A Study on the Status and Spatial Autocorrelation of Vacant Houses in Jeollabuk-do, South Korea

Kim, Jun-Young [*]

Abstract

Many houses have been left vacant in cities worldwide due to changes in the economy, society, and urban composition. The increase in vacant houses causes social problems and decrease in the value of real estate. Considering the cost of preparing a new residence because the existing residence no longer functions, it is an important problem to solve empty houses in the existing residence. Accordingly, policy attempts and studies to reduce and utilize vacant houses are in progress in various countries. In South Korea, the ratio of vacant houses was 6.4% of all houses as of 2021, and in Jeolla-buk-do, it was 11.6%, which is higher than the national average. Jeollabuk-do conducted a fact-finding survey on countermeasures against vacant houses; 17,732 vacant houses (2.4%) were surveyed. The urbanization, population, and terrain of Jeollabuk-do, consisting of 14 cities and counties, were considered. The ratios, types, grades, and spatial autocorrelations of vacant houses were analyzed after classification into city areas (focus, small, and medium) and county areas (plains and mountains) areas to derive policies according to the distribution of vacant houses. The average difference in ratio, type, grade, and spatial autocorrelation of vacant houses was used to analyze the characteristics of the distribution of vacant houses according to these classifications. There were significant differences in the averages of the ratios, grades, and spatial autocorrelations between city and county areas. The autocorrelation of vacant house distribution exhibited differences between urban and county areas.

1. Introduction

After the era of industrialization and the baby boom, many houses have been left vacant in many cities worldwide due to the effects of changes in the economy, society, and urban composition, such as the deterioration of houses and population decrease(Immergluck, 2016; Jeon & Kim, 2016; Mallach, 2006; Park & Oh, 2018). As of 2021, the ratio of vacant houses was 11.1% in the United States; and 13.6% in Japan, which is the highest among OECD countries(OECD, 2021). The increase in vacant houses causes social problems, such as the collapse of village communities along with damage to urban aesthetics, and problems such as the risk of crimes due to vacant houses and a decrease in real estate values, as indicated by the broken window theory(Kelling & Wilson, 1982). In terms of regional sustainability, the collapse of local communities due to the increase in vacant houses is very bad. Accordingly, various policy attempts and studies to reduce and utilize vacant houses are in progress in various countries. The vacant housing problem is a global issue. However, the manifestations of vacant housing issues in the United States, Europe, China can vary slightly. In Europe, the vacant housing problem is often caused by population decline due to decreasing birth rates (Couch & Cocks, 2013). In the United States,

vacant houses may result from urban expansion and development (Kraut, 1999). Additionally, China's vacant housing problem may arise from excessive housing construction(Sorace & Hurst, 2016) or rural-to-urban migration (He et al., 2016).

South Korea also had 1.39 million vacant houses as of 2021, accounting for 6.4% of all houses. Among them, 380,000 vacant houses, accounting for 1.77% of all houses, had been vacant for at least one year(Statistics Korea, 2022). As South Korea's housing supply ratio exceeded 100% and reached 102.2% in 2021(Statistics Korea, 2023), the deterioration of existing houses and the increase in vacant houses was inevitable. However, the unequal distribution of residential areas due to the expansion of cities is a serious problem. In the case of Seoul, the capital, the ratio of vacant houses is 2.5% and the ratio of vacant houses that have been vacant for at least one year is 0.28%, which is very low compared to the national ratio. However, in the case of Jeollanam-do, the ratio of vacant houses is 14.9% and the ratio of vacant houses that have remained vacant for at least one year is 5.9%, indicating that the ratio of vacant houses in rural areas is very high compared to cities due to population decrease and urbanization leading to local extinction.

Jeollabuk-do, which is adjacent to Jeollanam-do, also has a high ratio of vacant houses (11.6%) and a high ratio of vacant houses that have remained vacant for at least one year (4.16%), based on

*Jun-Young Kim, Associate Prof., Jeonju University, Jeonju, junyoungkim@jj.ac.kr

the National Statistical Office(Statistics Korea, 2022). Data were collected through fact-finding surveys conducted by the Korea Land and Geospatial Informatix Corporation from 2020 to 2021 to analyze the current state of vacant houses in greater detail. Although there was a difference in their number due to differences in data collection procedures and methods between the National Statistical Office and the vacant house fact-finding survey organization, 17,732 vacant houses, accounting for 2.4% of all houses in the Jeollabuk-do area, were surveyed. The rate of vacant houses is high, and further studies on policy support are required.

A previous study of vacant houses in the Jeollabuk-do area was conducted with part of the data and was limited to a certain area. Therefore, there are limitations in the study of vacant houses across the entire Jeollabuk-do area. Jeollabuk-do consists of 14 cities and counties of diverse sizes, ranging from a city with a population of 600,000 to a county with a population of 20,000. In addition, there are many differences in the distribution and types of vacant houses between the west (plain-type areas) and east (mountain-type areas). Therefore, to establish a plan for policy support according to regional differences in vacant houses, a study on the distribution of vacant houses according to the spatial types of Jeollabuk-do is required. This research paper focuses on the specific characteristics of vacant housing in a particular region of South Korea. Putting emphasis on the Jeollabuk-do province as a significant unit of local administration, the paper conducts an empirical study based on the locations and aging data of 17,731 vacant houses in the region. Through this empirical research, the paper aims to describe the uniqueness of the vacant housing problem in this area while supporting its universality as a global issue. This study represents a novel approach as it examines the universal global phenomenon of the vacant housing problem from the perspective of local administration, which has not been explored in previous research. Moreover, the inclusion of various geographical conditions encompassing urban, rural, and mountainous areas within the Jeollabuk-do province adds to the interest and potential discoveries of this study.

This study, based on vacant house fact-finding survey data from 14 cities and counties in Jeollabuk-do, analyzed the spatial characteristics of the distribution of vacant houses, along with the differences in the characteristics of the deterioration and types (apartment, house) of vacant houses. The clustering tendency of vacant houses was analyzed using Global Moran's I, a global autocorrelation analysis, which is a spatial autocorrelation analysis, and the Local Indicators of Spatial Association (LISA) of Local Moran's I. This study aimed to examine the autocorrelation of vacant house distribution to analyze whether there are regional differences in the occurrence trends of vacant houses. Furthermore, the variations in these vacant house distribution patterns imply differences in exploring solutions to address the vacant house issue at a regional level.

This paper is organized as follows. The next section further reviews previous studies related to the vacant houses and spatial autocorrelation, and the third section explains the regional characteristics of Jeollabuk-do. In the fourth section, the statistical analysis of the grade, types and autocorrelation of vacant houses were analyzed. In the fifth section, we discuss the results of the analysis in the previous section. Finally, major findings, the advantages, and limitations of this paper are concluded.

2. Previous Studies

In this chapter, existing studies related to vacant houses and analysis methods related to spatial autocorrelations are reviewed and analyzed using spatial associations.

2.1. Vacant house- related studies

Studies on factors resulting in vacant houses, problems caused by vacant houses, and patterns of their occurrence in the space have been conducted.

First, studies on the problems caused by vacant houses focus on crimes related to vacant houses (Cui & Walsh, 2015; Immergluck & Smith, 2006b; Spelman, 1993) and decrease in the value of the surrounding real estate (Han, 2014; Immergluck & Smith, 2006a; Mikelbank, 2008). Cui et al(Cui & Walsh, 2015). analyzed the effect of house foreclosures and vacancies on violence and property crimes and found that in Pittsburgh, Pennsylvania, USA, foreclosures alone had no effect on crime; however, when foreclosed houses became vacant, violent crime rates increased by approximately 19%. Immergluck et al.(Immergluck & Smith, 2006b) analyzed the relationship between single-family house mortgage foreclosures and violent crimes and found that approximately 2.8 foreclosures per 100 self-owned real estate in one year increased violent neighborhood crimes by approximately 6.7%. Immergluck, Smith(Immergluck & Smith, 2006a), and Mikelbank (Mikelbank, 2008) analyzed the effect of vacant houses foreclosed because of mortgages on the surrounding real estate.

Second, a study conducted by Hillier et al.(Hillier et al., 2003) identified important relationships between vacant room occurrence patterns, socioeconomic characteristics, and institutional factors using logistic regression as an early system to predict vacant houses to determine significant attributes, such as whether the house is vacant, violation of the Housing Act, whether payments are in arrears, delayed payments, and the characteristics of surrounding real estate. Silverman et al. (Silverman et al., 2013) used multiple regression analysis to identify significant relationships between vacancy patterns, socioeconomic characteristics, and institutional factors to

investigate housing vacancy patterns in Buffalo, New York, USA. Rieniets (Rieniets, 2009) found that urban decline, which affects the occurrence of vacant houses, appears to be due to population loss resulting from the interactions of various complex and overlapping factors such as low birth rates, aging, and low growth rates.

Related studies on the Jeonbuk region in South Korea include an analysis of the state of the present situation of vacant houses in Jeonbuk by Oh (Myungrok Oh, 2017) of the Jeonbuk Research Institute. Hwang(Jeong-Im Hwang et al., 2012) analyzed the actual state and perceptions of vacant house owners in Wanju-gun, Jeollabuk-do regarding vacant house management. Lee (Lee Dayeon, 2020)predicted vacant house occurrence factors in Jeonju-si. Nam(Hyekyung Nam, 2017) studied how to use empty houses as a countermeasure against empty houses occurring in the ancient preservation district of Iksan, Jeollabuk-do. Kim and Ham(Junyoung Kim & Sungil Ham, 2022) studied measures for empty houses, focusing on the perception of residents and administrators of empty houses in Jeollabuk-do.

2.2. Spatial autocorrelation

Spatial autocorrelation analysis has been used to analyze the spatial distribution of vacant houses. This analyzed whether the occurrence of vacant houses is accidental, or spatial patterns are formed according to the system as regional and social characteristics. Through spatial patterns, Odland and Balzer (Odland & Balzer, 1979) investigated house aging patterns in space and time using time-series data of housing occupancy in Indianapolis to find that house deterioration can develop into spatiotemporal patterns that negatively affect neighboring houses, and predict the probability of house vacancy. Pachcco and Tyrrel (Pacheco & Tyrrell, 2002) analyzed the spatial pattern of household distribution in urban clusters using the spatial clustering pattern of households in southern New England from 1980 to 1990 and integrated the spatial location of regional growth effects using a spatial search technique and a growth model. They analyzed the effect of the interaction between changes in one area of household distribution and changes in neighboring areas.

Spatial autocorrelation analysis uses Moran's I statistics to analyze the spatial autocorrelations of data and can be divided into global and local statistics. Global Moran's I represents the clustering tendency of overall similar values in the study area as one index and has a value between -1 and 1. Values closer to one indicate that regions with similar values are adjacent. The LISA was used to determine spatial associations locally. LISA can be used to analyze spatial cluster formation and show similar associations. In addition, spatial associations were analyzed using Moran scatter plots. There are four types of spatial associations: high-high (HH), LL (low-low), high-low (HL), and low-high (LH). HH is the type where high values exist around high values based on the origin point. LL is the type

where low values exist around low values, HL is the type where low values exist around high values, and LH is the type where high values exist around low values. Because HH and LL are types that are highly correlated with the surroundings, and HL and LH are types that are less associated with the surroundings, Moran's I is higher when there are more HH and LL types, and lower when there are more HL and LH types.

3. Characteristics of regions and cities in Jeollabuk- do

Jeollabuk-do is one of eight provinces in South Korea and is located in the southwest. Jeollabuk-do is divided into western plains and eastern mountain-type areas with mountain range boundaries, as shown in Figure 1(a). Jeonju-si, Gunsan-si, Iksan-si, Gimje-si, Jeongeup-si, Gochang-gun, and Buan-gun were classified as western plain areas, and Wanju-gun, Namwon-si, Muju-gun, Jinan-gun, Jangsu-gun, Imsil-gun, and Sunchang-gun were classified as eastern mountain-type areas.

(a) Terrain

(b) Population distribution by city and county

(c) Building distribution
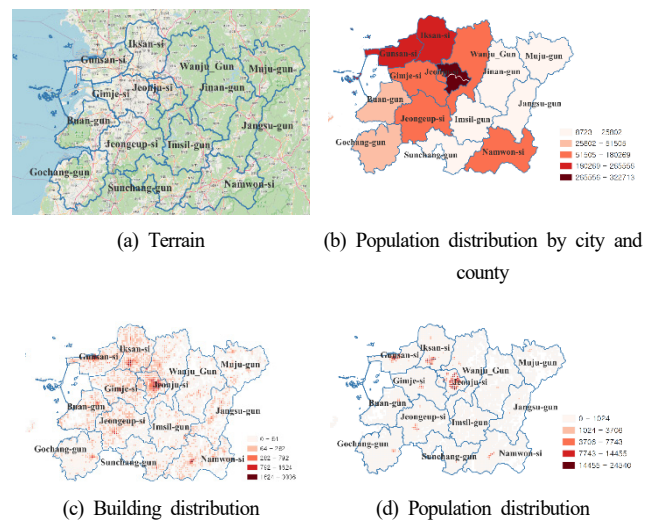
(d) Population distribution

Fig. 1. Population and Housing Distribution in Jeollabuk-do

Jeollabuk-do has a low population density, with a population of 1.8 million as of 2021. Its main industry is agriculture, because of the plains in the west; however, Jeonju, Iksan, and Gunsan are cities with high population densities and developed industries. Therefore, as shown in Table 1, there were differences in populations up to 30 times, ranging from 20,000 in Jangsu-gun to 650,000 in Jeonju-si. In proportion to the population, there were differences in the number of houses up to 25 times, ranging from 9,500 in Jangsu-gun to 240,000 in Jeonju-si. Therefore, there are many differences in the population and housing distributions according to terrain, industry, and city structure, as shown in Figure 1 (b), (c), and (d).

Table 1. Types of areas according to the number of houses and population distribution in Jeollabuk-do

Cities and counties	Number of houses	Population	GDRP (million dollars, 2020)	The elderly aged 65 or older (%,2022)	Area	
Jeonju-si	240,012	652,859	12,159	14.99%		Focus city area
Gunsan-si	116,663	266,687	7,267	18.93%		
Iksan-si	117,355	283,174	6,385	19.90%	City area	
Jeongeup-si	48,152	108,474	2,513	27.89%		Small and medium sized city area
Namwon-si	34,965	80,654	1,384	28.13%		
Gimje-si	37,736	82,405	2,399	31,92%		
Wanju-gun	38,905	91,372	3,713	23.37%		
Gochang-gun	25,269	54,579	1,229	34.44%		Plain type county area
Buan-gun	24,541	52,251	1,200	33.32%		
Sunchang-gun	13,135	27,930	628	34.00%	County area	
Muju-gun	11,195	24,069	579	33.60%		Mount type county area
Jinan-gun	10,908	25,361	520	35.04%		
Jangsu-gun	9,555	22,159	430	34.22%		
Imsil-gun	12,830	27,928	613	36.44%		

* Number of houses (units) and population:2020 data from the National Statistical Office

Since analyzing the characteristics of 14 individual cities and counties is difficult because there are large differences in society, and economy among the cities and counties, as shown in Table 1, areas were classified based on population, percentage of the elderly, GRDP(Gross Regional Domestic Product), terrain. Areas with a population of less than 200,000 were classified as focus city areas, areas with a population between 80,000 and 110,000 as small and medium city areas, and areas with a population smaller than 60,000 as county areas. The county areas were classified into two groups: mountainous and plains. Plain-type counties have a population of approximately 50,000, while mountain-type counties have a population of approximately 20,000. Although Wanju-gun is a county, it is classified into small and medium sized city area based on its population.

4. Jeollabuk- do vacant house fact- finding survey

In this section, the vacant house fact-finding survey method is explained. Based on the results of the fact-finding survey, the differences between city types according to the distribution of vacant houses in Jeollabuk-do by grade and type are analyzed through a t-test.

4.1. Vacant house fact- finding survey method

Fact-finding surveys of vacant houses in Jeollabuk-do were conducted by the Korea Land and Geospatial Informatix Corporation, a professional organization stipulated under the Special Case act [5]. The items in the vacant house fact-finding surveys included address, longitude and latitude coordinates, house type, grade, illegality, lack of permission, building properties (site area, total floor area, building area, date of approval, etc.), survey date, and time. As for the task procedure, as shown in Figure 2, a preliminary survey was conducted with houses that had not been used for more than one year; vacant houses were identified, and their grades were determined through a field survey. Finally, vacant houses were registered on the vacant house platform through owner interviews and consent forms. Depending on the fact-finding survey method, data from the National Statistical Office differed in terms of the number of vacant houses.
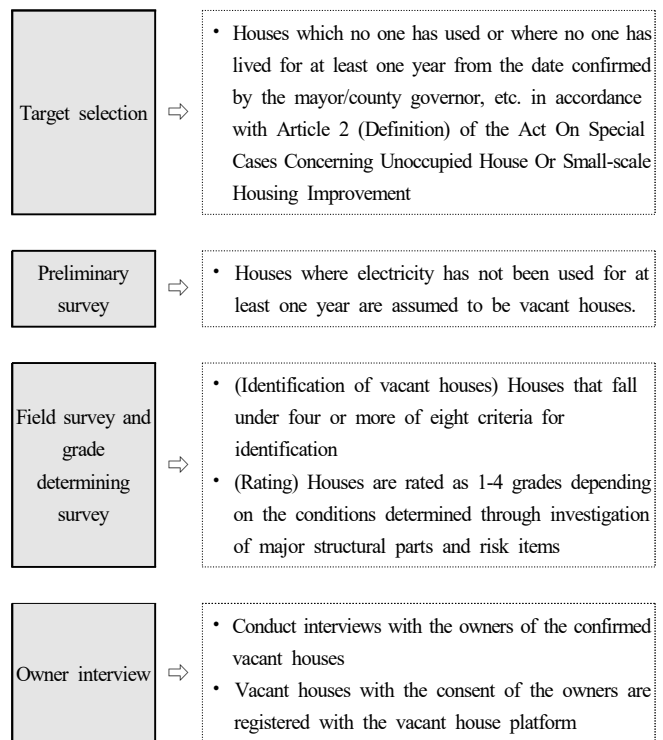

Target selection	⇨	• Houses which no one has used or where no one has lived for at least one year from the date confirmed by the mayor/county governor, etc. in accordance with Article 2 (Definition) of the Act On Special Cases Concerning Unoccupied House Or Small-scale Housing Improvement
Preliminary survey	⇨	• Houses where electricity has not been used for at least one year are assumed to be vacant houses.
Field survey and grade determining survey	⇨	• (Identification of vacant houses) Houses that fall under four or more of eight criteria for identification • (Rating) Houses are rated as 1-4 grades depending on the conditions determined through investigation of major structural parts and risk items
Owner interview	⇨	• Conduct interviews with the owners of the confirmed vacant houses • Vacant houses with the consent of the owners are registered with the vacant house platform

Fig. 2. Procedures for vacant house fact-finding

4.2. Vacant house fact- finding survey method

Fact-finding surveys of vacant houses in 14 cities and counties in Jeollabuk-do were conducted from 2020 to 2021. Vacant houses in Gunsan-si, Iksan-si, Namwon-si, Jeongeup-si, Muju-gun, Gochang-gun, and Jangsu-gun were surveyed in 2020; those in Sunchang-gun, Buan-gun, Gimje-si, Wanju-gun, Jinan-gun, and Imsil-gun were surveyed in 2021; and those in Jeonju-si were surveyed in 2020 and 2021.

（1）Ratio of vacant houses

According to the vacant house fact-finding survey of 14 cities and counties, the number of vacant houses in Jeollabuk-do was 17,732, accounting for 2.4% of all 740,000 houses, as shown in Table 2. When the ratios of vacant houses by region are compared, it can be seen that the ratio of vacant houses is higher in areas with smaller populations and county areas. The average vacant house ratio in the hub city areas was 1.6%, that in the small and medium city areas was 3.4%, that in the plain-type county areas was 4.0%, and that in the mount-type county areas was 4.5%.

A t-test was conducted to analyze the difference in the ratios of vacant houses between city areas and county areas, and according to the result, the significance probability of equal variance test was 0.408, which is greater than 0.05. Therefore, the difference in the ratios of vacant houses between the "city and county" groups was significant because it satisfied the equal variance test ($t=-2.2226$, p $(0.046) <0.05$). The average vacant house ratio in county areas is 4.44%, which is 1.8% higher than the average vacant house ratio of 2.64% in city areas. The average difference among the four regions(focus city area, small and medium sized city area, plain type county area, mount type county area) was not significantly different between the groups ($F = 2.218$, $p = 0.149$).

Table 2. Vacant houses in Jeollabuk-do and the ratios of vacant houses according to the numbers of houses

Area		City and county	Number of vacant houses	House(unit)	Ratio of vacant houses
City area	Focus city area	Jeonju-si	2,752	240,012	1.1
		Gunsan-si	2,350	116,663	2.0
		Iksan-si	2,680	117,355	2.3
		Total	7,782	474,030	1.6
	Small and medium sized city area	Jeongeup-si	2,351	48,152	4.9
		Namwon-si	1,251	34,965	3.6
		Gimje-si	842	37,736	2.2
		Wanju-gun	924	38,905	2.4
		Total	5,368	159,758	3.4
County area	Plain type county area	Gochang-gun	1,150	25,269	4.6
		Buan-gun	863	24,541	3.5
		Total	2,013	49,810	4.0
	Mount type county area	Sunchang-gun	489	13,135	3.7
		Muju-gun	683	11,195	6.1
		Jinan-gun	730	10,908	6.7
		Jangsu-gun	474	9,555	5.0
		Imsil-gun	193	12,830	1.5
		Total	2,569	57,623	4.5
Jeollabuk-do		Total	17,732	741,221	2.4

* Number of houses (units):2020 data from the National Statistical Office

（2）Grade of vacant houses

In the fact-finding survey, vacant houses were classified into four levels according to their conditions. Grade 1 refers to good houses, grade 2 refers to normal vacant houses, grade 3 refers to bad houses, and grade 4 refers to vacant houses to be demolished. The condition of vacant houses is also an important factor in vacant housing policies. Grades 1 and 2 can be rented immediately. In the case of grade 3, rental can be expanded by supporting repair costs, whereas in the case of grade 4, a policy to reduce vacant houses is pursued by supporting demolition costs. When looking at the degree of deterioration of vacant houses, as shown in Table 3, it can be seen that the ratio of grades 3 and 4 is the highest in plain-type counties at 64.5%, followed by small- and medium-sized city areas at 58.7% and mountain-type county areas at 52.7%. Only the focus city areas have many good vacant houses, with a ratio of grades 3 and 4 of 48.5%, which is lower than 50%. However, in the comparison of averages between city and county areas by grade, there was no significant difference as equal variance was not assumed (0.018), the t-value was -0.125, and the significance probability (two-sided) was 0.903 (>0.05). In the analysis of the averages of the four region typess, there were no significant differences in F(0.772) or significance probability(0.536 > 0.05).

In Jeollabuk-do, the ratio of grade 1 and 2 vacant houses was 45.8% and the ratio of grade 3 and 4 vacant houses was 54.2%, indicating that policy support for deteriorated vacant houses is necessary.

Table 3. Distribution of the grades of vacant houses in Jeollabuk-do

Area		Level 1·2		Level 3·4		Number of vacant houses
		Ratio of vacant houses (%)	Number of vacant houses	Ratio of vacant houses (%)	Number of vacant houses	Total
City Area	Focus city area	51.5	4,006	48.5	3,776	7,782
	Small and medium sized city area	41.3	2,216	58.7	3,152	5,368
	Total	47.3	6,222	52.7	6,928	13,150
County area	Plain type county area	35.5	715	64.5	1,298	2,013
	Mount type county area	47.3	1,215	52.7	1,354	2,569
	Total	42.1	1,930	57.9	2.652	4,582
Jeollabuk-do		45.8	8,152	54.2	9,580	17,732

(3) Types of vacant houses

The types of vacant houses were classified into Single House, multihouses (multi-unit houses/townhouse), apartments, and other houses. A townhouse means "a house whose total floor area of one building used as a house (if two or more buildings are connected by an underground parking lot, they are regarded as one building) exceeds 660 square meters and the number of floors is 4 or fewer." A multi-unit house has a total floor area of 660 square meters or lesser and four or fewer floors. An apartment is a house with five or more floors used as a house [19]. The other houses were residential units or illegal/unlicensed houses in commercial districts. In all areas, the ratio of vacant detached houses was the highest at 50% or higher; in particular, the ratio of vacant detached houses in mountain-type county areas was high at 84.3%. The ratios of multiple houses were high in city areas, with 11.9% or higher in focus city areas, 5.0% in small and medium-sized city areas, and lower than 1% in plain-type and mount-type county areas.

Because the number and ratio of vacant houses to other houses account for a significant portion, data collection for concrete type classification is required.

4.3. Analysis of Spatial autocorrelation of Jeollabuk- do cities

This chapter examines the characteristics of the spatial distribution of vacant houses based on the ratios and distributions of vacant houses

Table 4. Distributions of vacant houses by type in Jeollabuk-do

Area		Single House		Multihouses (multiunit house/townhouse)		Apartment		Other house		Total
		Unit	Ratio (%)	Unit	Ratio (%)	Unit	Ratio (%)	Unit	Ratio (%)	
City area	Focus city area	4,681	60.2	783	10.1	141	1.8	2,176	28.0	7,781
	Small and medium sized city area	3,163	58.9	33	0.6	236	4.4	1,936	36.1	5,368
	Total	7,844	0.60	816	0.06	377	0.03	4,112	0.31	13,149
County area	Plain type county area	1,045	51.9	6	0.3	0	0.0	962	47.8	2,013
	Mount type county area	2,166	84.3	2	0.1	2	0.1	399	15.5	2,569
	Total	3,211	0.70	8	0.00	2	0.00	1,361	0.30	4,582
Jeollabuk-do		11,055	62.3	824	4.6	379	2.1	5,473	30.9	17,731

Table 5. Spatial autocorrelation of Jeollabuk-do cities using Ratio of Vacant Houses

Type	Subtype	City	Moran's I	LISA
City area	Focus cities	Jeonju-si	0.173	HH(57), LL(0), LH(37).HL(12)
		Gunsan-si	0.123	HH(82), LL(142), LH(63).HL(9)
		Iksan-si	0.07	HH(62), LL(140), LH(98). HL(16)
		Average	0.122	-
	Medium and Small cities	Jeongeup-si	0.003	HH(90), LL(0), LH(117). HL(41)
		Namwon-si	0.103	HH(68), LL(0), LH(173), HL(58)
		Gimje-si	0.081	HH(67), LL(0), LH(95), HL(47)
		Wanju-Gun	0.084	HH(80), LL(0), LH(184), HL(81)
		Average	0.068	-
		Average	0.091	-
County area	Plain type county area	Gochang-gun	0.013	HH(38), LL(0), LH(105), HL(52)
		Buan-gun	0.034	HH(58), LL(0), LH(124), HL(41)
		Average)	0.024	-
	Mount type county area	Sunchang-gun	0.027	HH(21), LL(0), LH(121), HL(58)
		Muju-gun	0.051	HH(39), LL(0), LH(125), HL(49)
		Jinan-gun	0.027	HH(42), LL(0), LH(184), HL(74)
		Jangsu-gun	0.014	HH(36), LL(0), LH(147), HL(39)
		Imsil-gun	0.002	HH(23), LL(0), LH(152), HL(59)
		Average	0.024	-
		Average	0.024	-
Jeollabuk-do		Average	0.058	HH(1031), LL(0), LH(1622), HL(597)

in individual areas. The analysis is based on a vacant house fact-finding survey of 14 cities and counties in Jeollabuk-do conducted by the Korea Land and Geospatial Informatix Corporation(LX).

GeoDA(GeoDA Center, n.d.) was used to analyze Moran's I. The data were generated using QGIS in a 500mx500m grid of the ratios of vacant house ratios. In this study, the size of the grid structure can change depending on the size and structure of the city, but the grid size was calculated as 500 meters according to Perry's Neighborhood Unit(Perry, 1998). The ratios of vacant houses were used instead of the numbers. When the number of vacant houses is used, the index may be affected because the number of houses in cities and those in county areas are large. Queen contiguity, the default value of spatial weight, was used to set contiguity(Anselin, 2003).

Moran's I value was the highest at 0.173 in Jeonju-si, where the ratio of vacant houses was the lowest, while the residential density was high. The lowest Moran's I value was 0.002 for Imsil, the county area with the lowest ratio of vacant houses next to Jeonju.

Using Moran's I values, the average difference in the spatial autocorrelations of vacant houses in the four region types was analyzed. Without assuming equal variance in city and county areas, the average difference was significant, with a t-value of 3.257 and a significance probability of 0.007 < 0.05. The average difference in the spatial autocorrelations of vacant houses in the four region types was also significant, with an F-value of 5.434 and a significance probability of 0.018 < 0.05. However, the average difference between the two groups were not significant, with significance probability of 0.193 > 0.05 and the significance probability of 0.964 > 0.05. We can see that there was a significant difference in the relationship between the spatial autocorrelation of vacant house occurrence in city and county areas. This means that the spatial autocorrelation is higher in city areas than in county areas. Through this, when comparing the density average of the four regions, it can be said that the significant probability and density are different. There is also a significant difference in comparing the average density of urban and county areas. In other words, it can be said that urban areas are more dense than other areas. However, the difference in density between focus city and small/medium city among urban areas was not much different. In addition, the difference in density between mountain type county and plain type county in rural areas was not much different. Taken together, it can be said that the density in urban areas is higher than that in county areas, and other areas are not very different in terms of density.

Table 6. Comparison of the average difference between the four region types and the average differences between two groups

One way ANOVA		
Group	Average Comparison	
Comparison of averages among four region types	F	p
	5.434	0.018 < 0.05
Independent sample t-test		
Group	Average Comparison	
Comparison of averages between city and county types	t	p
	3.257	0.007 < 0.05
Comparison of averages between city types(focus city and small and medium city)	t	p
	1.502	0.193 > 0.05
Comparison of averages between county types (plain type county and mount type county)	t	p
	-0.047	0.964 > 0.05

Local spatial autocorrelations were examined using LISA. The most common type of cluster in Figure 3 is HH (high-high) in Jeonju, which means that if there are vacant houses in the surroundings, the frequency of occurrence of vacant houses is high in that area. The frequency of HH (High-High) was highest in Jeonju. Unlike Jeonju, which is a hub, Gunsan and Iksan showed the highest frequencies of LL (Low-Low). The frequencies of type LH (low-high) were the highest in all cities and counties, except for three.

This means that the spatial autocorrelation of the distribution of the occurrence of vacant houses is low because the residential density is low, and residences are organized centering on villages because of the characteristics of county areas. The cities classified as small and medium city areas mainly consisted of county areas, except for the main central areas, and showed low spatial autocorrelations with vacant houses. In contrast, focus city areas have relatively high spatial autocorrelations and require preventive policy measures for the expansion of vacant houses.
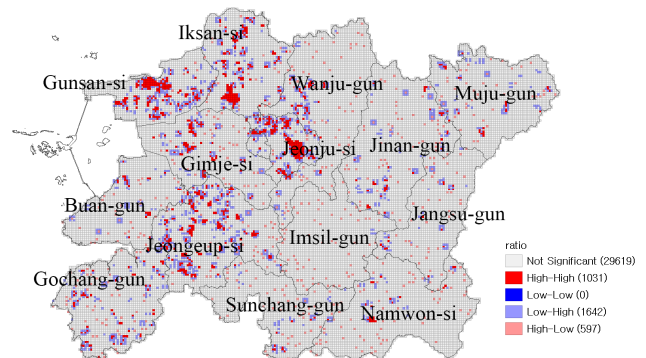

Fig. 3. LISA cluster map of Jeollabuk-do

5. Discussion

The occurrence of vacant houses is a phenomenon that can be observed in both urban and rural areas of Jeollabuk-do, and the vacancy ratio of buildings was 2.4%. However, the distributional tendencies of vacant house occurrence can differ between urban and rural areas. In this study, we examined the autocorrelation, ratio, grade and type of vacant house occurrence to understand the differences in patterns between urban and rural areas. High autocorrelation indicates that vacant houses are concentrated in specific regions, while low autocorrelation suggests that vacant houses are scattered throughout the entire area rather than being concentrated in specific regions. Such variations in the distribution patterns of vacant houses imply that different approaches may be needed in formulating strategies to address the vacant house issue.

The previous research trends have focused on methodologies for measuring the distribution of vacant houses(Tomita et al., 2022), exploring policy alternatives that central and local governments can implement to address vacant houses (Kim & Nam, 2016), and associating the patterns of vacant house distribution and the causes of vacancy in specific regions (Lee et al., 2022). In contrast, this study takes a distinctive approach by distinguishing between urban and rural areas within the local administrative divisions of Jeollabuk-do, a region in South Korea with an area of 8,069 Km2 (8.05% of the national territory area), based on regional vacant house distribution data. It analyzes the differences in trends and proposes a unique approach. This unique approach is also proposed in the solutions, where the approach for addressing the issue could vary for each region.

Based on the analysis of 17,732 vacant houses in 14 cities and counties in Jeollabuk-do, the following trends were identified: Firstly, in city areas with a population close to 100,000, the autocorrelation of vacant houses is higher than in areas with a smaller population (county areas), although the ratio of vacant houses is higher in counties. This contrasts with the fact that county areas with smaller populations actually have a higher average vacancy rate compared to urban areas. The high autocorrelation of vacant house occurrence in urban areas suggests that there may be specific causes of vacant house occurrence in certain regions of urban areas (Lee et al., 2022). Although this study did not investigate these specific causes for the region, it is possible to conduct future research on this topic. Secondly, the high autocorrelation of vacant houses in urban areas indicates that vacant houses spread in specific regions, exacerbating the issue of urban sprawl. Examining the autocorrelation of vacant houses can serve as a predictive tool for future regional vacancy in specific areas. Finally, in formulating strategies to address vacant houses, urban areas can consider solutions that encompass a broader range of areas, including specific regions with high vacant house occurrence, rather than focusing solely on improving individual houses. In contrast, for rural areas, it may be suggested to utilize vacant houses for community facilities or landscape parks on a case-by-case basis, considering the scattered occurrence of vacant houses.

6. Conclusion

Vacant houses are gradually increasing due to the decrease in population and the deterioration of houses. They are recognized as an important urban problem in many cities around the world due to decreases in real estate prices, increases in crimes, and damage to urban aesthetics. In South Korea, vacant houses are increasing in all cities owing to rapid decreases in population, deterioration of cities, and migration to cities. In particular, Jeollabuk-do is a province located in the south of South Korea, where vacant houses are rapidly increasing and recognized as an important issue in the area.

Jeollabuk-do conducted a vacant house fact-finding survey from 2020 to 2021 before developing important policies against vacant houses. It is composed of 14 cities and counties, and its characteristics, such as population, number of houses, distribution of houses, and terrain, differ by city and county. Therefore, Jeollabuk-do was classified into city areas (focus cities, small- and medium-sized cities) and county areas (plain-type and mount-type counties) for analysis.

The results of analysis are as follows.

First, regarding the ratios of vacant houses to the number of houses, the ratios of vacant houses are higher in county areas, which have small populations and are rural areas. When comparing the average ratios of vacant houses, there was a significant difference between city and county areas. Second, the focus city areas had the highest ratios of good houses of grades 1 and 2, followed by mountain type county areas, small and medium city areas, and plain type county areas, in order of precedence. However, there are no statistically significant differences in the average ratios of vacant houses. Third, the ratios of single houses were the highest in all areas; in particular, the highest ratio was found in mountain-type county areas. The ratio of multiple houses and apartments was high in city areas and below 1% in plain- and mountain-type county areas. Fourth, in the analysis of spatial autocorrelations, the Moran's I values were smaller than 0.2 in all cities and counties. Therefore, the spatial autocorrelations were not high but were higher in urbanized areas. In the comparison of averages, there was also a significant difference between the city and county areas.

Table 7. The results of comparison of mean differences between regions

Type	Ratio of vacant houses	Grade of vacant houses	Spatial autocorrelation	Possible Measure for Vacant House
City types	Lower	Similar	Higher	Broader range of areas approach
County types	Higher	Similar	Lower	One by one approach

Lastly, based on the results of spatial autocorrelation analysis, although rural areas exhibit a higher proportion of vacant houses in terms of the vacancy rate, it can be observed that urban areas tend to have a denser concentration of vacant houses. This concentration has the potential to exacerbate issues stemming from this pattern. The distribution density trends of vacant houses vary across regions, leading to potential differences in strategies for addressing them. In urban areas, where vacant houses tend to be concentrated in one place, it might be more effective to handle multiple vacant houses over a broader spatial range rather than addressing individual buildings one by one. Housing development can be proposed through active use of vacant houses and renovation in connection with local urban regeneration. In contrast, in the case of county areas, individual empty houses can be resolved separately. Since empty houses are very old and often scattered, the building can be led to demolition and used as a part of a pleasant landscape or as a resting place for the village community. Residential improvement projects using dense empty houses in urban areas or the use of individual empty houses in county areas as local public spaces are ways to improve the sustainability of the residence.

References

1. Anselin, L., GeoDa 0.9 user's guide. Spatial Analysis Laboratory (SAL), Department of Agricultural and Consumer Economics, University of Illinois, Urbana-Champaign, IL, 2003.

2. Couch, C., & Cocks, M., Housing Vacancy and the Shrinking City: Trends and Policies in the UK and the City of Liverpool, Housing Studies, 28(3), 2013.

3. Cui, L., & Walsh, R., Foreclosure, vacancy and crime, Journal of Urban Economics, 87, 2015.

4. GeoDA Center. (n.d.). GeoDA, Retrieved June 1, 2023, from https://geodacenter.github.io/index.html

5. Han, H.-S., The impact of abandoned properties on nearby property values, Housing Policy Debate, 24(2), 2014.

6. He, G., Mol, A. P. J., & Lu, Y., Wasted cities in urbanizing China, Environmental Development, 18, 2016.

7. Hillier, A. E., Culhane, D. P., Smith, T. E., & Tomlin, C. D., Predicting housing abandonment with the Philadelphia neighborhood information system, Journal of Urban Affairs, 25(1), 2003.

8. Nam, H. K., A Study on the Change Trend and Their Using Method of Vacant Houses in the Historic Conservation District: Focused on the Keumma Historic Conservation Area in Jeonbuk Province, Korean Institute of Rural Architecture, 19(2), 2017.

9. Immergluck, D., Examining changes in long-term neighborhood housing vacancy during the 2011 to 2014 US national recovery, Journal of Urban Affairs, 38(5), 2016.

10. Immergluck, D., & Smith, G., The external costs of foreclosure: The impact of single-family mortgage foreclosures on property values, Housing Policy Debate, 17(1), 2006.

11. Immergluck, D., & Smith, G., The impact of single-family mortgage foreclosures on neighborhood crime, Housing Studies, 21(6), 2006.

12. Jeon, Y., & Kim, S., The causes and characteristics of housing abandonment in an inner-city neighborhood: Focused on the Sungui-dong area, Nam-gu, Incheon, J. Urban Des. Inst. Korea Urban Des, 17, 2016.

13. Hwang, J. I., Choi, Y. J., & Kim, H. J., Analysis of Current Situation and Perception of Empty Homes Owners` Managing and Using Rural Empty Houses: Focused on Jeonbuk Wanju County, Korean Society of Agricultural Extension, 19(4), 2012.

14. Kim, J. Y., & Ham, S. G., Journal of the Regional Association of Architectural Institute of Korea, Journal of the Regional Association of Architectural Institute of Korea, 24(6), 2022.

15. Kelling, G. L., & Wilson, J. Q., Broken windows, Atlantic Monthly, 249(3), 1982. https://kosis.kr/statHtml/statHtml.do?orgId=116&tblId=DT_MLTM_2100&vw_cd=MT_ZTITLE&list_id=&scrId=&seqNo=&lang_mode=ko&obj_var_id=&itm_id=&conn_path=E1&docId=02548&markType=S&itmNm=%EC%A0%84%EA%B5%AD

16. Kim, J., & Nam, J., A study on vacant house distribution and management of urban declining area, Journal of the Korean Regional Science Association, 32(1), 2016.

17. Kraut, D. T., Hanging out the no vacancy sign: eliminating the blight of vacant buildings from urban areas, NYUL Rev., 74, 1999.

18. Lee, D. Y., A study on factors and prediction of housing abandonment: In the case of Jeonju, Hanyang University, 2020.

19. Lee, J., Newman, G., & Lee, C., Predicting detached housing vacancy: A multilevel analysis, Sustainability, 14(2), 2022.

20. Mallach, A., Bringing buildings back: From abandoned properties to community assets: A guidebook for policymakers and practitioners, Rutgers University Press, 2006.

21. Mikelbank, B. A., Spatial analysis of the impact of vacant, abandoned, and foreclosed properties, Community Development Reports, 2008.

22. Oh, M. R., A Study on the Analysis and Utilization of Empty Houses in Jeollabuk-do, 2017.

23. Odland, J., & Balzer, B., Localized externalities, contagious processes and the deterioration of urban housing: An empirical analysis, Socio-Economic Planning Sciences, 13(2), 1979.

24. OECD. (2021, May 1). Housing market. https://www.oecd.org/housing/data/affordable-housing-database/housing-market.htm

25. Pacheco, A. I., & Tyrrell, T. J., Testing spatial patterns and growth spillover effects in clusters of cities, Journal of Geographical Systems, 4, 2002.

26. Park, J.-I., & Oh, S.-K., Spatial pattern and causative factor analysis of vacant housing in Daegu, South Korea using individual-level building DB, Journal of the Korean Regional Science Association, 34(2), 2018.

27. Perry, C., The neighbourhood unit (1929), Reprinted Routledge/Thoemmes,

London, 1998.

28. Rieniets, T., Shrinking cities: Causes and effects of urban population losses in the twentieth century, Nature and Culture, 4(3), 2009.

29. Silverman, R. M., Yin, L., & Patterson, K. L., Dawn of the dead city: An exploratory analysis of vacant addresses in Buffalo, NY 2008‒2010, Journal of Urban Affairs, 35(2), 2013.

30. Sorace, C., & Hurst, W., China's phantom urbanisation and the pathology of ghost cities, Journal of Contemporary Asia, 46(2), 2016.

31. Spelman, W., Abandoned buildings: Magnets for crime? Journal of Criminal Justice, 21(5), 1993.

32. Statistics Korea. (2022, July 28). Types of vacant houses and houses by year of construction. KOSIS(Korean Statistical Information Service). https://kosis.kr/statHtml/statHtml.do?orgId=101&tblId=DT_1JU1512&markType=C

33. Statistics Korea. (2023, January 25). Housing supply rate. KOSIS(Korean Statistical Information Service). https://kosis.kr/statHtml/statHtml.do?orgId=116&tblId=DT_MLTM_2100&vw_cd=MT_ZTITLE&list_id=&scrId=&seqNo=&lang_mode=ko&obj_var_id=&itm_id=&conn_path=E1&docId=02548&markType=S&itmNm=%EC%A0%84%EA%B5%AD

34. Tomita, K., Akiyama, Y., Baba, H., & Yachida, O., Estimating the Spatial Distribution of Vacant Houses with Machine Learning using Municipal Data, IGARSS 2022-2022 IEEE International Geoscience and Remote Sensing Symposium, 2022.