APPLICATION OF THE FUZZY LOGIC MODEL IN REAL ESTATE VALUATION

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Abstract – In recent years, the real estate sector has become the favorite sector of corporate and individual investors. In particular, construction and real estate investments have made a great contribution to Turkey's rapidly developing economy. The demand for real estate and sectoral developments offer important opportunities for both domestic and foreign investors. Determining the real values of real estate is a very important issue. Knowing the real estate value is necessary for purchase and sale, leasing, easement, limited rights in title deed, expropriation of real estate, and tax transactions. At the same time, the present and future value of real estate is important for investors. Accurate and reliable valuation of real estate is also a vital point for the financial system. From this point of view, the valuation process consists of a combined, detailed and comprehensive set of activities in which many related factors are considered together and carried out in relation to each other. There are different valuation methods in the literature such as traditional, statistical, modern and GIS. In this study, fuzzy logic model research was conducted to determine the real estate values. For this purpose, models were created using the Fuzzy Logic method with the help of the obtained data. The market values were compared with the help of the created models. For the data set, the average approximation was found to be 95.35% in the calculation with fuzzy logic. As a result, it was concluded that it would be appropriate to use the fuzzy logic model in real estate valuation.

Keywords - Fuzzy Logic, House Valuation, Real Estate, Real Estate Valuation

I. INTRODUCTION

The need for shelter and protection is gaining more and more importance day by day. Elements that constitute a source for real estate valuation are buildings such as houses, factories, workshops, offices, plazas, shopping malls, commercial stores, schools, universities, etc. In addition, the lands on which these structures will be built are also subject to valuation. In modern life, real estate, especially housing, is seen as an investment tool as well as a necessity. The valuation of immovables and the taxation of these values constitute one of the important economic resources of developed societies. As a matter of fact, 56% of the world's capital resources are based on real estate [1].

Today, peer comparison, income method and cost methods are frequently used in real estate valuation methods. There are many factors that affect the current value and vary according to the regions, with the difficulty of finding the real estate to be appraised and a real estate that can be considered equivalent to this real estate. Therefore, difficulties arise in the rapid and realistic conclusion of real estate valuation [2]. With the development of technology, artificial neural networks (ANN) method and fuzzy logic have been added to real estate valuation methods. Both them are widely used in the field of economics due to their predictive feature of predicting the future. Realizing machine learning, learning by using examples, storing information, giving information about unprecedented examples are the most important features of artificial neural networks [3]. In this study, the valuation of 25 houses in Meram district of Konya City was made with the fuzzy logic method. Results are compared with actual market values.

II. DATA AND METHODOLOGY

A. Data

In the study, a total of 25 houses located in the Ahmet Özcan Street area of Meram District of Konya (Uzun Harmanlar, Gazanfer, Küçük Aymanas, Büyük Aymanas neighborhoods) were used. This street is located in the city center of Konya City. This area has become the center of attraction for the city, especially in the last 10 years. Building ages vary between 0-15 years. The houses are in the form of apartments and the number of rooms is chosen as 3 or 4. It was preferred that the selected houses are close to each other. Thus, their distance from the city center was not taken as a parameter. This situation is shown in Fig 1. The maximum distance between the selected houses is 1200 m.

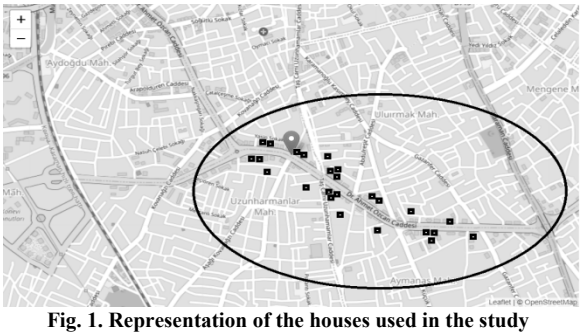


Fig. 1. Representation of the houses used in the study

B. Real Estate Valuation

A valuation is an opinion of one or more economic factors at a particular date, concerning a correctly identified land or structure, supported by analysis of appropriate data. Valuation is the estimation of the market value obtained by analyzing appropriate

information within the framework of professional standards. The nature of the valuation; it largely depends on the expertise of the people and groups who do the valuation, the tools and measures at hand, and the factors and conditions of the person doing the work [4].

Valuation is an appraisal of the subject asset to determine the value of an object. Basically, it is possible with the valuation process to find the value of the assets that can have an economic equivalent in monetary terms in a certain foreign currency [5]. Real estate appraisal is the process of determining and appraising the value of a real estate in an objective and impartial manner by evaluating factors such as quality, interest, environment, and utilization conditions. The said value can be the price that constitutes the cost, as well as the market price, the price related to the sale, and is determined by applying different approaches [6].

In other words, valuation is the monetary value of economic assets, a company's building, land, machinery, equipment, product stock, etc. It is possible to express the total value of all assets in the form of an estimation by making appraisals and assumptions. Real estate is an economic element. Therefore, the factors affecting the value of the real estate do not depend only on it. These values are determined by other factors that make up the market. The relationships that create value are complex, and value changes as the factors that influence value change. Typically, four economic elements create value. These; utility, scarcity, desire, and effective purchasing power.

Four real estate valuation methods commonly used in the literature; comparison, revenue, cost and nominal valuation methods. In addition to these methods, artificial neural networks method has been used in recent years [7]. In determining the method to be used for valuation, the location of the real estate, its characteristics and the common habits of the real estate market are taken into account. For zoning parcels, whether there is a building on it or not, the comparison method is known as the most ideal method in cases where there is sufficient precedent value. In cases where the value of real estate can only be determined according to the income they will bring in the future, for example, it is appropriate to apply the income method to find the release prices in rental housing or workplaces. For real estates with structures such as factories and farms and whose rental income is unknown, the release value is calculated according to the cost method. In a region-based valuation, it may be possible to express it with a numerical variable in nominal terms [8]. Successful results can be achieved by using the Artificial Neural Networks method with a data set with sufficient parameters and coverage for places that have various difficulties in terms of real estate valuation, such as metropolitan areas [9].

C. Fuzzy Logic Modelling

Fuzzy logic is a generalization of classical two-valued logic. In other words, fuzzy logic refers to technologies and theories that use fuzzy sets [10]. This term, which was used for the first time by Zadeh, was basically created on the fields of multivariate logic [11], probability theory, artificial intelligence, genetic algorithms and artificial neural networks [12]; defines a concept that deals with the degree of occurrence of events rather than the probability of occurrence.

One of the situations in which fuzzy logic is most valid is that the analyzed event is very complex and in the absence of sufficient information, people's opinions and value judgments are included. This model requires human understanding and judgment. Uncertainty is an important source of information in human thought, even if it is not numerical. Fuzzy logic principles help in the original use of such information sources in the analysis of events [13].

Fuzzy logic modeling is carried out in three basic steps: fuzzification, rule extraction and defuzzification. In the blur stage, the inputs are blurred. In this step, the membership degrees of the inputs to the appropriate fuzzy sets are determined by forming membership functions. The fuzzy inference phase consists of associating one fuzzy set with another using membership functions and "if-then" rules.

Defuzzification is the conversion of the fuzzy output value to an exact output value. Fuzzy logic is a collection of operations that allow the system to behave with an output by gathering all the relations established between the input and output fuzzy sets in the rule base. In a fuzzy rule-based system, different analysis methods can be applied. The most important of these are the Mamdani and Sugeno Models [14]. Detailed theoretical information on the subject accessible from [9]- [10]- [13].

In accordance with the fuzzy inference system (Fuzzy Inference System) in MatLab software, with the help of the FIS Editor, the main factors affecting the value of the real estate are defined one by one. The “Mamdani” algorithm is chosen as the inference method. The membership functions of the set can be defined with standard functions such as triangle, trapezoid and gaussian curves, as well as different functions. In real estate valuation work, the membership function for each variable is usually chosen as triangle and . Impact distances are determined by expert opinion. The final result is assigned to the variable named “value” and the output range is defined as [0,10].

III. APPLICATION

Eight parameters were used in the value analysis of the data. The significance coefficients of the parameters were determined according to the characteristics of the region and market conditions. The parameters used are the age of the building, the number of floors, the floor

on which it is located, its facade, the area of the flat, the number of rooms, the type of heating and its distance from the social facility. In the system created with the Mamdani structure, there are 8 input variables and 1 output variable. The age of the building, the number of floors, the floor where it is located, the facade, the number of rooms, the area of the flat, the type of heating and the distance to the social facility are defined as the input variable. The output variable is defined as price. MATLAB Version 9.4 (R2018a) software was used in the study.

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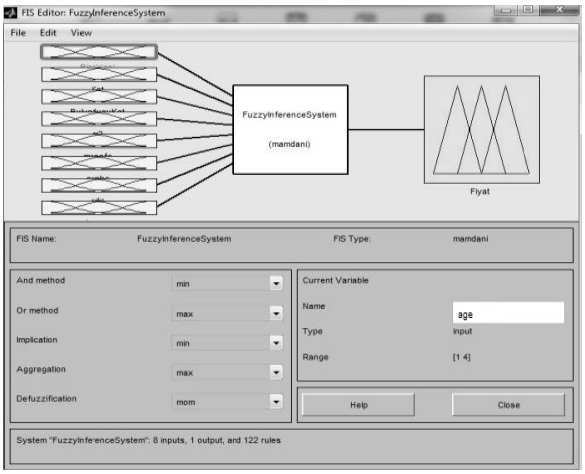


Fig. II. Identification of factors affecting the value of real estate in the FIS Editor

Membership functions for the determined criteria were created and blurred. Memberships created according to the criteria were entered into the program. Memberships were created using the Mamdani method and triangular graphs were used. The screenshot of the "building age" as the membership sets created for membership is shown Fig.III.

In order to determine the effects of the memberships determined for immovables in the rules system on the immovable value, a total of 122 rules were created by using the conjunction 'and' (and). The rules were first written in tables in Excel format and entered into the MATLAB software. Rule codes are written for the created rules and each code is given according to the membership functions of the inputs. The rule codes written for inputs and output are as follows:

Building age, number of floors, floor, facade, flat area, number of rooms, heating type and distance to social facility

1. Input: Building Age
VERYNEW: 1, NEW:2, OLD:3
2. Input: Number of floors
VERY GOOD:1, GOOD:2, NORMAL:3,BAD:4
3. Input: The floor where it is located
HIGH:1, NORMAL:2, LOW:1
4. Input: Facade
GOOD: 1, BAD:2
5. Input: Field
LARGE:1, NORMAL:2, SMALL:3
6. Input: Number of Rooms
LARGE:1, NORMAL:2, SMALL:3
7. Input: Warm-up type
SHARE METER:1, CENTRAL:2, SEPARATE:3
8. Input: Distance to Social Facility
NEAR:1, NORMAL: 2, FAR:3

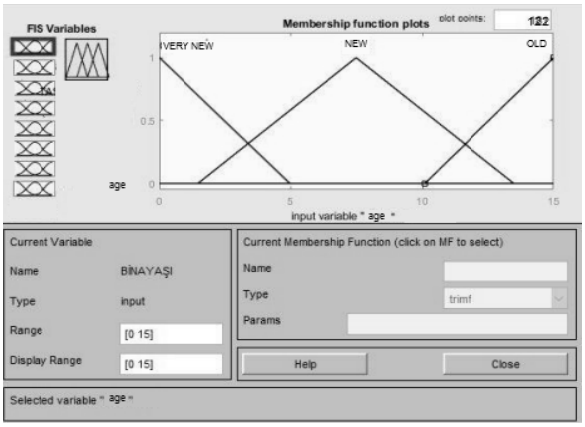


Fig III. Membership functions of the building age input Variable

Some of the codes assigned to memberships and an example of what these codes mean in the rule base are as follows:

Rule 1 Codes: 1, 3, 2, 1, 1, 1, 1, 1, 1:1 (Building Age: VERYNEW, Number of floors: NORMAL, The floor where it is located: NORMAL, Facade: GOOD: 1, Field: LARGE:1,Number of Rooms: LARGE, Warm-up type: SHARE METER, Distance to Social Facility: NEAR, then the value of the property is TOO EXPENSIVE).

Rule 3 Codes: 1, 1, 2, 1, 1, 1, 3, 2, 1: 2 (Building Age: VERYNEW, Number of floors: VERY GOOD, The floor where it is located: NORMAL, Facade: GOOD: 1, Field: LARGE:1, Number of Rooms: SMALL, Warm-up type: CENTRAL, Distance to Social Facility: NEAR, then the value of the property is EXPENSIVE).

5. Rule Codes: 1, 2, 2, 2, 1,2, 1, 2, 1: 3 (Building Age: VERYNEW, Number of floors: GOOD, The floor where it is located: NORMAL, Facade: BAD: 1 , Field: LARGE:1, Number of Rooms: NORMAL, Warm-up type: SHARE METER, Distance to Social Facility: NEAR, then the value of the property is NORMAL).

7. Rule Codes: 1, 2, 2, 2, 1, 4, 1, 3, 3: 4 (Building Age: VERYNEW, Number of floors: GOOD, The floor where it is located: NORMAL, Facade: BAD: 1 , Field: LARGE:1, Number of Rooms: LARGE, Warm-up type: SEPERATE, Distance to Social Facility: FAR, then the value of the property is CHEAP)

The approximation table of the values calculated with Fuzzy Logic and the real estate values is shown in Table I.

No	Real Estate Market Value (Turkish Liras)	Fuzzy Logic Value (Turkish Liras)	Approximate %
1	1450000	1250000	0,862069
2	1875000	1675000	0,893333
3	2200000	2025000	0,920455
4	1825000	1680000	0,920548
5	2750000	2550000	0,927273
6	2150000	2000000	0,930233
7	2200000	2050000	0,931818
8	2980000	2800000	0,939597
9	2325000	2450000	0,948980
10	2050000	1950000	0,951220
11	1600000	1525000	0,953125
12	1950000	1875000	0,961538
13	1950000	1880000	0,964103
14	1550000	1500000	0,967742
15	1525000	1570000	0,971338
16	1750000	1800000	0,972222
17	1625000	1580000	0,972308
18	1850000	1900000	0,973684
19	1925000	1975000	0,974684
20	2200000	2250000	0,977778
21	2250000	2200000	0,977778
22	2750000	2800000	0,982143
23	1600000	1575000	0,984375
24	2300000	2325000	0,989247
25	2700000	2725000	0,990826

Table I. Approximation table of values calculated with Fuzzy Logic and market values of real estate

As can be seen from Table I, the market values of the selected houses vary between 1450000 and 2980000 Turkish liras. According to the Fuzzy Logic analysis, the house values were found between 1250000 and 2800000 Turkish liras. The approximation rate was between 0.86 and 0.99. Even the minimum approximation rate is a fairly high value. Compared to classical methods, closeness to real values is high.

IV. RESULTS AND DISCUSSION

The subject of valuation is an important and researched subject for national economies. For this reason, modeling in order to obtain objective and accurate results will prevent both time, labor and economic losses. In order to make an accurate valuation, besides choosing the appropriate method, the parameters must be handled objectively. Parameters vary from region to region. In this study, flat area, location, number of rooms, heating and sun exposure, construction year, building characteristics were taken as parameters. According to the location, criteria such as view, sun exposure, landslide danger can be added to these parameters.

Real estate valuation is a very complex process that requires consideration of many parameters such as properties, qualities, and the economic situation of the market. For these reasons, it is not possible to use exact models in valuation processes. It has been tried whether it is an easy and fast method for real estate valuation using the fuzzy logic method. It is important to reach and design the correct required parameters for a highly consistent result with the fuzzy logic approach. According to the results of these values, the average approximation was found to be 95.35% in the calculation with Fuzzy Logic. Looking at the results of the analysis, it was seen that the fuzzy logic model in real estate valuation gave the prediction values closest to the real value. Thus, the applicability of real estate valuation has been demonstrated by using the least variable with the fuzzy logic model.

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