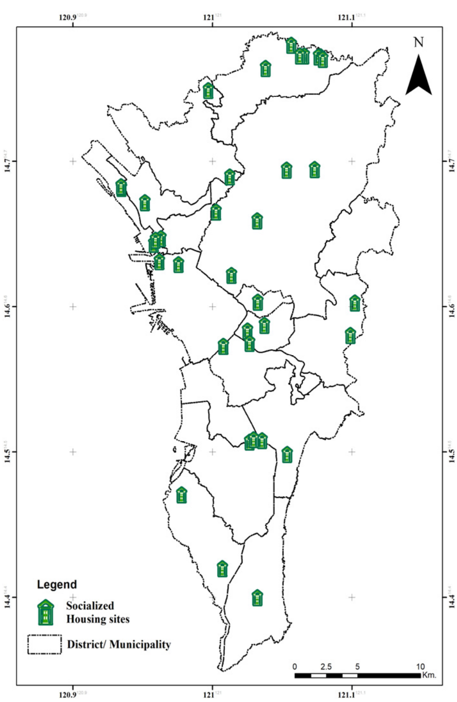

Fig. 2. Socialized Housing Model (Model_SH)

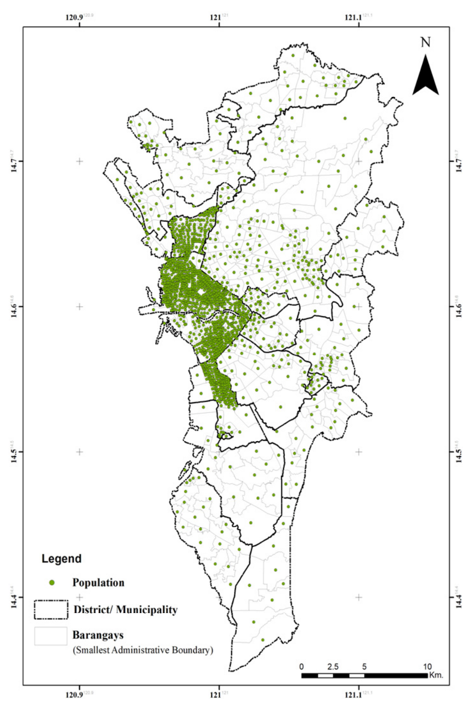

Fig. 3. General Housing Model (Model_GH)

and the dependent variable as the incident. In the study, Model_SH and Model_GH accessibility variables closest facility analysis is calculated and measured.

Arc GIS Spatial Analysis Tool Line Density is used to quantify the road density, it calculates the density of linear features in the neighborhood of each output raster cell. In the study, the road network and the number of lanes were inputted as the linear feature and population field. Arc GIS Zonal Statistics Tool (Spatial Analyst) is then used to convert the output raster, it calculates statistics on values of a raster within the zones of another dataset.

Arc Map Network Analysis Service Area is used to measure all accessible streets in the road network within a specified impedance. In this study, a 1 km buffered line-based road network buffer was created from each centroid point of the two models using Arc Map Network Analysis Service Area. The land-use layer was intersected to each centroid point's line-based road network buffer to create a layer including only land uses falling within the buffer area. The total area is calculated for each type of land use for each centroid point's line-based road network buffer

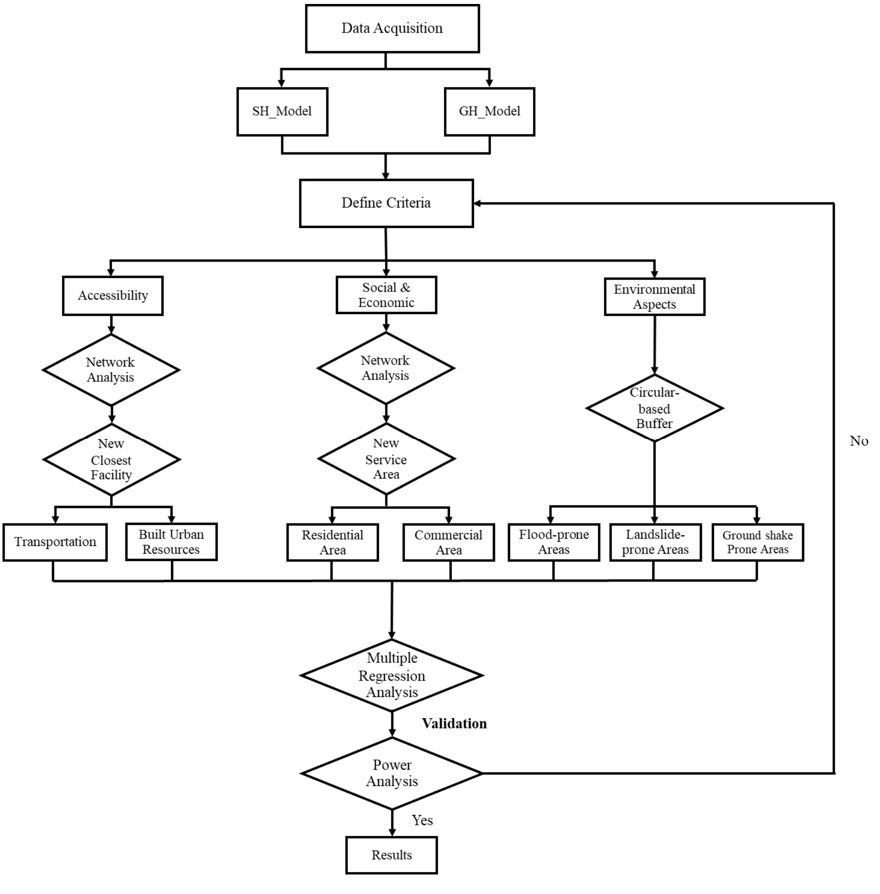

Fig. 4. Data Construction Process

and then calculated a portion of the total area within each centroid point's 1 km buffer.

The circular-based method was applied to measure the proximity of each point by constructing a 1 km circular buffer around each centroid point of the two models. Each of the following layers: Flood-prone, Landslide prone, and Ground shaking prone layers were intersected to each centroid point's circular buffer to create a layer including only the environment hazard-prone areas falling within the buffer area. ArcGIS is used to calculate the total area of each type of environmental hazard for each centroid point's circular buffer and then calculated a portion of the total area within each centroid point's 1 km buffer. To help readers' understand, the data construction process is presented as a figure (See Fig. 4).

3.3 Multiple Regression Analysis

Multiple Linear Regression is a multivariate statistical technique that allows the researcher to incorporate potential important variables in one model and develops a more accurate and precise understanding of the relationship of each predictor variable with the dependent variable.

$$Y = \beta_{o+}\beta_1 X_1 + .. + \beta_p X_p + \epsilon \quad (1)$$

As shown in Equation 1, quantitative variable Y is a vector of n samples on the dependent variable, and the set of predictor variables, β is a vector of regression coefficient and is the vector of error terms, the Multiple Linear Regression (MLR) model assumes that the expected values of Y can be determined by a linear combination of the following predictor variables.

In multiple regression analysis, it assumes no multicollinearity. Researchers use correlation coefficient cut-offs of 0.5 and above (Donath et al., 2012) but the most typical cut-off is 0.80 (Berry and Feldman, 1985). The Pearson correlation values for the two regression models are shown

Table 4. Pearson Correlation Values between Variables of Model_SH

	BS	RW	RD	HF	PM	PS	Educ	POW	COM	RES	FP	LP	GS
BS	1.00												
RW	0.17	1.00											
RD	(0.54)	(0.60)	1.00										
HF	0.52	0.06	(0.23)	1.00									
PM	0.10	0.70	(0.55)	0.35	1.00								
PS	0.32	0.19	(0.32)	(0.05)	0.05	1.00							
Educ	0.45	0.14	(0.24)	0.75	0.28	0.07	1.00						
POW	(0.03)	0.53	(0.20)	0.13	0.45	0.27	0.25	1.00					
COM	(0.21)	(0.42)	0.47	(0.30)	(0.50)	(0.37)	(0.29)	(0.27)	1.00				
RES	(0.03)	(0.61)	0.45	(0.25)	(0.41)	0.09	(0.35)	(0.33)	0.29	1.00			
FP	0.19	(0.00)	(0.43)	(0.10)	(0.19)	0.02	0.03	(0.13)	0.13	(0.12)	1.00		
LP	0.12	(0.12)	0.08	0.13	0.02	(0.08)	(0.15)	(0.25)	(0.22)	0.24	(0.27)	1.00	
GS	(0.01)	(0.33)	0.35	(0.26)	(0.46)	(0.16)	(0.06)	(0.17)	0.21	0.30	0.22	(0.17)	1.00

Table 5. Pearson Correlation Values between Variables of Model_GH

	BS	RW	RD	HF	PM	PS	Educ	POW	COM	RES	FP	LP	GS
BS	1.00												
RW	0.54	1.00											
RD	(0.34)	(0.43)	1.00										
HF	0.29	0.32	(0.17)	1.00									
PM	0.34	0.46	(0.31)	0.37	1.00								
PS	0.25	0.36	(0.28)	0.20	0.50	1.00							
Educ	0.28	0.43	(0.27)	0.32	0.44	0.35	1.00						
POW	0.57	0.61	(0.43)	0.36	0.48	0.47	0.42	1.00					
COM	(0.26)	(0.34)	0.50	(0.22)	(0.38)	(0.23)	(0.22)	(0.33)	1.00				
RES	0.06	(0.07)	0.05	(0.13)	0.05	(0.13)	(0.18)	(0.07)	(0.28)	1.00			
FP	0.22	0.24	(0.29)	0.17	0.10	0.17	0.00	0.27	(0.21)	(0.07)	1.00		
LP	0.06	0.28	(0.18)	0.12	0.13	0.07	0.26	0.11	(0.16)	0.08	(0.12)	1.00	
GS	(0.04)	(0.30)	0.37	0.03	(0.14)	(0.18)	(0.13)	(0.25)	0.36	(0.10)	(0.08)	(0.39)	1.00

in Table 4 and 5, no collinearity can be observed in the non-transformed predictor variables, as the Pearson coefficients are always below (<0.76).

Both the dependent variables of Model_SH and Model_GH show large variations and have non-linear distribution. Thus, both variables were log-transformed and to approximate the normality assumptions of the linear regression model, as in previous research (Oh and Oh, 2011).

3.4 Power Analysis

Evaluating an adequate sample size to the number of predictor variables is a critical aspect of a research design to be interpreted from the sample statistics to the statistical population. According to Gross (1973) with the question of how large a sample is required to produce reliable results with multiple linear regression, "As with any statistical analysis that is computed using sample data, the size of the sample (n) in large part determines the 'value' of the statistical results of a multiple regression analysis". Numerous rules-of-thumb have been recommended for determining the minimum sample number of subjects to the number of predictor variables required to do multiple regression analyses, one common rule of thumb when doing regression analysis is the 'one in ten rule' the rule states that one predictive variable can be studied for every ten observations (Harrell et al., 1984).

Vittinghoff and McChulloch (2007) states the 'one in ten rule' may be too conservative and Harris (2001) argues no empirical evidence supporting this rule and proposes an alternative rule dealing not with the ratio of the number of predictors to the size of the sample, but with their difference, as such N should exceed by at least 50. Green (1991) has two rules for the minimum acceptable sample size for multiple regression, $N \geq 50 + 8k$ or $N \geq 104 + k$, where k is the number of predictor variables. Also, Green (1991) states results did not support the use of rules-of-thumb that simply specify some constant as the minimum number of subjects or a minimum ratio of the number of samples to the number of predictors. The consideration of rules of thumb tends to persist in the designs of multiple regression studies and still depends on your sample characteristics.

However, Cohen Statistical Power Analysis is one of the most popular approaches in planning studies in deciding the required sample sizes (Cappelleri et al., 1994; Cohen, 1992). As defined, the power of a binary hypothesis test is the probability that the test rejects the null hypothesis when a specific alternative hypothesis is true — i.e., it indicates the probability of avoiding a type II error. A type II error is a statistical term referring to the acceptance (non-rejection) of a false null hypothesis. MacCallum et al. (1996) also explained using power analysis can determine the smallest sample size that is suitable to detect the effect of a given test at the desired level of significance. Lastly, the objective of using Cohen's statistical power analysis to calculate an adequate sample size to optimize as opposed to maximizing sampling effort within the constraint of data availability and to help justify the available sample size to the number of predictors considered in the study.

To compute statistical power for multiple regression analysis, we use Cohen's effect size f^2 which is defined by Equation 2:

$$f^2 = \frac{R^2}{1-R^2} \tag{2}$$

To calculate the power of multiple regression, the number of k predictor variables are considered, we use the noncentral F distribution F(dfReg, dfRes, λ) where dfReg = k, dfRes = n−k−1, and the noncentral parameter λ is defined by Equation 3.

$$\lambda = f^2 n \tag{3}$$

Therefore, the adequacy of the size samples to the number of predictor variables of the two regression models was also considered in the study. Especially for the Model_SH wherein, only 36 observations are available with 13 predictor variables. The dfReg and drRes values were calculated as 22 and 13. R^2, f^2, and λ values were calculated to be 0.801, 4.025 and 144.905, respectively.

4. Results and Discussion

4.1 Empirical Results

The regression coefficients and significant values of Model_SH and Model_GH are shown in Table 6. All the variables showed significance at a 95% confidence level. It was observed the following predictor variables of Model_SH that exerts a higher significance effect on the socialized housing are RW, RD, PM, PS, Educ, POW, FP, and LP, whose significance is below 0.05. The predictor variables that have the lowest significance are BS, HF, COM, RES, and GS, whose significance is over 0.05.

The following predictor variables of Model_GH that exerts a higher significance effect on the General Residential Development are BS, RW, PS, COM, RES, FP, LP, and GS, whose significance is

Table 6. Regression Results

Predictor Variables	Code	Model_SH		Model_GH	
		Coef.	Std. Err.	Coef.	Std. Err.
Accessibility					
Transportation					
Bus Stop	BS	-30.1003	21.9100	15.56***	3.3000
RailWay stations	RW	19.410***	5.7000	19.40***	1.7900
Road Density	RD	-19.701***	5.1060	-304.821	328.1026
Urban Resources					
Hospital & health Facilities	HF	31.1272	20.2600	3.9100	3.8700
Public Markets	PM	-79.246***	15.3400	0.4490	2.3500
Police Station	PS	-40.1909**	16.7100	18.61***	4.0000
Educational institutions	Educ	49.3467**	17.9200	-8.1100*	4.5500
Place Of Worship	POW	67.755***	22.1600	3.5400	6.5100
Social and Economic					
COMmercial area	COM	20.0934*	11.3000	-2.65***	0.9160
RESidential area	RES	7.7467	5.0100	2.340***	0.7370
Environmental Aspects					
Flood-Prone areas	FP	-19.3088**	8.2200	3.9100**	1.7100
Landslide-Prone areas	LP	27.624***	8.7500	18.40***	2.1200
Ground Shake	GS	7.8742	6.2600	-8.54***	0.8600
Constant		8.8777***	1.3670	7.670***	0.1338
R-squared		0.801		0.451	
RMSE		0.67485		0.9543	

Significant predictor variables *** p<0.01, ** p<0.05, * p<0.1

below 0.05. The predictor variables that have the lowest significance are RD, HF, PM, Educ, and POW, whose significance is over 0.05.

Despite the results of the two models, two indicators are proposed to assess the adequacy and accuracy of the models. The first one is R-squared defined as the "percent of variance explained", the R-squared result of the following models, Model_SH and Model_GH, are 80.1%, and 45.1%, respectively, wherein the Model_SH fits above average and the Model_GH fits averagely.

And the second indicator is to assess the residual plots as proposed by Tsai et al. (1998) for nonlinearity and heteroscedasticity in multiple regression models. A residual plot is a graph that shows the residuals on the vertical axis and the predictor variable on the horizontal axis. If the points in the plots exhibit a randomly dispersed scatter around the horizontal axis, the regression results are appropriate. As shown in Fig. 5 and 6, the residual plots of each model display a random dispersed scattered pattern, thus, each model is

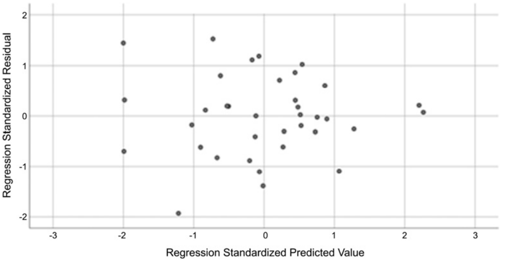

Fig. 5. Residual Plot for Model_SH

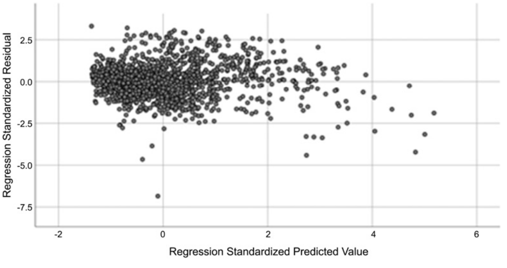

Fig. 6. Residual Plot for Model_GH

considered adequate.

Lastly, the power analysis was only performed to the Model_SH due to the number of observations available, thus, the statistical power of the model is 99.95%, and is considered adequate.

4.2 Comparative Analysis of Regression Models

The results show a better understanding of the nature and quality and distribution of the following built urban resources to the SH and GH developments. Intuitively, residents would prefer to live in communities in which they feel safe and reassured. Between the SH and GH, the variable Police Stations (PS) had a positive significance on GH and negative significance on SH. The result on SH presented a negative significance wherein PS are accessibly located to the SH compared to GH. Generally, the public and criminologists viewed public housing as an image problem, a platform in which a host of unpleasant behaviours, crime, and disorder take place (Holzman, 1996). Thus, the presence of police stations to the community provides security and public reassurance, defining reassurance as 'the feeling of security and safety that citizen experiences' (Bahn, 1974), and reassurance of public safety is also addressed through increased visibility, familiarity, and accessibility (Millie and Herrington, 2005).

As presumed, between SH and GH, the variable for education (Educ) presented interesting results. The variable Educ had a positive significance on SH and negative significance on GH. The positive significance of the variable explains wherein educational institutions that have the shortest distance affect the number of socialized housing present, and wherein the SH are not located in areas where education is accessible. While, the variable Educ had a negative significance on the general housing, this explains how the residents from GH greatly considers the value of education and prefer to live in areas where education is accessible and has the privilege to choose which educational institutions by quality, and not by distance. On the contrary, every individual has the right to quality education irrespective of race, gender, nationality, or social group, however, one debatable issue that aggravates inequalities to socially disadvantaged groups is having no access to education (West and Fenstermaker, 1995).

In terms of livelihood, between SH and GH, the variable public markets (PM) had a negative significance on SH and no significance on GH. The result is intuitive as accessibility to social services and facilities such as public markets attract more residents. However, a negative significance of the variable PM only explains the residents in SH have less accessibility to public markets.

The variable related to cultural factors such as distances from places of worship (POW), can be very interesting. The variable POW had a positive significance on SH and no significance on GH. This can be explained by the positive and negative effects of the presence of places of worship in residential areas. In general, wherein POW had no significance on SH can be interpreted from previous researches. The presence of places of worship within the vicinity does not substantially affect residential property prices (Brandt et al., 2014; Do et al., 1994) but identified negative effects such as noise from liturgical ringing and caused by visitors, and causing busy over-crowded streets. However, the positive significance of the variable POW on SH, wherein the POW that has the shortest distance positively affects the number of residents. The positive significance of the variable POW on SH, wherein few SH are located near POW. However, the presence of places of worship can contribute more to disadvantaged groups, as (Carroll et al., 1996; Do et al., 1994), identified positive effects such as it could provide access to services, community events, and recreational activities for the residents especially the young and old, and reduction in crime rates (Lee and Ousey, 2005).

Compared to high- and middle-class income people inequities in access to hospitals and healthcare facilities are aggravated for low-income people who are more like to have poorer health and limited transportation options. Regarding health care, (Gelberg et al., 2000) developed a behavioral model to raise the issue of access to healthcare that is particularly for vulnerable populations. Accessibility is one major factor to reduce inequities in healthcare outcomes of each population group as healthcare disparities are the result of disproportionate distribution of population, hospital and healthcare facilities, and transport system (Messinger-Rapport, 2009). As it also relates the role of geographical distances in the interactions between population demands and hospital and healthcare facilities (Langford and Higgs, 2006). The results showed the variable hospitals (Hosp) had no significant effect on both SH and GH, despite the fact, hospital and healthcare facilities should be allocated and distributed to cater to both the general population and disadvantage vulnerable groups.

In terms of accessibility to transportation, the variables Bus stop (BS), and Railway stations (RW) had a positive significance on the GH, although the SH only had a positive significance on RW. The positive significance of the variables explains wherein transit services that have the shortest distance affect the number of residents in that area. This result is intuitive as locations with high accessibility to transportation such as access to the nearest bus stop and railway station attract many pedestrians and increase walkability. As analysed, both locations of the SH and GH have less accessibility to public transportation services. However, the residents living in SH with a lack of access to a private car are more on the disadvantage side, they are more likely to be dependent on the service of public transportation accessibly located near them compared to the residents in GH.

Between SH and GH, the variable road density (RD) was only significant to SH and not for GH. RD had a negative significance to SH, wherein the increase in road density will result in a decrease in the number of occupants in that area. The result is intuitive as residents do not prefer to live in areas where road density is high wherein overcrowding and pollution are present.

The following land-use types were considered: Residential area wherein the purpose of the area is for housing and commercial area wherein it is designed for businesses and infrastructures related to commerce. The findings showed the variables residential (Res) and commercial (Com) is significant on GH, Res had a positive significance and Com had a negative significance, wherein the general populace prefers to live in residential areas and not in commercial areas. However, the variables had no significance on SH, this result is intuitive as only the GH had a significant impact from the variables, this explains adequate land use planning was not considered in the development of SH and produces inequities and unwanted development across cities.

In the study, we have examined the capital region's vulnerability to floods (FP), landslides (LP), and ground shaking (GS). Analyzing the GH the following variables were all significant, however, FP and LP had a positive significance and GS had a negative significance. The results are intuitive and interesting, the findings showed that both variables FP and LP are positively significant where the general residential development is located where floods and landslides are prone to occur. Whereas, the variable GS had a negative significance, wherein the residential development is not located in areas that are prone to ground shaking.

Analyzing the SH, only FP and LP were significant, FP had a negative significance and LP had a positive significance. The results showed a positive and negative effect, as the socialized housing is not located in flood-prone areas, however, they are located where landslides are prone to occur.

This generally explains, Philippines' high disaster risk profile and the country's geographical location within the Pacific Ring of Fire and the typhoon belt of the North Pacific basin. As the Philippines is exposed to various natural hazards and calamities of tropical storms, tsunamis, floods, earthquakes, volcanic eruptions, landslides, and droughts that contribute vulnerability to the general population, most especially the urban poor.

Thus, with the Philippines' rapid urbanization and vulnerability to natural hazards, the socially disadvantaged population and communities are the ones in highly vulnerable situations. As Metro Manila urbanizes, low levels of income and lack of areas allocated for socialized residential developments have led to the proliferation of unplanned, informal, and overcrowded settlements, and are often located in more hazard-prone communities.

5. Conclusion

The research findings provide significant insight to enhance housing and urban development policies for housing programs. To develop a comprehensive framework tool that urban planners and local decision-makers can determine and establish policies for further development.

Overall, the multivariate analysis was instructive and effectively defined the relationship of different predictor variables as housing distribution dimensions and facilitated comparisons between the two regression models. The research finds significant correlations between the spatial distribution and characteristics of both dependent variables, examining how the current privatization housing policy may not address the country's housing crisis, especially for the marginalized and low-income households.

The comparative analysis between the two regression models has shown that the socialized housing distribution is significantly related to the exclusion of public transportation and facilities, residential areas and commercial facilities, vulnerability to geological and environmental hazards, and less influence over the housing policies with site selection planning. It describes how the privatization of housing developments and gentrification results in the systematic spatial and economic dislocation of the urban poor. The current approach to public-private partnership production has not met the Philippines' housing sector's objective in uplifting the underprivileged and homeless citizens' conditions in urban areas and resettlements.

Land use planning and development planning require alignment with people's needs. The supply and production of housing units is not the main issue of housing it is more of social inequalities. Access to social opportunities and urban resources for the underprivileged population is not addressed in land use planning that requires labor-intesive economic growth, enhanced labor mobility, and human capital development. Local government units should constantly prepare, revise, and update their comprehensive land use plans in accordance with future spatial development and projects for future socio-economic development.

The process of land acquisition with government intervention can be carried out through housing and land reform programs. Land's present and future values are determined by its inherent features such as area, shape, soil type, geological features, and external features such as the land's location, adjacent settings, and future developments. The following information and data could be acquired privately with huge costs as local governments usually cannot provide. A comprehensive inventory of land has yet to be developed at the local level, including both the land's inherent and external features.

The findings of the spatial analysis of both models have shown great significance to its vulnerability to environmental hazards. Promoting greater consideration of the technical aspects of disaster risk reduction needs to be more systematically mainstreamed into all aspects of planning in Metro Manila. The quality and availability of disaster risk reduction planning tools such as geohazard maps need to be continuously updated and developed.

To promote a balanced housing strategy that ensures the development of high and middle-class housing along with the production of socialized housing. Create integrated and sustainable communities where high and low-income households are both physically and socially interwoven. Providing incentives to private sectors in producing socialized housing in the form of simplifying accreditation, financing procedures, and tax exemptions.

Implementation of alternative and innovative housing solutions particularly for low-income beneficiaries such as public rental housing, mixed-use housing development, housing microfinance initiatives, and incremental housing programs to address the issue of low occupancy rate.

The value of research and development has not been prioritized by the housing sector, with no research investments that create new developments necessary for urban planners and policy makers to reassess further development. Lastly, the unavailability of reliable databases of completed and on-going developments and available but often not updated cannot be used as a reference for decision-making. The study is also studying spatial entities. The spatial entities can have autocorrelation. The study has limitations in that it overlooked this point and used multiple regression analysis.

References

1. Arcilla, C. A. C. (2018), "Producing empty socialized housing privatizing gains, socializing costs, and dispossessing the Filipino poor", *Social Transformations: Journal of the Global South*, 6(1): 77~105.
2. Bahn, C. (1974), "The reassureance factor in police patrol", *Criminology*, 12(3): 338~345.
3. Berry, W. and S. Feldman (1985), *Quantitative Applications in the Social Sciences: Multiple Regression in Practice*, SAGE Publications, Inc.
4. Brandt, S., W. Maennig and F. Richter (2014), "Do houses of worship affect housing prices? Evidence from Germany", *Growth and Change*, 45(4): 549~570.
5. Bullard, R. D. (1996), "Environmental justice: It's more than waste facility siting", *Social Science Quarterly*, 77(3): 493~499.
6. Cappelleri, J. C., R. B. Darlington and W. M. K. Trochim (1994), "Power analysis of cutoff-based randomized clinical trials", *Evaluation Review,* 18(2): 141~152.
7. Carroll, T. M., T. M. Clauretie and J. Jensen (1996), "Living next to godliness: Residential property values and churches", *Journal of Real Estate Finance and Economics*, 12: 319~330.
8. Cohen, J. (1992), "Statistical power analysis", *Current Directions in Psychological Science*, 1(3): 98~101.
9. Do, A. Q., R. W. Wilbur and J. L. Short (1994), "An empirical examination of the externalities of neighborhood churches on housing values", *The Journal of Real Estate Finance and Economics*, 9: 127~136.
10. Donath, C., E. Gräßel, D. Baier, C. Pfeiffer, S. Bleich and T. Hillemacher (2012), "Predictors of binge drinking in adolescents: Ultimate and distal factors - A representative study", *BMC Public Health*, 12(263). https://doi.org/10.1186/1471-2458-12-2-263.
11. Dunkerley, H. B. and C. M. E. Whitehead (1983), *Urban Land Policy: Issues and Opportunities*, Oxford University Press for the World Bank, Oxford.
12. Geurs, K. T. and B. van Wee (2004), "Accessibility evaluation of land-use and transport strategies: Review and research directions", *Journal of Transport Geography*, 12(2): 127~140.
13. Gelberg, L., R. M. Andersen and B. D. Leake (2000), "The behavioral model for vulnerable populations: Application to medical care use and outcomes for homeless people", *Health Services Research*, 34(6): 1273~1302.
14. Gonzalez-Feliu, J., J. M. Salanova Grau and A. Beziat (2014), "A location-based accessibility analysis to estimate the suitability of urban consolidation facilities", *International Journal of Urban Sciences*, 18(2): 166~185.
15. Green, S. B. (1991), "How many subjects does it take to do a regression analysis?", *Multivariate Behavioral Research*, 26(3): 499~510.

16. Gross, A. L. (1973), "How large should sample size be in a regression analysis?", *Proceedings of the Annual Convention of the American Psychological Association*, 17~18.

17. Harrell, F. E., K. L. Lee, R. M. Califf, D. B. Pryor and R. A. Rosati (1984), "Regression modelling strategies for improved prognostic prediction", *Statistics in Medicine*, 3(2): 143~152.

18. Harris, R. J. (2001), *A Primer of Multivariate Statistics*, New York: Psychology Press.

19. Hodgart, R. L. (1978), "Optimizing access to public services: A review of problems, models and methods of locating central facilities", *Progress in Human Geography*, 2(1): 17~48.

20. Holzman, H. R. (1996), "Criminological research on public housing: Toward a better understanding of people, places, and spaces", *Crime and Delinquency*, 42(3): 361~378.

21. Langford, M. and G. Higgs (2006), "Measuring potential access to primary healthcare services: The influence of alternative spatial representations of population", *Professional Geographer*, 58(3): 294~306.

22. Lee, M. R. and G. C. Ousey (2005), "Institutional access, residential segregation, and urban black homicide", *Sociological Inquiry*, 75(1): 31~54.

23. MacCallum, R. C., M. W. Browne and H. M. Sugawara (1996), "Power analysis and determination of sample size for covariance structure modeling", *Psychological Methods*, 1(2): 130~149.

24. Messinger-Rapport, B. (2009), "Disparities in long-term healthcare", *Nursing Clinics of North America*, 44(2): 179~185.

25. Millie, A. and V. Herrington (2005), "Bridging the gap: Understanding reassurance policing", *The Howard Journal of Criminal Justice*, 44(1): 41~56.

26. NEDA, National Economic and Development Authority (2017), *Philippine Development Plan 2017-2022*, National Economic and Development Authority.

27. Oh, P. S. and S. J. Oh (2011), "What teachers of science need to know about models: An overview", *International Journal of Science Education*, 33(8): 1109~1130.

28. Oliver, L. N., N. Schuurman and A. W. Hall (2007), "Comparing circular and network buffers to examine the influence of land use on walking for leisure and errands", *International Journal of Health Geographics*, https://doi.org/10.1186/1476-072X-6-41

29. PSA, Philippine Statistics Authority (2019), *Updated Population Projections based on the Results of 2015,* POPCEN. Retrieved on Nov 15, 2020 from https://psa.gov.ph/content/updated-population-projections-based-results-2015-popcen.

30. Szasz, A. and M. Meuser (2000), "Unintended, inexorable: The production of environmental inequalities in Santa Clara county, California", *American Behavioral Scientist*, 43(4): 602~632.

31. Shen, L. Y., J. Jorge Ochoa, M. Shah and X. Zhang (2011), "The application of urban sustainability indicators - A comparison between various practices", *Habitat International*, 35(1): 17~29.

32. Small, M. L. and K. Newman (2001), "Urban poverty after the truly disadvantaged: The rediscovery of the family, the neighborhood, and culture", *Annual Review of Sociology*, 27: 23~45.

33. Tsai, C. L., Z. Cai and X. Wu (1998), "The examination of residual plots", *Statistica Sinica*, 8: 445~465.

34. Vittinghoff, E. and C. E. McCulloch (2007), "Relaxing the rule of ten events per variable in logistic and cox regression", *American Journal of Epidemiology*, 165(6): 710~718.

35. West, C. and S. Fenstermaker (1995), "Doing difference", *Gender & Society*, 9(1): 8~37.

요 약

필리핀 마닐라의 급속한 도시화는 유래 없는 인구성장을 가져왔고, 이는 국가 전체에 이중적 주택문제 즉 공영주택의 공실과 부족 현상을 동시에 초래하였다. 이 연구의 목적은 GIS 기반의 2개 통계모형을 개발하여 접근성, 사회·경제요인, 환경재난의 취약성 등 사이의 관계성을 기준으로 일반주택과 비교하여 공영주택의 공간분포 특성을 파악하는데 있다. 이 연구에서는 공간분석을 위해 다중회귀모형과 GIS를 연계시켜 공영주택과 일반주택의 공간분포에 영향을 미치는 주요 변수를 각각 확인하였다. 2개 회귀모형의 분석결과를 비교하였더니, 공영주택은 부적절한 토지이용에 교통과 도시지원시설에의 접근성이 열악한 곳에 분포하여 입지하고 있음을 확인하였다. 나아가 2개의 모형 모두 환경재난 취약성을 매우 중요하게 설명하였다. 이는 현재 주택정책이 국가의 주택 위기상황, 특히 소외된 저소득층 가구의 주택문제를 해소하지 못하는 이유를 밝히고 있다. 그러므로 이들 모형의 적용결과는 도시계획가와 지자체 의사결정자로 하여금 주택부문의 발전을 목적으로 수행 중인 현재의 정책 개입을 혁신적으로 개선해야 함을 시사점으로 제공한다.

주제어 : 공실 현상, 주택 부족, 공영주택, 다중회귀분석, 검정력 분석