PREDICTION OF ABSORPTION RATE IN HOUSING PROJECT BY ARTIFICIAL NEURAL NETWORK

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When performing a feasibility study and undertaking project design for housing projects, the absorption rate, e.g., the number of units sold per month, is one of the most important parameters to be predicted. However, the conventional prediction approach relies a lot on the knowledge and experience of experts, which are rare. The objectives of this study were to analyze the factors affecting the absorption rates of housing projects and to develop an absorption rate prediction model using an Artificial Neural Network (ANN). The research was done by collecting factors from interviews with five homebuyers and from a literature review. Factors about 100 housing projects were collected from market research reports and websites, and an ANN network was developed. The acquired model has 18 input nodes, from eight factors: (I) house type, (II) project zone, (III) selling price, (IV) number of bedrooms, (V) number of bathrooms, (VI) land plot area, (VII) distance to shopping mall, and (VIII) distance from gas station, with two hidden layers with 11 and six nodes, respectively. When testing the model with a new set of data, the model had $R^2 = 0.459$. The research results could guide real estate developers to be the focus when investing in new projects, which could increase the required absorption rate.

Keywords: Artificial Neural Network, Prediction Model, Feasibility, Design.

1 INTRODUCTION

The type of real estate business that real estate developers prefer, are housing projects (Tochaiwat 2020). In Thailand, entrepreneurs' sales forecasts mainly rely on the knowledge and experience of experts, though, the number of specialists is limited due to the time required to accumulate experience (Nuntanach 2021). There are people in the education community who have tried to fix the problem by creating various models. For example, the research by Khalafallah (2008) and Limombokunchai et al. (2004) on market situation analysis of housing and forecasting the selling price of houses in housing projects. However, it was found that the research used a model to forecast the sales rates of housing projects was hard to find. The review of the literature found that an ANN is a potential tool for analyzing complex and multifactorial problems (Abiodun et al. 2018). Therefore, the researchers selected this technique for forecasting the absorption rate, or the sales rate per month, of housing projects.
2 LITERATURE REVIEW

2.1 Factors Affecting Absorption Rate of Housing Project

The residential development process consists of specific factors that depend on many factors and local conditions (Henilane 2016). In addition, the factors affecting the absorption rate of a housing project include a number of sub-factors (Gibler and Nelson 2003), as follows:

2.1.1 Project attributes

The common area is a feature of the project that is commonly used as a selling point (Ariyawansa 2010). A review of the literature found that properties with a good common area influence the residents (Riratanaphong et al. 2016). These areas often contain swimming pools, fitness areas, parking lots, and sidewalks, as well as garden areas within projects (ALM Media Properties 2014, Tochaiwat et al. 2018). In addition, Suttiwongpan et al. (2019) discussed the elements of common areas, such as sidewalks, roads, universal design, and waste management systems. Common areas also consist of utility systems within projects that enhance the quality of life and support the convenience and promote the well-being of the residents (Land and Houses 2016). According to research done by Wang (2013) and Aryani and Tu (2017), it was found that the facilities in the project were a factor that supported the purchase decisions for a housing estate.

2.1.2 House attributes

House attributes is a fundamental factor that leads to the purchase decision and affects the absorption rate of housing projects (Tochaiwat 2020, Sbakhi et al. 2018). Therefore, developers need to address the problems that may arise and provide solutions to their customers (Quester et al. 2007). A review of the literature found that the appearance, interior, and view from a house are the factors affecting the buyer's decision to buy a house (Kumar and Khandelwal 2018), and good house attributes support higher purchasing demand and contribute to decision-making (Elsinga and Hoekstra 2005). In the research of Chia et al. (2016), the appearance of a home is the most important factor in a resident's purchasing decision. However, entrepreneurs should take into account the characteristics of the house that interact with the environment (Hsu et al. 2012).

2.1.3 Project location and location zone

Location is one of the most important factors that affect the project's sales rate (Poindexter 1994). On the other hand, a poor location will negatively affect the sales rate of the project (Mang et al. 2018). According to Maoludyo and Aprianingsih (2015), location can affect the type of project. Moreover, Ismail and Shaari (2020) and Khan et al. (2017) found that location and neighborhood were the most influential factors when choosing future housing for the new generation. This finding is consistent with Rahman et al. (2019) and Zeng (2013), who found that project location is the most important factor in home purchase considerations for residents, classified into various demographic characteristics. Most of the time, it was found that the effect of the location on the residence depends on the distance to workplaces or important places (Grønhaug et al. 1987). In this research, the project location was separately defined by two factor groups: (1) project location group and (2) location zone. The zone group of factors consisted of 10 zones in the Bangkok Metropolitan area, according to the Bangkok Information Center (2021).

2.2 Artificial Neural Network (ANN) and its Applications

ANN are one of the most popular and recognized artificial intelligence models for their accuracy. The mechanism of action was derived from the study of human brain processes (Matel et al. 2019). ANN consists of three types of layers: input layer, hidden layer, and output layer.
(Boussabaine 1996). It is through the process of connecting the relationship between the input layer and the output layer to find the relationship between the two and set the binding weight (Geetha and Nasira 2014). As to the applications of ANN models in the housing business, Nguyen and Cripps (2001) and Morano et al. (2015) applied ANNs for value appraisal of houses, while Zainun et al. (2010) and Khalafallah (2008) used ANNs for forecasting the demands of the housing market. Nguyen and Cripps (2001) created an ANN model and a Multiple Regression Analysis (MRA) model and found that the ANN model could better forecast the housing value for a moderate to large data sample size. Morano et al. (2015) summarized that an ANN is appropriate for predicting property value in Italy, even on limited data. Zainun et al. (2010) forecast the low-cost house demand in Malaysia using an ANN model. Moreover, Khalafallah (2008) presented the development of ANN models to support real estate investors and home developers in making appropriate financial decisions. It was hard to find work that applied ANN to predict the absorption rate of housing projects.

3 METHODOLOGY

The determinants in each group that affect the absorption rate were acquired from a literature review, e.g., project attributes, house attributes, project location, and location zone, which were collected from five interviewees, that is the minimum number of interviewees suggested by Nastasi and Schensul (2005), by a semi-structured questionnaire. The criteria for selecting the informants were: (1) each informant should have experience in buying a house in a housing project and (2) the selected informants should have various demographic factors. Twenty-seven factors related to project attributes, house attributes, and project location factors acquired from interviews were combined with the factors about the location zone group acquired from the literature review. Then, 100 data sets for these 28 factors were collected from real estate market survey reports published by the Agency for Real Estate Affairs (2017, 2021). The data were verified and some missing data were additionally collected from project websites. The acquired data were input into RapidMiner, as suggested by Ghaus and László (2004), as it has a high accuracy and execution time and has been used in several research works, such as by Geetha and Narisa (2014), Çelik and Başarır (2017) and Siththikankun et al. (2021), to develop an ANN model for absorption rate forecasting. The data were divided into two groups: 90 data sets for model development and 10 data sets, randomly selected by Systematic Random Sampling, for model testing. The network was started in accordance with rules-of-thumb suggested by Ranjan (2019) and adjusted to find minimum RMSE and acquired model was tested with 10 separate data sets.

4 RESULTS

4.1 Factors Affecting Absorption Rate of Housing Projects

The interviewees for this research were aged 22 to 60 years old and worked as private company employees, university lecturers, and university students. They were asked about the list of project facilities and project location, and their impact on the decision to buy a house. These factors were then added to the list of model input data.

4.2 ANN Model for Absorption Rate Prediction

After trial-and-error processing by RapidMiner, the authors obtained a model whose RMSE value was ±11.138, as shown in Figure 1. Compared to the RMSE of ±13.012 of the linear regression, the acquired ANN model was more accurate and efficient for forecasting than the linear
regression model. The model has 18 input nodes or determinants (X1 to X18), which were derived from eight factors. The output node of the model is the absorption rate of the project.

![Figure 1. ANN model for predicting absorption rate of housing project.](image)

5 FINDINGS AND DISCUSSION

The acquired factors were in accordance with the interview data and were found to be consistent with the literature review that home attributes, project attributes, project zone, and project location affected the absorption rate of the project. The analysis found that the factors affecting the absorption rate of a housing project mainly depended on the location and the attributes of the residence in the project. When making a decision, buyers will take these various factors into account together. When the model was tested with a separate randomized set of data, it was found that the model had an R\(^2\) value of 0.459, compared to the R\(^2\) value of 0.249 for the linear regression model. This finding showed that the ANN model was more reliable than the linear regression model, in accordance with the findings from their RMSE discussed in Section 4.2 and Limsombunchai et al. (2004), Zainun et al. (2010), and Khalafallah (2008) confirming that ANN can be an effective technique, even when the data sample size is limited. These findings are in accordance with Morano et al. (2015), and different from Nguyen and Cripps (2001), that ANN is still an interesting choice even with limited data.

6 CONCLUSIONS AND RECOMMENDATIONS

There were eight variables that affected the sales rate, which are detailed in descending order of weight as follows: (I) type of house, (II) project location, (III) selling price, (IV) number of bedrooms, (V) number of bathrooms, (VI) land area, (VII) distance from shopping malls, and (VIII) distance from gas station. The analysis found that the factors affecting the sales rate of the housing estate project are mainly due to the location and the nature of the residence in the project. Buyers will bring various factors considered together.

For real estate developers and those involved in project development and management, the factors and categories derived from this research should be taken into account in the project design and development process to stimulate homebuyers’ decisions to buy houses in projects. Moreover, large real estate companies can develop their own ANN model, similar to the suggestion of Khalafallah (2008), by following the methodology of this research. Finally, it should be noted that this research seems to have data limitations because the data of the housing
project absorption rates are difficult to be collected. Research that needs such data should have a well-planned data collection process. Interested researchers may develop similar models with more samples, which will have greater accuracy, as revealed by Nguyen and Cripps (2001), or may apply to other types of real estate projects, such as condominiums, industrial estates, or hotels (occupancy rate prediction model).

References


