**Composite hedonic land price model considering past price inertia**

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**Abstract**
Past price inertia sometimes interrupts urban renovation projects with private initiatives. A composite hedonic land price model, which adopts the idea of a switching regression model is proposed in this research. In contrast to traditional hedonic land price models where land price is generally modeled assuming a single value function, urban land price modeling has been done assuming competition among two types of bidders proposing different bids depending on their individual preferences regarding usage values of a particular piece of land, and a virtual bidder representing the reluctance of the present owner to sell the land at a lower price. The model is used to identify the spatial distribution of different types of evaluators and locations where past price inertia has existed in Osaka Prefecture, Japan. The model is also used to spatially analyze the usage value improvement requirement in the study area.

**Key words**
Hedonic model, land price, usage value, asset value, coexistence, urban renovation, GIS

**1. Introduction**
Urban renovation is the process of qualitative improvement of urban spatial structure. Ideally, this is a kind of planned intervention done fundamentally to improve the quality of urban space in particular areas within urban setting, in line with expectations of urbanites across various age groups and socio-economic divides, in terms of spatial arrangement of various land-uses (urban facilities) and standard of infrastructures. Traditionally, urban renovation projects were carried out by public agencies or cooperative agencies. Due to the overwhelming presence of public or quasi-public agencies, in terms of both funding and direct construction activity, land price was a less important consideration in deciding locations for those projects in the first generation of urban renovation projects from the 1930s to the 1960s (Carmon, 1999). After the first oil shock in 1973, with a shift in economic structure towards high value-added intellectual resource-based industries and service industries, in many developed nations, especially in Japan, land prices in the town centers started to shoot up. In the 1980s, in search of affordable and better living conditions, massive outflow of urban population from city centers to city fringes began. Many businesses started relocating from town centers to the fringes, and town centers began to loose their vitality. At the beginning of the 1990s, the economic "bubble" broke, and urban land prices in Japanese cities started to decline. However, land prices in city centers remained considerably higher than in the suburbs due to the fact that landowners in city cores, who had bought land at high prices during the bubble economy, were reluctant to sell their land at lower prices and thus incur heavy financial losses. Due to scarce public funding for large-scale public-sector renovation projects, and the reluctance of private entrepreneurs to undertake any projects due to high land prices, significant amounts of urban land became derelict and vacant in the traditional city centers, seriously impairing the quality of urban development there. A place where such deteriorated quality of urban growth is observed has implications for the usage value of land lots there. It can be assumed that the current usage values of these land lots do not match their corresponding asset values (i.e., land prices), which are assumed to represent previous time-point prices of these land lots.

In this research, in order to identify spatial distribution of such land lots which we call lots with 'past price inertia', and to analyze required improvements of usage values affecting such lots due to urban renovation measures, a composite hedonic residential land price model is proposed.

**2. Related researches and objectives of this research**
The hedonic technique is based on the premise that goods traded in the market are made up of different bundles of attributes or characteristics. Hedonic land price models are used in the operational land price modeling for a wide variety of purposes. Garrod and Willis (1992) examined neighborhood or environmental characteristics of countryside parcels in the UK using a hedonic price model. Spahr and Sunderman (1995) used Wyoming ranchland sales data to model the contribution of scenic and

recreational quality to agricultural land price. Bockstael (1996) estimated a hedonic model in order to predict probabilities associated with converting undeveloped land to developed lands. Important variables included lot size, public services, zoning, proximity to population centers and variables associated with the percent of agricultural use, forestlands and open space in the Patuxent watershed. Hedonic price models (HPM) which include GIS delineated variables, permit inferring the impact of land attributes on land values. But only a few to date have incorporated the spatial specificity afforded by GIS measurements. A hedonic rural land study using GIS was conducted by Kennedy et al (1996). The analysis identified rural land markets in Louisiana based on economic, topographic and spatial variables. GIS was used for defining distance to market as well as soil type variables. Geoghegan et al. (1997) developed GIS data for two landscape indices and incorporated them in a hedonic model for Washington, DC, suburban properties. Their measure of fragmentation is defined as perimeter to size ratio. They also used land cover measure as an index of land-use type, which is a surrogate for flora and fauna habitat. Bastian et al.(2002) used GIS data in a hedonic price model to estimate the impact of amenities and agricultural production characteristics of land on price per acre for a sample of counties in Wyoming, USA. Sengupta and Osgood (2003) used ranchette sales data as dependent variable and satellite greenness indices as explanatory variables along with access to roads, cities and neighboring ranchettes to estimate the value of remoteness for ranchettes in Yavapai County, USA. Most of the applied models referred so far have used an ordinary least-square method to estimate the parameters of models. Moreover, single bid or land value functions were used in those models, ignoring the notion that in urban contexts, land prices are determined by the competition of different coexisting buyers having different evaluation functions even for the same type of land-use.

In contrast to traditional hedonic land price models where land prices are generally modeled assuming a single value function, a switching regression model by Fair and Jaffee (1972) has been applied assuming competition among several types of competing bidders who propose different bids depending on their individual preferences regarding usage values of a particular piece of land. The switching mechanism is also extended to consider the effect of past price inertia. The model is used to analyze the spatial distribution of different type evaluators, especially to identify locations where past price inertia exists in Osaka Prefecture, Japan. The model is also used to quantify the usage value improvement requirement, i.e., requirement of urban renovation in the study area.

**3. Proposed composite hedonic model**

In order to capture differences in evaluation, a composite hedonic price model, formulated by adopting the idea of switching regression model by Fair and Jaffee (1972), is proposed. Switching regression is based on the premise that an observed quantity (in case of present research land price) can be regressed to any of the regressor functions if one regressor functions are larger than the others, depending on assumed probability distribution.

**3.1 Assumptions for the model**

In urban areas, the value of a particular parcel of land is a function of not only features related to the geographic position but also to the features of wider geographic regions within which the parcel is located. Moreover, different buyers may evaluate a particular land parcel differently depending upon their mobility patterns, or, more specifically, usages of personal automobiles. Some may consider that accessibility to various local amenities is important, while others may think that availability of amenities on a wider regional scale is important. In addition, land has value as an asset, which is usually determined by its power if used as collateral in the banking system, and this is different than its usage value. The asset value of land is usually dependent on the macro-economic situation of a country. So, even though the usage value of a particular piece of land goes down, land is not always sold by the landowner, but he or she keeps the land and waits for better economic conditions.

In this model it is assumed that two competing bidders compete for buying a piece of land. The first one (referred to hereafter as Type 1) proposes his bid-price considering usage value of that land in terms of accessibility to various local facilities; the second one (referred to hereafter as Type 2) considers the availability of facilities at a wider regional level. Moreover we consider a virtual buyer (referred to hereafter as Type 3) who bids for the lot with the “reservation price” of the present landowner. The third one does not consider usage value but asset value, which is assumed to be represented by the past price of that piece of land. The land price of a particular place would be determined by the winner among these three types of bidders. When the Type 3 buyer becomes the winner, no transaction is realized and the reserved price is observed. The land price of a previous time point (five years back) is used as a surrogate of asset value for the Type 3 bidder.

### 3.2 Model formulation

Let $V_{1n}$ and $V_{2n}$ be proposed bid-prices by Type1 and Type 2 evaluators, respectively, and $V_{3n}$ be proposed bid-price of Type 3 who formulates his bid-price considering past price, for any land lot $n$, and these bidding functions are expressed by following equations:

$$V_{1n} = f_{1n} + \varepsilon_{1n} = C_1 + \alpha_1 A1_n + \alpha_2 P_n + \alpha_3 I_n + \alpha_4 L_n + \varepsilon_{1n} \quad (1)$$

$$V_{2n} = f_{2n} + \varepsilon_{2n} = C_2 + \beta_1 A2_n + \beta_2 P_n + \beta_3 I_n + \beta_4 L_n + \beta_5 R_n + \varepsilon_{2n} \quad (2)$$

$$V_{3n} = f_{3n} + \varepsilon_{3n} = C_3 + \theta\ M_n + \varepsilon_{3n} \quad (3)$$

$$Y_n = \max(V_{1n}, V_{2n}, V_{3n}) \quad (4)$$

where,

$C_1$, $C_2$ and $C_3$ are constants.

**$A1_n$** and **$A2_n$** are two accessibility vectors for Type 1 and Type 2 evaluators, respectively, expressed as shortest distances in meters from each price point to various facilities.

**$P_n$** is a vector of planning permission variables, composed of dummy variables, 1 if there is permission and 0 otherwise, for residential use, commercial use, and both residential and commercial type of use and fire prevention requirements.

**$I_n$** is a vector of infrastructure availability dummy variables: 1, if infrastructure exists, 0 otherwise, used for gas and sewerage facilities.

**$L_n$** is a vector of lot characteristics; lot size in square meters; buildable area in percentage; and permitted floor area ratio.

**$R_n$** is a vector of wider regional characteristics, used for Type 2 only, expressed by the number of various facilities within 2 km from the sample points.

$M_n$ is the past price (1997)

$\alpha_1\ \alpha_2,\ldots, \beta_1,\beta_2,\ldots\ \theta$ are parameters to be estimated.

$\varepsilon_{1n}$, $\varepsilon_{2n}$ and $\varepsilon_{3n}$ are independent and identically normally distributed error terms.

Let $P_n(1)$ be the joint probability that $V_{1n} > V_{2n}$, $V_{1n} > V_{3n}$, and the observed land price $Y_n = V_{1n}$. This event can be rewritten by $V_{2n} < Y_n$, $V_{3n} < Y_n$, and $V_{1n} = Y_n$; furthermore, by $\varepsilon_{2n} < Y_n - f_{2n}$, $\varepsilon_{3n} < Y_n - f_{3n}$, and $\varepsilon_{1n} = Y_n - f_{1n}$. Because of independence of error terms, $\varepsilon_{1n}$, $\varepsilon_{2n}$, and $\varepsilon_{3n}$, the joint probability is given by multiplication of the cumulative probability function of $\varepsilon_{2n}$ and $\varepsilon_{3n}$ with a probability density function of $\varepsilon_{1n}$. Due to the normality of the distributions, it follows:

$$P_n(1) = \Psi(Y_n - f_{2n})\Psi(Y_n - f_{3n})\psi(Y_n - f_{1n}) \quad (5)$$

where,

$\Psi(\varepsilon)$ and $\psi(\varepsilon)$ are normal cumulative function and normal density function, respectively.

Let $P_n(2)$ be the joint probability that $V_{2n} > V_{1n}$, $V_{2n} > V_{3n}$ and the observed land price $Y_n = V_{2n}$. The joint probability is similarly given by multiplication of cumulative probability function of $\varepsilon_{1n}$ and $\varepsilon_{3n}$ probability density function of $\varepsilon_{2n}$, as follows:

$$P_n(2) = \Psi(Y_n - f_{1n})\Psi(Y_n - f_{3n})\psi(Y_n - f_{2n}) \quad (6)$$

With similar logic, $P_n(3)$ the joint probability that $V_{3n} > V_{1n}$, $V_{3n} > V_{2n}$ and $Y_n = V_{3n}$ is given as

$$P_n(3) = \Psi(Y_n - f_{1n})\Psi(Y_n - f_{2n})\psi(Y_n - f_{1n}) \quad (7)$$

Total probability $P_n(1) + P_n(2) + P_n(3)$ gives unit likelihood for one price point, then the logarithm of likelihood over the total samples becomes:

$$L = \sum_n \ln\left[P_n(1) + P_n(2) + P_n(3)\right]. \quad (8)$$

Equation (8) is used for a maximum likelihood estimation by the Newton-Raphson method to get parameter estimates for equations (1), (2) and (3). Ordinary least-square estimates of parameters for equation (1), (2) and (3) are used as the starting values for maximum likelihood estimation. Logarithmic transformations of the independent variables are pursued for accessibility variables measured by shortest distances from sample points.

**3.3 Study area**

Osaka, the second most populous prefecture in Japan, situated 500 kms west of Tokyo, has been selected as the study area for this land price model. The Osaka region is considered as a gateway of foreign culture and trade in Japan. Osaka led Japan's economic development from the 17th through 19th centuries, through industry activities such as cotton textiles. Land reclamation projects, together with new town developments in Senri (in the north) and Senboku (in the south), and road and rail networks helped Osaka to play a role as an engine of Japan's post-war economic boom. Land prices in the region also showed a declining trend from 1992, after the rupture of the economic "bubble." But still, the price of land in Osaka Prefecture today is considerably higher, regardless of land category, compared to the average price of land in other nearby prefectures. On the other hand, in comparison to Osaka Prefecture, the average price of land is 1.5 times higher in Tokyo in residential areas, 2.0 times higher in business areas, and 1.4 times higher in industrial areas. In comparison to Tokyo, where land-use demands in the city cores and downtown areas have recovered since the late 1990's, downtown Osaka is still experiencing lost demand concurrent with spatial expansion of suburban areas.

**3.4 Data and variables**

Geographic information systems (GIS) permit a quantitative means of affixing land characteristics to their locations. The Geographical Survey Institute of Japan distributes the official database regarding locations of various public facilities across Japan. This spatial database contains geographic coordinates of all public facilities. Osaka Prefecture's portion of this database is used in this research. Different shape files are prepared for different types of facilities. The Official Land Price Database of Japan's Ministry of Land, Transport, and Infrastructure is used for land price data. This database contains 1,985 points for price information. These points (referred to hereafter as price points) contain coordinate information, land price information from 1984 till 2002, information regarding planning restrictions, infrastructure availability, and lot characteristics. A "buffering function" is used to create 500 meter and 2 km buffers from each of the price points. The number of each type of facility within these buffers is calculated by using "points in polygon" extension. Shortest distances to the nearest facility are calculated by using a "spatial join" function. A shop statistics database, available at 1 km x 1 km resolution, provided by Japan's Ministry of Economy, Trade and Industry is used to calculate the number of shops in each of the 500 m and 2 km buffer zones from price points.

**4. Estimated results and discussion**

**4.1 Parameter estimates**

Table 1 shows estimates, Student's t-statistics, and levels of significance (p-value) of the parameters of the model. It can be observed that all parameters of the model have expected signs and are statistically significant. As expected, Type 3 evaluators rate past price information very high. Among accessibility variables, the distance to the nearest railway station is evaluated highly by both Type 1 and Type 2 evaluators. The distance to Osaka City Hall has a strong effect on the evaluation of Type 2 evaluators. In the case of Type 1, parameter values for other accessibility variables, such as distance to the nearest hospital and to the nearest junior high school, are also found significantly negative.

For Type 2 evaluators, wider regional characteristics, such as numbers of hospitals, police stations, and public buildings in the 2 km buffer are found to have strong positive effects. On the other hand, numbers of government offices and fire stations have negative effects. The existence of a strict fire prevention code shows a positive effect for Type 1, but negative for Type 2. For densely-built districts, a strict fire prevention code may decrease the risk of fires spreading from surrounding buildings, but for sparsely-built areas, such policies increase building costs. Lot size is found to be insignificant for both types of evaluators, and therefore is dropped in the estimation. Finally, among infrastructure availability variables, the availability of a sewage system is strongly evaluated by both types, but for Type 2 households a positive evaluation is not so strong for the gas supply system.

**Table 1 Parameter estimates of the model**

| Variables | Parameter Estimate | t-statistic | P-value |
|---|---|---|---|
| $C_1$ Constant in equation (1) | 11.4024 | 18.37 | 0.000 |
| $C_2$ Constant in equation (2) | 15.4082 | 19.42 | 0.000 |
| $C_3$ Constant in equation (3) | 1.3341 | 24.16 | 0.000 |
| $\theta$ Parameter for the past price in Type 3 function, equation (3) | 0.8612 | 195.71 | 0.000 |
| Distance to nearest railway station (for Type 1) | -0.0655 | -2.98 | 0.003 |
| Distance to nearest hospital (for Type 1) | -0.0444 | -2.28 | 0.022 |
| Distance to nearest elementary school | -0.0337 | -1.20 | 0.229 |
| Distance to nearest junior high school | -0.0591 | -2.56 | 0.010 |
| Distance to nearest public building | -0.0029 | -0.09 | 0.924 |
| Distance to nearest government office | -0.0494 | -2.55 | 0.011 |
| Distance to nearest railway station (for Type 2) | -0.0517 | -2.44 | 0.015 |
| Distance to Osaka City Office (for Type 2) | -0.5180 | -13.24 | 0.000 |
| Distance to nearest hospital (for Type 2) | 0.0275 | 2.72 | 0.006 |
| Number of police stations in 2 km buffer | 0.1123 | 6.08 | 0.000 |
| Number of public buildings in 2 km buffer | 0.0087 | 6.36 | 0.000 |
| Number of govt. offices in 2 km buffer | -0.0183 | -3.43 | 0.001 |
| Number of fire stations in 2 km buffer | -0.1630 | -2.93 | 0.003 |
| Dummy: 1-residential use permitted (for Type 1) | -0.0417 | -1.01 | 0.310 |
| Dummy:1-residential and commercial use permitted (for Type 1) | -0.0259 | -0.82 | 0.409 |
| Dummy: 1-Commercial use permitted (for Type 1) | -0.8885 | -1.14 | 0.250 |
| Dummy: 1-Fire prevention code (for Type 1) | 1.3810 | 1.63 | 0.101 |
| Dummy: 1-residential use permitted (for Type 2) | 1.2201 | 1.79 | 0.073 |
| Dummy:1-residential and commercial use permitted (for Type 2) | 1.0012 | 1.47 | 0.141 |
| Dummy: 1-Commercial use permitted (for Type 2) | 0.4232 | 0.58 | 0.555 |
| Dummy: 1-Fire prevention code (for Type 2) | -0.2640 | -4.17 | 0.014 |
| Dummy: 1-gas network exists (for Type 1) | 0.3359 | 0.31 | 0.000 |
| Dummy: 1-Sweage network exists (for Type 1) | 0.8615 | 2.53 | 0.000 |
| Dummy: 1-Sweage network exists (for Type 2) | 0.2375 | 3.35 | 0.000 |
| Standard error of $\varepsilon_1$ | 0.1376 | 15.44 | 0.000 |
| Standard error of $\varepsilon_2$ | 0.1671 | 19.55 | 0.000 |
| Standard error of $\varepsilon_3$ | 0.1110 | 48.62 | 0.000 |

Log likelihood :1,528.66, Number of observations: 1,868

Goodness of fit of this model to the observed price is sufficiently high, as observed by the correlation coefficient 0.975. When single independent regressions are carried out on all samples using the same independent variables for $f_{1n}$, $f_{2n}$, and $f_{3n}$, correlation coefficients are found to be 0.56, 0.53, and 0.97, respectively. It is intuitively understandable, as only previous price information is used to construct bid-rent for Type 3, so the correlation coefficient is observed to be high for $f_{3n}$.

**4.2 Spatial distribution of three types of evaluators**

The model in this case outputs three predictions of prices for each sample point. Type 1 and Type 2 evaluations represent usage values, while Type 3 evaluation represents asset value of each point. All

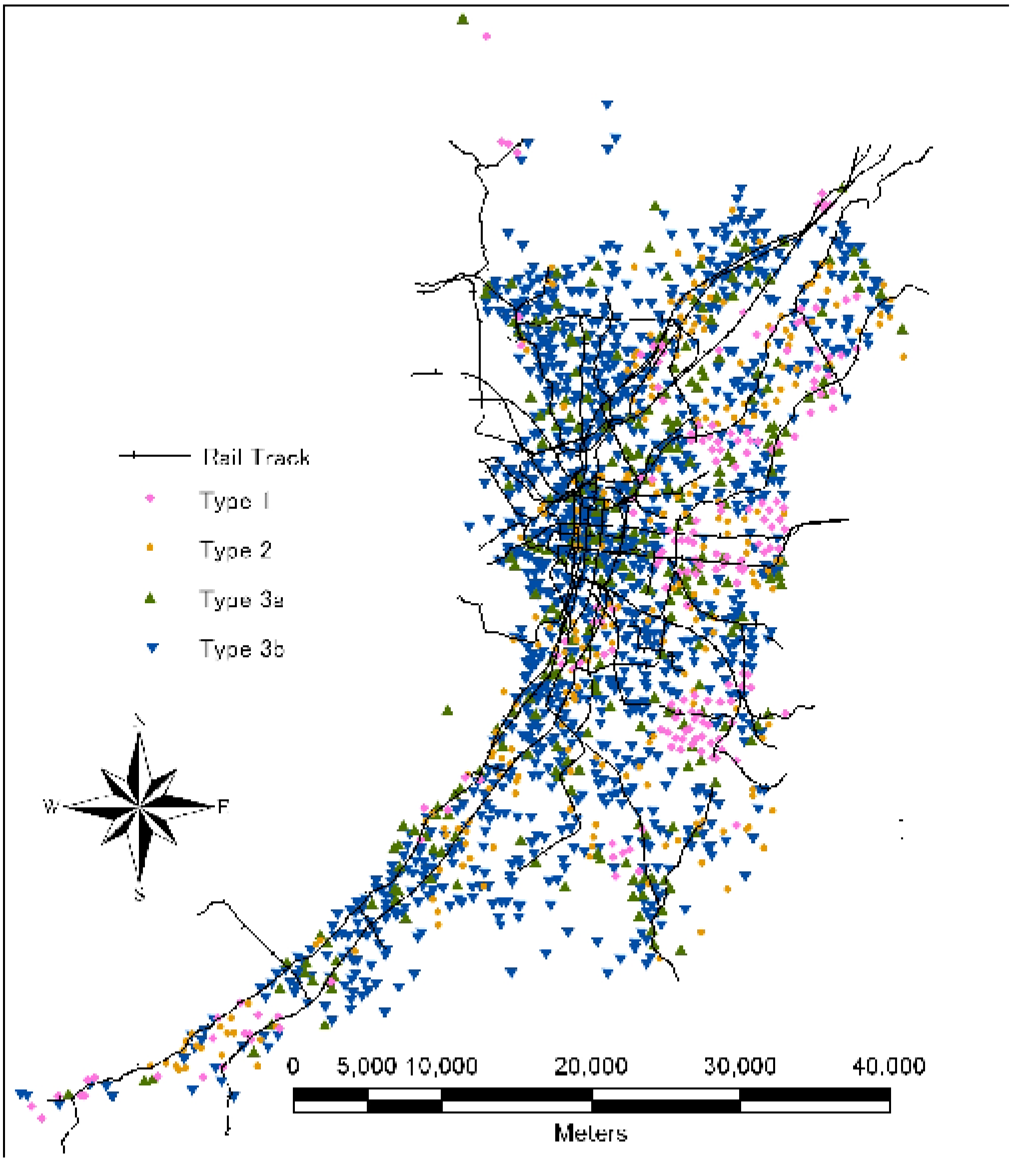


**Figure 1 Spatial distributions of Type1, Type 2 and Type 3 evaluators**

**Table 2 Spatial characterizations of evaluators (3 Types)**

| Indices | Type 1 | | Type 2 | | Type 3 |
|---|---|---|---|---|---|
| Number of predicted price points | 192 | | 248 | | 1428 |
| Mean distance to nearest hospital | 740 | < | 933 | =< | 938 |
| Mean distance to nearest elementary school | 310 | =< | 348 | < | 459 |
| Mean distance to nearest junior high school | 492 | < | 549 | < | 700 |
| Mean distance to nearest public building | 182 | < | 217 | < | 259 |
| Mean distance to nearest railway station | 571 | < | 739 | < | 885 |
| Mean distance to Osaka City Hall | 7598 | < | 9852 | < | 17662 |
| Number of shops within 500m buffer | 601 | = | 601 | > | 404 |
| Number of shops within 2Km buffer | 3025 | >= | 2950 | > | 1816 |
| Number of hospitals within 2Km buffer | 6 | = | 6 | > | 4 |
| Number of public buildings within 2Km buffer | 64 | >= | 62 | > | 42 |
| Floor Area Ratio (FAR) (in %) | 214 | =< | 219 | < | 233 |
| Mean lot size | 4.99 | =< | 5.01 | < | 5.30 |

All distance units are in meter, areas in sq. meter sample points are classified into three types viz., Type 1, Type 2, and Type 3, depending on the highest bid-rent value for each of the sample points. This classification helps identify the spatial distribution of the three types of evaluators, especially Type 3 points, which are termed 'points of past price inertia'.

Out of total 1,868 sample points 1,428 points are found to be of Type 3 points, i.e., points where past price inertia exists. Numbers for Type 1 and Type 2 are found to be 192 and 248 respectively. Table 2 shows the spatial characterization of the three types of evaluators and Figure 1 shows the spatial distribution, where type 3 points are further sub-classified into type3a and type 3b.

A higher concentration of Type 3 points along the western border of the prefecture and especially in areas close to Osaka City suggest that higher past price inertia is observed in historically-developed older urban areas of the prefecture. Type 1 points are observed close to railway stations and Type 2 points in sparsely developed areas left between old development axes along railway lines. From Table 2 it can be observed that both accessibility indices and indices for wider regional aspects are worse for Type 3 locations among the three types. This suggests that usage values of these points are less due to their poor accessibility and poor surrounding conditions in terms of offering convenience to urbanites. Mean lot size and FAR for Type 3 locations are, however, observed to be higher than these of Type 1 and Type 2, suggesting that Type 3 locations are a bit far away from congested areas and possess fewer urban facilities. Such locations can therefore become easy choices for urban renovation projects such as land readjustment projects.

**4.3 Sub-classification of past price inertia points**

Within past price inertia (Type 3) points, evaluators similar to Type 1 and Type 2 are identified on the basis of higher bid-rents among these two types and are further classified as Type 3A and Type 3B. Given the fact that past price inertia points are the locations where usage values, given by two types of evaluation discussed above, are lower than predicted price, spatial distribution and characterization of Type 3A and Type 3B points within Type 3 have significant importance in deciding type and nature of urban renovation policies, in terms of usage values improvement requirements of these points, and also their implementing agencies.

Out of 1,428 points identified as past price inertia points, 283 points are identified as Type 3A while remaining 1,145 are identified as Type 3B. Table 3 shows the spatial characterization and Figure 1 shows the spatial distributions of Type 3A and Type 3B points. No appreciable differences are observed in wider regional characteristics variables, as both types are only sub-categories of Type 3, and therefore are omitted from Table 3.

Comparing Table 2 and Table 3, a similar trend of spatial characteristics can be observed for Type 3A and Type 3B points, just as observed for Type 1 and Type 2. Type 3A points are found to locate closer to various facilities than Type 3B points. Therefore, permitted Floor Area Ratios are also found to be higher in the case of Type 3A points. However, average area (i.e., average lot sizes) for Type 3B points is found to be higher than for Type 3A points. Points are further characterized according to non-spatial attributes. Table 4 shows comparisons regarding usage values, and predicted and observed prices per square meter for Type 3A and Type 3B points.

**Table 3 Spatial characterization of Type 3A and Type 3B points**

| Indices | Type 3A | | Type 3B |
|---|---|---|---|
| Number of predicted price points | 283 | | 1145 |
| Mean distance to nearest hospital | 748 | < | 986 |
| Mean distance to nearest elementary school | 435 | < | 465 |
| Mean distance to nearest junior high school | 678 | < | 706 |
| Mean distance to nearest public building | 220 | < | 268 |
| Mean distance to nearest railway station | 619 | < | 951 |
| Mean distance to Osaka City Hall | 16013 | < | 18070 |
| Floor Area Ratio (FAR) | 279 | > | 222 |
| Mean lot size | 5.07 | < | 5.10 |

**Table 4 Characterization of Type 3A and Type 3B points with non-spatial attributes**

| Indices | Type 3A | Type 3B |
|---|---|---|
| Mean predicted usage value | 92967 | 108012 |
| Mean predicted price | 226386 | 173610 |
| Mean observed price | 221904 | 179871 |

It can be observed from Table 4 that the mean predicted usage value for Type 3A points is lower than that for Type 3B points. But both mean predicted and observed prices are higher for Type 3A than for Type 3B points. Higher predicted and observed prices for Type 3A points are reasonable given the fact these points are closer to various facilities than are type 3B points. Type 3B points are observed to be located in places left between older development axes along railway lines in comparatively newly-developed areas, away from existing urban facilities. But Type 3B evaluators seem to rate less congested urban fringes higher in their location decisions, and they do not mind the unavailability of facilities in their immediate neighborhoods if such facilities are available at the wider regional level. Therefore, a higher usage value for these points seems to provide a reasonable explanation for the automobile-dependent lifestyle esteemed by new-generation urbanites.

### 4.4 Estimation of price gap to be overcome for active land use

The model outputs three bid-price predictions for each of the sample points. Difference of predicted bid-prices between Type 3, and maximum of Type 1 and Type 2 evaluations, are calculated for past price inertia points (i.e., where Type 3 is realized) which express the price gaps to be overcome if that land lot might be used as new land-usage. There are possibly two ways to overcome these price gaps; one way is monetary support to the present landowners to compensate the temporal loss from selling the land for the present usage value. The other way is improve the usage value of those points through urban renovation projects. Spatial distribution and implications of usage value improvement in urban renovation are then, discussed here.

Marked differences are observed in the amount of price gap and its spatial distribution across Type 3A and Type 3B points. Price gaps are classified into three categories:

- Low, less than or equal to 5% of predicted usage value,
- Medium, from greater than 5% up to less than or equal to15% of predicted usage value,
- High, greater than 15% of predicted usage value.

Table 5 shows spatial characterization and Figure 2 shows the spatial distribution of these three categories. Out of 1,428 points where usage values are found to be lower than predicted land price, 888 are found to have small gap, requiring low improvement, 494 medium gaps and 46 large gaps, i.e. high improvements. Of these 888 points, 72 are of Type 3A and remaining 816 are of Type 3B. Difference in numbers of Type 3A and Type 3B points in case of medium and large price gaps are found not as substantial as low gap points.

It can be observed from Figure 2 and Table 6 that points with medium and large price gaps are located at comparatively closer distance from railway stations. As most of the Type 3B points are observed at comparatively wider distance from existing developed areas so small price gaps i.e., low improvement requirement points are grossly found at comparatively distant locations from railway stations. Higher land prices close to stations are thought to be main reason for the large price gaps and then higher improvement requirement. Though, average lot sizes of such points are found to be lower than the smaller price gap points.

**Table 5 Price gap magnitudes for Type 3A and Type 3B points**

| Price gap magnitude | Type 3A | | Type 3B | Total |
|---|---|---|---|---|
| Less than or equal to 5% (Small, Low) | 72 | << | 816 | 888 |
| Greater than 5% up to 15% (Medium) | 193 | | 301 | 494 |
| Greater than 15% (Large, High) | 18 | | 28 | 46 |
| Total number of points | 283 | | 1145 | 1428 |
| Average improvement requirement | 7.97% | | 4.34% | 5.06% |

**Table 6 Spatial implications of price gap magnitudes**

| Price gap magnitude | Mean distance from railway station (m) | Average lot size ($m^2$) |
|---|---|---|
| Small, Low | 955 | 6 |
| Medium | 771 | 5 |
| Large, High | 770 | 5 |

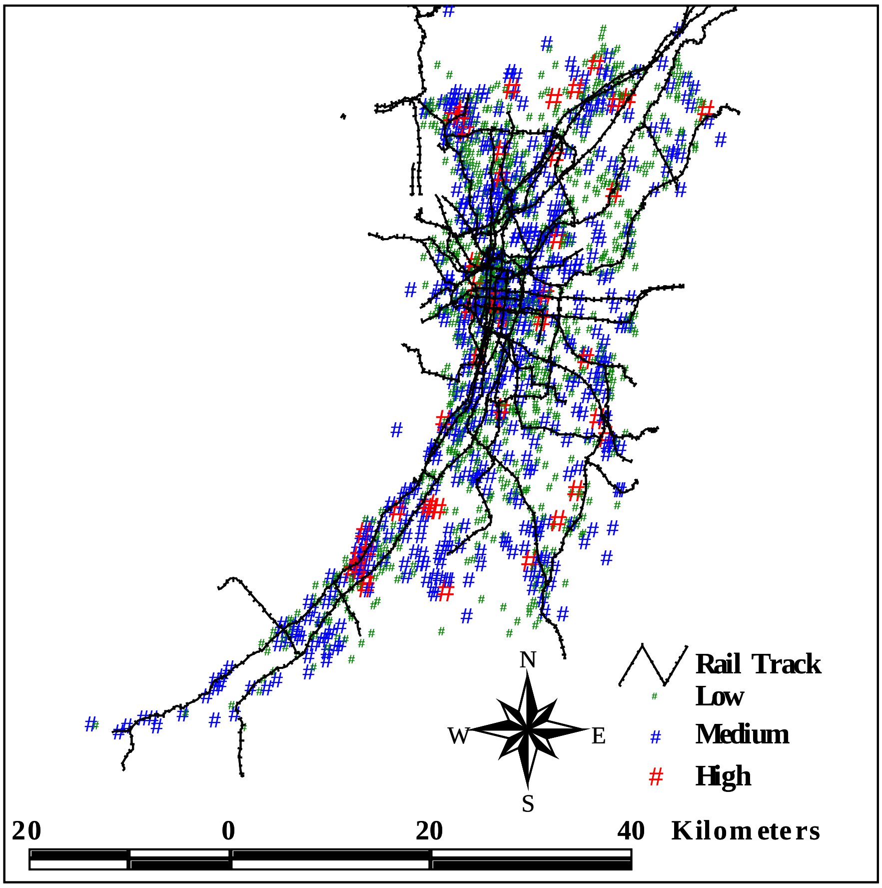

**Figure 2 Spatial distribution of usage value improvement requirement**

**5. Conclusions**

In this research, a composite hedonic price model has been proposed. In contrast to traditional approaches of hedonic price models, land price has been evaluated considering the coexistence of two types of evaluators for the same type of use and the present landowner reluctant to sell the land for a lower price than the reservation price. Introduction of a third bidder in the model is done as a surrogate to check for the past price inertia. In a time when urban land prices are showing a decreasing trend, this past price inertia is generally alleged to retard growth in urban core areas. GIS data development ushers in the possibilities of using more spatially explicit variables and model specifications than qualitative representations, such as ordinary rankings of land attribute levels, and/or indicator variables, signaling the presence of amenities. Estimation of the composite hedonic model using proposed techniques is expected to provide more accurate value estimates of both local and regional determinants of land value.

It has also been substantiated that major shares of land lots in the study area have lower usage values than actual land prices. Among these land lots, those which are close to railway stations require medium to high improvement of usage value, and those located at a higher distance from railway stations require less improvement. Lots requiring higher improvement may require direct intervention in terms of construction activity by the public sector. Land lots requiring less improvement may be developed by private entrepreneurs, and soft policies, such as construction or renovation cost support from public bodies, might help attract private developers to renovate those land lots.

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