applied sciences

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Vacant House Characteristics by Use Area and Their Application to Sustainable Community

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Abstract: The problem of vacant houses is important to identify its causes and then solve it. This study aims to determine the factors affecting the occurrence of vacant houses and examines their influence. The results highlight that the residential environment, population, social, physical environment, and geographic factors are statistically significant for the residential areas' vacant house occurrence, but physical environmental was not significant for the commercial area vacant house occurrence; however, the individual building factor was significant. In residential areas, if the housing itself becomes obsolete or the area is outdated, people often depart from the area, leaving behind empty houses. In the commercial area, it is possible to decrease the number of vacant houses by converting old houses into shops in line with revitalizing a commercial district; a decrease in the number of businesses can be interpreted as a decline in commercial districts and an increase in vacant houses.

Keywords: vacant houses; residential areas; commercial areas; sustainable community

Citation: Joo, H.; Lee, S.; Kang, S.-J.; Kim, S.-Y. Vacant House Characteristics by Use Area and Their Application to Sustainable Community. *Appl. Sci.* **2022**, *12*, 10696. https://doi.org/10.3390/app122110696

Academic Editor: Edyta Plebankiewicz

Received: 13 August 2022
Accepted: 19 October 2022
Published: 22 October 2022

1. Introduction

Vacant houses have emerged as a modern social issue and become a chronic problem in large cities as well as rural and provincial small- and medium-sized cities. Vacant houses threaten cities' social and economic stability, accelerate urban decline, and may lead to a vicious cycle of increased vacant houses. Data from the Ministry of Land, Infrastructure and Transport show an upward trend in vacant houses: 104.2% in 2019, 104.8% in 2020, and 103.3% in 2021 [1]. Further, the vacant houses mainly occur in old downtown areas [1]. The Population and Housing Census by Statistics Korea shows that the number of vacant houses nationwide in 2019 was about 1,518,000, an increase of about 980,000 compared to the year before, accounting for about 8.4% of all housing [2]. Given that this trend is expected to continue, the estimated vacancy rate in Korea is expected to reach 13% in 2025 [3].

The increased rate of vacant houses is high in small- and medium-sized cities; this should be understood from the same perspective as the issue of local extinction [4]. After the metropolitan area, Gyeongsangnam-do has the second largest number of vacant houses in the country. Excluding unsold houses for sale, old and defective townhouses in Gyeongsangnam-do include 1394 houses in Goseong-gun, 1278 in Tongyeong-si, 1250 in Changwon-si, and 1180 in Jinju-si.

Many factors underlie the emergence of vacant houses. Silverman [5] argued that poor socio-economic or housing market conditions lead to vacant houses in areas with high-poverty rates and long-term absenteeism from the workplace. Molly [6] identified housing oversupply and low demand as causes of vacancy. In the past, people were indifferent to the vacant house problem because they saw it as one of the many physical symbols of urban decline and similar problems [7]. At present, many cities worldwide have been unable to break the vicious cycle of urban decline in a way that presupposes development and growth and are experiencing difficulties in solving various problems [8]. Decline related to

continuous urban stagnation causes decreased regional population, long-term economic recession, and changes in the physical environment of an urban space [9,10]. Vacant house occurrence cannot be attributed to any single cause; it should be viewed in combination with population, economy, and social conditions to facilitate an understanding of the wider vacancy problem [11]. Because vacant houses occur in almost all regions in Korea, there is currently an urgent need to investigate the causes underlying vacant houses and to find potential solutions to alleviate the problem of vacant houses [12].

Central and local governments have worked to improve vacant house management policies and systems. The 1994 Agricultural and Fishing Villages Improvement Act and the 1995 Act on the Promotion of Amelioration of Housing in Agricultural and Fishing Villages supported the use and management of vacant houses in rural areas. However, with the increase in the number of vacant houses and their spread to urban areas, the relevant law was amended into the Building Act in 2016. The Act on Special Cases Concerning Unoccupied House or Small-Scale Housing Improvement (hereinafter referred to as the Vacant Houses Act) was enacted in 2017, which led to vacant house ordinances in each local government. The Vacant Houses Act was the first law to systematically establish an empty house management system; additionally, it has policy significance because it recognizes vacant houses as an urban problem and seeks to manage them in an efficient manner. However, since the law focuses on implementing small-scale housing maintenance projects through demolition, there is a limit to fundamentally solving vacant houses [13]. Consequently, several problems have been identified, including reactive and passive policy responses and difficulties with the systematic management of densely populated regions with vacant houses.

Against this background, this study identifies the current status and causes of vacant houses at the regional level and examines how to utilize vacant houses by type. The study aims to propose an effective vacant house management plan by exploring the characteristics of vacant houses according to use area, such as residential and commercial, and by analyzing the factors affecting them. This study divided residential and commercial areas and analyzed and compared the characteristics of vacant houses in each area. The purpose of this study is to seek utilization measures for each type based on the derived vacant house occurrence factors.

2. Literature Review

In 2015, world leaders at the 70th session of the United Nations General Assembly adopted 17 Sustainable Development Goals as part of the 2030 Agenda for Sustainable Development. Among them, the goal of sustainable cities and communities seeks to make cities and dwellings safe and sustainable through measures such as "support[ing] a project in slums for safe housing. You can volunteer in slums to help with building houses, fixing existing ones, setting up public or green spaces."

Regarding what constitutes a sustainable community, several scholars hold differing viewpoints. Spelman [14] focused on the physical space that refers to the space, administrative system, place, and residents in which the activities of residents living in a community are circulated as space. In this study, a sustainable community is considered as one that not only repairs empty houses by improving the physical environment but also uses the empty houses as a space for local residents to secure local sustainability. This study focuses on how areas that can become slums in the future due to vacant clusters can instead be used to create a sustainable community. A neglected vacant house can become a source of crime and safety accidents and may even lead to social problems, such as aggravating the residential environment and causing slums. Therefore, this study expects to contribute to the creation of a sustainable community by discussing how a space densely populated by neglected empty houses can be utilized (Table 1).

Table 1. Definitions of sustainability and pilot research.

Classification	Researcher	Year	Title	Contents
Definitions of sustainability	Broman, G. I. and Robèrt, K. H	2017	A framework for strategic sustainable development	• The degree to which a business or community organization can recognize and address social problems and risks.
	Sachs, J. D.	2015	The age of sustainable development	• Development that meets the needs of the present without compromising the ability of future generations to meet their own needs. • Consistent with the essential definition of sustainability, the concept of a sustainable community gradually evolved into a concept that encompasses social inclusion beyond the environment.
	Blanco, H. and Mazmanian, D. A.	2014	The Sustainable City: Introduction and Overview	• A holistic concept encompassing environmental protection and social development, rather than being simply oriented toward economic growth. • Growth, environmental conservation, and social equity to meet the needs of the present without excluding or undermining the opportunities of future generations.
Pilot research	Masatomo, S Hino, K. and Muto, S. [15]	2022	Negative externalities of long-term vacant homes: Evidence from Japan	• Empirical analysis of negative external effects caused by long-term vacancy. • When one long-term vacant house is added, it is derived that the transaction price decreases by about 3%.
	Lee, J. K. Newman, G. and Lee, C. Y. [16]	2022	Predicting Detached Housing Vacancy: A Multilevel Analysis	• Predict the characteristics and spatial distribution of vacant houses through a multi-level model based on individual lot data. • The year of construction, building structure, and road access conditions have a significant effect on the number of vacant houses at the individual lot level.
	Collins, T. and Overbey, D. [17]	2020	Leveraging the U.S. Department of Energy Solar Decathlon Design Challenge as a Framework for Student LED Adaptive Reuse Projects to Address Context-Specific Sustainable Design, Housing Affordability, and Community Resilience	• Utilizing an vacant house as a sustainable design project. • Use adaptive recycling projects to provide contextual design direction.

As for the preceding studies, research on factors affecting vacant houses and research related to vacant house recycling projects are in progress. Masatomo et al. [15] argued that

long-term vacancy had a negative effect on the surrounding area. Lee et al. [16] analyzed areas with a high probability of vacancy in the future by analyzing and predicting factors affecting vacancy. Collins et al. [17] studied the feasibility of using an empty house as a sustainable recycling resource.

Factors causing vacant house research are divided into studies on the vacant house occurrence and formation process and studies on vacant houses' external effects. Studies on vacant house occurrence and formation include physical and environmental factors [13,18,19], housing market aspects [20,21], social-economic factors [22,23], social-demographic aspects [23,24], and spatial structural aspects [25,26].

We reviewed Mallach's [21] and Lee's [20] studies on vacant houses from a physical and environmental point of view. Mallach [21] confirmed that houses' physical aging and structural risks impede their usability, leading owners to stop managing the house and leave it unattended. Environmental defects, such as small usable area and outdated infrastructure, also lead to vacant houses. Lee [20] analyzed vacant single-family houses' major influencing factors in the Incheon Metropolitan City original downtown area and found that the size, shape, and proximity of the site affect vacant house occurrence; at the neighborhood level, the slope and the maintenance area designation were influencing factors. At the regional level, the proportion of households with elderly individuals living alone affected vacant house occurrence, indicating that residents' socio-economic vulnerability influences vacant houses. New housing supply can act as a triggering factor for vacant houses in a state where housing demand does not increase.

Scafidi et al.'s [27] and Keenan et al.'s [28] studies examined factors influencing vacant houses from the perspective of housing. Scafidi et al. [27] found that the probability of a house being neglected increases according to its physical level. Keenan et al. [28] found that the unchanging housing demand and large supply of new housing caused conversion of low-market and poorly aged housing into vacant housing. Park and Oh [29] analyzed the vacant house factors using data from individual buildings in Daegu Metropolitan City. Building area, number of stories, and level of deterioration had a significant effect on vacant house occurrence. Small size, lower number of floors, and older age were linked with higher probabilities of vacancy. Important regional characteristics included the number of adjacent vacant houses, presence or absence of a maintenance area, population growth rate, and the ratio of elderly population over the past five years. The probability of vacant houses increased as the number of adjacent vacant houses increased. Location within the maintenance area, regional population growth rate, and proportion of the elderly population were all significant factors. The results indicated that vacant houses may lead to additional vacant houses in adjacent areas.

Basset et al.'s [30] study is representative of a socio-demographic point of view. Analyzing the cause of vacant houses in the Flint area at a macro level, it confirmed that race, school closures, neighborhood change processes, and large-scale debt caused vacant houses. Molly's [23] study also demonstrated that increases in the unemployment rate, the proportion of poor households, and the proportion of foreclosed housing were associated with vacant houses, suggesting that changes in demographic structure and lifestyle increased the number of vacant houses in the region. Park and Lim [31] analyzed vacant house distribution characteristics from Jeonju data. Regional characteristics included residential benefit recipients, population growth rate, seniority ratio, old housing ratio, and average actual transaction price. Physical characteristics included house age, total building area, and nearest road width. Characteristics of vacant house hotspot areas were analyzed using the National Land Planning and Utilization Act and other laws as variables of land use planning. The results suggested that the regulation of excessive land use, absence of actual physical changes in housing, housing prices, and the ratio of elderly are closely related to vacant house occurrence. Lim and Na [32] analyzed types of vacant houses and factors influencing vacant houses in Incheon Metropolitan City. The area was divided into original downtown type, surrounding mixed type, extended type, and island type. The results showed that vacant house density was highest in the original downtown type, surrounding

mixed type, island type, and extended type in that order. Vacant houses' degree of aging was highest in the original downtown type, because the location with poor accessibility to the metropolitan area and economic feasibility were not accompanied by reconstruction and redevelopment; population decrease had the highest correlation with vacant houses. In the surrounding mixed type, the ratio of vacant houses with relatively less advanced aging was high. Although the proportion of empty houses was low in the island type, the risk of empty houses was very high because of the natural occurrence of empty houses related to young people departing and elderly people dying. In the expansion type, since the city expands through innovative industries, etc., housing quality was good and vacant house density and degree of deterioration were low, but it was characterized by vacant houses in the original downtown area owing to population movement to newly developed areas.

We also reviewed studies that examined vacant houses from both a spatial structural and geographical point of view. Kim et al. [33] analyzed the influence of regional characteristics of vacant houses and found a relationship between empty houses and the distance from nearby living facilities, such as the distance from elementary schools and convenience facilities. Kim and Kim [34] confirmed that the local extinction index had a significant relationship with the vacant house ratio because all houses become vacant when there are no residents in the area. This suggests that the probability of vacant houses increases as problems arise in a region's permanence, demonstrating the need for mid- to long-term inflow of new investment to stimulate housing transactions. Kim and Kim [26] also studied the effect of regional characteristics on vacancy rate change and found that geographical defects, such as high altitude, steep slope, and poor accessibility, were related to vacant houses. Morckel [35] analyzed the relationship between vacancy and gentrification in Columbus and Youngstown and found that geographic and gentrification characteristics influence housing neglect and that the influence of family characteristics differs by region. Hiller et al. [36] reported similar results, where defects such as house structure, size, and site were factors in vacant houses. House location was also closely related to vacant house occurrence. Joo and Lee [37] studied the occurrence of vacant houses in terms of environmental location. Vacant houses occurred when there was an increase in the number of workplaces emitting environmental pollutants, the number of workplaces in the industrial complex, and the amount of wastewater generated and discharged and when the distance to the workplace was closer and the location nearer the workplace. These previous studies show that vacant houses are not the result of a single cause but multiple causes, with various pathways and factors.

Studies that examined externalities caused by vacant houses analyzed the relationship between vacant houses and social problems (crime, housing prices, etc.). The broken windows theory proposed by criminologists James Q. Wilson and George L. Kelling is a representative study on the relationship between empty houses, crime, and social deviant behavior. The theory asserts that, if a broken window is left unattended, crime begins to spread in the neglected area [38]. Spelman's [14] related study confirmed that more than half of the abandoned vacant houses in the Austin area were used as crime sites. In a similar study, Immergluck [39] confirmed a positive relationship between the vacant houses seized in Chicago and the crime rate in the area. Mikelbank [40] studied the relationship between vacant houses and house prices by analyzing the influence of vacant and neglected houses on surrounding house prices in the Columbus area and found that a higher frequency of vacant houses (which differ from foreclosed houses) was associated with lower housing prices. Cui and Walsh's [41] study of Pittsburgh reported results similar to Mikelbank's [40]. These studies show that the externality of vacant houses is linked to the houses' physical, regional, and owner characteristics. Cho et al. [42] confirmed that owners' behavior affects vacancy in urban areas. For example, an owner purchases a house as an investment and leaves it vacant despite a demand for rentals. In addition, if vacant houses are left unattended, neighboring houses are more likely to become vacant, and eventually the entire area may become a slum; thus, an active improvement plan for empty houses is needed.

Previous studies show that it is important to understand the causes of vacant houses, as well as their regional spatial characteristics. However, most previous research analyzed vacant houses from a macroscopic point of view. Few studies have analyzed vacant houses microscopically by linking the causes of vacant houses with their spatial characteristics. This study differs from previous studies in that it identifies the causes of vacant houses and suggests ways to use vacant houses based on their actual condition.

In addition, this study divides residential and commercial areas to examine the relationship between spatial characteristics and vacant houses. Few prior studies included this type of categorization. Choi et al. [43] and Kim and Choi [44] divided use area and found differences in the results by use area. Our study extends further in that it also identifies use area differences that affect vacant house occurrence. This approach contributes to establishing a vacant house management system for each use area based on the site characteristics.

3. Materials and Methods

The spatial scope of this study is Jinju-si, Gyeongsangnam-do. Jinju-si is currently experiencing an urban hollowing-out and old downtown decline from large-scale outward development spurred by the creation of an innovative city and a new station area. The 2020 survey data reported 11,436 vacant houses in Gyeongsangnam-do, 1180 (about 10%) of which are in Jinju-si. Jinju-si has the second highest number of empty houses in Gyeongsangnam-do after Goseong-gun with 1394 houses (about 12%). Additionally, the recent creation of an innovative city has caused the old downtown area's population to decrease and the number of vacant houses to increase. With more people moving to the innovative city, the outflow from the old city has accelerated. This study analyzed the vacant house address data surveyed by Jinju-si officials. Based on the second field survey, the data included physical environment, individual building, demographic, and geographic characteristics.

The study spanned from 2019 to 2021. Three field surveys of the condition of empty houses were conducted based on the Jinju-si data collected in 2019. The first, second, and third survey were conducted in 8–23 May 2020, 3–27 September 2020, and 8–21 July 2021, respectively.

As shown in Table A1 (Appendix A), the survey identified 580 vacant houses in the urban area, the center of Jinju-si, and 600 vacant houses in the non-urban area outside the city. We conducted a vacancy density analysis to establish the study's scope, as shown in Figure 1. Even within the urban area of Jinju-si, 45 to 134 or more vacant houses were concentrated in the old downtown area, with high concentrations of empty houses in Cheonjeon-dong (178, about 15.1%), Sangbong-dong (111, about 9.4%), Jungang-dong (80, about 6.8%), and Seongbuk-dong (41, about 3.5%). Therefore, this study analyzed the characteristics of empty houses in Cheonjeon-dong, Seongbuk-dong, Jungang-dong, and Sangbong-dong, which are old downtown areas.

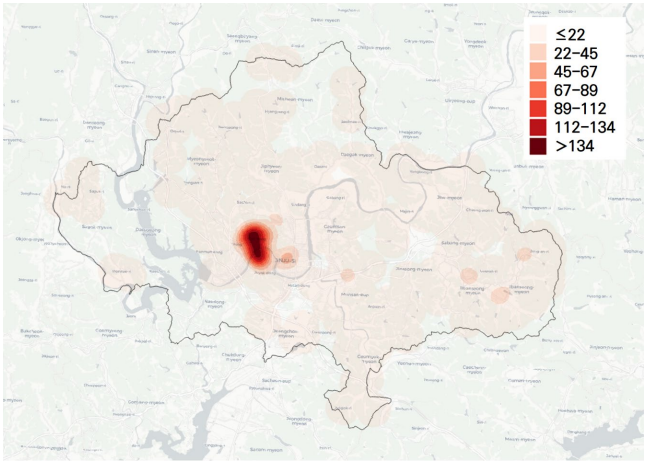

Figure 1. Status of vacant houses in Jinju-si's old downtown area.

We divided the target site use area into residential and commercial, extracted the number of vacant houses, analyzed factors affecting vacant house occurrence, and prepared vacant house measures by region.

This study (1) identified the vacant house distribution within the site and investigated its current status, (2) established the analysis methods and variables, and (3) analyzed vacant house occurrences and regional characteristics. To this end, factors influencing the occurrence of empty houses were analyzed through literature review, field status survey, and geographic information system (GIS) analysis. IBM SPSS Statistics (v.28) and Process Macro for SPSS (4.0) were used for analyses. The study process details are shown in Figure 2.

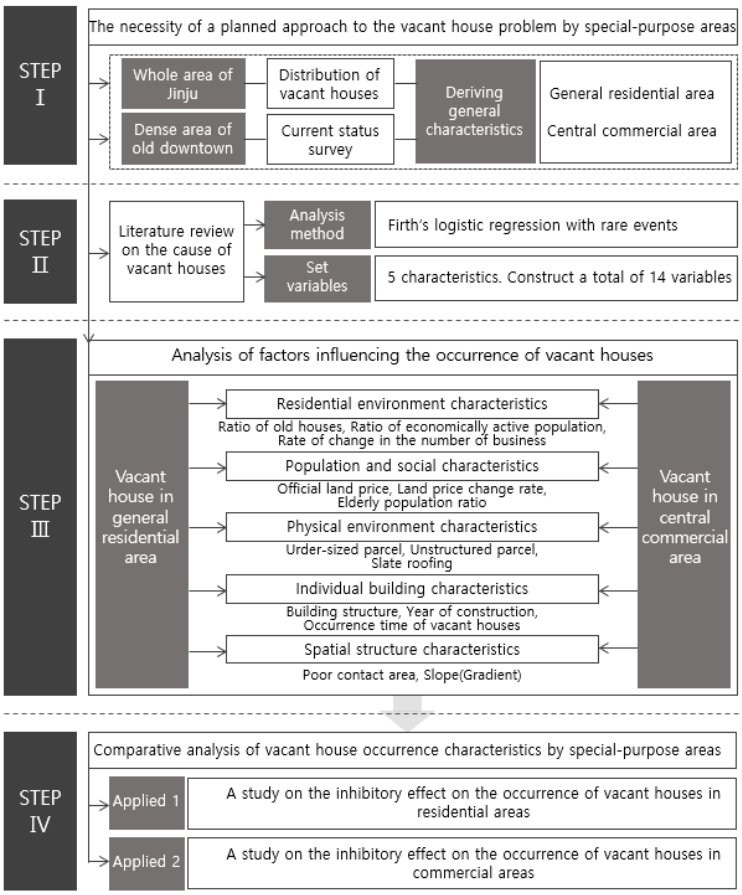

Figure 2. Study process flowchart.

For Step I, we used GIS to confirm the general status of Jinju-si and the distribution of vacant houses. In addition, the general characteristics of vacant houses in residential and commercial areas were derived through the on-site surveys of four buildings in old Jinju-si downtown. For Step II, we established both the cause of vacant houses as a variable through the review of previous studies and an analysis method. For Step III, we analyzed the characteristics of vacant house occurrences in residential and commercial areas and drew conclusions. Finally, for Step IV, we derived the utilization plans for vacant houses by type, based on vacant house factors.

3.1. Analytical Framework

Distributional Status of Vacant Houses in the Sample Region

As shown in Figure 3, the number of vacant houses in Jinju-si, the subject of this study, has steadily increased from 903 in 2017 to 967 in 2018 and 1180 in 2019. If the problem of existing vacant houses is not addressed, the number of vacant houses is expected to continue to increase.

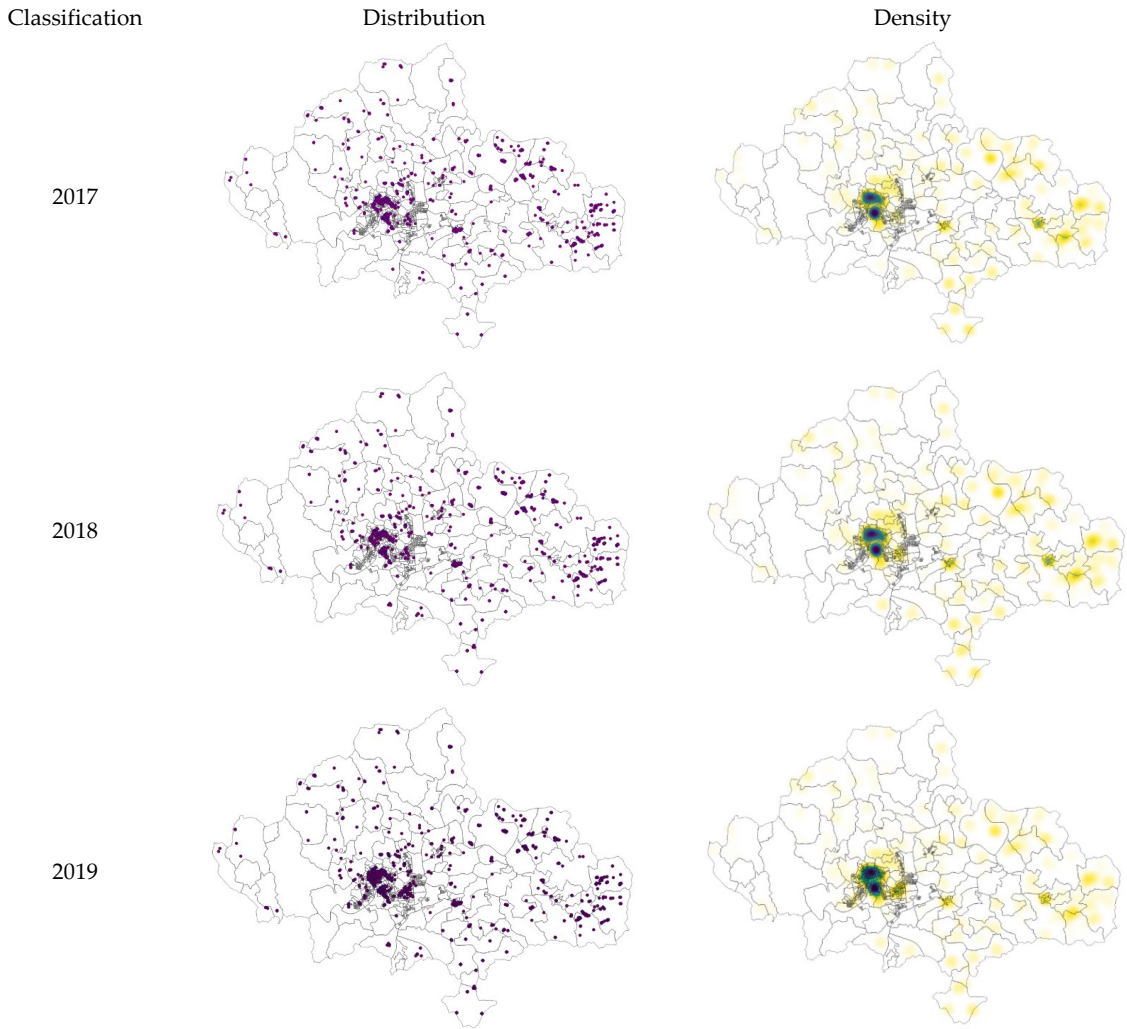

Figure 3. Distribution of vacant houses in Jinju-si.

Figure 3 shows the distribution status by use area and all the vacant houses in Jinju-si. Forty percent of Jinju-si's vacant houses are concentrated in the old downtown area, which has 419 empty houses, 228 in residential areas and 191 in commercial areas.

A field survey was conducted to confirm the location of vacant houses by use area through GIS and to identify the general characteristics and differences between vacant houses in residential and commercial areas. A residential area has more residential buildings (houses) than commercial buildings and is designated to protect daily residential functions. Most vacant houses in residential areas were in densely populated areas, many were in poor condition, and many were located on narrow or irregular lots (for example, see Figure 4).

Figure 4. Status of vacant houses in residential areas.

Adjacent roads were also observed to affect vacant house occurrence, such as roads that make it difficult to enter a property because of a blind spot or when the road width was three meters or less. House condition and location also affect vacancy. Many vacant houses occurred where the housing was poorly managed or accessibility was poor because the house was located on a high slope. Interviews with residents revealed that many of them had been living in the area for more than 10 years, were attached to the neighborhood, and were interested in ways to use nearby empty houses.

Commercial areas are mainly designated for commercial and business functions but include residential and mixed-use buildings. Vacant houses in commercial areas are a mixture of shopping malls and houses. Most buildings in commercial areas undertake active retail activities, are located on flat land, and have good transportation access. However, vacant houses in commercial areas are more often located on the second floor (for example, see Figure 5).

Figure 5. Status of vacant houses in commercial areas.

Even if they are in contact with the road, they are often left vacant. We can infer from these findings that the presence or absence of vacant houses is determined by the influence of commercial activities (the degree of commercial activity in individual buildings, etc.) rather than the geographical location. In addition, although commercial areas have more floating population than residential areas, their residents are less interested in using vacant houses than those of residential areas. The characteristics of the vacant houses in the surveyed areas are summarized in Table 2.

Table 2. Characteristics of vacant houses in residential and commercial areas.

Vacant Houses in Residential Areas	Vacant Houses in Commercial Areas
- Residents have a high level of interest in vacant houses. - Floating population age group is 40 to early seniors. - Generally located in a high slope area. - Poor transport and accessibility.	- Residents have no or insufficient interest in empty houses. - The age of floating population is 20 s to 60 s (all ages). - Generally located on flat ground. - Good transportation and accessibility.

3.2. Analytical Methodology

This study conducted a logistic analysis to identify vacant house factors in the empty house samples concentrated in residential and commercial areas. In particular, this study applied a rare event logistic method because the probability of not having an empty house is higher than the probability of a vacant house occurrence; therefore, a binary logistic regression model may underestimate values and introduce bias. Two methods for resolving the logistic regression bias problem were available: King and Zeng's [45] method and Firth's method [46]. King and Zeng's rare event logistic analysis method removes the potential bias in the prediction estimation and corrects the bias in the weight of the dependent variable by using an exogenous stratified sampling method. It also increases the model's explanatory power by taking advantage of the reduced sample size and adding a better independent

variable. However, unlike King and Zeng's method, which arbitrarily reduces the size of the data in the constant term bias correction, Firth's method uses the information of all raw data but assigns a weight according to the weight of observations in the function estimation step. Both methods have been shown to remove the bias of the maximum likelihood estimator in the logistic regression model and are expected to have similar performance; however, when applied to actual rare event data, Firth's method shows much better results in terms of algorithm stability. Therefore, this study constructed a rare event logistic model based on Firth's methodology. The analysis was performed using IBM SPSS Statistics (v.28) and the Process Macro for SPSS (4.0).

3.3. Variable Definitions

We selected variables through a review of the related literature and previous studies. The dependent variables were based on whether there were empty houses, classified as 1 when the vacant house was in a densely populated space and 0 when it was not in a densely populated space. The independent variables were factors that affect vacant house occurrence and explain why they are not utilized and increase after an occurrence.

The causes of vacant houses in Jinju-si's old downtown area include station area development, movement to innovative cities, and housing deterioration. However, the factors that generate other vacant houses in the vicinity may be different. Accordingly, 14 variables were selected, based on the related literature and previous studies, as shown in Table 3.

Table 3. Factors affecting the occurrence of vacant houses.

	Variables	Content	Type
Dep. Variable	Presence of vacant houses in the area	1: vacant house in the corresponding special-purpose areas 0: vacant house not in the corresponding special-purpose areas	Dummy
Indep. Variable	Official land price	Ln (individual official land price designated in 2019)	Number
	Land price change rate	Rate of change in the median price of individual official land prices for 2017–2019	Number
	Poor contact area	1: facing a road where vehicles cannot pass 0: facing a road where vehicles can pass	Dummy
	Undersized parcel	1: parcel area of less than 90 m^3 0: land parcel area over 90 m^2	Dummy
	Unstructured parcel	1: irregular parcel shape 0: regular parcel shape	Dummy
	Ratio of economically active population	(number of employed people aged 15–64 in 2019/population aged 15–64 in 2019) × 100	Number
	Ratio of elderly population	(population over 65 years old in 2019/total population in 2019) × 100	Number
	Slope	Median slope	Number
	Building structure	1: wooden structure 0: brick, concrete structure	Dummy
	Rate of old houses	(number of detached houses 31 years from the date of construction/total number of detached houses) × 100	Number
	Year of construction	1: buildings built before 1970 0: buildings built after 1970	Dummy
	Slate roofing	1: slate roof 0: not a slate roof	Dummy
	Rate of change in the number of businesses	(number of businesses in 2018/number of businesses in 2019) × 100	Number
	Occurrence time of vacant houses	1: vacant house that occurred before 2010 0: vacant house that occurred since 2010	Dummy

4. Results of Analysis of Factors Affecting Vacant House

4.1. Feasibility and Reliability Analysis

After classifying the variable characteristics using exploratory factor analysis, we verified each variable's reliability. The Kaiser–Meyer–Olkin (KMO) standard fit and Bartlett values were used to measure selected variables' suitability. As shown in Table 4, the KMO value, which indicates the degree to which the correlation between variables is explained by other variables, was 0.809, indicating that the variable selection for the vacancy occurrence factor analysis was appropriate. The x^2 value, indicating whether the model is suitable, was 2127.764, and the significance probability value of the Bartlett sphericity test was 0.000 ($p < 0.001$), indicating that common factors exist. Since the Eigen value, which indicates the degree of variance that a factor can explain, was greater than 1 for all factors, one factor can explain the variance of at least one variable. In addition, the cumulative variance explanatory power was 69.583%, indicating the 14 indicators' validity when classified into five characteristics. Most of the factor loadings for the measurement variables by index were over 0.4, but land price change rate and slate roof were excluded from the independent variables because the factor loadings were less than 0.4. Cronbach's α coefficients were 0.716, 0.814, 0.837, 0.692, and 0.825, confirming internal consistency, with each exceeding the general standard value of 0.6.

Table 4. Affecting factors of vacant houses and reliability analysis.

Factors	Variables	Factor Analysis				Reliability
		Factor Loadings	Communalities	E.V.	% var	Cronbach's α
Residential environment	Rate of old houses	0.934	0.905	2.67	16.2	0.855
	Ratio of economically active population	0.769	0.694			
	Rate of change in the number of businesses	0.761	0.912			
Population and social	Official land price	0.814	0.681	1.85	31.2	0.624
	Land price change rate	0.771	0.719			
	Ratio of elderly population	0.519	0.508			
Physical environment	Undersized parcel	0.734	0.686	1.52	44.6	0.635
	Unstructured parcel	0.651	0.617			
Individual building	Building structure	0.760	0.793	1.36	55.8	0.729
	Year of construction	0.759	0.615			
Geographical	Poor contact area	0.824	0.777	1.14	69.6	0.838
	Slope	0.681	0.628			

Cumulative var (%) = 69.583%; KMO = 0.809; Bartlett's rectangularity test significant p-value = 0.000; x^2 = 2127.764; df = 78.

4.2. Analysis of Factors Influencing the Occurrence of Vacant Houses by Use Area

The results showed differences in the causes of vacant houses in residential and commercial areas (Table 5). The residential environment, population, social, physical environment, and geographic factors were statistically significant for the residential areas' vacant house occurrence, but physical environmental was not significant for the commercial area vacant house occurrence; however, the individual building factor was significant.

Table 5. Firth logistic regression results: significant factors affecting vacant housing.

Variables	Special-Purpose Areas	General Residential Area			Central Commercial Area		
		B	S.E.	Exp(B)	B	S.E.	Exp(B)
Intercept		−1.110	0.167	0.476	−1.253	0.427	0.163
Residential Environment	Rate of old houses	0.148 **	0.038	1.087	−0.041 ***	0.039	0.877
	Ratio of economically active population	−0.005 **	0.002	0.022	0.016 ***	0.004	0.285
	Rate of change in the number of businesses	−0.287	0.083	0.042	−0.960 ***	0.135	0.134
Population and social	Official land price	−0.017	0.002	0.131	−0.006 **	0.002	0.949
	Land price change rate	0.356	0.047	1.688	0.082	0.103	0.520
	Ratio of elderly population	0.418 *	0.442	1.361	0.076 **	0.150	1.180
Physical Environment	Undersized parcel	0.618 ***	0.034	0.387	−0.589	0.032	0.495
	Unstructured parcel	0.173 *	0.066	0.978	−0.128	0.082	1.037
Individual building	Building structure	0.153	0.054	1.061	0.044	0.069	1.078
	Year of construction	−0.486	0.069	0.495	0.455 **	0.069	1.282
Geographical	Poor contact area	−0.104 ***	0.003	0.935	0.108 ***	0.002	0.431
	Slope	0.227 **	0.072	0.663	0.407	0.085	1.755

B: Regression coefficient; S.E.: Standard error; Exp(B): Odds ratio; statistically significant *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

In the residential environment, the ratio of old houses and the ratio of economically active population were significant for vacant house occurrence in both residential and commercial areas. In residential areas, when the ratio of old houses increases, the number of empty houses increases; and when the ratio of economically active population increases, the probability of vacant houses decreases. Conversely, in commercial areas, when the ratio of aged housing increases or the number of businesses increases, the number of vacant houses decreases; and when the ratio of economically active population increases, the probability of vacant houses also increases.

In residential areas, if the housing itself becomes obsolete or the area is outdated, people often depart from the area, leaving behind empty houses. In the commercial area, it is possible to decrease the number of vacant houses by converting old houses into shops in line with revitalizing a commercial district; a decrease in the number of businesses can be interpreted as a decline in commercial districts and an increase in vacant houses.

Among the socio-demographic variables, the proportion of the aged population was significant in vacant house occurrence. The land price change rate was not significant for either the residential or commercial areas. When the official land price increases only in commercial areas, the probability of vacant houses increases. This suggests that vacant houses (empty shops) occur as tenants move to another area because of increases in rent when the official land price is high.

The physical environment factor had a significant effect on vacant houses only in the residential area. No variables were significant in commercial areas. For residential areas, the probability of vacant house occurrence increases when the residential area lot is narrow or irregular, indicating that lot size and shape are significant factors in residential vacant house occurrence.

Building structure did not have a significant effect on vacant houses in either residential or commercial areas. The year of construction was only significant for commercial areas; a large number of old houses leads to more vacant houses. Commercial areas have a large floating population and frequent retail activities. The findings suggest that many old houses in the vicinity negatively affect the commercial district's formation and, the number of vacant houses in the commercial area also tends to increase.

Poor contact area was significant for both residential and commercial areas. In commercial areas, there is a high probability of vacant houses in places with poor contact, and accessibility and convenient transportation favorable to commercial activities affect vacant house occurrence. Conversely, in residential areas, the probability of vacant houses is high in places where safety is not secured because of poor accessibility and high slope or poor function location.

5. Conclusions

This study analyzed factors that cause vacancy in the residential and commercial areas of Jinju-si's old downtown. The results show that there are common factors that cause more vacant houses by use area, but some factors show opposite results.

In Jinju-si's old downtown residential area, the probability of vacant houses increases as the proportion of aged housing and elderly population increases and when the lot size is narrow or irregular, the slope is high, and accessibility is poor. The probability of vacant houses decreases as the ratio of the economically active population increases and when buildings were built before 1970 and accessibility is poor. In commercial areas, the probability of vacant houses increases as the ratio of the economically active population and the elderly population increases and when the buildings were built before 1970. The probability of the occurrence of vacant houses decreases as the ratio of old houses and the number of businesses increase and when the official land price increases.

The relationship between the occurrence of vacant houses and variables such as the ratio of aged housing, the ratio of the economically active population, and poor contact is reversed in residential and commercial areas, except for the ratio of elderly population. In addition, underpopulated lots, irregular lots, and slope have a significant effect on vacant houses in residential areas; the rate of change in the number of businesses, official land price, and construction year have a significant effect on vacant houses in commercial areas.

These results indicate that, in residential areas, vacant houses occur and cluster under poor physical conditions, such as building state and land characteristics. These vacant houses negatively affect the physical condition of nearby detached houses and the surrounding environment; as the living conditions deteriorate, residents leave the area and the number of vacant houses increases, reinforcing a vicious cycle.

Conversely, in commercial areas, vacant houses may result from socio-economic conditions, such as commercial districts, floating population, people's accessibility, and transportation convenience, rather than individual buildings' physical condition. Therefore, when the economically active or floating population is small in a place where access to commercial facilities and transportation environment is unfavorable, it negatively affects the formation of commercial districts, leading to an increase in vacant houses. Where there are many old houses, the use or accessibility of the building for commercial purposes is restricted, and the houses may be neglected and, as a result, become vacant houses.

Based on these results, urban architectural alternatives to prevent or suppress vacant house occurrence in residential and commercial areas are needed. First, since there are many houses in a residential area, it is necessary to repair old houses to improve living conditions and the condition of the roads adjacent to the houses (improving contact ratio, etc.). In the case of a house located on a narrow and irregular lot, it is necessary to apply a development method by combining adjacent land because it is difficult to repair or manage individual houses. In addition, since many people with mobility impairments, such as the elderly, live on roads with complex structures or where vacant houses are concentrated on slopes, it is necessary to secure roads connected to individual houses and to improve infrastructure, such as installing stairs on slopes. Such an environmental improvement method has been partially applied to the Sae-Tul Village project (a project to remodel living conditions in vulnerable areas) jointly promoted by the Korean government's Regional Development Committee, the Ministry of Land, Infrastructure and Transport, and the Ministry of Agriculture and Forestry since 2015 [47].

Second, in commercial areas, lot shape and building characteristics have little effect on vacant house occurrence. There is a high possibility of vacant houses in places with low traffic and accessibility and in places with a small floating population. Therefore, remodeling deteriorated or old houses into distinctive buildings and converting them to commercial use will revitalize commercial districts and increase the floating population, which will have a positive effect on reducing vacant houses to some extent. This method is also evident in urban regeneration at home and abroad. Actively preventing vacant houses requires improving the physical environment and social and economic support programs. Researchers can develop ways to expand on these findings by discussing the results and how they can be interpreted from the perspective of previous studies and their working hypotheses. The findings and their implications should be discussed in the broadest context possible.

A neglected vacant house is a private property, but it also plays a significant role as a public good that affects the surrounding living environment. It should be actively utilized to form a sustainable community by inducing the owner to voluntarily maintain and use it as a community facility needed by local residents.

Restoring the sustainability of the community by repairing empty houses neglected for a long time requires the government's support. Financial support in terms of building acquisition or demolition cost will be needed to conduct a full investigation of vacant houses and to systematically identify vacant houses that need to be demolished. Local residents can purchase vacant houses at the city or government level, which can then be used as shared spaces, thus creating a sustainable community. This study identified and determined the causes and factors affecting the occurrence of vacant houses. Building on these findings, future research must concentrate on various measures or policies that will help to utilize empty houses, benefitting the community.

The significance of this study is as follows. First, it will be possible to use it as basic data for countermeasures against vacant houses. In previous studies, there was a limit to the local response by using macroscopic data. This study analyzed the factors for the occurrence of vacant houses according to the area of use. Based on the research results, it will be possible to prepare countermeasures to prepare for urban decline and regional slums. From the perspective of urban planning, a plan for vacant house management linking residential value improvement and regional planning was presented. The limitations of this study are as follows. Due to data structural limitations, 3years data were used for analysis. If panel data are established in the future, it will be possible to identify the cause of the occurrence in more detail.

Author Contributions: H.J. conducted the literature reviews and wrote the first draft of the manuscript. S.L.'s suggestions and comments contributed to the analytical framework. S.-J.K. verified the reliability of the statistical analysis results and contributed to the interpretation of the analysis results. S.-Y.K. coordinated the research results of the collaborators during the writing of the manuscript and led the setting of the overall direction. All authors contributed to modifying this manuscript. All authors have read and agreed to the published version of the manuscript.

Funding: This work was supported by the National Research Foundation of Korea (NRF), grant funded by the Korean government (MSIT) 2020R1G1A1101214.

Institutional Review Board Statement: Not applicable.

Informed Consent Statement: Not applicable.

Data Availability Statement: Not applicable.

Acknowledgments: The authors thank the anonymous reviewers and editors for their valuable and constructive suggestions for improving this article.

Conflicts of Interest: The authors declare no conflict of interest.

Appendix A

Table A1. Vacant houses by district.

Classification	Admin. District	Number of Vacant Houses	Ratio
Urban areas	Gaho-dong	2	0.17
	Sangdae-dong	47	3.98
	Sangbong-dong	111	9.40
	Sangpyeong-dong	8	0.68
	Seongbuk-dong	41	3.48
	Sinan-dong	4	0.34
	Ihyeon-dong	18	1.53
	Jungang-dong	80	6.78
	Cheonjeon-dong	178	15.09
	Chojang-dong	50	4.24
	Panmun-dong	13	1.09
	Pyeonggeo-dong	17	1.44
	Hadae-dong	6	0.51
	Chungmugong-dong	5	0.42
Non-urban areas	Munsan-eup	52	4.41
	Geumgok-myeon	67	5.68
	Geumsan-myeon	35	2.96
	Naedong-myeon	2	0.17
	Daegok-myeon	51	4.32
	Daepyeong-myeon	4	0.34
	Myeongseok-myeon	41	3.48
	Micheon-myeon	8	0.68
	Sabong-myeon	25	2.12
	Sugok-myeon	11	0.93
	Ilbanseong-myeon	40	3.39
	Ibanseong-myeon	126	10.68
	Jeongchon-myeon	13	1.09
	Jisu-myeon	75	6.36
	Jinseong-myeon	21	1.78
	Jiphyeon-myeon	29	2.46
Sum		1180	100.00

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