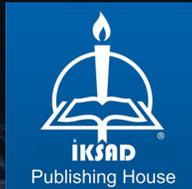


MODERN METHODS APPROACH IN REAL ESTATE VALUATION

Dr. Naci BÜYÜKKARACIĞAN



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(The Licence Number of Publicator: 2014/31220)
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Iksad Publications – 2021©

ISBN: 978-625-8007-83-1
Cover Design: İbrahim KAYA
November / 2021
Ankara / Turkey
Size = 16 x 24 cm

PREFACE

From ancient times to the present, real estate plays an important role in people's lives. Real estate has been one of the safest and most well-established investment instruments for many years. With this feature, it is an indispensable safe investment for many people. In a world that is constantly changing, the constantly changing conditions have become the preferred money, investment place, namely real estate, to secure their own future. Therefore, real estate or commercial real estate will be the best investment tool in the future.

Determining the value of real estate in developing and developing country economies has gained great importance in recent years. Real estate valuation is a process that affects the development of urban and rural areas and the development and urbanization process. In order to complete this process with objective criteria, it is very important to determine the criteria that affect the real estate value. With the increase in demand for real estate and investments, it is now a necessity to carry out objective valuation studies.

Real estate valuation is a fundamental principle for all businesses. Land and property are factors of production. Real estate valuation; In its simplest form, it is the determination of the amount that the property will trade on a given date.

Real estate valuation is an activity carried out in a wide range of areas such as; buying, selling or leasing a real estate, obtaining a loan as collateral, selling it for auction and/or liquidation, determining the

scrap value for the real estate, determining the value that will be the basis for insurance transactions, using it in taxation procedures and expropriation processes, company merger, transfer, acquisitions, rental and leasing transactions, and determination of tax bases for real estate. In this context; Real estate appraisal activity is very important for many segments of society, the state and the general economy.

Valuation methods can be grouped as traditional methods and advanced methods. The traditional methods are regression models, comparable, cost, revenue, profit and contractor method. Methods that are outside of traditional methods and statistical methods are called modern methods. In this study, real estate valuation applications of modern methods are discussed

With the hope that this book, which explains Modern Real Estate Valuation Methods, will help users...

Dr. Naci BÜYÜKKARACIĞAN

Konya- 2021

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INTRODUCTION

Real estate has become the favorite of corporate and individual investors in recent years. In this respect, in order to make successful investment decisions in the real estate sector, it is necessary to master the local market elements. The acceleration of construction and real estate investments, especially in Turkey's rapidly developing economy in recent years, is very important. However, in order to make successful investment decisions in the real estate sector, which has become increasingly popular with institutional and individual investors, it is necessary to master the local market elements.

The demand for real estate and sectoral developments offer important opportunities for both domestic and foreign investors. In order to seize these opportunities, the current position and development of this sector, whose performance is highly dependent on internal and external factors and which has complex problems, should be carefully monitored with an experienced staff who has a good command of the dynamics of the sector.

Valuation is the process of estimating the utility and value of an asset. The quality of the estimation depends on the expert's education, experience, importance to his work, objectivity, legislation and current situation analysis. In practice, valuation studies are needed for different purposes. Especially; Mortgage and pledge lending, free purchase-sale transactions, expropriation, consolidation, determination of the income and rental money of the real estate, determination of the

loss amount, determination of the reciprocal price, inheritance sharing, company valuation, insurance, issuance of real estate certificates, public real estate In studies such as sale, nationalization and privatization, it is often necessary to determine the values, rental fees or incomes of real estates.

Real estate is seen as an investment tool in our country as well as all over the world. It is also evaluated for this purpose. However, it is important to accurately and reliably determine the market values of the real estates included in the "fixed assets account group" in the assets of the balance sheets of the companies. Meanwhile, real estates that are not registered in company assets and that are in return for mortgages can contribute to the financial system with an accurate valuation.

Value is an uncertain concept that is reached as a result of the evaluation of the analysis results obtained using valuation methods and changes according to the point of view. It is based on the collected data, according to the type and qualities of the real estate, deemed appropriate by the appraisers. In principle, value has two aspects. First; availability and supply of one item, the second; is the effective demand for that substance. active demand; It is a direct reflection of the usefulness or usefulness of that item to its present or future owner or users. The value of a property appreciated by its owners or potential buyers; may differ from the potential price obtainable in a competitive market. Supply and demand are interrelated concepts (Saraç, 2012).

In order to use the concept of value correctly, the current parameters should be observed well. The concept of value for real estate has a variable structure due to the effect of the factor. Although the value of a real estate is directly related to supply and demand, it can also be affected by independent parameters such as interest rates from economic indicators and crime rate from social parameters. These are seen as external factors that affect value. For various reasons, it is not possible to use all economic, social and environmental variables that may affect the values of real estate and assets in the preparation of individual parcel or building valuation reports.

The value of a country's resources and produced assets can be determined With real estate valuation. However, the experts who will make the valuation must act in a knowledgeable, fair, impartial, independent, honest, confidential manner, not causing conflicts of interest, and abide by the standards. During the determination of the legal and legal status of real estate, it is important to know the rules in force and to finalize the valuation in a way that reflects the truth.

Real estate valuation is an important area of expertise for the public and private sectors both in Turkey and in the world. The public has regulated the determination of the values of real estates with various laws, starting from the collection of fees in cases brought to court due to disputes related to real estate, to taxes to be collected from obliged parties in all areas of life. The private sector, on the other hand, sees real estate assets as an important equity capital, and continues to aim to evaluate fixed assets by adding them to its assets at any time. These

developments show that all types of real estate have a value and valuation adds value not only to individuals but also to companies and countries. Factors such as the increase in the importance of real estate values in the economy with the development of the real estate sector in the world, the purchase and sale of corporate real estate, the determination of the price in the transfer and exchange, and the restructuring of the financial sector contributed to the development of the market. As a result of the developments, the demand for experts, qualified, reliable people and companies in valuation transactions has increased for the new needs in the market. In this respect, a correct valuation is very important for the country's economy (Pagourtzi,2003, Ergin, 2013).

Knowing the value of real estate is very important. At the same time, knowing the real estate value is necessary for purchase and sale, leasing, easement rights, 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. It is a general acceptance that; real estate; They are investment instruments that are least affected by the economic crisis, protect the savings of the investors, and provide great gains above inflation.

Real estate appraisals should be carried out by real estate appraisers. Because each real estate asset is different from all other assets. That is, properties of real estate are different, that is, heterogeneous. Practitioners stated that many factors can affect prices in different situations. At the same time, real estate is rarely traded, perhaps every

5-10 years for the average home. The amount of sales varies greatly in certain situations, but generally there are few enough similar properties for sale to be considered "comparable" (Kummerow, 2003).

In this study, besides the traditional valuation methods, advanced valuation methods that have just started to be used in the literature are explained. The book consists of 3 parts. In the first part, real estate and real estate valuation methods are explained. In the second part, advanced valuation methods in general are emphasized. Advanced valuation methods and their applications in real estate valuation are given in the third chapter. The general valuation was carried out in the last section.

1. REAL ESTATE VALUATION

Real estate means 'impossible to move'. The use of real estate as 'real estate' is also common in the sector. Goods with economic value and convertible into cash are classified as movable and immovable goods. The most basic and important distinction between real estate and movable is that the assets expressed as real estate are real estate. Every valuable and real property can be defined as real estate. Land, buildings, houses and similar elements can be given as examples of real estate.

According to Article 704 of the Civil Code, which gives its owners the right to use it as they wish, except for the limitations developed for the benefit of society; The land is the independent and permanent rights (right of construction, right of source) recorded on a separate page in

the land registry and the independent sections registered in the condominium registry. Real estate; It is the general name of residences, commercial properties and properties that cover all kinds of real estate properties such as land, garden, building, flat.

Valuation is a value creation activity. Real estate valuation is defined as the whole of the processes necessary to determine the real estate value by evaluating factors such as the quality, benefit, environment, usage conditions of a real estate in an objective and impartial manner.

The valuation process is an area that arises out of people's desire to value a property they own and is tried to be made more objective. It is a provision for valuation, trading or corporate transactions that varies according to needs, desires and financial capacity (Ring and Dasso, 1977). At the same time, valuation is defined as the process of determining the seller's provision according to real estate properties for investment or long-term use (Brown, 1965).

Value is an economic concept related to the price established between buyers and sellers for a good or service to be purchased (Nathan et al., 2002). Value has several types and definitions. Some defined values are frequently used in valuation. Others are used under very carefully defined and explained conditions in special cases (Yalçın, 2006). The concept of value can be objective value or subjective value. Although the two value concepts seem to be close to each other, they are actually different concepts. Also called subjective value, use value or utility value. It indicates the relative importance a person gives to

various goods. It reflects the value that individuals appreciate for any property or goods. It is subjective as it includes personal opinion (Yalçın, 2007).

The location of the real estate is one of the most important criteria and decisions that determine the value in real estate valuation. An effective real estate value estimation is only possible with an objective analysis of land characteristics. It is the process of determining the value of the real estate in question by evaluating the factors such as quality, benefit, environment, usage conditions related to a real estate in an objective and impartial manner. This value can be the cost price, the market price, the selling price and it can be found by using various methods (Boyce, 1975).

Valuation refers to the process by which experts independently and impartially analyze market and environmental conditions and prepare valuation reports at international standards. Real estate valuation refers to the independent and impartial appraisal of the probable value of a real estate, real estate project or rights and benefits attached to a real estate at a certain date, according to the communiqué on the companies that will provide real estate valuation services within the framework of the capital market legislation and the principles regarding the listing of these companies by the board (Karapınar, 2013).

Since real estates are seen as an investment tool all over the world, they are subject to valuation especially for purchase-sale, tax and expropriation transactions. Accurate and reliable evaluation of real estate is very important 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. The purpose of real estate valuation should be known At the beginning of the valuation process. The value of a real estate is not always the same, it can vary according to time, situation and review.

The methods used in the valuation process depend on the available data, the characteristics of the real estate market, legal regulations and valuation purposes. It is noteworthy that different terms and methods related to valuation are enumerated in different legal regulations, and it is observed that there are important technical information and data deficiencies regarding the use of each of these methods, and therefore significant problems are experienced in practice. In practice, traditional valuation methods and the market value, income, cost or a combination of these are often used in valuation studies, and economic, social and environmental features other than numerical criteria are generally neglected. This structure is considered as one of the main reasons for the differentiation between the value found by traditional valuation methods and the market value of the asset (Tanrivermis 2008).

Real estate valuation is carried out to be used in various fields for different purposes. In this context, the areas where real estate valuations are used are listed below:

1. Credit transactions by securing real estate,
2. Urban planning studies,
3. Determining the value increases resulting from public investments,
4. Consolidation and appropriate structuring in dense urban settlements,
5. Determining the real estate value in company assets in companies reporting according to international accounting standards,
6. Ensuring openness and trust in real estate markets,
7. Monitoring real estate values, creating statistics, buying-selling and leasing transactions,
8. Determination of tax base in taxation,
9. Fair distribution of property in inherited properties,
10. Financial leasing and insurance transactions,
11. In expropriation procedures,
12. To reveal the most ideal and efficient use analysis of real estate,
13. Determination of the current project values of investments and determination of the ratio of income to expenses that will be created by years,
14. Determination of the value of the receivables of the banks, which are subject to enforcement proceedings,

15. Purchase and sale transactions,

16. In rental transactions.

1.1. Major Factors Affecting the Value of Real Estate

As is known, real estate is an economic element. Therefore, the factors affecting the value of the real estate do not occur only by nature. These values are determined by the individuals and conditions that make up the market. The relationships that create value are complex, and when the factors that influence value change, value changes. Typically, four economic elements create value. These;

- a. Usefulness:** This is the ability of a product to satisfy a human need, want, or desire. The contribution of usefulness to value depends on the properties of the property.
- b. Scarcity:** This is the demand for a good versus its existing or expected supply. In general, if demand is stable, scarcity of a good makes it more valuable. If usefulness and scarcity are not combined in any property, including real estate, that property is not valuable.
- c. Desire:** It is the desire to meet the needs of the buyer (such as shelter) or to meet individual needs other than the things that will sustain life.
- d. Effective purchasing power:** It is the purchasing power of an individual or group for goods and services in cash or cash equivalents. The existence of a person or persons capable of

paying for that real estate is an important factor in determining the correct value of a real estate.

The four economic elements that make up the value described above affect supply and demand, which are the basic principles of economics. In any event, the usefulness, scarcity, or abundance of a real estate, the intensity of human desire to acquire that real estate, and its effective purchasing power affect the supply and demand for that real estate.

Internal and external factors affect the value of real estate. Intrinsic factors are utility, scarcity, physical conditions, and transferability. External factors, on the other hand, are the external factors that affect the real estate value and do not directly belong to the real estate, in the form of economic, socio-cultural and legal legislation. The value of the real estate; location, characteristics and human needs determine. The value of real estate may increase or decrease over time. Increases and decreases occur within the framework of supply-demand principles. Applications such as zoning, tax and expropriation studies determined by the state are among the legal factors that affect the value of real estate. The percentage of real estate's use of reinforcement areas, construction conditions, view, shape and location can be counted as physical factors that affect the value.

As mentioned before, real estate valuation studies should be carried out in an objective and impartial manner. For this, first of all, all the parameters that affect the real estate value must be determined correctly. These parameters then need to be linked to a mathematical

or statistical expression. Some of these factors may have a very high impact on the value of the property, while others may have a very limited impact. The need for valuation to be made on objective criteria and mathematical foundations; requires the identification of all factors affecting value and the mathematical expression of these factors. Factors affecting the value of real estate differ for land and plot.

In order to ensure reliability in real estate valuation, the basic principles that are effective in the valuation process should be well known and taken into account in the value estimation. In the valuation process; There are many principles such as expectation, balance, change, competition, harmony and premium gain or loss, contribution, externality, increasing or decreasing revenue or income, conjuncture and residual income and they should be well known.

The types of real estate that can be appraised can be summarized as follows:

Housing: It covers all kinds of places that people use for their shelter needs. The most important requirement for a dwelling to be called a residence is that it is for shelter. Examples of housing types are flats (independent sections on the floor), villas, and residences.

Agricultural Real Estate: As the name suggests, it is a type of real estate that is used for agricultural purposes and also provides income to its owner. Such as land, land, field. Many factors come into play when valuing, from providing

employment to the productivity of the land, from its shape to its location.

Commercial Real Estate: It is the type of real estate used for commercial activities and can be bought and sold. These are real estates that are not residential but are used to earn commercial income. Office buildings, offices, hotel buildings, shopping mall buildings, stores and shops are considered as commercial real estate.

Industrial Real Estate: It includes all kinds of real estate where industrial production is realized. They are immovables used for industrial purposes such as factories, production facilities, workshops. Since it has a wide scope, the valuation of this type of real estate also brings with it the need for special expertise.

Special Purpose Real Estate: It mostly includes real estate allocated for use in a private area. Examples include schools, places of worship, hospitals, even golf courses. It is also known as real estates that are not easy to value because they do not change hands frequently in the real estate market.

Factors affecting real estate valuation are listed as follows:

a. Location: The distance of a real estate to the city center, transportation and proximity to public service areas, presence of shopping centers in the region, presence of facilities such as health and education, places of worship, water source, shore,

etc. The distance to places, the distance to the noise generating facilities greatly affects the value of the real estate.

b. Shape and size: The shape and size of the property affect the value to a large extent. The most suitable shape for plots are rectangular shapes whose length does not exceed one and a half times its width. The earthquake resistance of buildings also depends to some extent on the relationship between the facade and the depth. The shape of the parcel; It is measured by the number of parcel boundary points and the angle between these points. Regularly shaped parcels have few border points. The steeper the angle at the parcel corners, the smoother the parcel shape.

c. Topographic and Geological Characteristics of the Real Estate: The high slope increases the construction cost and construction time considerably. Retaining walls must be constructed to prevent further excavation and landslides to ensure building settlement on high sloping lands. On the other hand, reducing the slope by filling the natural ground creates significant drawbacks in terms of soil strength. The construction of infrastructure facilities in these areas also becomes difficult and causes an increase in costs. Although the soil structure and depth, which is effective in all areas from product variety to yield, especially in agricultural real estates, are not so effective in other real estates, it is seen that lands with deep soil structure

are more valuable in terms of foundation and construction costs compared to rocky lands.

d. Usable space: The usage area is the area where the real estate is utilized without encountering any physical and legal restrictions. This area may be legally restricted by the easement rights on the parcel, or it may be physically due to reasons such as a rocky area on the parcel or a pond.

e. Productivity: Since the quality and productivity of the soil affect the income obtained from the product sown on the land, it directly affects both the value of the real estate and the real estate investments and demand. The fact that the soil can be irrigated in agricultural lands and that no additional investment is required for this is one of the factors that increase the value of the real estate. The variety of products grown in dry agricultural land and the low yield also decrease the value of the parcel.

f. Technical Features of the Real Estate: Features covering technical issues such as materials used in real estate, project, electricity, heating, thermal insulation, earthquake resistance, elevator features, security are effective. It has similar physical characteristics with a quality, correct and well-planned housing project; but it is more valuable than a housing project with an ordinary project. Although these features are seen as more striking elements in residential real estate, they are now the

desired features of industrial, commercial, agricultural and special purpose real estates.

g. Features of the Environment Where the Real Estate Is

Located: The environmental characteristics of the area where a real estate is located are among the factors that have a direct impact on the value. of the environment; Infrastructure and superstructure service status, density, proximity to the center, status in terms of recreation areas and green areas, status of negativities such as noise, environmental pollution, parking problems, status of basic needs such as education, health, worship, shopping, visual quality structure, climatic and It includes features such as micro-climatic elements, social texture and proximity to water-based landscapes.

h. Features of Buyer and Seller:

The buyer or seller's desire to buy or sell, bargaining style or obligation, whether an intermediary is used in the purchase-sale transactions, the number of right holders of the real estate or the number of addressees, and the kinship or acquaintance of the buyer and the seller may also cause changes in the value. In order to make purchase and sale transactions on a real estate, the right holders of the real estate must be stakeholders in accordance with the agreement and common ownership provisions. Valuation studies are adversely affected in cases where there is a large amount of right holders and in case of disagreement.

i. Economic Indicators

Depending on the general economic trends in the country, an increase or decrease in value occurs in the supply-demand balance and with the reflection of all other effective environmental factors. Real estate is seen as a long-term investment tool and is a preferred economic investment tool in terms of protecting its asset value against inflation risk. Real estates that generate rental income in addition to their own appreciation over time are assets that are affected by global and national financial policies. Inflation increases the real estate manufacturing costs, which is reflected in the real estate value.

k. Zoning Factor: Zoning factors are actually the technical factors that affect the valuation the most. It is especially important in land valuations. In order for an immovable to be considered as land on the valuation day;

- Being in the municipality zoning plan,
- If it is not in the zoning plan, it is located in the municipality or adjacent area,

In addition, benefiting from municipal services,

- It must be inhabited.

1.2. Real Estate Valuation Process

The valuation process is the whole of the technical examinations in order to determine the value of the real estate. As a result of these examinations, an independent and impartial appraisal of the probable value of the real estate, its rights and benefits at a certain date is expressed.

The valuation process in Turkey is carried out by real estate appraisers licensed by the Capital Markets Board (CMB). The reports prepared by these experts are checked by CMB licensed experts who work as controllers (auditors) in the valuation company. Responsible valuation experts, who have at least 10% share in the capital of the company and have the authority to sign the valuation reports on behalf of the company, constitute the last leg of this process with signing authority. The scope and flow of the real estate valuation process is as follows:

a. Defining the Valuation Problem: The purpose of the valuation is to determine how and for what purpose the customer will use the information in the valuation report. That is, the subject for determining the valuation problem is to define the information about the real estate. The main information required is:

1. Location, physical, prohibited and economic features,
2. Property rights to be valued,
3. Assets to be valued other than real estate,
4. Restrictions on land use.

- b. Defining the Scope of the Work:** At this stage, the physical and legal characteristics of the real estate are determined in detail. These features include the legal rights of the buyer and seller of the real estate in question and environmental factors. Environmental factors, as explained before: proximity to shopping mall, hospital, school, transportation etc. are the distances. This is the stage in which the purpose of the valuation is clearly determined by examining these factors in detail.
- c. Data Collection and Identification of Real Estate:** At this stage, factors such as social, economic and political factors and the environment are examined. Then, the physical properties of the real estate are examined. Among these features, factors such as the construction quality of the house, the quality of the materials used, and the nature of the market in which the real estate is located are considered. The final stage is the determination of competitive supply and demand.
- d. Data Analysis:** At this stage, the purpose of the evaluation is clearly stated and its applicability is analyzed. It consists of data analysis, market analysis and efficient use analysis. Market analysis is the study of determining the market for a particular economic good or service.

Application of Valuation Methods: A real estate value is created with unique valuation procedures by using different data analysis methods. Ideally, each method should be applied as

long as the data are available. The methods used depend on the type of property, the intended use of the valuation, the defined scope of work, and the quality and quantity of data for analysis.

e. Reconciliation of Value Indicators and Estimation of Final

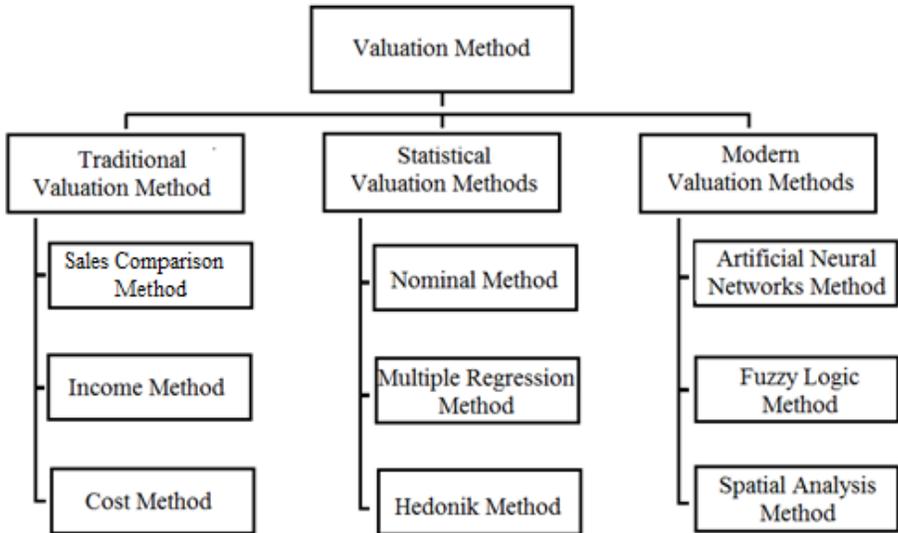
Value: Different indicators created from different methods, value results and applied methods need to be explained. It is tried to reach a final value with the value created by the application of different methods and the result value is tried to be expressed in terms of money. The result can usually be expressed as a single digit or as a range of values.

f. Writing the Valuation Report: As a result of all the work done above, the final appraisal report is created by the real estate appraiser. The results of all the work done are clearly stated in this report. In addition to these, three different methods are taken as a basis while valuing real estate.

2. REAL ESTATE VALUATION METHODS

There are different methods in the literature on real estate valuation. However, in practice, the three most well-known methods are; market (comparison), income and cost methods and traditional valuation methods of these methods are used. In addition to traditional methods, there are statistical valuation methods and advanced valuation methods (Figure 1). It is also important that the preferred method takes into account the characteristics of the real estate to be appraised,

as well as which method is used. Method selection in the valuation study; It depends on the type and type of real estate, the valuation purposes and related legislation, the characteristics of the real estate



market and other factors (Tanrıvermiş 2016).

Figure 1. Real estate valuation methods (Tanrıvermiş 2014)

The most widely used traditional valuation method is the Sales comparison method. This method of valuation based on market value is generally the most commonly used approach for development plots with or without buildings. Comparison method is known as the ideal method in cases where sufficient comparable real estate sales value can be obtained in the local area. In cases where the values of real estates can be determined according to the income they will bring in the coming years, it would be appropriate to apply the income method. While the income method is preferred in the valuation of real estates with known rental income, such as business centers, offices and

residences, the value of real estates with unknown income is obtained according to the cost method.

2.1. Traditional Valuation Methods

2.1.1. Sales Comparison Method

In this valuation method, data are examined for comparable examples with basic similar characteristics to the real estate to be valued in the region. This method should be used in cases that are recent, transparent and have sufficient precedent value. Generally, the valued real estate is compared with the sales of similar real estates in the open market.

Especially in housing valuation, it is the most preferred method in practice since many sales information can be accessed in a short time and easily in electronic and internet environment.

In the sales comparison method, the effects on the market price are evaluated by revealing positive or negative differences such as age, maintenance, floor, installation, parking lot, scenery, security, transportation, social facilities of the real estate to be valued and the comparable real estate in the same region and close to it. In other words, it is the determination of the value of the real estate subject to appraisal by applying the necessary mathematical corrections according to the selected comparison criteria. Adjustment is the action taken to make comparable property equivalent to the subject property at the valuation date. After the collection of general and specific data, the market value of the real estate is analyzed.

The following points are the usage areas where the application of the sales comparison method gives reliable and healthy results:

- a. It can be applied to all types of real estate if sufficient and reliable data is available.
- b. In the case of data, it is the most appropriate approach to determine the value.
- c. It is not used to determine the value of real estate built for special purposes. (For example; museum, library, mosque, school etc.)
- d. It is generally used in the valuation of non-income real estate (such as land).
- e. It is widely used in housing valuation in Turkey.
- f. When evaluating historical data, changes in market behavior that have developed since the data period should be taken into account.
- g. Used in land valuations
- h. Courts and valuation commissions often consider this method.
- i. It is easy to understand by individuals.
- j. Sales with legal obligations such as bankruptcy and expropriation.
- k. Sales between close relatives.
- l. Sales of property, plant and equipment due to financial difficulties.
- m. In special cases such as the purchase and sale of real estate adjacent to the real estate

Some difficulties are encountered in the application of this method. These:

- a. It is not easy to reach the actual sales prices of the comparables that have been sold within a certain period.
- b. It is difficult to mathematically model the differences between sales.
- c. In case of insufficient data, it causes errors.
- d. In markets with rapid changes and turbulence, it may not yield reliable results if used in the valuation of rarely sold and special-purpose properties.

The main trading value and other data sources that can be used in the Sales Comparison Method can be listed as follows:

- a. Realized sales
- b. Contracts
- c. official records
- d. Auction results
- e. Valuations made by public and private institutions.
- f. The work of appraisers and organizations.
- g. Media: Newspapers/internet/real estate magazines information,
- h. Information received from real estate agents,

When using this method, the similarity of the real estate to be valued and the accuracy of the information are examined. The sale of the real estate selected as a precedent must have actually occurred before the date of the lawsuit or the date of public interest in the valuation

processes made with legal requirements. Real estate property advertisements for sale should not be chosen as a precedent, and sales for special purposes, collusion and speculative purposes should never be taken into account.

In the process of Sales Comparison Method (Tanrivermiş 2016):

1. Investigation of data (Collection of data on the sale of real estate with similar characteristics).
2. Checking the accuracy of the data and that it is made between parties without any conflict of interest (Verification of the obtained data).
3. Selection of relevant comparison units
4. Review and correction of sales
5. Reconciliation of many value indicators on a single value or value limits
6. In this study, it is extremely important that the expert closely monitors the market conditions. The expert should always verify the information he has reached.

This method can be applied to all types of real estate when there are enough new, reliable sales transactions. The sales comparison method is the most accurate and simple way to explain and support an appraisal when data is available. The sales comparison method generally provides the primary indicator of market value in valuing properties that are not purchased due to their income-generating characteristics. It provides the best indicator of value for commercial

and industrial properties used by owners. It is widely used in housing valuation in our country.

2.1.2. Income Methods

This method is used for valuing income generating land, residential or non-residential structures and businesses. Income generation power and discount rate, which are the main variables of this method, are determined by the market. Therefore, while estimating the expected rate of return and income, the appraiser has to consider the supply and demand situation of the real estate in question.

The process of converting an asset's income into value is called "capitalization". Project valuation of a real estate or real estate project according to cash flows is another type of income method. It examines the capacity of real estate to generate future benefits and capitalizes income against a current value indicator. The important features of the income method are (Tanrivermiş 2016):

- a. Income methods do not take into account non-pecuniary value.
- b. A small change in the capitalization rate changes the value drastically.
- c. It gives erroneous results in the lands in the transition process, which is called the urban fringe.

The ability of real estate to generate income is calculated according to the income multipliers approach. It is estimated how the determined income will progress over the years. Potential income sources and cash flows are identified. Net operating income is calculated after

deducting operational costs, general expenses, taxes, operating expenses, vacancy-rental losses, operating expenses, insurance, management, maintenance-repair, consultancy, advertising and investment expenses. The capitalized value of the real estate subject to the appraisal is calculated from the net operating income (Tanrivermis 2008).

The criterion for determining the value of a real estate with a structure is the net income that can be obtained in this method. This net income consists of the building, its annexes and the land share. The income value of the real estate is reached after the general expenses, operating costs, taxes, working capital needs and investment expenditures are deducted by estimating how the income of the relevant real estate can develop and change over the years. The market value is obtained by making the necessary increases and decreases in order to make the income value of the real estate suitable for the local market conditions.

In addition, residual income can be found by calculating the value of the potential net income that the real estate will generate for a single year, by dividing it by a capitalization rate formed according to the current real estate market conditions. In a competitive environment, residual income equals rent.

If the value of real estates can only be determined according to the income they will bring, it is a rule to apply the income method to find the release costs. The criterion in determining the value of a real estate with a structure on it with the income method is the net income that

can be obtained. This is net income; consists of the building, other structural facilities related to the building and the income share of the land. Despite the possibility of continuous use of the land, the period of use of a building is limited.

When applying the income capitalization method, it is assumed that the investor ultimately expects a total return greater than or equal to the amount invested. Therefore, the return that the investor expects has two components.

1. Full recovery of the invested amount, i.e. return of capital.
2. A reward for assuming risk, ie return on invested capital.

Real estate returns can take a variety of forms. Therefore, many rates or yield criteria are used in capitalization. All measures of return are classified as either an "income ratio", such as a capitalization rate, or a "rate of return," such as the discount rate or internal rate of return used to convert future payments into present value.

The income method, just like the cost method, is mostly used if there is not enough precedent that creates the market value. This method is based on detailed mathematical formulas and the accurate determination of the large number of variables used in these formulas through extensive research.

Income Capitalization Method Process

The application process of the income capitalization method is as follows.

1. Income and expense data are searched for the subject real estate and precedents.
2. The potential gross income of the property is estimated by adding up the potential rental income and any potential income.
3. Vacancy and rent collection losses are estimated.
4. To arrive at the effective gross income, the vacancy and collection losses of the subject real estate are subtracted from the total potential income.
5. The total operating expenses, fixed expenses, variable expenses and replacement cost for the subject real estate are estimated.
6. Subtract the total operating expenses from the effective gross income to find the net operating income.
7. To estimate value with the income capitalization method, one of the direct or yield capitalization approach techniques is applied to these data.

The difficulties that may be encountered in the application of the income capitalization method; It is necessary to select the data of the samples with similar income-expense expectations, the return rates should be selected from the properties with similar characteristics, and the practitioner needs to calculate the income, expense and vacancy estimates very well. In cases where it is not appropriate to use; Non-income real estates are situations where there is no data from which appropriate and healthy measurable value can be obtained.

Capitalization Rate: The capitalization rate is the value used to convert net operating income to the value of the total real estate. This value is

a ratio that reflects the relationship between a single year's net operating income and the total real estate value.

$$\text{Capitalization Rate} = \frac{\text{Net Operation Income}}{\text{Real Estate Value}} \quad (1)$$

The capitalization rate is determined depending on the sales and rental prices that change in parallel with the supply/demand relationship in the real estate market. It requires the determination of the annual rental prices of the comparables that have been sold according to the market conditions of that day in the immediate vicinity of the real estate to be appraised. However, generally accepted capitalization rates have been determined in Turkey due to the difficulty in precedent information. Capitalization rates have been adopted as 7-9% for residential use, 10-11% for offices, and 12-14% for uses such as hotels and shopping malls.

Discount Rate: Discount is a rate used to convert future cash flows that will occur over a certain period of time into present value.

Net Present Value (NBV): Net present value is a coefficient of value that converts the potential benefits of an income generating property into its property value. To find this value, the capacity of a property to generate future benefits is examined. The revenue is then discounted to a current value indicator. The future benefits of income-earning properties include all cash flows from the property during the ownership and review period, plus proceeds from the disposal of the

property at the end of the investment. Net present value is calculated with the following formula:

$$NBV = \frac{A}{(1+i)} + \frac{A_2}{(1+i)^2} + \frac{A_3}{(1+i)^3} + \dots + \frac{A_n}{(1+i)^n} \quad (2)$$

NPV = Net Present Value

A_i = cash flow for the specified period,

i = Appropriate periodic rate of return (discount rate)

n = Number of periods

In the income method, the gross rent multiplier and the gross income multiplier are used in the valuation of real estates that generate rental income.

$$\text{Gross Rent Multiplier} = \frac{\text{Value (Sales Price)}}{\text{Annual Gross Rent}} \quad (3)$$

$$\text{Gross Rent Multiplier} = \frac{\text{Value (Sales Price)}}{\text{Gross Income}} \quad (4)$$

Internal Rate of Return (IRR): The internal rate of return is the rate of return earned for a given capital investment during the ownership period. The internal rate of return of an investment is the rate of return that equates the present value of the future benefits of the investment to the capital invested. That is, it is the ratio that exactly equates the present value of the project's cash outflows to the present value of the cash inflows.

The internal rate of return is applied to all expected returns at the end of the investment. It can be used to calculate the return on any capital investment, either before or after income tax. The net present value in the internal rate of return is zero. This ratio assumes the time value of money and considers the expected cash flows over the entire economic life of the investment. In a selection among alternative projects, the project with the highest internal efficiency ratio is given importance.

In the application of the direct capitalization technique, first of all, income and expense data for real estate are researched. The potential gross income of the property is then found by adding up the rental income or any other potential income. The vacancy and collection loss are estimated. To find the real estate's effective gross income, the vacancy and collection loss are subtracted from the total potential gross income. Total operating expenses for the property are estimated. Total operating expenses are subtracted from effective gross income to find net operating income. At the end of all transactions, a value is estimated by choosing an appropriate capitalization rate.

The basic formula used in the direct capitalization method is:

$$\text{Value} = \frac{\text{Annual Net Operating Income}}{\text{Capitalization Rate}} \quad (5)$$

In the yield capitalization technique, the expected benefits in the future are evaluated. The first step in establishing the model is to estimate the expected cash inflows. In this technique, possible cash

inflows (income) and cash outflows (expenses) are taken into account during the ownership period ranging from five to ten years. Yield capitalization is the technique used to convert a series of future cash flows into a present value indicator by applying an appropriate rate of return.

Net present value is future cash flows converted to present value. Periods for real estate investment analysis are usually set annually. The typical period for rental cash flow calculations is 5 or 10 years.

The following steps are followed for implementing return capitalization:

1. An appropriate ownership period is selected.
2. All future cash flows are estimated.
3. An appropriate rate of return is selected.
4. Future benefits are converted into present value. A suitable formula is chosen for this. Here is a total rate to discount each future annual benefit or reflect the revenue model, change in value, and rate of return.

All present value problems consider the following;

1. The initial cost of starting the business,
2. Periodic cash flows over time,
3. The return or resale value of the real estate.

Some real estates have high annuity yields and are used for investment purposes. For this reason, trading is not done frequently in the market.

One of the most important approaches used in determining the market value of unique real estates such as office-residence-shopping center buildings, hotels, congress centers and office buildings is the income capitalization method. In addition to these unique structures, sometimes there are cases where the lands have no precedent.

Situations where a land has no counterpart with similar characteristics are encountered either in regions where the land supply is limited or in regions where the zoning status has changed recently. This method can be applied in such cases if the land generates income. Residual value is the net income of the land after the other factors of production have been paid for. In a residual value analysis, the land value is the residual income after restructuring costs are covered. This method can be applied when testing the feasibility of alternative uses of a particular land in the most effective and efficient use analysis or in cases where there are no land sales. In land residual value applications, an appraiser will often consider a new most efficient use, assuming a non-existent building.

By using the land residual value method, it is possible to estimate the land values in cases where there is no up-to-date data on land sales. This method is mostly used in practice to test the most effective and efficient use of the land for proposed new constructions. Residual value analysis is useful in the analysis of the most effective and efficient use of the land and which alternative use will bring the highest return. As part of the traditional approach to value, the method

is used to estimate the land value as well as to test the feasibility of various uses in line with the most effective and efficient use analysis.

The most effective and efficient use of the land is a very important concept in real estate valuation. While appraising, the appraiser has to determine the highest price possible for the real estate in question. In this respect, the following procedure should be followed in order to accurately determine the most effective and efficient use of the real estate:

1. A supportable real estate project development plan is created,
2. Development cost and schedule are determined,
3. A realistic price list preliminary estimation is made over time,
4. Stages of land development and related expenses are estimated accurately,
5. The discount rate includes overhead and entrepreneurial profit.

This analysis also allows for testing the feasibility of a proposed project and calculating the estimated profit discounted by the appropriate discount rate. The land residual value method can be determined as a result of market analysis and the most efficient use of real estate analysis. Market analysis and most efficient use analysis are also two components of data analysis.

Some real estates may need to be valued considering that they will be developed in terms of their properties. In this case, the net income that will be provided by the development of the real estate is taken into account by deducting the net revenues from the expenses to be made

due to the development, and the present value of the real estate is reached with an acceptable discount rate by taking into account the contractor's profit

The income method considers the probable net income stream for an investor or a user over the remaining economic life of a property. This income stream is compared to income from similar real estate. The probable return on the investment is then compared with the gains from similar real estate or other types of investments. Various techniques are used for the interest and capitalization rate to be used in reflecting the estimated net income stream of the real estate in question to an indicator of the market value of the real estate. In the comparison of the real estate in question with other similar real estates, the same basic physical, functional and economic factors are taken into account as in the comparison of sales method, especially in terms of rent.

Usage areas of the method:

- It can be used for income-generating real estates or real estates that are expected to generate income.
- It is used in the valuation of real estates where the age of the building is high and therefore cost management is not reliable.
- It is used in the valuation of real estates with land characteristics and in the control of the values determined by other methods.
- It is used in the valuation of real estates with land quality.

- It can be used to support and control other cost and sales comparison methods.
- It can be used to control the expectations of the investors.

Resources used for the implementation of the method;

- A detailed breakdown of past income and expenses, if any, of the subject property.
- Income and expenses of comparable real estate.
- Market interest rates, inflation expectations.
- Market risk-return ratio estimation.

2.1.3. Cost methods

Real estate valuation with the cost method is based on the principle of substitution in the economy. This method is based on the determination of the cost value of the building on the valuation day. The value of the real estate is the sum of the building value, external facility, special operating equipment and land values. The cost of a good can be expressed as the sum of production costs.

The cost method is the method used in the valuation of special purpose real estates that are not frequently traded in the market, and in the valuation of real estates that do not have comparable sales data, that are unconventional and do not have a market, and that do not generate income. In the cost method, the land and building value are calculated separately. The cost method is used in the valuation of the projects of new or slightly worn constructions, new or in the tender stage. The method is particularly useful in insurance applications where building values are determined separately.

In the case of a building being rebuilt or, in exceptional cases, it is valued at the cost of the replacement construction. Building approximate cost values, T.C. It is published by the Ministry of Environment, Urbanization and Climate Change. Along with these values, the technical features of the buildings, the materials used in the buildings, the construction costs of the buildings built with the same characteristics in the market are evaluated together, and the approximate cost of the building is calculated by adding the entrepreneurial profit.

It is assumed that the value of the building will decrease over time due to physical wear, functional and economic obsolescence. Thereafter, depreciation is deducted from the cost of rebuilding. The wear rate is calculated by taking into account the visible physical condition of the building with the ruler showing the building wear shares over the years. The value is determined by adding the land value of the real estate to this value (Altıparmak et al, 2013; Atatürk, 2018).

In the cost method, the market value of the real estate is calculated with the formula below.

$$\text{Property Value} = \text{Land Value} + (\text{Building cost amount} - \text{Wear}) \quad (6)$$

The general usage areas of the cost method are as follows;

- In the valuation of real estates that are not frequently bought and sold in the market,
- If buildings with private use are subject to valuation,

- In the absence of comparable sales information,
- When you have an unusual real estate or a very slow market,
- When there is no income generating real estate type,
- In the valuation studies of the projects that are unfinished or at the tender stage,
- In cases where it is necessary to evaluate the land and buildings separately,
- When it comes to add-ons and upgrades,
- If peer sales information is insufficient,
- If the income capitalization approach cannot be fully trusted,
- In the monetary adjustments of some items in the sales comparison method,
- In feasibility studies.
- Construction contracts,
- Indices (if any),
- Information of the contractor companies,
- Companies that make professional cost calculations (abroad),
- Construction cost information of completed projects,
- Ministry of Environment and Urbanization annual lists and
- The appraiser's own records.

The following process is followed in the cost method.

1. The land value is estimated as if it is empty and ready for use in the most efficient and productive way.
2. Determine whether rebuilding cost or replacement cost is appropriate.

3. The direct and indirect costs of the configurations are calculated as of the actual valuation date.

Direct (direct) costs are expenses incurred for labor and materials used during construction to rebuild the structure at the actual valuation date. These:

- Labor used in construction,
- Materials, products and equipment,
- Construction permits,
- Security expenses during construction,
- Site structures and storage expenses,
- Power line installation and electricity expenses,
- Contractor general expenses, including social security expenses, severance pay, fire and liability insurance,
- They are letters of guarantee.

Indirect costs are expenses that are necessary for construction but are not typically part of the construction contract. These;

- Architecture and engineering fees for the project,
- Valuation, consultancy, accounting and legal expenses,
- Expenses incurred according to the land and contract during the construction,
- Insurance and taxes paid during construction,
- Expenditures made after the construction until it starts operating,
- Marketing expenses, sales commissions,
- General administrative expenses.

4. A suitable entrepreneurial profit is estimated from the market analysis.
5. The total costs of the configuration (estimated direct and indirect costs and entrepreneurial profit) are added up.
6. The amount of wear on the structure is estimated and if necessary apportioned between the three categories.

2.2. Statistical Valuation Methods

These are the methods based on the calculation of the factors affecting the value of the real estate with statistical analysis and mathematical model. It is used as an alternative to traditional methods. Statistical valuation methods are supported by statistical analysis programs.

The possibility of establishing mathematical relations for the others by making use of one of the variables is weak. On the other hand, there may sometimes be random dependencies between real estate values that make up a cluster. Such dependencies between values are called stochastic dependencies. The word stochastic consists of probability and statistics (Athen and Ballier 1972). The difference of the methods, the analysis of which is carried out with statistical programs, from the classical methods is that more data can be processed in less time.

Statistical methods are based on the comparison technique, which is one of the traditional valuation methods, as a basis for the way of working. These methods also use the ability of modern valuation methods to simultaneously, collectively, value large numbers of properties spread over a wide area. These methods transform the

relationship between the elements of the set of real estate values into numerical and proportional relations. Information systems are used to process large amounts of digital data together. One of the most important inputs in the mathematical models to be created is the market value verified information. Nominal, multiple regression and hedonic analysis approaches are the most frequently used mass valuation methods (Saçın et al., 2009).

2.2.1. Nominal valuation method

Value is directly related to the qualities of the real estate. By considering different criteria, the approximate value of the real estate can be determined. For this reason, it is very difficult to determine the net value of a real estate. The unit to be taken as a basis in the value distribution may also be the values related to one or more variables to be obtained with a scoring. For this, ceiling and floor scores are determined and a value coefficient representing each real estate value is calculated.

In a region where there is a large number of real estates, it is necessary to determine the value distribution of the real estates relative to each other while valuing the real estates. Fair values can be used to determine the value distribution, as well as parametric values derived by scoring. In order to derive parametric values, the factors affecting the value are formulated, the floor and ceiling scores are determined, and a coefficient is calculated for each real estate. These coefficients, which show the relative value of the immovables, can be quickly converted to the current value if necessary. In this way, real estate

valuation is a different approach from other classical methods and is called nominal valuation in the literature (Yomralıođlu 1997).

With the nominal method, valuation of immovables can be done practically and objectively as much as possible, in cases where a large number of real estates will be valued, as is the case in tax valuation (Doldur and Alkan, 2021).

In the nominal valuation method, first of all, the value distribution between the real estates should be revealed. The factors affecting the value of each real estate should be expressed with a numerical variable in nominal terms, depending on the degree of impact of each. The unit to be taken as a basis in this value distribution may be the current price or the parametric values to be obtained with a scoring. In the nominal value method to be used for this purpose, the ceiling and floor points are determined by formulating the value criteria to be taken into account, and a value coefficient expressing each real estate is calculated (Karapınar, 2013).

Value coefficients express the relative value of real estates in terms of value in this method. These coefficients are converted to market value. This method is called the “nominal” valuation method. The number of factors affecting real estate value cannot be strictly limited. For this reason, it may be possible to express the factors affecting the value of each real estate with a numerical variable in nominal terms, depending on the degree of impact of each. The criteria that can affect the value of a real estate and in their formulation, it is assumed that the unit

square meter value in the best conditions is a maximum of 100. Accordingly, each factor is scored over 100% according to the degree of goodness. One of the most important steps in the nominal valuation method is to decide on the factors affecting the value. Because the factors affecting the values of real estates may differ on a regional or even a provincial basis. The value of each real estate related to one or more variables is calculated with the formula below.

$$D_i = \sum_{j=1}^k (f_{ij} \cdot w_j) \quad (7)$$

In the formula; D : Total nominal value, f : Factor value (Score), w: Factor weight, k : Total factor number.

The variable “f” value is the effect of the determined factor on the real estate. The “f” score value can be a value between 1 and 100. Each factor determined in this way affects the real estate value with a different weight “w”.

The socio-economic structure of the country affects the units based on the valuation method used. Properties of real estates mostly remain at the same level. Since changes in market conditions also cause price speculation, it becomes very difficult to keep unit values on real estate under control. In addition, the large areas to be appraised and the large number of real estates make the valuation process difficult. Similar difficulties are encountered in valuation procedures for property tax (Ünal, 2015).

While valuation is made, the values of real estates on the same street or street are mostly accepted. This is quite a wrong practice. Because

each real estate may have some positive or negative qualities in terms of value compared to other neighboring real estates. . Therefore, it would not be correct to say that a real evaluation was made with a general approach made in this way. Therefore, it is necessary to determine the value distributions between the real estates in question with the research to be carried out in a region where there are many different properties. The unit to be referenced in this distribution may be the current value, as well as the parametric values to be determined by a scoring method (Demir, 2009).

For the successful implementation of this method, it is necessary to take into account the local characteristics of the area to be valued and to produce results that are closer to reality.

2.2.2. Multiple Regression Method

Another name for this method is the least squares method. The multiple regression method is the application of a multiple regression model by including a large number of independent variables that will affect a dependent variable in the analysis. These dependent variables are often the result of more than one cause. Too many variables can come together and affect another variable. With this aspect, it is accepted as a method that can be used in real estate valuation.

It is a method in which statistical information collected from the real estate market is evaluated together and applied. The actual purchase and sale values of the real estates and the quality information of the real estate are collected. The accuracy of the method increases when

the real sales value of a large number of real estate is used. Due to the large number of factors affecting the value of the real estate, the multiple regression method should be preferred in determining the real estate value. Although it is difficult in practice, it is a very important and preferred method in terms of getting very close to the real value.

Multiple regression analysis consists of dependent and independent variables. The number of dependent variables is odd, but the number of independent variables can be more than one. If there is only one independent variable, it is called simple linear regression, if there are two or more independent variables, it is called multiple linear regression. In regression analysis, it is aimed to make functional sense of the relationship between the variables and to explain this relationship with a model (Chatterjee and Hadi, 2015).

This technique is basically connected with the sales comparison approach. The method in question is simply based on the assumption that the regression of the adjusted values of comparable real estates for fully adjusted real estate properties should yield low coefficients of certainty, meaningless F and t statistics (Isakson, 1998). According to this assumption, the covariance between the adjusted prices of comparable properties and the properties of the correct adjusted properties will be very low or close to zero.

It is common for some values to be clustered in applications to show large deviations. Thus, Gauss's "Least Squares Method" is applied to determine the balancing line free from personal effects. The meaning

of this method regarding the real estate value is as follows: "Let's find such an equalizing line that the sum of the squares of these direct distances of the values of the cluster is as small as possible." If the definition of distance in this expression is made as "The distance of the point equal to the value from the direct coordinate axis of the balancer", it will be easier to apply the theory and make the calculation.

The regression method can be expressed as a statistical technique that enables the evaluation of the real estate together with its relevant features in order to identify the important factors affecting the real estate value and measure its size. Regressions can be made with hybrid methods such as comparison of sales price data, average or median of sales prices, hedonic pricing, resale data analysis, artificial intelligence methods. In fact, this method is the process of finding the coefficients a and b that minimize the sum of the squares of the distances between the points (x, y) on the $y = a + bx$ line and the given (x_i, y_i) scattered points. When these coefficients are calculated, the line $y = a + bx$ (regression line) is found. Scattered points and obtaining the $y=a+bx$ line are presented below (Figure 2). The form of the function is not known beforehand. The form of the function is decided according to the direction of the relationship between the property value and its properties. In this function, the dependent variable y , which expresses the value, is the independent variable that affects the value (Tanrivermis 2016).

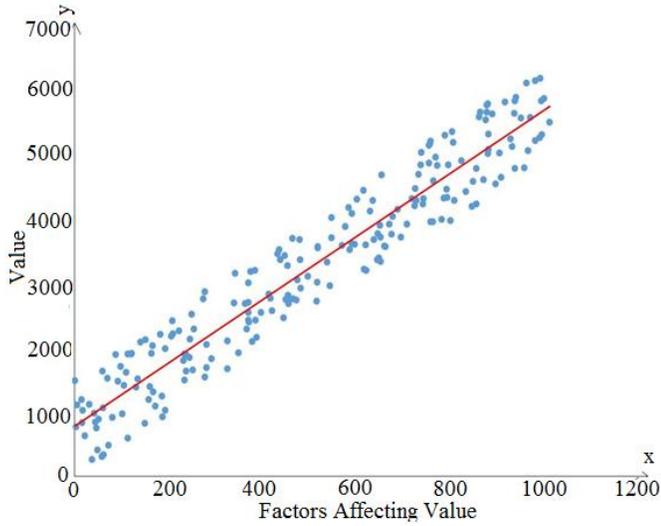


Figure 2. Finding the $y=a+bx$ line with multiple regression analysis

In the application, the data collected instead of graphics are analyzed by bringing them into tabular form and a function that models this data is determined. However, it is often not possible to find a function that fits this table exactly. In this case, the function that best fits the data table is determined.

There are different ways of combining the evaluations to get enough datasets to test the hypotheses tried in the method. First of all, multiple valuations of the same appraised property by different appraisers can be used.

Another way is the combination of immovables subject to similar valuation, which were evaluated by the same valuation specialist. In order to be able to use this way, the properties must be in the same or similar neighborhood, with similar dimensions and features. A third way to pool multiple valuations is to combine valuations of different

valuation professionals on properties subject to different valuations. This is the most desired type of pooling of evaluations (Özer, 2010).

2.2.3. Hedonic valuation model

This method is based on the Hedonic price theory. The hedonic price theory, on the other hand, is the sum of individual attributes or characteristics for each good, assuming that goods are heterogeneous. Each quality characteristic is treated as a good or service and therefore has its own price.

Hedonic valuation is a model used to calculate the indirect prices of structural, economic, environmental and social factors that affect the value of real estate. In the hedonic valuation equation, the degree of influence and directions of many factors are evaluated depending on the signs and sizes of the parameters of the model (Tanrivermis 2016).

The use of the hedonic price model for housing demand calculation was first introduced by Rosen (1974). The hedonic price model is the most widely used analysis technique for empirically measuring the effect of change in accessibility on price. The model is generally a statistical method used in the determination of urban rent and the effects of investments in transportation infrastructure on real estate value (Chau and Chin, 2003).

According to this theory, housing is assumed to be a heterogeneous property consisting of a combination of different characteristics. The effect of each of the characteristics that make up a heterogeneous good on the price can be defined. Accordingly, the price of a

composite good is the sum of the prices given in the market for the different qualities that compose it. Thus, the hedonic price model is used to predict the apparent prices of the different attributes that make up a heterogeneous good.

In the literature, it is seen that hedonic valuation method is used in many fields such as real estate, automobile, computer. When the model is applied to the housing market, it can be extracted and used effectively with the help of this type of regression model without leaving the value declarations to the citizens for real estate taxation purposes. According to the hedonic price model, housing value; It is explained with the help of four main sets of variables such as real estate, location, transportation and quality attributes (Tanrivermiş 2016).

$$D=f(H,N,L,\beta,\varepsilon) \quad (8)$$

In the model; D: Price of the property, H: Vector of variables describing the properties of the property, N: Vector of variables describing the characteristics of the neighborhood in which the property is located, L: Vector of variables describing the location of the property, β : vector of calculated parameters, and ε : random error term.

The first studies on the hedonic model in the field of valuation generally used linear or log-linear (exponential) function forms (Henneberry 1998). The logarithmic linear model is suitable for use in housing market analysis. This situation has been determined according

to the results of empirical studies. One of the reasons for preference is that a dummy variable can be added to the model.

In general, it can be applied to heterogeneous goods consisting of different characteristics, where each feature is identifiable. The difference from regression is; In this model, the effect of each feature added to the real estate on the value can be determined. The data used while constructing the hedonic valuation model are generally obtained from surveys and real estate data banks. The accuracy of the information used in the model is very important to accurately determine the value of the real estate.

2.3. Advanced Valuation Methods

The processing and transfer of information has the power to reshape the world. Especially the use of developing computer technology enables complex analysis of very large data groups in a short time. The concept of logic, which is a human characteristic, can now be applied to computer systems. These systems are called artificial intelligence. The concept of artificial intelligence was first introduced by Alan Mathison Turing with the question "Can machines think?" II. It was brought to life with the production of devices for needs such as crypto analysis and deciphering messages during World War II. John McCarty named this concept in 1956.

Artificial intelligence makes it possible for machines to learn from experience, adapt to new inputs, and perform human-like tasks. Most examples of AI you hear today – from computers playing chess to

self-driving cars – are based on deep learning and natural language processing.

Artificial Intelligence is the invention that provides the ability of a computer or a robot connected to a computer system to perform certain actions similar to living things. The Artificial Intelligence system works by observing the existing situation and processing this observation in line with the predetermined parameters.

Artificial intelligence is defined in the scientific world as the ability of a computer or computer-assisted machine to perform tasks related to higher logical processes, such as human-specific qualities, finding a solution, understanding, inferring a meaning, generalization, and learning from past experiences (Nabiyev, 2012). .

Artificial intelligence technology is developing more and more every day. New products appear and show themselves more in daily life. Automation systems are also equipped with artificial intelligence technology and the decision-making power of the computer is utilized. Newer commercial systems are emerging day by day and the functional features of the systems are increasing. In addition, it is used in areas such as cyber security and defense industry, voice assistants, language translations, suggestion systems, navigation, social security, health services, e-commerce.

There are different methods in which artificial intelligence applications are used in the literature. The main ones are artificial neural networks and fuzzy logic (control). Unique to real estate

valuation, the spatial analysis method is an advanced valuation method in which computer technology and information systems are actively used.

Advanced valuation methods require intensive mathematical knowledge and effective use of geographic information systems. It is more convenient to use in serial valuation processes and is not suitable for an expert to work alone. In addition, there is not much work done in this area.

Modern methods are widely used in engineering applications as they are an effective alternative for problems that are difficult to solve with classical methods. Although computers can process much faster and error-free than the human brain, they cannot perform functions such as learning and recognition as much as a human brain.

2.3.1. Artificial neural networks (ANN) method

The human brain demonstrates the existence of neural networks that can be successful in cognitive, perceptual and control tasks that humans excel at. The human brain has computational abilities required for perceptual actions (hearing, speech, recognition) and control activities (body movements and body functions) that require computation (Abraham, 2005).

The advantage of the brain is its ability to effectively use massive parallelism, highly parallel computing structure, and imprecise information processing.

Artificial Neural networks are computer systems that perform the learning function, which is the most basic feature of the human brain. In this method, the learning process is provided with the help of examples (nets). These networks consist of artificial nerve cells connected to each other. Each link has a weight value. The information of the artificial neural network is hidden in these weight values and spread over the network. Artificial neural networks propose a different computation method than known computation methods. It is possible to see successful applications of this calculation method, which adapts to their environment, can work with incomplete information, can make decisions under uncertainties, and is tolerant to errors, in almost every field of life. Despite the lack of a certain standard in determining the structure of the network to be created, the selection of network parameters, the fact that the problems can only be shown with numerical information, it is not known how to finish the training and cannot explain the behavior of the network, the interest in these networks is increasing day by day. In particular, artificial neural networks are the most well-known techniques in classification, pattern recognition, signal filtering, data compression and optimization studies. It is possible to come across successful examples that we will see in our daily lives in many fields such as data mining, optical character transport, optimum route determination, fingerprint recognition, material analysis, job scheduling and quality control, medical analysis (Öztemel, 2003).

Advanced artificial intelligence started with classical philosophers' attempts to define human thought system as a symbolic system. But the field of artificial intelligence was not formally established until 1956. The term “artificial intelligence” was coined for the first time in 1956 at a conference held at Dartmouth College in Hannover, New Hampshire (Lewis, 2014).

After 1970, artificial neural networks became popular again as a result of a limited number of researchers continuing their studies and solving the XOR problem. Later studies left the laboratories and became systems used in daily life. These studies have been supported by developments in both artificial intelligence and hardware technology. Now everyone accepts that they can learn on their computers and wants to benefit from this technology.

ANN models are also used in social sciences such as economics and business, as well as basic engineering applications. Co and Boosarawongse (2007) used ANN models for the estimation of Thailand's rice export in their study and the results of different methods were compared. Dhar and Chou (2001) compared and used nonlinear methods used in estimating the future profits of firms and found that ANN has better predictive power. Pao (2006) modeled Taiwan's electrical energy consumption based on National income, GDP, consumer price index using ANN.

Huang Vd. (2007) studied the input variables related to the artificial neural network model used in the estimation of exchange rates, stock

market index and economic growth indicators. In addition, it is used for ANN models in engineering calculations. For example, Anusree and Varghese (2016) used artificial neural networks (ANN) method to predict the daily flow of a river in India. To develop the models, precipitation data from nine precipitation measurement stations were used. In the health sector, for example, ANN is used in breast cancer studies. Machine learning with artificial neural network, image processing (Shi, He, 2010 and Ramirez-Quintana et al, 2012), character definition, classification, prediction, clustering, sound processing (Uncini, 2003), data filtering and optimization. Many applications are possible. One of the main reasons why artificial neural networks are preferred in these areas is to minimize the learning errors of all kinds of data, regardless of the algorithm used, and therefore can make realistic predictions.

Artificial neural networks are a system that emerges by artificially modeling the working system of the human brain. In general terms, it can be thought of as a complex system formed as a result of the connection of many nerve cells in the human brain with each other with different levels of influence (Figure 3). The studies, which started with the mathematical modeling efforts of neurons in the human brain in basic medicine units, continued regularly over time.

The basic processing elements of neural networks are called artificial neurons or nodes. In a simplified mathematical model of the neuron, the effects of synapses are represented by connection weights that modulate the effect of associated input signals, and the nonlinear

characteristic exhibited by neurons is represented by a transfer function. The neuron impulse is then calculated as the weighted sum of the input signals converted by The learning ability of an artificial neuron is provided by adjusting the weights according to the chosen learning algorithm (Bishop, 1995).

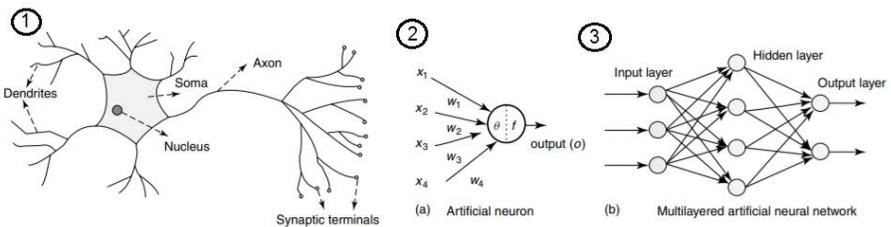


Figure 3. Mammalian neuron (1) Artificial neuron (2) and Multilayered artificial neural network (3)

Artificial neural networks are an information processing network that consists of processes that require intelligence and are distributed parallel to each other with information processing feature. This system consists of processing elements connected to each other by one-way connections (Figure 3).

In the model, the target element is only one, but it can be duplicated if necessary. The artificial neural network system imitates the human brain. They can shape their behaviors according to environmental effects. It can adjust itself to produce different results by giving inputs and desired outputs to the system. However, its internal structure is extremely complex. The data set is examined to reach the target

element. During this examination, the equations made by the program are unknown and do not depend on any equation.

Artificial neural networks are inspired by biological neural networks and model the human brain. The most important feature of this method is that it has the ability to learn like a real brain. Since adaptation and generalization are made according to the data used, it is necessary to work with high accuracy data.

2.3.2. Fuzzy logic method

Fuzzy logic is a generalization of classical two-valued logic. In other words, fuzzy logic refers to technologies and theories that use fuzzy sets.

The meaning of the English word fuzzy is “vague”. This term, which was used for the first time by Zadeh, was basically created on the fields of multivariate logic (Zadeh, 1965), probability theory, artificial intelligence, genetic algorithms (Holland, 1975) and artificial neural networks (Werbos, 1994); defines a concept that deals with the degree of occurrence of events rather than the probability of occurrence (Bush, 1996).

Fuzzy Logic was very effective in controlling large systems in the 1980s. In the early 1980s, theoretical progress was very slow. The reason for this is that very few scientists have focused on this subject. Thanks to the sensitivity of Japanese engineers to new technologies, the applications of Fuzzy Logic in process control have accelerated. In 1980, Sugeno implemented Japan's first Fuzzy Logic control

application. Then in 1983, he took control of a self-parking robot car with Fuzzy Logic. In the early 1980s, Yasunobu and Miyomoto of Hitachi started work on automatic train inspection in the Sendai subway. They finished this project in 1987 and realized the most advanced subway control system in the world (Sugeno, 1985).

Logic is the branch of science that studies the ways in which true conclusions can be drawn from true premises. With fuzzy logic, it is possible to include verbal uncertainties used in everyday speech into modeling and calculation. People get along by speaking with verbal data. The main area that fuzzy systems will evaluate is how to think in order to reach a conclusion if such information is found. With fuzzy logic, it is tried to model any problem approximately and to control it with mathematically simple solutions.

Fuzzy Rule systems have been applied in many fields such as, rail traffic control (Fay, 2000), flow time reduction in semiconductor manufacturing systems (Chang, and Liao, 2006), urban development modeling (Liu and Phinn, 2003), bankruptcy risk assessment (Gim and Whalen, 1999) fire support planning (Pereira, 1999), medical diagnosis (Alayon, 2007), Greenhouse automation (Ötük and Allaverdi, 2009), Calculation of concrete strengths (Büyükkaracıgan et al., 2011), Computing and Construction Fields (Büyükkaracıgan et al., 2009), lift system control of high-rise It has been used in many fields such as buildings (Büyükkaracıgan et al., 2011), evaporation prediction on water reservoirs (kumar et al., 2002).

Computer technology is used in many areas of daily life. The concept of fuzzy logic was defined by revealing the areas where classical logic was not sufficient in computers that were studied to imitate human thought. Fuzzy logic is based on fuzzy sets and subsets. In classical logic, an entity is either a member of the set or it is not.

The main purpose of applying the fuzzy logic method in engineering or other scientific fields is to draw valid conclusions in the light of unclear information. There are a large number of verbal rule patterns consisting of interpretations, meanings and evaluations reinforced as a result of knowledge and experience in memories.

With symbolic logic rules, it is possible to obtain general inferences by making propositions based on not only concrete but also abstract ideas. However, while doing this, the ambiguities and ambiguities in the concepts and terms should be clarified at the beginning of the work and given certainty. Therefore, symbolic logic includes ideal conclusions to be drawn from idealized terms and concepts. However, in the real world, blur and uncertainty is an inevitable reality.

Fuzzy theory is used to implement a linguistic control strategy based on human knowledge. While designing control systems, respectively; fuzzy control rules that make up the target, knowledge base are determined and blurring and clarification are done. The fuzzy theory was proposed in 1965. Shortly after this date, fuzzy control developed very quickly (Ödük, 2019).

The scope of application areas of Fuzzy Control is wide. These applications allow to provide an economical control. Fuzzy Logic is a mathematical discipline that we use in our daily life and that brings us to the structure in which we interpret our behaviors. We see the concepts of Fuzzy Logic in many parts of our lives. These concepts are high, medium and low values. Besides; It also includes very low, medium and very high intermediate values. Fuzzy set is the basis of Fuzzy Logic. Fuzzy sets are the most basic elements of fuzzy systems. The first explanation of fuzzy sets was put forward in 1965. One of the faculty members of Berkeley University, originally from Azerbaijan, Prof. Dr. It was first introduced by Lotfi A. Zadeh's article "Fuzzy Sets" published in the "Information and Control" magazine (Ödük, 2020).

The most important feature of this logic form is that the principle of the inconsistency of the third, which can be considered as the basic rule for other logic rules, and the principle of non-contradiction are not valid in fuzzy logic. In fuzzy logic, a proposition can be true and false at the same time. This is due to the fact that accuracy is very valuable. The ambiguity between a proposition and its not creates blurriness.

However, one of the situations in which fuzzy logic is most valid is to include the opinions and value judgments of people in case the investigated event is very complex and there is not enough information about it. The second is the need for human understanding and judgment. Uncertainty, even if not numerical, is an important

source of information in human thought. Fuzzy logic principles help in the original use of such information sources in the analysis of events.

In order to examine any event with fuzzy logic, it is necessary to decide in advance that the inferences to be made will remain within certain tolerance limits. Excessive accuracy leads not only to high costs, but also to the very impossibility of solving the problem. Before starting to solve a problem, the most appropriate method should be decided by evaluating the numerical and verbal data that can be collected. Fuzzy logic is effective in processing verbal data as well as numerical data. Such information can be defined to the computer and fuzzy inferences can be made. The most valid method in this field is science fuzzy set, logic and systems.

With fuzzy logic, it is possible to model the verbal ambiguities in everyday speech and to include them in the calculation. People get along by speaking with verbal data. The main area where fuzzy systems will be evaluated is how to think about going for analyzes if such information is found. With fuzzy logic, any problem should be modeled approximately and it should be tried to be controlled with mathematically simple solutions.

The fuzzy logic approach can make more precise calculations because it contains ambiguous expressions instead of sharp expressions. In a study in the field of real estate valuation, the traditional method and

the fuzzy logic method were compared and more realistic results were obtained with the fuzzy logic approach created with the help of rules

In order for information systems to make a similar analysis in the face of any situation, it is necessary to transfer a set of rules consisting of knowledge and experience related to that situation to the computer environment. The mathematical equivalent of verbal rules such as "If this is so and this is so, then do this" ... is formed by associating the expressed fuzzy sets with each other appropriately. This is called an inference engine. Fuzzy decision making process also uses this system. The fuzzy inference process in computers generally consists of fuzzification, fuzzy inference and defuzzification.

In the classical set approach, the elements either belong to that set (1) or they do not (0). However, in the Fuzzy Logic approach, the belonging of the elements to that set varies between 0 and 1. Fuzzy logic is an extended form of classical set notation. In the fuzzy entity set, each entity has a membership degree. The membership degree of the assets can be any value in the range of [0,1]. Any degree of temperature may or may not be warmer than the classical set. According to the fuzzy set, this temperature has a certain degree of membership in the cluster it belongs to (Ödük, 2020).

Fuzzy Logic is more about the degree of occurrence of events than the probability of occurrence. For this reason, some scientists have thought of fuzzy logic as a continuation of probability. But probability and fuzziness are quite different concepts. Probability measures

whether something will happen. In other words, it has an uncertainty related to natural events symbolized by the idea of randomness. On the other hand, turbidity measures the extent to which an event occurs and the extent to which a condition exists.

The first of the two situations in which fuzzy logic is valid is that people's opinions and value judgments are included in the event that the investigated event is complex and there is not enough information about it. The second valid situation is those that require human understanding and judgment. The uncertainty inherent in human thought is a useful, if not numerical, resource. The fuzzy logic approach will help the original use of such information sources in the analysis of events.

In order to examine the event with fuzzy logic, it is necessary to decide in advance that the inferences to be made will remain within certain limits. “High precision causes not only high costs but also very complex problem solving” (Sen 2009).

If it is accepted that a proposition is false or does not satisfy the boundary condition, then the truth value of the relevant proposition is matched with the number "0". “In fuzzy logic, unlike binary logic (or finite-valued logics), the truth value of propositions does not have to be one of only two options (or finite values)” (Yen and Langari 1999).

“As explained above, the truth value of a proposition in binary logic consists of the set $\{0,1\}$, whereas in fuzzy logic, the truth value is chosen from the set of $[0,1] \subseteq \mathbb{R}$ numbers” (Ross 1995). Fuzzy logic is

used in two senses. In the narrow sense, fuzzy logic is a generalization of classical two-valued logic.

To sum up, the general purpose of logic systems is to reveal a new proposition from the existing proposition and to generate the truth value of this new proposition. The statement that contains a correct or incorrect result and gives a certainty is called the proposition, and the numerical measure taken by the proposition due to this correctness and inaccuracy is called the truth value. Propositions express certainty. A verbal statement that enables a provision to be accepted as true or false can be considered as the boundary condition of the set that is directly related to the provision in question. An object is considered to be a member of the set if it satisfies the boundary condition created. In cases where the created boundary condition is not satisfied for the relevant object, it is stated that the object is not a member of the set.

Fuzzy logic controllers are criticized because they need more information and sensors about the process, so they are both expensive and less reliable. This is not always true. The high performance of fuzzy logic controllers compared to traditional controllers can also be achieved through a nonlinear controller. This may be true, but most likely the non-linear controller will not be able to be achieved with a smaller-capacity processor as in the fuzzy controller.

In addition, the rules used in fuzzy control are very dependent on experience. There is no specific method for selecting membership

functions. The most suitable function is found by trial. This can take quite a long time. A stability analysis of the supervised system cannot be made and it cannot be predicted how the system will respond. The only thing to do is to simulate.

After deciding to design a fuzzy system, the first step is to create a society of fuzzy rules if-then. These rules are made with the help of experts. An example of fuzzy control chart is shown in Figure 4 below.

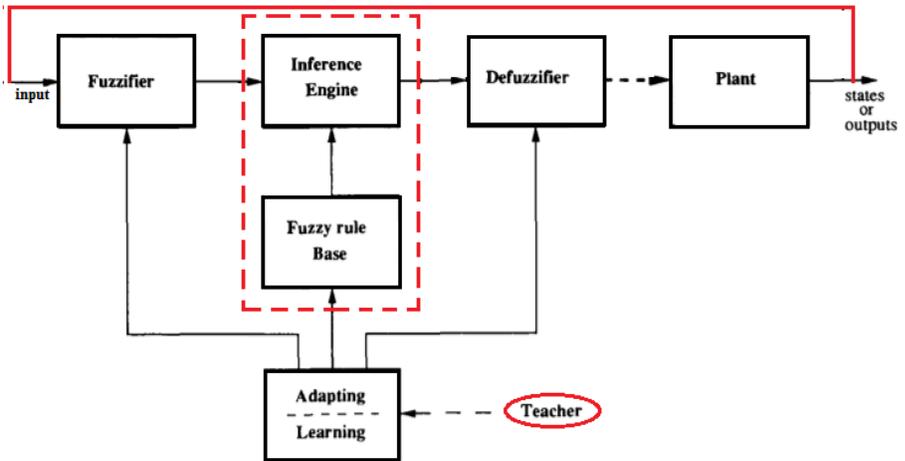


Figure 4. Block Diagram of Fuzzy Control

Blurring: Input values are converted to fuzzy values to be used in the fuzzy system. Input values are converted into fuzzy values according to the membership functions they belong to, and these fuzzy values obtained correspond to the membership degrees in the membership functions they belong to. Figure 5 shows the conversion of a real value to a fuzzy value.

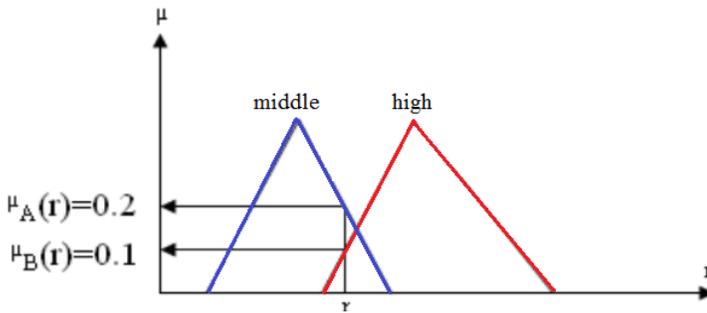


Figure 5. Blurring Process

Fuzzy Rule Base and Database: After deciding to design a fuzzy system, the first thing to do is to obtain the IF THEN rules table. It contains all the rules that can be written as a logical IF-THEN type that binds inputs to output variables in the database. In writing these rules, only all possible interval (fuzzy set) connections between input data and outputs are considered. Thus, each rule logically connects a part of the input space to the output space (Ödük, 2020). All of these contexts form the rule base (Figure 6.)

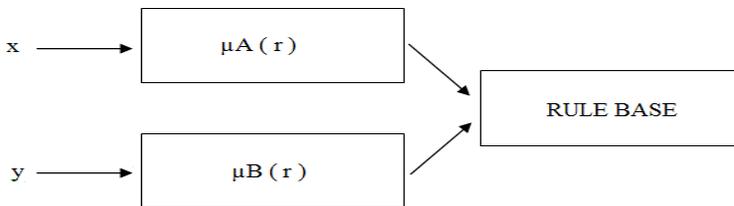


Figure 6. The IF-CONCEPT Concept

Fuzzy Inference Engine Mechanism: It is the mechanism that includes a collection of operations that ensure that the system behaves with an output by gathering all the relations established between the input and output fuzzy sets in the fuzzy rule base. This engine collects

the implications of each rule and determines what kind of output the whole system will give under the inputs. The decision making unit is also called the Fuzzy Engine. It is the core part of the Fuzzy Logic control. This part processes the fuzzy concepts in a way similar to the human's ability to make decisions and make inferences and determines the necessary control by making inferences.

The basis of a fuzzy controller is a rule-based system consisting of a rule analyzer, database, and rule base. Here, as in expert systems, the rules created in the rule base in the IF-THEN structure, the types and limit values of the membership functions used in the database are kept. The internal structure of a rule-based inference system used in a fuzzy controller is seen in more detail in Figure 7.

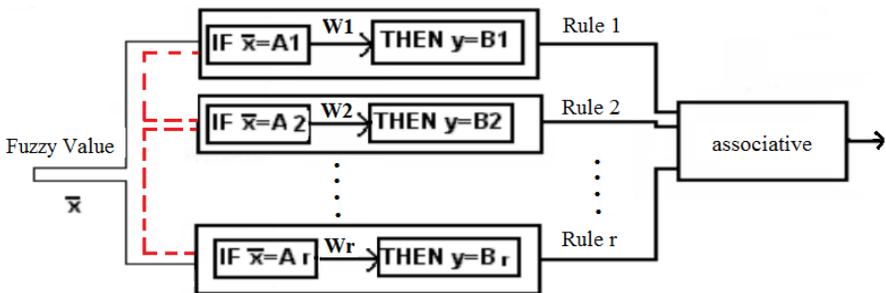


Figure 7. Fuzzy Rule-Based Inference System Structure

Determination of Degree of Membership: As in probability calculation, different probability functions can be defined for any variable. “It is possible to fit too many membership functions to fuzzy sets. It is common for beginners to use personal intuition, logic and experience in determining the membership degrees of fuzzy sets and

the membership functions that can represent all of them. In practice, these approaches are often sufficient to overcome many problems” (Şen, 2009).

Here, the opinion of each expert plays an important role. The simplest example of this can be considered the indefinite subsets of the word temperature, which people come across almost every day and express their opinion. At least four subsets can be identified, such as cold, cool, warm and hot. Each of these subsets can be represented by a certain geometric shape (Figure 8) (Sen 2009).

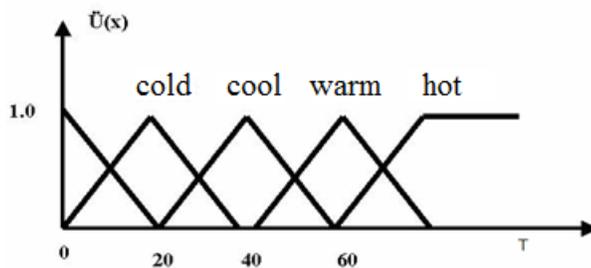


Figure 8. Example (temperature) fuzzy subsets

The geometric shapes obtained naturally vary according to the experts living in that region. For example, the concept of cold for people living in the poles is different from that of people living in the tropics.

(Defuzzification Module): As a result of the inference process, a fuzzy set is obtained. Since fuzzy sets do not make sense in the real world, the fuzzy information obtained at the end of inference must be converted into real data.

The choice of defuzzification methods is very important for the

performance of the controller. The most commonly used clarification methods are listed below.

Clarification with Center of Gravity Method: This method is the most well-known clarification method. With the center of gravity clarification method, the exact value of BMD is calculated with the help of the following equations.

In case of discrete domain;

$$u = \frac{\sum_{i=1}^1 u_i \cdot \mu_{out} u(u_i)}{\sum_{i=1}^1 \mu_{out} u(u_i)} \quad (9)$$

in case of continuous domain:

$$u^* = \frac{\int u \cdot \mu_{out} u(u) du}{\int \mu_{out} u(u) du} \quad (10)$$

Here:

$u_i=i$.: membership function

$\mu_{out} u(u_i)$: i th is the degree of the membership function.

This method determines the center of the region under the combined membership functions. The disadvantage of the method is that it is computationally complex, so the inference is very slow.

Defuzzification by Weighted Average of Centers: The resulting fuzzy output set is obtained by combining the implied fuzzy output sets (implied fuzzy output sets C_1 and C_2 in Figure 9). The approximate value of the center of gravity calculation can be found by calculating the weighted average of the centers of the implied fuzzy output clusters.

E.g; u_n , n . let the center of the implied fuzzy set be and let w_n be the height of this set. Accordingly, the numerical value of the output of the controller is calculated with the following equation:

$$u^* = \frac{\sum_{n=1}^m w_n \cdot u_n}{\sum_{n=1}^m w_n} \tag{11}$$

Since the output calculation is easier in this method, it is one of the most used methods in fuzzy control applications. In this method, there is no need to COLLECT. Because the numerical value of the output is calculated using directly implied fuzzy output sets (Akpolat, 2000). It should be noted that w_n is actually the degree of certainty of the relevant rule.

$$z^* = \frac{\int u_{ebC}(z)zdz}{\int u_{ebC}(z)dz} \tag{12}$$

Here, $u_{ebC}(z)$ denotes the sub-region dominated by the convex fuzzy set with the largest area.

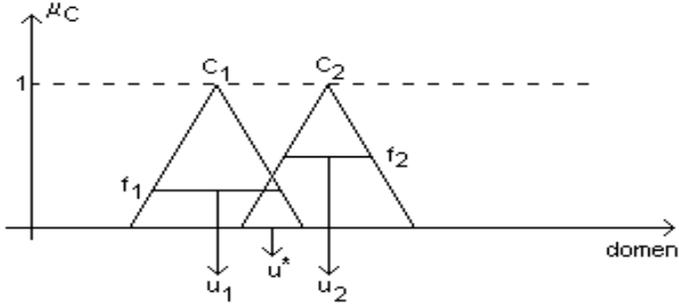


Figure 9. Graphical Representation of the Weighted Average of Centers Method

The shapes of the output fuzzy sets are not important since only the centers of the output fuzzy sets are used in the calculations.

Defuzzification by Calculating the Center of the Largest Region on the Domain: If the output fuzzy set contains at least two convex fuzzy subsets, the centroid of the convex fuzzy set with the largest area is used in defuzzification. The mathematical expression of the clarification process shown in Figure 10 is as follows.

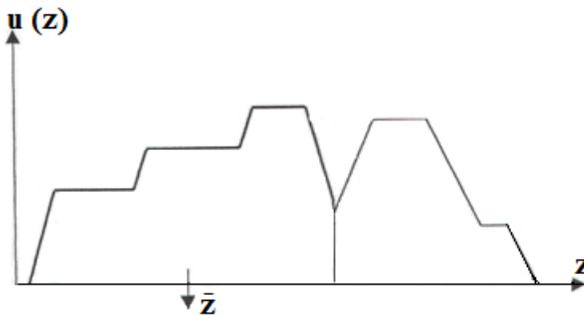


Figure 10. Calculating the Center of the Largest Region on the Domen

Average of Maximums Clarification Method: In this method, control motion is determined by taking the arithmetic average of the points on the domain where each membership function captures the maximum membership degree. In this clarification method;

$$z^* = \frac{a + b}{2} \tag{13}$$

formula is used.

If it is calculated according to the fuzzy output sets given in Figure 11;

$$z = \frac{a + b}{2} \tag{14}$$

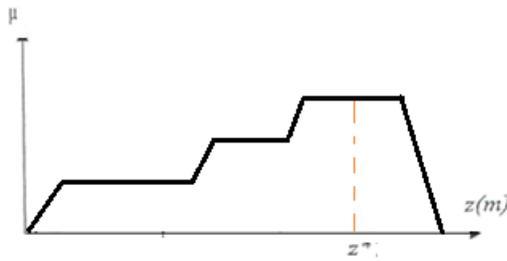


Figure 11. Defuzzification by Maximum Membership Function Average Method.

The basic elements that make up the structure of Fuzzy Logic are the Fuzzification Module, the Inference Unit, the Data and Rule Base, and the Defuzzification Module. With the Blurring Module, input information is converted into a form that the inference unit can understand. The inference unit provides which control action is performed against the rules in the rule base. In defuzzification, the blurred variables are converted back into numerical variables.

Although there are many methods for clarification, the most used method is the Weight Average Method.

2.4. Location analysis (Geographical Information Systems)

In parallel with the developments in computer technology, the concept of Geographic Information Systems (GIS) has begun to be used in many areas. GIS applications, which started in Canada in the 1960s, began to be widely used in education over time. GIS provides important opportunities for students to develop their geographic inquiry skills, to provide rich information resources to increase their geographical knowledge, to support permanent learning by providing access to visual resources about nature and people, and to facilitate students in perceiving the real world. At the same time, GIS is seen as a tool that supports the development of students' thinking, data analysis, active learning, problem solving, accessing geographic information, and geographic inquiry skills (Johansson, 2006).

Location systems; It is an information system that performs the functions of collecting, storing, processing and presenting the graphical and non-graphical information obtained by location-based observations in an integrated manner. GIS is a system consisting of hardware, software and users for the purpose of obtaining, storing, processing, analyzing information about geographical assets, obtaining and presenting new information from the information produced.

The healthy operation of GIS depends on the fulfillment of the following basic functions. These;

- Data collecting
- Data management
- Data processing
- Stop data presentation.

In order to solve complex environmental, social, cultural and economic problems on the earth, GIS can help users in decision-making processes regarding spatial and location, It is the whole of software, hardware, personnel, geographical data and methods that perform the functions of processing, collecting, bringing together, managing, spatial analysis, querying and presenting (Yağmahan, 2019).

It is necessary to collect geographic data and convert it from paper or map media to computer environment. Afterwards, GIS application is performed. In some cases, it may be necessary to interconvert or analyze data types for specific GIS projects. One of the important functions for GIS is the presentation of data, namely visual functions. What is done as a result of many geographical operations is visualized with map or graphic representations. Maps are the tools that provide the best communication between geographical information and the user (Yomralıoğlu, 2000).

Today, geographic information system (GIS) software is widely used to create infrastructure in many areas. These areas are:

- Cartography.
- Telecom Network Management.
- Electricity Distribution Network Management.
- Natural Gas Distribution Network Management.
- Water and Sewerage Distribution Network Management.
- Traffic Management.
- City Planning and Management.
- Transportation Planning

Applications of real estate, which has an important place especially in national economies, are actively used in developed and developing countries. Academic studies from the 1990s to the present show that the use of GIS in the field of real estate valuation has become widespread (Wyatt , 1998; Zeng and Zhou, 2001; Liu et al., 2011; Kucklick et.al., 2021;Doldur and Alkan, 2021; Mete and Yomralıoğlu, 2021).

2.5. Multi-Criteria Decision Making Methods

Decision making is to choose one or more of the most appropriate options based on at least one goal and one criterion from the set of options. It is the evaluation process that multi-criteria decision making methods appear (Saaty, 1980). An appropriate and effective for evaluation, it is necessary to analyze a lot of data. It is a very difficult process as it has to consider many factors during the analysis phase.

Many problems experienced in real estate valuation have been eliminated by using multi-objective decision making methods. As

explained above, these methods have been used since the second half of the 20th century. Today, these methods gain importance thanks to the international practices of real estate valuation. These methods, which are sometimes referred to as other valuation methods and included in the modern methods classification, are mostly based on market modeling and economic assumptions (Malien et al, 2002).

Multi-criteria decision making methods have been used since the middle of the 20th century. The point here is that a set of tools is necessary to assist decision making. Many parameters affect the decision. The unique features of each of the options to be evaluated for selection complicate the decision-making process. The purpose of using multi-criteria decision making methods is that the number of options and parameters is high.

The main methods most commonly used in Multi-Criteria Decision Making are the Analytic Hierarchy Process (AHP-Analytic Hierarchy Process (, ELECTRE (For Elimination and Choice Translating)'. Reality) Method, TOPSIS (For the Technique for Order Preference by Similarity to Ideal Solution) Methods.

2.5.1. The Analytical Hierarchy Process (AHP) method

This method is a multi-criteria decision-making method developed by Thomas L. Saaty in the 1970s that incorporates qualitative and quantitative criteria into the process¹⁸⁰. It is a method based on the principle of operating the administrative decision mechanism by

giving relative importance to decision, options and criteria in complex decision problems (Al Harbi, 2001).

AHP method is a combination of quantitative and qualitative analysis of multi-criteria decision making method. This method divides the decision-making problem into criteria and alternatives in terms of quality and calculates quantitative hierarchy importance weights with the relationship within the holistic structure of these factors, examines the relative importance of various factors and expresses its decision. AHP has a simple hierarchy and analytical processes to make complex problems easy and solvable. This method, which can be used in almost every decision-making process, has a wide application area (Hamurcu and Eren, 2017). Multi-criteria decision making method can be used for real estate valuation, which is a decision making problem (Chen, 2006).

AHP is based on the principle that the decision maker evaluates all available alternatives and all their criteria and makes pairwise comparisons to the importance of the criteria. According to the hierarchical structure of AHP, the goal of the decision maker is at the highest level. As you go down to the lower levels in the hierarchical structure, there are criteria and sub-criteria belonging to these criteria. As the hierarchy level decreases, sub-criteria are reached and the details of these criteria are elaborated (Bozdağ and Ertunç, 2020).

In the AHP application, first of all, pairwise comparison matrices of the criteria should be created. The pairwise comparison matrix

constitutes the actual data of the AHP. The matrix is based on comparing all alternatives under all sub-criteria. The criteria at each level are compared in pairs for their importance relative to the next higher level criteria.

2.5.2. Elimination and Choice Translating Reality Method (ELECTRE)

This method was introduced to the literature in 1971 by Benayoun, Roy et al. Electre method; It provides ordering of options by establishing a superiority relationship between preferred and undesirable alternatives. Pairwise comparisons of the options are used separately for each criterion. (Buchanan and Shepard, 1999).

Electre method; It shows that alternatives are more dominant than each other, depending on certain criteria and the weights of these criteria. In this method, in order to establish a dominance relationship, indicators of harmony and incompatibility are determined. Consistency and incompatibility boundaries are a step that must be determined by decision makers (Sambulas et al., 1999).

In decision making, whether a set of binary relations of options is completed or not, it is called the superiority relation of preferability. Then, the decision maker is expected to determine the weights or degrees of importance to explain the relative importance of the criteria (Triantaphyllou, 2000).

Configuring the original form of the ELECTRE method is done in seven steps:

Step 1: Decision Matrix is created and normalized.

Step 2: Normalized Decision matrix is weighted.

3. Step: Conformity and Incompatibility Sets are determined.

Step 4: Concordance and Incompatibility matrices are created.

Step 5: Conformity and Incompatibility Superiority Matrices are created.

Step 6: The Total Superiority Matrix is created.

Step 7: Less suitable options are eliminated.

Studies on this method are available in the fields of finance-banking, supply chain and engineering. (Buchanan et al., 1998, Becalli et al., 2003, Cagil, 2008, Mozouk, 2011, Vandani et al., 2010, Rogers et al., 2013, Yanie et al., 2018, Amirghodsi, 2020, Siregar et al., 2021).

2.5.3. Technique for Order Preference by Similarity to Ideal Solution (TOPSIS)

It was presented by Yoon and Hwang in 1980 as an alternative to the ELECTRE method. The method is used as one of the most common multi-criteria decision making methods. According to the method; the chosen option should be the shortest geometric distance from the ideal solution and the furthest from the negative-ideal solution. TOPSIS assumes that each criterion has a uniformly increasing or decreasing utility trend. Thus, it becomes easy to find ideal and negative-ideal solutions. The Euclidean distance approach aims to evaluate the relative closeness of the options to the ideal solution. Thus, the order of preference of the options can be inferred through a series of comparisons of these relative distances (Ching et al., 1981).

In this method, there is the principle of positive-ideal and negative-ideal solutions. With this principle, these criteria of the chosen option can be fulfilled at ideal levels when all criteria of the ideal solution are taken into account. However, in some cases, the ideal solution may be impractical or unattainable. For this, what needs to be done is to choose the closest point to the ideal.

TOPSIS method includes a solution process consisting of 6 steps. The first two steps of the method are common with the Electre method (Arshia et al., 2009).

Step 1: Creating the Decision Matrix (A)

Step 2: Creating the Normalized Decision Matrix (R)

Step 3: Creating the Weighted Standard Decision Matrix (V)

Step 4: Constructing Ideal ($* A$) and Negative Ideal ($- A$)
Solutions

Step 5: Calculation of Discrimination Measures

Step 6: Calculating Relative Closeness to the Ideal Solution.

TOSIS method is based on ELECTRE. The first 2 stages of both methods are the same. The first step starts with a normalized decision matrix basis for comparison of scales. In the second stage, both methods take the weight values of the preferences from the decision makers. In the third stage, the methods differ. As a difference, while ELECTRE qualifies according to the superiority of one of the options over the other, TOPSIS shows that the option closest to the ideal

solution and the farthest from the negative ideal solution is the best option. One advantage of TOPSIS is that each option gets its own value. Therefore, a good view can be obtained about the differences between the options and how different the criteria are from each other (Spee, 2005).

3. APPLICATION PRINCIPLES OF ADVANCED METHODS IN REAL ESTATE

In the real estate literature, hedonic approaches have been widely used to evaluate real estate investments or the relationship between sales prices and properties owned by properties (Del Giudice et al., 2017).

Worzala et al. (1997) and Khamis and Kamarudin (2014) in the United States, Gallego and Esperanza (2004) with Tabales et al. (2016) used the ANN method in the analysis of house prices in Spain. Wilkowski and Budzynski (2006) used ANN method for valuation of lands in Poland. They used different parameters from each study for modelling. As a result, they concluded that the ANN was largely compatible.

In Turkey, artificial neural networks are used especially in housing valuation studies. Yazgan et al. (2017), Ecer (2014), İlhan and Öz (2020) have seen that ANN gives successful results compared to other valuation methods in their studies in different cities.

Advances in computing techniques have had a wide impact on the real estate valuation process. These have led to the use of more complex

analytical applications such as Artificial Neural Networks, Fuzzy Logic and Expert System (Zurada et al, 2006).

Bagnoli and Smith, in 1999, studied the application of Fuzzy Logic systems to real estate valuation. In their study, they provided a fuzzy set output, ignoring some of the relevant real estate risk factors. In another study, a fuzzy analytical hierarchy process was used to evaluate the risk in residential real estate projects through different variables instead of exact values (Sun et al., 2008). In addition, fuzzy cost approach has been used to determine building depreciation for real estate purposes and over time (Cui and Hao, 2006). Del Guidice et al. (2017) is about the purchase of an office building. The results obtained with Fuzzy Logic are also compared with the results obtained from a deterministic approach using exact numbers.

Longley et al. (1994) used a street-based geographic information system to model the value of each home in an interior area of Wales. As a result of the study, it has been revealed that geographic information systems are an appropriate tool in real estate valuation. Zeng and Zhou (2001) developed a GIS-based model to be used in the real estate sector with optimal spatial decision making methods, using environmental, social and personal factors as data in Sydney, Australia. As a result of the study, it has been revealed that this model applied in real estate valuation gives the same results at a rate of 95% with the real values. Cichocinski and Parzych (2006) investigated the applicability of GIS in property valuation in Poland, Droj and Droj (2015) in Romania, Giannoulakis et al (2015) in Greece, and Gatheru

and Nyika (2015) in Kenya. As a result of the studies, it has been revealed that the use of GIS in valuation provides rapid decision-making thanks to the value maps produced.

In study of Dmytrów and Gnat (2019), AHP (Analytical Hierarchy Process) method was used for the weights of each attribute the influence of each attribute on the real estate value was assessed. All 318 plots were used for housing purposes and constituted a part of the properties owned by the Szczecin City (Poland) Municipality.

In Turkey, Deveci and Yılmaz (2009) in Afyonkarahisar, Çağatay and Tecim (2014) in İzmir, Yurt et al. (2016) in Düzce, Yener (2017) in Istanbul, Özgüven and Eroplu (2020) in Çanakkale, they created geographic information systems-based value maps and made real estate valuations.

The criteria affecting institutional innovations in the real estate sector were determined by the AHP method by Sarathy (2011), taking expert opinions for real estates in India—Bangalore, Delhi, and Mumbai. Criteria by Safian and Nawawi (2012) to spatially evaluate special purpose offices located in Malaysia Koziol-Kaczorek (2014) aimed to present a method for multi-criteria valuation of real estate in Warsaw. Gutierrez-Bucheli et al. (2016) used the AHP method for plot selection for a real estate project of the study in Kolomiya.

Yılmaz (2010) examined the criteria affecting the value of real estate in Istanbul with the AHP method, and the results obtained by Akkaynak (2014) by using comparison, income, cost, AHP and fuzzy

AHP methods in real estate valuation application were compared. Kavas and Topçu (2014) carried out a real estate valuation application by examining the criteria determined as a result of expert opinion and literature review with the AHP method. İpek and Şahin (2018) determined 6 main and 18 sub-criteria for the selection of housing that a family of four can buy, based on expert opinions and literature review. Bayramoğlu (2021), a survey study was conducted with 104 enterprises determined by purposive sampling method in Evren district of Ankara province and their opinions about the factors affecting the value of agricultural lands were taken. AHP method was used in the analysis of the obtained data.

Alexic et al. (2014) used the ELECTRE method in the analysis of criteria to select the most appropriate investment in residential buildings in Belgrad. Generally accepted criteria and alternatives were considered for evaluation: area of the flat, condition of the flat, location, functionality, quality of construction, floor, number of floors in the building, elevator, central heating, environment, natural lighting of the apartment and the view from the apartment. The severity of the criteria and the degrees of alternatives according to these criteria were obtained by expert estimates. As a result, they concluded that the different significance levels of the criteria do not always have an index of fit when applying the ELECTRE method.

Taillandier and Abi-Zeid (2013) applied a property valuation method to improve the environmental characteristics of a building stock. The proposed method is based on comparison of data with reference values

and multi-criteria clustering using ELECTRE TRI. They demonstrated the working of the proposed method on a building stock example.

Yertutan and Çetinyokuş (2020) compared the corrected AHP, TOPSIS, COPRAS and ELECTRE applications in 5 alternative provinces selected in Turkey, based on the data obtained from the surveys made by experts. They identified ten main criteria as income-related house prices, income-related rental costs, employment accessibility, crime rate, infrastructure services, access to social life, environmental problems, access to schools, accessibility to health services, and interest. As a result of the research, COPRAS and RAHP methods gave the same ranking result for the 5 alternatives evaluated. The ELECTRE III method was evaluated. gave the same ranking result as COPRAS and RAHP for 60% of alternatives (5 alternatives). TOPSIS method alternatives It gave the most inconsistent result compared to other methods applied in terms of prioritization. TOPSIS method, other methods showed similarity only in that the worst performing alternative was Bursa.

Real Estate Valuation with Artificial Neural Networks

It has been observed that artificial neural networks perform quite well even with sample sizes smaller than 50 (Zhang et al., 1998). Another researcher stated that their models usually need at least 50 data points to predict successfully (Box, 1976).

It is possible to list the basic working steps of an artificial neural network as follows.

- a-) Selecting the appropriate set from the working set and applying the input vector to the neural network
- b-) Calculating the output value of the neural network
- c-) Calculating the error between the output value of the neural network and the desired value
- d-) Calculation of neural network weight to minimize errors
- e-) Continuing until the errors are acceptable.

Artificial neural networks method can solve many problems at the stage of determining the real estate value. ANN, as mentioned before, was developed by being inspired by biological neural networks. Artificial neural networks are defined as an artificial intelligence technique that has been studied for many years in order to find solutions to problems with unknown or complex internal relations. It was developed by repeating the learning process of the human brain.

The basic steps required for this system to work are (Rossini, 2000):

- a-) Determining a training set, the results of which are known beforehand, so that the system can be trained correctly,
- b-) Calculating the output value after the application of the inputs in the work set and calculating the error between it and the desired value, defined as the black area or hidden layer,

- c-) It can be listed as calculating the neural network weight that will minimize the errors and continuing until the errors reach an acceptable level.

First of all, Artificial Neural Networks Application normalized real estate data should be defined to Matlab software. The training of the neuron and the network should be carried out by using the experimental data with the created feed forward artificial neural network. The training process is repeated several times to ensure that the learning process is more accurate. By entering the maximum error value (recommended 200-600 values), the amount of iteration is determined as the maximum (recommended value: 1000). By looking at the regression graph after the training, the accuracy and consistency values of the data are checked. The trained network is simulated with test data. The house values are determined by applying the maximum normalization to the obtained values in reverse.

In the system to be created with ANN, different number of input and 1 output variable are selected. As the input variable, the age of the building, the number of floors, the floor, the facade, the number of rooms, the area of the flat, the type of heating and the distance to the center can be defined. The output variable (output) is defined as the price.

Housing Valuation

Parameters used in housing valuation are: flat area, floor, number of rooms, age of building, parking lot, elevator, site, pool, landscape,

residence, transportation and income level of the region. All these data should be digitized and made available for analysis. Digitization of parameters can be done as follows;

- Flat area: The usage area of the flat is calculated within the measurements made on site and digitized with the m^2 parameter. Sample; $100 m^2=100$
- The floor it is located on: The floor of the apartment is digitized according to the ground level (0.00) and used in the data set. Knit; 1. Basement floor = -1, Ground floor = 0, 1.Normal floor = 1
- Number of Rooms: The number of rooms in the flat is digitized and used in the data set. For example, the total number of rooms is taken as 2 for a 1+1 flat, and 3 for a 2+1 flat.
- Building age: The age of the apartment where the flat is located is digitized and used in the data set. For example, for a building built in 2001, the building age is 20.
- Parking Lot: The feature of having a parking lot within the apartment is digitized and used in the data set. Sample; 1 for real estate without parking lot, 2 for real estate with parking lot
- Elevator: The feature of having an elevator in the apartment is digitized and used in the data set. Sample; For real estate without elevator, 1 is taken, for real estate with elevator, 2 is taken
- Site: The property of being in the site is digitized and used in the data set. Sample; 1 is taken for the real estate that is not in the site, and 2 is taken for the real estate located in the site.

- Landscape: The landscape feature of the real estate is digitized and used in the data set. Sample; 1 for real estate without sea or mountain view, 2 for real estate with sea or mountain view.
- Residence: The property of real estate to benefit from residence services is digitized and used in the data set. Sample; 1 for real estate without residence service, 2 for real estate with residence services.
- Transportation: The transportation features of the real estate are digitized and used in the data set. Sample; 1 for real estate with limited means of transportation, 2 for real estate that can be reached by bus and minibus, 3 for real estate that can be reached by bus, minibus, metrobus, metro or tram, Real estate that can be reached by bus, minibus, metrobus, metro, tram and sea vehicles for 4 is taken.

The integer of the above values can also be taken as intermediate values. In artificial neural networks applications, it is recommended to use NeuroSolutions program, Artificial Neural Networks development program. To create Artificial Neural Networks, the series set is digitized and a table is prepared in MS-Excel format. The prepared data set can be called in MS-Excel format from the program settings.

Application of Fuzzy Logic Modeling

The fuzzy logic approach has advantages as well as disadvantages. Valuation results obtained with the fuzzy logic approach can be very useful in controlling the results obtained with traditional valuation

methods. It turns out that it is possible to evaluate the accuracy of the valuation reports and especially the expert reports submitted to the courts by using this method in the valuation units of public and private institutions during the development and implementation of expropriation, mass housing, urban transformation and large-scale commercial real estate projects, and to audit the report.

Which of the traditional methods is appropriate to use in valuation applications is a controversial issue. So there is no consensus on this matter. In the appraisal process, it is recommended to make a separate valuation according to three methods for the final value estimation, and as a result, a single value or value range should be determined according to the properties of the real estate, the valuation purpose and the legislation (Tanrivermiş 2016).

The use of fuzzy logic for real estate analysis and modeling can be a powerful tool in advanced planning, as many researchers have pointed out (Bagnoli and Smith, 1999). The most important advantages of fuzzy modeling are:

- It is a more realistic approach by using linguistic variables instead of numbers.
- A hierarchical order of objects (eg buildings, parcels) rather than an inclusion - exclusion list.
- Less repetition of the model.

In valuation studies with fuzzy control, the graphic information of the parcels should be digitized and transferred to the computer. The

factors affecting the value of the real estates and the values obtained from their sizes should be converted into numerical values in the fuzzy logic inference model with MatLab software. Stages applied in modeling with fuzzy logic; can be listed as blurring, rule extraction and clarification.

In the fuzzification phase, the inputs to the appropriate fuzzy sets are determined by forming membership degrees and membership functions, in the fuzzy extraction phase, the inputs of the fuzzy set are associated by using membership functions and related rules, and in the clarification phase, the fuzzy output value is converted to a definite output value. It may be preferable to choose the "Mamdani" algorithm as the fuzzy rule analysis methods.

The main factors affecting the value of the real estate are defined one by one with the help of the FIS Editor, in accordance with the Fuzzy Inference System in MatLab software. 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 curve, as well as different functions can be created.

The rules in which the factors affecting the value of the real estate are expressed verbally are added to the system through the "rule editor". In order not to complicate the system, different rules should be defined. The weights of these rules can be considered different as well as the same. Depending on the valuation purpose and the condition of

the parcels, more rules can be added to the system by using different weights.

In defining the rules, the situation of increasing or decreasing the value according to the size and direction of the factors affecting the value of the real estate should be evaluated. Rules should be created accordingly. Incorrect rule definition should be studied carefully as it will be misinterpreted by the inference system and may conflict with other rules.

Creating a Land Valuation Model with Fuzzy Logic:

Fuzzy logic, one of the artificial intelligence methods, is also a suitable model for modeling with uncertain variables. For example, since the transfer of buyers and sellers is a controlled approach technique, it is necessary to know the criteria for the object of sale in depth and to choose the variables well (Malaman and Amorim, 2017).

When we look at the use of the land valuation model with fuzzy logic outside our country, many studies are seen. The aim of this study is to create a land valuation model by using fuzzy logic, which is one of the artificial intelligence methods.

Fuzzy logic toolbox in Matlab is a tool used in Matlab programming language for creating and editing fuzzy inference system. In the fuzzy logic toolbox, operations can be performed mainly through the graphical user interface, but also from the part known as the command line. The fuzzy logic toolbox provides the use of three tools. These are

command line, simulink blocks, graphical interactive tools. In the case of m-format files written about the command line, fuzzy logic functions can be applied by using the names of these files on the command line. A function file written in this way is obtained by writing and executing the following statement on the command line: `type function_filename`. Graphical interactive tools are another possibility provided by the fuzzy logic toolbox. This possibility is the use of the graphical user interface, that is, the interface referred to as GUI in the program. Thus, it provides the creation, analysis and application of the fuzzy inference system with a graphical user interface. Simulink blocks allow fuzzy logic applications to be implemented very quickly.

Membership Functions in Matlab The only condition to look for in membership functions is that they must be between zero and one. The function can be chosen as desired, but speed, efficiency, proficiency, etc. Considering such issues, it is important that the function is simple. The fuzzy logic toolbox in Matlab contains different kinds of membership functions. Some of these are the sigmoid curve, the Gaussian distribution function, quadratic and cubic polynomial curves, and piecewise linear functions. It is named by adding `mf` to the end of all membership functions in the fuzzy logic toolbox. The simplest of the membership functions are the triangular functions called `trimf`. The trapezoidal shape, which is another membership function, is called `trapmf`. Mamdani type fuzzy modeling and Sentroid method are used in the application. Neither method is advantageous over the

other. Because the choice of which method to be used or suitable is primarily based on the opinion of the designer or expert (Ibrahim and Cervatoğlu, 2004).

Fuzzy Inference System Components and functions of the fuzzy inference system in Matlab: The fuzzy inference system editor is where the inputs and outputs of the fuzzy system are added. The membership function editor is used to create the shapes of the membership functions. The rule editor is used to define the rules that are used to display the behaviors in a list. The rule and surface monitor is used to monitor the created system and the operation of the system. These are non-editable tools. (Yalpir, 2007).

Office Valuation with Fuzzy Logic Model:

First of all, office space data set should be created. The variables that should be included in the office space survey dataset: The location of the office, the office transportation facilities, the floor where the plug is located, the office usage area, the presence of the kitchen in the office, the presence of the bathroom / WC in the office.

Next, the office building dataset should be created. Variables that should be included in this set: Number of floors in the building, number of floors in the building, age of the building, floor area of the building, number of offices in the building, number of elevators in the building, total number of vacant offices in the building, parking lot size, total number of offices in the building, vacant office space

Variables that should be included in the office building + office area dataset: Number of rooms in the office, number of employees in the office, number of employees in the office, number of employees in the office, number of floors in the building, age of the building, floor area of the building, total number of offices in the building, vacant office space in the building, parking lot size , the number of owner offices in the building.

Rule 1: If (the number of employees in the office is small) and (the number of rooms in the office is small) and (the number of offices in the building are many) and (the number of elevators in the building is very small) and (the parking space is small), then (the rental value of the office) 1. belongs to Group) or

Rule 2: Or

Rule N: If (too many employees in the office) and (too many rooms in the office) and (too many offices in the building) and (too many elevators in the building) and (if the parking lot is too big) Then (office rental value) belongs to x. group)

Fuzzy Logic Modeling Methods of Houses:

There are three basic steps in modeling real estate valuation with the Fuzzy inference system. These; blurring, rule-making and clarification. In the blur stage, the inputs are blurred. That is, 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 the fuzzy rule-based system, there are different analysis methods. Mamdani Method and Sugeno Method are the most used models (Sen 2009). In accordance with the fuzzy inference system (Fuzzy Inference System) in MatLab software, the main factors affecting the value of the real estate should be defined with the help of the FIS Editor. Membership functions of the set can be defined with standard functions such as triangle, trapezoid and gaussian curve. However, the most appropriate membership function in real estate valuation is triangular and trapezoidal shapes.

Fuzzy logic toolbox is a tool used in Matlab programming language for creating and editing fuzzy inference system. In the fuzzy logic toolbox, operations can be performed mainly through the graphical user interface, but also from the part known as the command line. The fuzzy logic toolbox provides the use of three tools. These are command line, simulink blocks, graphical interactive tools. In the case of m-format files written about the command line, fuzzy logic functions can be applied by using the names of these files on the command line. A function file written in this way is obtained by writing and executing the following statement on the command line:

type function_filename. Graphical interactive tools are another possibility provided by the fuzzy logic toolbox. This possibility is the use of the graphical user interface, that is, the interface referred to as GUI in the program. Thus, it provides the creation, analysis and application of the fuzzy inference system with a graphical user interface. Simulink blocks allow very fast implementation of fuzzy logic applications.

Components and functions of the fuzzy inference system in Matlab: The fuzzy inference system editor is where the inputs and outputs of the fuzzy system are added. The membership function editor is used to create the shapes of the membership functions. The rule editor is used to define the rules that are used to display the behaviors in a list. The rule and surface monitor is used to monitor the created system and the operation of the system. These are non-editable tools (Yalpir, 2007).

Table 1. Membership Assignment Values for the Land

Criterion	Sizes	Scoring
Area	Small	0-50-100-150-200
	Middle	100-150-200-250
	Big	200-250-300-350
Location	Not central	0-50-100-150-200
	Less Center	100-150-200-250
	Central	250-500-600-700
Shape	Smooth	0-50-100-150-200
	Less Smooth	100-150-200-250

	Smooth	200-250-300-350
Topography	Rugged	0-50-100-150-200
	Less Rugged	100-150-200-250
	Not Rugged	200-250-300-350
Peer	0,00-0,50	0,30-0,60-0,90-1,00
	0,50-1,00	0,50-0,60-0,80-1,00
	1,00-1.50	0,80-1,00-1,20-1,50

The data are taken from the valuation reports made for the region where the land is located. Scoring according to the selected criteria is defined in the membership functions editor in Matlab programming language. Afterwards, the rule database is created in the rule editor, and the land value is determined in terms of square meter unit price with the rule viewer.

Rule Definition The rules that verbally express the factors affecting the value of the real estate should be added to the system through the "rule editor". Depending on the valuation purpose and the condition of the parcels, more rules can be found by using different weights in the system. In defining the rules, the situation of increasing or decreasing the value according to the size and direction of the factors affecting the value of the real estate should be evaluated and the rules should be established accordingly.

Position Analysis (GIS)-AHP-TOPSIS Applications

Location is one of the most important factors for the value of a property. The distance of the real estate to facilities such as transportation points and socio-cultural equipment is very important. Distances to educational facilities, entertainment areas, places of worship and public transportation are evaluated in terms of time and length and are reflected in the value of the real estate.

Buffer analysis and maps are produced with the help of ArcGIS software. While examining the spatial characteristics of the selected real estate; The distance to transportation facilities (stop-housing distance), education facilities, places of worship, health services and green areas are taken into account.

Positional factors affecting the value of the real estate are scored according to the distance of the real estate. Then, each location score is multiplied by the local weights for the location main criterion and sub-criteria, which are determined based on expert opinions with the AHP method. A weighted total positional score is obtained for each property. The sum of the points of each real estate for spatial factors (health facility, education facility, etc.) is determined as the location score of the real estate.

A hierarchical order was created according to the determined criteria in order to make the site selection according to the AHP method. Then, pairwise comparisons were made between the criteria. Normalization matrices are created from the obtained pairwise

comparison matrices. Priority vectors were also calculated from the normalization matrices. Consistency tests are performed to check the consistency of pairwise comparisons within themselves. The consistency ratio is calculated to question the reliability of the decisions made by the decision makers as a result of pairwise comparisons. If the value of this ratio is 0.1 or less, two-way comparisons are assumed to have acceptable consistency.

According to AHP, Local Weights and Consistency of Main Criteria: Location, Infrastructure, Transportation, population, structural features.

Scoring of API Features Sub-Criteria: Security system (available: 10, no: 0 points), elevator (available: 10, no: 0 points), parking lot (available: 10, no: 0 points), number of rooms (3,4,5) ,6 points), disability (yes: 10, no: 0 points), facade (south:10, east:8, north:3, west:5 points), age of building (0-2 years: 10, 2- 10 years old:: 5 points, over 10 years old: 2 points), the floor (2-20 points)

Then, the scoring made from the infrastructure, population and transportation main criteria is multiplied by the local weights calculated with the AHP to find the structural score for EV 1. The AHP-based problem is solved using the Expert Choice (EC) program.

The decision matrix is created in the first step, while determining and ranking the selection priorities of real estates with the TOPSIS method. The options in the decision matrix are listed one after the other and the features of each criterion according to the options are

listed. In the second step of the method, the normalization of the matrix is performed by taking the square root of the sum of the squares of the scores or features belonging to the criteria in the decision matrix. Then, the elements of the normalized decision matrix are weighted according to the importance given to the criteria. Here, the subjective opinions of the decision maker may take place in determining the weights.

Based on the assumption that the price is more important than other criteria for the customer who comes first while establishing the model, TOPSIS is applied by giving 10 points to the price criterion and less than 10 points to the criteria other than price. Then, the TOPSIS analysis is finalized by giving re-scorings according to the 10-point scale for each criterion that is considered important for the customer, respectively.

The criteria for the valuation of a house located in the city center can be summarized as follows:

Building Features: Size, number of rooms, number of toilets and bathrooms, building facade, Total Floor, Number of Floors, Flat Shape, Number of Balconies, Existence of Playground, Presence of Sports Ground, Fire Escape, Disabled Accessibility, Heating System, Age of Building, Existence of Parking Lot , Apartment Attendant Presence, Sound Insulation, Swimming Pool Presence, Elevator, Site Form, Security Presence,

Location: Close to the city center, Close to Educational Institution, Close to Health Institution, Close to Entertainment Areas, Close to Business and Working Area, Close to Worship Areas, Proximity to Harmful Areas, Being in the Site, View.

Infrastructure: Road, water, electricity, sewerage, natural gas, internet.

Transportation: Proximity to the Main Road, Proximity to the Bus Stop, Proximity to the Metro Station.

Population: Density, Rate of Increase, social and demographic texture.

Building Type: Detached, Detached Multi-Storey, Apartment, Site.

Building Type: Reinforced concrete, steel, wood, Masonry, Adobe, masonry, Ruin

Heating Type: Central Heating Heating, Indoor Heating, Floor Heating, Stove, air conditioning.

Exterior: Plastered, painted, Siding, marble, btp.

elevator: 1 unit, more than 1 unit.

Points (between 0-1) should be given to the features that make up each group. The total score of each group is 1. An example of this is given below.

Building Type: reinforced concrete: 0.30 p, Steel: 0.30 p, wood: 0.2 p, Stacking: 0.1 p, masonry: 0.5 p, ruin: 0.04p, Other: 0.01p. **Total of points: 1.00**

Structure Type: Detached: 0.24p, Detached Multi Storey 0.30p, apartment: 0.12p, Business Center: 0.12p, Industrial Site: 0.21p, Other: 0.01p. **Total of points: 1.00**

Heating Installation Type: Central Heating Heating: 0.28p, Indoor Heating: 0.20p, Floor Heating: 0.15p, stove: 0.05p, Natural Gas Stove: 0.18p, Air conditioning: 0.13p, Other 0.01p. **Total of points: 1.00**

Exterior: Plastered 0.10p, Painted 0.20p, Brick 0.10p, Siding 0.18p, Marble 0.18p, BTP: 0,23p, others: 0.01p. **Total of points: 1.00**

Car park: Outdoor Parking: 0.35p, Indoor Parking 0.65p, none: 0p. **Total of points: 1.00**

Lift: 1 Piece: 0.4p, 2 Pieces and Above: 0.60p, None: 0p. **Total of points: 1.00**

Construction Class: Lux: 0.35p, 1st Class: 0.25p, 2. Class: 0.20p, 3rd Class: 0.15p, Simple: 0.05p. **Total of points: 1.00**

Beat insulation: Sheathing: 0.99p, Other 0.01p. **Total of points: 1.00**

4. CONCLUSION and RECOMMENDATIONS

People are constantly in the desire to acquire real estate for different purposes. Therefore, real estates constitute a large part of society's wealth. People also want to know the real estate value accurately. The objective, correct and healthy determination of real estate values is not only important for real estate owners, buyers and sellers, but also for the country's economy. The inability to determine the real estate values correctly causes economic and sociological problems in many applications such as real estate tax, expropriation, privatization and urban transformation. The necessity of a healthier structure of transactions in determining the real estate values is also important for the country's economies.

The subject of valuation is an important and researched subject for all national economies. Therefore, modeling to obtain objective, unbiased and accurate results prevents both time, labor and economic losses. The most important issue here is the selection of the most appropriate valuation method.

With the developing information technologies, institutions, businesses or individual users can find advanced solutions for increasing needs and problems. Advanced valuation methods offer significant opportunities by removing the boundaries in the fields of storage, computing and network solutions.

In order to make an accurate valuation, it is necessary to review all the above-mentioned parameters and carefully digitize the data used for

data containing the necessary parameters and to design the used parameters correctly in order to reach a highly consistent result with the fuzzy logic approach. These methods can be used especially to reveal the value differences between the parcels in the study area.

Real estate valuation is a very complex field of study where many parameters must be taken into account. The number and features of the parameters used vary according to the type and location of the real estate. Studies show that the most important of the main criteria used in real estate valuation is building features and infrastructure. In addition, location, transportation and population criteria are also very important. The location, which is the sub-criterion of the main criterion, the view and the proximity to the business and study center are the most important criteria as close to the city center. Road, water, electricity, natural gas and sewerage, which are sub-criteria of the main criterion of infrastructure, have equal importance. It is a rule that the difference between the values reached as a result of valuation made with different methods for real estate in a settlement is around 5%.

Valuation of multiple data is not possible with the classical valuation methods used in valuation. Advanced valuation methods, which are used as an alternative to these methods, are faster and have fewer steps. Many studies show that the artificial neural network method is a more suitable method, especially because it approaches market values more.

It is seen that the results of real estate valuation studies obtained with traditional methods and the valuation results obtained by fuzzy logic method (a method that requires advanced mathematics and valuation knowledge) are consistent. It is thought that the valuation results obtained with the advanced valuation methods will be very useful in checking the validity of the results obtained with the traditional valuation methods. It is especially recommended to be used in the development and implementation of urban transformation, expropriation, mass housing and large-scale commercial real estate projects. At the same time, the use of advanced methods will enable the evaluation of the accuracy of the valuation reports to public and private institutions, and especially the expert reports submitted to the courts, and the audit of the report.

However, it has been determined that there are very few studies on real estate valuation with artificial neural applications and fuzzy logic approach in Turkey. It is thought that the establishment of a real estate data bank, which is lacking in our country, and allowing the use of data, will increase the real estate valuation work with the advance methods and reach effective results. For real estate valuation, there should be a secure information system where all kinds of spatial, economic, social, legal and technical inquiries and examinations regarding the real estate can be made. However, there is no system for the collection of real estate values in our country yet. It is possible to benefit from GIS technology in collecting, analyzing, querying and presenting the data affecting the real estate value to certain standards.

By making use of the GIS infrastructure, an effective and accurate valuation structure can be established with the use of up-to-date data in real estate valuation. This reveals the features that affect the real estate value. Thanks to these features, it is possible to analyze the differences in urban and rural areas and to create visual outputs using GIS infrastructure.

Especially in expropriation and urban transformation studies, there are parcels on the site that are similar in quality to each other. However, there may be some details that may create a value difference between them. The decisive detail here is the location. For this, using methods based on spatial analysis, making use of transportation opportunities on the data set, etc. It gives a more effective result in terms of using parameters.

Insufficient transparency of the real estate market, deficiencies in the economic and legal infrastructure, lack of expert personnel, lack of knowledge and experience in valuation, and lack of a data bank are the factors that cause real estate valuation transactions to not be carried out properly. Apart from this, it is a fact that our country is still limited to classical methods, new methods are not used or new techniques are only limited to academic studies. In this context, while determining the real estate price, the real data set, correct timing, knowledge and analysis should be done by an expert.

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