A Feasible Sales Price Decision Model of Apartment Housing Units Considering the Market Price and Buying Power

Hyesung Park¹, Donghoon Lee² and Sunkuk Kim*³

¹Ph.D., Incheon Development & Transformation Corporation, Korea
²Lecturer, Department of Architectural Engineering, Kyung Hee University, Korea
³Professor, Department of Architectural Engineering, Kyung Hee University, Korea

Abstract
Sales price closely correlates with the market price of neighboring apartment-housing units, which reflects the real transaction price. In addition, sales price is dependent on goods including the apartment's location, environment, traffic, residential conditions and housing characteristics. Studies on the sales price of apartment housing units mostly estimate the price in regard to the market price, the cost to build the apartments or a combination of both. Currently, there are studies in progress analyzing the factors that impact the sales price and the importance of purchase decision factors of consumers. However, the purchase decision factors of consumers and their importance are always changing. Thus, a sales price decision model that can account for the dynamic nature of purchase decision factors and market price is needed. In this regard, the purpose of this paper is to develop a feasible sales price decision model of apartment housing units considering market price and buying power. This model can be used as a decision-making tool in the initial phases of a project to help contractors' achieve a reasonable sales price and improve their successes with apartment housing projects.

Keywords: sales price; market price; buying power; decision model; apartment housing units

1. Introduction
The sales price of apartment housing units is a key factor in the success of a project for contractors. This is because sales price is an important factor in consumers' decision to purchase an apartment-housing unit. Sales price correlates strongly with the market price of neighboring apartment housing units, and, in other words, the real transaction price. In addition, buying power is provided to the consumer in regard to the goods that the unit offers, such as the apartment's location, environment, traffic, residential conditions and housing characteristics.

Because an apartment unit involves the economic concept of property and investment in addition to the physical characteristics of the residential space, the buyer may not buy a unit if they believe that its value is less than the market price, or that such value will not overcome the future difference in market price. In addition, the real estate market trend, policies, institutions, social environment and physical environment are exogenous variables that must be considered when determining sales prices, because they also affect the purchasing power of consumers.

The housing industry typically applies a general method to calculate the sales price by considering construction cost, market price of apartment buildings in the neighboring areas, other expenses and their profit. However, this general method resulted in around 60,000 housing units that were unsold throughout Korea in 2013. Thus, the purpose of this paper is to develop a feasible sales price decision model for apartment housing units considering market price and buying power.

The study analyzes the existing housing price decision theories and purchase decision factors using the theoretical considerations shown in Fig.1. Then, the sales price index and time-series analyses are conducted to develop a market price index. In addition, a buying power index that can reasonably account for the market price index is developed. The buying power index is composed of weighted factors, with weights calculated from purchase decision factors based on the location and marketability of the apartment and the Analytic Hierarchy Process (AHP) method. Lastly, a sales price decision model is developed using the market price index and the buying power index.

2. Theoretical Survey
The Hedonic Price Function (Rosen, 1974) has been frequently used to measure the price of goods
that have various characteristics, including houses. In addition, a wide range of hedonic analyses have been used to estimate the demand of specific housing characteristics as well as consumer's welfare. Studies that assess housing price indices generally include many variables including an estimation of the physical and structural characteristics of houses and environmental features. Blackley et al. (1986) used the AHS (Annual Housing Survey, USA) and the Hedonic Price Function to estimate housing price and rental fee. Also, Thibodeau (1989) calculated the average monthly rental fee and housing price index of 60 cities in the USA from 1974 to 1983. Also, Goodman and Kawai (1982) and Goodman (1988) used AHS data to develop a rental fee index and a housing price index. Subsequently, Bradford (2006) summarized the theories for calculation of housing price indices and verified them based on the AHS data. In addition, Mills and Simenauer (1996) used data from all over America to estimate the housing price index of houses of the same quality. Some studies were able to define specific characteristics that affect the market price of a residence. For example, Benson (1998) confirmed that houses with "good views" were sold for at least 60% more than houses with "poor views". Also, as a study related to the educational environment, Haurin and Brasington (1996) discovered that the quality of public schools has a great influence on the housing price. In America, the Office of Federal Housing Enterprise Oversight (OFHEO) prepares House Price Indexes (HPIs) with a repeated sales price index model (Calhoun, 1996). Freddie Mac, a mortgage lender, then estimates the Conventional Mortgage Home Price Index (CMHPI) using the repeated sales price index model (www.freddiemac.com).

Schniederjans et al. (1995) applied Goal Programming and AHP methods to propose purchase decision factors for housing that were distinguished by traffic, accessibility, ambient environment, characteristics of the apartment and the community environment. Also, Bender et al. (2005) conducted a study on preferences by dividing the factors by accessibility and ambient environment. Here, the accessibility included two factors: 1) the distance from public transportation, private traffic networks, downtown, shopping malls, parks and educational institutes, and 2) the ambient environment including the landscape (view), noise and whether any pollution facilities are nearby. More recently, Wu (2010) classified the factors into traffic and accessibility, ambient environment, safety and community environment, and used the AHP method for preference surveys.

Kim (2012) conducted an analysis on the appropriateness of individual house price based on sales price. Kim analyzed the appropriateness of house prices between regions and within a region through the reflection of actual sales price in Daegu, Korea, and considered a plan to improve the appropriateness of individual house price. Lee et al. (2006) assumed that the owner's pricing of housing in the market impacts the sales price, and verified a causal relationship using historical data. In addition, Kim et al. (2001) conducted a study on analysis of the ranking correlation between the apartment purchase price decision factor and amenity decision factor with cognition of the consumer. However, these studies differ from this study, which has the purpose of drawing an appropriate sales price for housing.

In general, the theory used for pricing of housing units are housing decision or the method based on market data. Some representative theories include the cost approach, market approach, income approach, economic equilibrium theory and hedonic price model. The theory of purchase decision for apartment-housing units is summarized based on and cited from the previous studies mentioned above (Lee, 1992).

A) Cost Approach: Cost Approach estimates the property price by subtracting the depreciation amount from the cost of constructing a building. It is a supplier-centered pricing policy to estimate the production cost, instead of the sales price of a given property.

B) Market Approach: Market Approach compares the property deals that have the same or similar properties to estimate the price by considering the point of sales or deals.

C) Income Approach: Income Approach capitalizes the expected income of a property using the current market interest rate, to estimate the value of a given property.

D) Economic Equilibrium Theory: It is a theory that a household determines the size and location of housing based on its income and land price, which is a theory for selecting a residential area rather than a housing unit.

E) Hedonic Price Model: It is a new theory of consumer behavior to supplement the irrational assumption of economic equilibrium theory and to obtain a bundle of characteristics that make up the goods. It is suitable for estimating the market value of various housing characteristics.

3. Analysis of Contract and Amount Relation

This study predicts the market price at point of sales and develops a sales price decision model that reasonably estimates the price of apartment housing units (as goods). The sales price of new apartment housing units is affected by the market price of existing apartment housing units in the area. Appropriate prices of the new apartments can be calculated from a model in a study by Kim and Park (2011) that accounts for transaction price. According to this study, it was demonstrated that the price level of existing apartment housing impacts the sales price of new apartment housing, but the sales price of new apartment housing has no impact on the price of old apartment housing. In
addition, it was found that when the contractor decides the sales price, the most generally accepted method of doing so is based on the market price.

Herein, the fluctuation of Korean housing prices is examined and coined the Korea Housing Price Index (KHPI). The KHPI is congruent to the AHS (Annual Housing Survey) in the USA.

Because the KHPI is relative to a certain reference point on a 100-point scale, the index is not equal to the sales price. By using the KHPI rather than the raw sales price, the model predicts the fluctuation of present/future sales indices and reflects such fluctuation in the expected sales price.

The Market Price Fluctuation Index \( (R_{MI}) \) is conceptually similar to the KHPI in that it is a relative term. It is the difference between the 'Present Market Index (\( MI_p \))' and 'Future Market Index (\( MI_f \))', and the formula used for calculation is as below:

\[
R_{MI} = (MI_f - MI_p) + MI_p
\]

For instance, if the 'Present Market Price' is 106.9 and the 'Future Market Price future' (after 6 months) is 105, the 'Market Price Fluctuation Index' can be calculated as shown below.

\[
R_{MI} = (105 - 106.9) + 106.9 = -0.018
\]

The 'Future Market Index' is lower than the present value, so the sales price is expected to decline, and the fluctuation rate is estimated to drop 0.18% compared to the present.

Here, authors present a time-series model for Yeonsu-gu, Incheon, South Korea in 2011 as a case study. The 'Future Market Index' is predicted based on a time-series analysis. In authors' model, the trend of the sales price index of Yeonsu-gu, Incheon in 2011 is assumed to be estimated, and the sales index that is presented up to the prediction point is inserted as a time-series value. Because the data represent a non-stationary time series, differential is selected and the ARIMA (1, 1, 1) model is applied. As shown in the Ljung-Box test result in Table 1., the outlier can be confirmed as white noise.

\[
x(t) - 0.239 = 0.906 \times \{ x(t-1) - 0.239 \} + u(t)
\]

The prediction of house price indices in Yeonsu-gu, Incheon using the time-series model is shown in Table 2. The actual sales indices were publicly announced in June 2011 and are incorporated into the model. The house price index of Yeonsu-gu, Incheon in October 2011, 4 months later, is estimated with the model. The forecast value is 107.02, which implies that the market price is going up.

Based on the forecast data, the Market Index is inferred for Yeonsu-gu, Incheon for June 2011. The Market Index reflects the fluctuation of the sales price index. The fluctuation index is calculated from the difference between indices at two time points, divided into the present index. The fluctuation error is the fluctuation index expressed as a percentage. The Market Index after June 2011 and its fluctuation rate (applied with Equation (2)) are shown in Table 3.

The market price of Yeonsu-gu was predicted to decline approximately -0.03% – -0.11% between June and September 2011, to increase to 0.11% in October and to further increase to 0.29% in November. Based on the forecast, the expected sales price in the future can be multiplied by the fluctuation index to infer the future market price, as shown in Equation (4).

\[
P = P_f \times (1 + R_{MI})
\]

Here, \( P_f \): Feasible sales price \( P_f \): Expected sales price \( R_{MI} \): Market Price Fluctuation Index

A feasible sales price using the market index is calculated by multiplying the fluctuation index by the expected sales price. If \( R_{MI} < 0 \), the market price is expected to decline and the feasible sales price is smaller than the expected sales price. On the contrary, if \( R_{MI} > 0 \), the market price is expected to soar, so the feasible sales price is larger than the expected sale.

4. Development of the Buying Power Index

For the measurement of buying power, the factors considered by consumers in purchasing a new apartment (in other words, the purchase decision factors) should be identified. In addition, the importance of each of the purchase decision factors should be measured to more accurately estimate the
buying power of apartment housing units.

The concept of Buying Index (BI) in this study reflects the marketability of the given apartment based on scores in a per item evaluation. The Buying Index is estimated according to the following procedure.

a) Select the purchase decision factors (buying power measurement factors): Use data from preceding studies;
b) Set the buying power measurement factors: Primary questionnaire survey;
c) Estimate the weight per factor: Secondary questionnaire survey (experts);
d) Measure the buying power of apartments: Evaluation;
e) Calculate the buying power index of the project.

According to the studies conducted by Blackley et al. (1986) and Thibodeau (1989), the purchase decision factors of consumers change according to time and the environment. In the case of Korea in the mid-2000s, the dynamic purchase decision factors were mainly physical factors like housing characteristics or location and features of the apartment complex. But, towards the end of the 2000s, various factors acquired more weight including social/psychological factors and environmental factors. It is inferred that this shift is due to the fall of the real estate business caused by the financial crisis in 2008 and an increase in the amount of unsold apartment housing units, which in turn impacted the consumer consciousness and purchasing pattern.

Based on the result of preceding studies, the factors were grouped according to characteristics of each factor. The purchase decision factors were then classified into main factors and sub-factors. The main factors and sub-factors were organized based on the preceding study results, data related to housing and housing sales and interviews with housing project experts. The primary questionnaire survey was conducted with 44 office workers 30-60 years old residing in metropolitan cities. It inquired upon the importance of various factors in consumers' buying decisions including cultural facilities, the financial environment (including factors such as consumer price, treasury revenue and composite stock price index), and institution & policy factors (such as the sales price ceiling system and activation of supplying rental housing units). Items were excluded from the list if the response rate was less than 30%, because this implies that the factor does not strongly impact the buying decision.

Fig.1. illustrates the result of the primary questionnaire survey. The purchase decision factors were composed of 6 main factors – economy, location, house, financial environment, institution & policy and "other factors", with 20 sub-factors.

Main factors are classified into Economic factors and Institution & Policy factors by reflecting the market approach based on the theory of purchase decision for apartment housing units, and Financial Environment is added based on the theory of income approach. In addition, it is composed of Location, Housing factors and others based on the economic equilibrium theory. In consideration of the hedonic pricing model, the importance of such factors related to consumers and housing is analyzed to estimate the weight. To draw sub-factors, 52 housing project experts were interviewed in cooperation with the public housing project contractors, construction companies, apartment sales agencies and private developers.

Subsequently, an AHP analysis was performed according to the hierarchy of main factors and sub-factors that go into a purchase decision, and only the response results with a consistency ratio (CR) < 0.1 were selected. The weight of main factors was, in this order: economic factors (0.349), location factors (0.340), financial environment factors (0.118), housing factors (0.073), other factors (0.066) and institution & policy factors (0.053). The differences between housing factors, other factors and institution & policy factors were trivial as shown in Table 4. There was a minor difference between the economic factor and the location factor, the factors with the greatest weights. Also, the weight of the financial environment factor was ranked third, which implies that loan interest or real estate business has a greater impact on the consumer's buying power compared to a previous study. The sales price was the most critical sub-factor in deciding the purchase, and sub-factors including educational conditions, traffic convenience, investment value and maintenance cost ranked in 5th place as far as their importance in the buying decision was concerned. These sub-factors were included in the economic and location main factors, which are conventionally important in purchasing new apartment housing units, and it was found that the housing and "other" sub-factors were relatively less important.

For measurement of the buying power, the evaluation criteria for each factor are required. Evaluation of
the marketability of the apartments and the scoring criteria have been reported in preceding studies. However, such criteria or evaluation methods are not publicized as legal standards, guidelines or objective figures, and the raw data are not available. Thus, the reported evaluation data cannot be considered the absolute standard. Moreover, the evaluations change according to time, social consciousness, environmental changes and residential trends. Thus, the evaluation criteria and scoring system in this study are based on those in existing studies, but they were re-organized based on evaluation criteria practically used by private construction companies, interviews with experts, sales review reports of private developers and proposals of sales agencies.

A score was then calculated for each of the buying power evaluation items for authors' analysis. For each item, it was given a score of "0 points" when it was intermediate and the scale was designed that the difference between the highest and lowest scores for each item was 20 points; however, the scale did not always range from -10 to 10. The overall score of evaluation items was calculated in the following manner. (a) Both questionnaire responses and existing data on the impact of each item on purchase were plotted as a function of the evaluation item, as shown in Fig. 2.a. (b) A function was defined for the 2 variables – evaluation items and purchasing influence. (c) Minimum and maximum values for each evaluation item were set. (d) Scores (quantitative values for the impact on purchase) and appropriate intervals for the evaluation item were defined.

The minimum and maximum values and the score intervals differ for each evaluation item because, in order to most accurately depict the purchasing influence, the scoring interval and width exhibit different optimal scales. In the case of the number of households per building in Korea, when the number of households increases, the purchase intent is likely to increase, and it is believed that sufficient satisfaction is fulfilled at approximately 2,000 households per building. Assuming that the purchase intent is not encouraged or discouraged, it is reasonable to give different scoring and intervals for an example apartment building of 500 households as shown in Fig. 2.

The criteria for overall evaluation items of the project are presented in Table 5. The score of each evaluation item is applied with the same deviation (20 points). This is because the importance of evaluation item is the same as the importance of purchase decision factor, and the importance per factor has been estimated by AHP. The score deviation is calculated from the collected data, and Table 5. shows examples of various evaluation criteria and scoring.

### Table 4. Weight of Purchase Decision Factors for Apartment Housing Units

<table>
<thead>
<tr>
<th>Main Factors</th>
<th>Weight</th>
<th>Sub-Factors</th>
<th>Weight</th>
<th>Final Weight</th>
</tr>
</thead>
<tbody>
<tr>
<td>Economic Factor</td>
<td>0.349</td>
<td>Sales Price</td>
<td>0.548</td>
<td>0.192</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Investment Value</td>
<td>0.263</td>
<td>0.092</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Maintenance Cost</td>
<td>0.189</td>
<td>0.066</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Traffic Convenience</td>
<td>0.301</td>
<td>0.102</td>
</tr>
<tr>
<td>Location Factor</td>
<td>0.340</td>
<td>Educational Conditions</td>
<td>0.459</td>
<td>0.156</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Convenience Facilities</td>
<td>0.088</td>
<td>0.030</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Accessibility</td>
<td>0.152</td>
<td>0.052</td>
</tr>
<tr>
<td>Housing Factor</td>
<td>0.073</td>
<td>Direction &amp; Arrangement</td>
<td>0.243</td>
<td>0.018</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Number of Households</td>
<td>0.079</td>
<td>0.006</td>
</tr>
<tr>
<td></td>
<td></td>
<td>View</td>
<td>0.236</td>
<td>0.017</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Housing Size</td>
<td>0.201</td>
<td>0.015</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Floor Planning</td>
<td>0.157</td>
<td>0.011</td>
</tr>
<tr>
<td>Financial Environment Factor</td>
<td>0.118</td>
<td>Loan Interest</td>
<td>0.496</td>
<td>0.059</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Real Estate Business</td>
<td>0.504</td>
<td>0.060</td>
</tr>
<tr>
<td>Institution &amp; Policy Factor</td>
<td>0.053</td>
<td>Housing Tax System</td>
<td>0.660</td>
<td>0.035</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Loan Regulation</td>
<td>0.340</td>
<td>0.018</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Brand</td>
<td>0.219</td>
<td>0.015</td>
</tr>
<tr>
<td>Other Factors</td>
<td>0.066</td>
<td>Social Environment</td>
<td>0.450</td>
<td>0.030</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Sales Period &amp; Conditions</td>
<td>0.331</td>
<td>0.022</td>
</tr>
</tbody>
</table>

A score was then calculated for each of the buying power evaluation items for authors' analysis. For each item, it was given a score of "0 points" when it was intermediate and the scale was designed that the difference between the highest and lowest scores for each item was 20 points; however, the scale did not always range from -10 to 10. The overall score of evaluation items was calculated in the following manner. (a) Both questionnaire responses and existing data on the impact of each item on purchase were plotted as a function of the evaluation item, as shown in Fig. 2.a. (b) A function was defined for the 2 variables – evaluation items and purchasing influence. (c) Minimum and maximum values for each evaluation item were set. (d) Scores (quantitative values for the impact on purchase) and appropriate intervals for the evaluation item were defined.

![Fig.2. Scoring by Evaluation Criteria](image_url)
An evaluator marks the score of the apartment housing units to be sold based on the scoring criteria for each item. When it is neutral, "0" is marked and, based on this reference point, the difference between maximum and minimum values is set to 20 points. An evaluation is made in accordance with the scoring criteria for each item. To calculate the Buying Index, first, the converted score is calculated by dividing the evaluated score by the maximum value (when the evaluated score > 0) or the minimum value (when the evaluated score < 0) for each factor. Next, the weight per factor is calculated by multiplying the weight of main factor and the weight of sub-factor. The Buying Index is then calculated by multiplying the weight per factor by the converted score.

**Buying Power per Factor**

\[
\text{Buying Power per Factor} = \left( \frac{\text{Evaluated score}}{\text{Max or Min value}} \right) \times \text{Weight per factor}
\]

For instance, if the final weight of 'a1' item is 0.041, the evaluation scale is -10 points to +10 points, and the evaluated score is 5 points, it is calculated as shown in Equation (6).

\[
\text{Buying Power of 'a1'} = 0.2 (5 \text{ points ÷ 10 \text{ points}}) \times 0.041 = 0.0205
\] (6)

The final buying power of the project (apartment building) is the sum of buying indices per factor as shown in Equation (7).

\[
F_2 = \sum (\text{Weight per factor} \times \text{Evaluated score per factor converted}) = \text{Buying Power of Project (BI_{proj})}
\] (7)

A model of the buying index quantifies the buying power of the apartment. The factors that are present in the model are used to appropriately adjust the expected sales price. The model is designed in the following structure. For example, a neutral factor (BI = 0) will not affect the sales price; when BI > 0, the buying power is above the neutral point so a positive value is added to the expected sales price; when BI < 0, value is subtracted from the expected sales price.

The purpose of designing a model in such a way is that the model can account for changes in consumers' preferences and, thus, the buying power. In the case of an apartment, the price differs according to many characteristics. Authors' model can be used in conjunction with the hedonic price theory, which states that a price is determined by the effective value of various characteristics.

A formula that is based on the sales price decision model for the sales price that considers the buying index and the market price is shown below.

\[
P = P_1 \times (1 + R_{stf}) + a \times BI_{proj}
\] (8)

Here, \(a\): Buying Coefficient

\(BI_{proj}\): Buying Index of the project

5. Application of the Buying Index

When measuring buying power, the neutral point is set as "0", so there are 3 cases of applying the buying index.

- **Case 1**: When the buying power is "0" (neutral)
  \[BI = 0, a = 0\] (9)

- **Case 2**: When the buying power is a positive value
  \[BI > 0, a = P_{max} - P_{min} (BI > 0, Buying power "+", \rightarrow Sales price up)\] (10)

- **Case 3**: When the buying power is a negative value
  \[BI < 0, a = P_{max} - P_{min} (BI < 0, Buying power "-", \rightarrow Sales price down)\] (11)

Here, \(P_{c}\): Expected sales price

\[a = P_{max} - P_{min} (\text{Coefficient: Value added to/ subtracted from the sales price})\]

\(P_{max}\): Upper limit of expected sales price

\(P_{min}\): Lower limit of expected sales price

1) **Case 1 (BI = 0)**

This is when the buying index of the project is "0". Because the evaluation of buying power items has the option for there to be positive or negative values, when the buying index of the project is "0", it means that the average of all the sub-factors for the given item was "0".

In such a case, the coefficient to be added to/ subtracted from the expected sales price becomes "0", so the expected sales price is calculated from the market index alone.

2) **Case 2 (BI > 0)**

When the buying index of the project is positive, it implies that the buying power is above neutral, and the marketability of the apartment is above average, although the magnitude may vary according to the size of the index. In such a case, it is believed that a certain amount may be added to the expected sales price or the sales price may be reviewed for an increase.

For calculation of a sales price, the coefficient calculated from the market index and the expected sales price (Equation 10), and the coefficient is multiplied by the buying index. The product is then added to the sales price.

3) **Case 3 (BI < 0)**

When the buying power of a project is estimated to be negative, it implies that the factor is in an inferior position in the aspect of marketability and sales. When the buying power is low, it is difficult to stimulate the purchasing needs of consumers, and the risk of unsold apartment units may increase accordingly. So, it is necessary to lower the sales price, or come up with alternatives to compensate for the marketability.
For calculation of a sales price, the coefficient calculated from the market index and the expected sales price (Equation 11), and the coefficient is multiplied by the buying index. The product is then subtracted from the sales price.

A feasible sales price decision model that reflects the market price, a forecast of the market condition at the point of sales, and the buying power of the project is drawn using the following equations:

Case 1: $BI = 0$, $P = P_1 \times (1 + R_{\text{proj}})$

Case 2: $BI > 0$, $P = P_1 \times (1 + R_{\text{proj}}) + (P_{\text{max}} - P_{\text{min}})$ \times BI_{\text{proj}}$

Case 3: $BI < 0$, $P = P_1 \times (1 + R_{\text{proj}}) - (P_{\text{max}} - P_{\text{min}})$ \times BI_{\text{proj}}$

6. Case Study

Yeonsu-gu in Incheon is a new city located in the Songdo International Business District built to accommodate 250,000 people and around 100,000 households from 2003 to 2020. It was easy to gather cases, as there were a lot of apartment housing units. The case was an actual project organized by a public enterprise. With the case, the explanation power of the model was to be verified. Therefore authors present an apartment building (38th floor) with a lot area of 75,338 m$^2$ located in Yeonsu-gu, Incheon, South Korea. The total number of households was 1,063 and it was a pre-construction sale in October 2011. The size of the households were 84 m$^2$, 96 m$^2$, 112 m$^2$ and 134 m$^2$, and the number of households of each size is shown in Table 6.

<table>
<thead>
<tr>
<th>Number of households (in Case Study)</th>
<th>Total</th>
<th>84 m$^2$</th>
<th>96 m$^2$</th>
<th>112 m$^2$</th>
<th>134 m$^2$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of households</td>
<td>1,063</td>
<td>354</td>
<td>560</td>
<td>146</td>
<td>3</td>
</tr>
<tr>
<td>Percent</td>
<td>100%</td>
<td>33.3%</td>
<td>52.7%</td>
<td>13.7%</td>
<td>0.3%</td>
</tr>
</tbody>
</table>

The project was on a large apartment complex situated in Yeonsu-gu, Incheon composed of mid/large housing sizes. It was sold in October 2011 by a public enterprise. The expected sales price was 3,230 USD/m$^2$ and the sales price was estimated to range from 3,095 USD/m$^2$ to 3,365 USD/m$^2$. The authors assumed that the sales price reflected the market index of October 2011 and the buying power of the project was estimated 5 months before the actual point of sales (in June 2011).

As mentioned previously, for the market index, when the real sales price index of an apartment announced by the point of forecasting is inserted as a value of time-series analysis and the sales price index of the expected sales point is forecasted using the time-series analysis based on the ARIMA model, it is presented in Table 7.

The market index at the expected sales point (October 2011) is forecasted as 0.001 as shown in Equation (15), expecting a very small increase in sales price.

<table>
<thead>
<tr>
<th>Model</th>
<th>Jul</th>
<th>Aug</th>
<th>Sep</th>
<th>Oct</th>
<th>Nov</th>
</tr>
</thead>
<tbody>
<tr>
<td>Incheon</td>
<td>Forecast</td>
<td>106.8</td>
<td>106.8</td>
<td>106.9</td>
<td>107.0</td>
</tr>
<tr>
<td>Yeonsu-</td>
<td>UCL</td>
<td>107.8</td>
<td>109.2</td>
<td>110.7</td>
<td>112.2</td>
</tr>
<tr>
<td>Model_1</td>
<td>LCL</td>
<td>105.7</td>
<td>104.3</td>
<td>103.0</td>
<td>101.8</td>
</tr>
</tbody>
</table>

$$R_{MI} = (MI_{\text{forecast}} - MI_{\text{proj}}) \div MI_{\text{proj}}$$

The sum of all the buying indices of the project was calculated to be -0.0148. Thus, $BI < 0$ Case 3 was used; the coefficient calculated from the market index and the expected sales price was multiplied by the buying index, and then the calculated value was subtracted. The feasible sales price decision model, considering the market price and the buying power, yielded 3,193 USD and is shown in Equation (16). The sales index of the expected sales point increased, but the buying power of the project was below the neutral point. All in all, the sales price was lower than the expected sales price.

$$P = 3,230 \text{ USD} \times (1 + 0.001) + \{(3,365 \text{ USD} - 3,095 \text{ USD}) \times (-0.0148)\}$$

$$= 3,193 \text{ USD}$$

As a result of verifying the model with a real case study, the market index was 0.001 based on the time-series analysis, forecasting a very little increase in sales price, yet the real sales price index of the apartment building dropped to -0.0015. Such a result can be explained because there are high degrees of fluctuation and it is difficult to quantify trends in a short period of time.

For measurement and evaluation of buying power, the quantitative evaluation based on objective criteria as well as the evaluator's subjective, intuitive judgments coexist. So, an arithmetic mean of experts' evaluation results should be calculated and used as an index in order to reduce the error.

According to the case study, the buying power was below the neutral point, resulting in a feasible sales price that was lower than the expected sales price. In reality, the ratio of sales was so low that the apartment project was cancelled. There may be other reasons that led to sales failure other than the sales price, and it is believed that there were a wide range of complications including the details within the organization, changes of interests and details of related projects.

7. Conclusion

Calculation of an apartment's sales price is complicated as its characteristics and various factors should be considered. The study herein forecasts the market price at the point of sales and identifies the factors that impact apartment purchasing to develop a feasible sales price decision model. The model includes a measure of buying power as well as the market price.
From authors’ analysis, four key results were drawn.

First, the concept and characteristics of the apartment sales price index of the Korean Housing Price Survey for development of the market index were analyzed to establish a frame for the market index model. Here, the apartment sales price index was used as basic data for the market index, and the market index of a sales point was estimated through a time series analysis. In addition, the difference between the market index forecasted through the time-series analysis and the present sales index (i.e., the market price fluctuation index) was calculated and reflected in the price to aid in the preparation for future market conditions.

Second, for the development of the buying index, purchase decision factors were classified according to characteristics from previous studies. In addition, a primary questionnaire survey was conducted to assess the factors that impact consumers in buying an apartment building. Then, the purchase decision factors for the apartment drawn from the survey were set as the buying power measurement items, and the importance of each factor was estimated using the AHP (Analytic Hierarchy Process) method. The main factors that were identified, in the order of importance, were: economic factors, location factors, financial environment factors, housing factors, other factors and institution & policy factors. In addition, the buying power of the project was then incorporated into a model that shows how the sales price should be adjusted. Three cases were defined to show how the sales price can be affected by the buying index.

Third, a feasible sales price decision model should be able to reflect changes in the market price and buying power of the product. It also should be able to forecast the market price to estimate the future sales point. It should be structured so that a value can be appropriately added to or subtracted from the sales price according to the buying power. The proposed feasible sales price decision model takes the market price and buying power into consideration and can be expressed in 3 conditional mathematical equations.

Fourth, the feasible sales price decision model developed through the process described above was verified with a real case. According to the case study, the fluctuation rate of the market index that was forecasted through the time-series analysis differed from the real sales price fluctuation index. The discrepancy may have stemmed from various features of the analysis. Furthermore, it was revealed that the higher the buying power of a project, the higher the rate of contract, and thus there is a positive influence on the rate of sales. Also, the result of sales differed according to the result of buying power evaluation.

The feasible sales price decision model considering market price and buying power forecasts the real estate market conditions of the given region, and the value of an apartment unit as a good is objectively estimated. Also, a pricing tool that quantifies related adjustments to the sales price is suggested. By forecasting the future market, measuring the marketability of apartment housing and establishing a differentiated and specialized strategy for the project, this model can be an important decision-making tool that reduces the risk of unsold housing in an unstable real estate market.

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References