Determination of Nominal Value by Fuzzy Analytic Hierarchic Process Weights

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SUMMARY

Although the accurate property appraisal standards have been designated in the developed countries, different research and analyzing studies are performed by developing new methods or correlating existed methods. Today, developing information technologies allow collecting thousands of data in the computers and evaluating them by using various analysis methods.

It is not possible to limit the number of the factors that affect the real-estate value definitely. Therefore, a "nominal" value may be created per each real estate by combining the factors affect the real estates based on the areas.

Decision makers may find intermittent assessment safer than the assessment, which contain definite values in general. For that reason, in order to represent the blurs in minds and judgments of people in the paired comparisons, verbal assessments should be expressed in blurred figures. Defining the blurred preferences of the people in the problems that contain too many factors, sub-factors and alternatives may be performed by using fuzzy analytic hierarchic process (AHP). Verbal assessments made for the fuzzy AHP may be expresses by triangle fuzzy figures and therefore weights are (w) calculated by basic arithmetic operations.

In this study, factor weights that affect the real estate values have been calculated by using fuzzy AHP and multiplied by the factor points of the real estate and thus, nominal value of each real estate have been found. Nominal values obtained have been assessed by Inverse Distance Weighting (IDW) interpolation technique through the ArcGIS program and thus, nominal value maps have been created.

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1. Introduction

All the people are decision makers, as a basis. Everything people encountered in their lives is the result of some decision taken by either consciously or not. However, information gathered may assist to make good decisions (T. L. Saaty, 2008). Science that solves the decision-making problems encountered in the business managements by using numerical solution method is called as numerical solutions. Numerical solutions, in other words, Operational Research (OR) allows making best decisions in the problems encountered related to using the limited sources (Taha, 1982; Tekin, 2008).

When the assessment of many criterions is the case in a problem of decision-making, such decision-making circumstances are examined under multi-criteria decision-making model (Timor, 2011). As the multi-criteria decision-making techniques allow the assessment of too many criterions and alternatives all together and simultaneously, it provides significant advantages that ease the decision-making accurately when the complex character of the problems encountered during the practice (Baysal and Tecim, 2006). In particular, assessments by using verbal variables lead blurring due to uncertainties in the colloquial language. Decision-making based on the fuzzy figures are important in such blurred situations. Verbal and numeric data may exist together in the assignment of the real estate values and decision should be made based on such data.

Many of the developed countries have formed standard methods for the assessment of the real estates owned. However, developed countries try to develop different approaches related to real estate assessment due to unsteady situation of the real estate development market. Real estate prices are in constant change under the global/local competition and market conditions, appraisers and academicians try to reach certain results by following such changes (Bostancı, 2008).
In this study, factor weights that affect the real estate values have been defined by using fuzzy AHP and thus, nominal values have been found.

2. Determination of Nominal Value

Certainly, it is not possible to limit the number of the factors that affect the real-estate value definitely. In this context, it is hard to assess the value of a real estate definitely, as well. Current value may be the base of the value distribution as well as the values related to one or more variables, which may be obtained by scoring.

Number of the factors that affect the real-estate value cannot be limited definitely. While an assessment operation to be performed on the location basis, a "nominal" value may be created per each real estate by combining the factors that affect the real estate. It may be possible to express the factors that affect the real estate by a numerical variable nominally, depending on the degree of effect of each (*www.yarbis1.yildiz.edu.tr)*.

In this context, nominal value of each real estate may be defined by the [1] equality (Yomralıoğlu, 1993). Such equality represents the total value of each real estate. This equality represents the total value of each real estate. Variable "P" in this formula represents the factors that affect the real estate. “P” is the effect of the factor which the value has been assessed to the real estate. “P” point value may be between 1–10 or 1–100. Each factor affects the value of the real estate in different weights, weight coefficients have been shown as "w" in the [1] formula. (Yomralıoğlu et al, 2007).

$$N_i = \sum_{j=1}^{k} (P_{ji} * w_j) \tag{1}$$

N : *Total nominal value*
P : *Factor value (Point)*
w : *Factor weight*

With this method, it has been aimed to find the specific value of the real estate by using the changes of the factors used in assessment methods based on points as well as the environmental effects (Erbil, 2014).

3. Fuzzy Analytic Hierarchic Process (Fuzzy AHP)

Fuzzy AHP, which is one of the techniques used to solve the multi-criteria decision-making on the problems, is a multi-criteria fuzzy decision- making method that supports the qualitative and quantitative and sub criterions grant the decision simultaneously. Fuzzy AHP is a suitable approach to the solution of the decision-making problems that contain blur or verbal uncertainty by using fuzzy scales with low, medium and high values. It uses fuzzy groups, affiliation functions and fuzzy figures to obtain the synthesis of relative weights.

While using the method, factors and alternatives have been compared pairwisely and assessments of the people related to the blur or uncertainty have been reflected to the decision process (Öztürk and Başkaya, 2012). Fuzzy importance sclae used in fuzzy AHP is shown in Table 1.

Table 1. Fuzzy importance scale in fuzzy AHP

Pairwise comparison preferences	Importance scale	Correlations of the importance scale
Equally important	(1,1,1)	(1,1,1)
Intermediate	(1,2,3)	(1/3,1/2,1)
Little more important	(2,3,4)	(1/4,1/3,1/2)
Intermediate	(3,4,5)	(1/5,1/4,1/3)
More important	(4,5,6)	(1/6,1/5,1/4)
Intermediate	(5,6,7)	(1/7,1/6,1/5)
Much more important	(6,7,8)	(1/8,1/7,1/6)
Intermediate	(7,8,9)	(1/9,1/8,1/7)
Highly important	(8,9,9)	(1/9,1/9,1/8)

If, $X = \{x_1,,x_2,\ldots,x_n\}$ criterion (object) group, $U = \{u_1,u_2,\ldots,u_m\}$ aim (target) group. According to the Chang (1992) method, each object is handled to realize an aim. Thus, M widened analysis value matrix is obtained by using pairwise comparison, which are as follows:

$$M_{g_i}^1, M_{g_i}^2, \ldots, M_{g_i}^m; \quad i = 1,2,\ldots,n$$

M (j = 1,2, ..., m) value parameters are *l, m* and *u,* which are triangle fuzzy figures.

Step 1: Fuzzy artificial greatness value may be described as:

$$S_i = \sum_{j=1}^{m} M_{g_i}^j \otimes \left[\sum_{i=1}^{n} \sum_{j=1}^{m} M_{g_i}^j \right]^{-1} \quad (2)$$

Step 2: $M_2 = (l_2, m_2, u_2) \geq M_1 = (l_1, m_1, u_1)$ probability level may be described as:

$$V = M_2 \geq M_1 = \begin{cases} 1 & ; \quad eğer\ m_2 \geq m_1 \\ 0 & ; \quad eğer\ l_1 \geq u_2 \\ \dfrac{l_1 - u_2}{(m_2 - u_2)(m_1 - l_1)} & ; \quad diğer\ hallerde \end{cases} \quad (3)$$

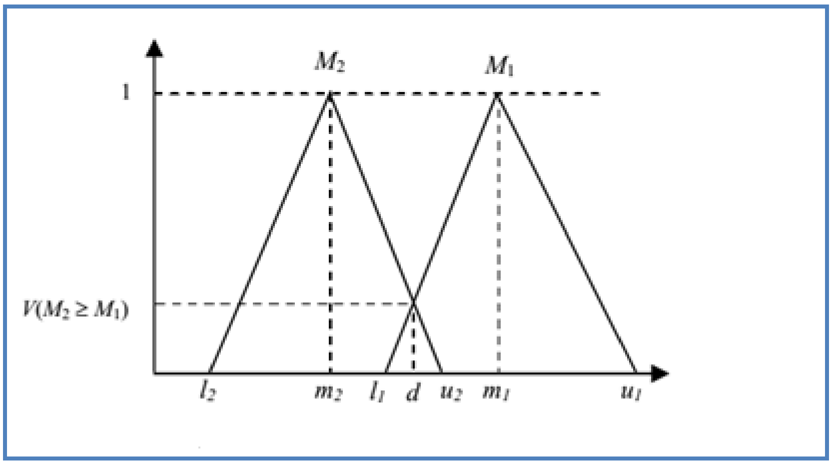

Figure 1. M_1 and M_2 intersection status (Çanlı and Kandakoğlu, 2007)

Step 3: Finding the weight vector,

$$V(M \geq M_1, M_2, ..., M_k) = V[(M \geq M_1) ve (M \geq M_2) ve ... ve (M \geq M_k) \\ = \min V(M \geq M_i),\ i = 1, 2, ..., k \tag{4}$$

Here $k=1,2,\ ...,\ n$ and for $k \neq i$

$$d'(A_i) = \min V(S_i \geq S_k) \tag{5}$$

$$W' = (d'(A_1),\ d'(A_2),\ ...\ , d'(A_n))^T \tag{6}$$

Step 4: Finding the normalized weight vector

$$W = (d(A_1),\ d(A_2),\ ...\ , d(A_n))^T \tag{7}$$

May be calculated, W is not a fuzzy figure.

4. Application

In order to practice the Nominal Assessment (NA) by using fuzzy AHP, data related to the residential features of 570 apartment houses located at approximately 20 avenues of Melikgazi town, Kayseri city collected in 2 months have been studied. Area of study and the location of the houses have been shown in Figure 2 in point basis.

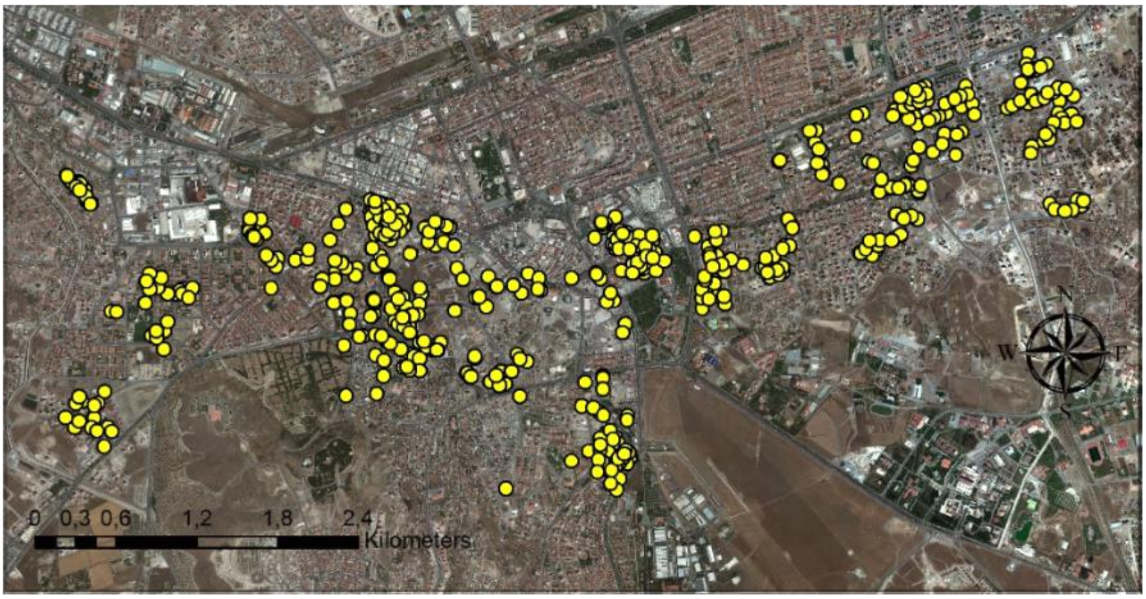

Figure 2. Melikgazi Town, location map of 570 houses

Data related to the houses has been collected under 20 factors. Such factors have been scored by surveying the experienced realtors in Kayseri according to the Importance Scale of Saaty between 1 to 9 and averaged therefore, average factor points have been obtained as shown in Table 2.

Table 2: Factor points according to the Saaty's AHP importance scale

S.N.	Factors	EML.-1	EML.-2	EML.-3	EML.-4	EML.-5	EML.-6	EML.-7	EML.-8	EML.-9	EML.-10	Average
1	Property's date	5	8	8	8	5	8	7	7	8	6	7
2	Property's exterior façade	8	8	7	8	9	9	8	9	9	7	8.2
3	Property's area	7	6	3	8	7	8	7	9	8	1	6.4
4	Number of rooms	5	8	8	8	7	6	8	9	1	1	6.1
5	Number of bathrooms	5	6	1	7	5	3	4	2	5	1	3.9
6	View	8	8	1	7	5	7	9	5	6	7	7.3
7	Whether in the complex	7	3	1	7	9	8	9	7	5	8	6.4
8	Car park	7	3	1	7	8	8	8	5	5	5	5.7
9	Security system	8	3	1	7	5	5	7	9	8	6	5.9
10	Road width of the main entrance	8	5	1	6	5	7	7	8	6	4	5.7
11	Floor of the property	6	6	5	7	7	8	8	8	8	4	6.7
12	Distance to school	8	8	3	6	8	7	6	7	5	3	6.1
13	Construction quality of exterior	9	8	1	8	8	8	9	8	7	5	7.1
14	Heating type	6	8	3	7	8	7	9	9	5	4	6.6
15	Fuel type	6	6	3	7	5	8	8	9	4	4	6
16	Maintenance fee	5	8	1	6	8	8	6	8	3	2	5.5
17	Rental income	9	8	2	7	8	4	7	5	8	8	6.6
18	Distance to the city center	6	6	1	7	8	7	7	7	5	7	6.1
19	Distance to the shopping center	4	3	1	6	8	6	8	6	6	5	5.3
20	Topographical structure of the land	5	3	1	3	5	8	9	5	4	4	4.7

"Fuzzy Importance Scale" shown in table 1 has been applied on the average factor points obtained from the questionnaire average; each factor has been compared pair wisely with the other, then matrix of M values, of which the parameters are *l*, *m* and *u* as triangle fuzzy figure has been found using Chang's (1992) widened analysis method (Table 3).

Table 3. Matrix of M values of the first 10 factors according to the fuzzy importance scale

		C1	C2	C3	C4	C5	C6	C7	C8	C9	C10
	Factors	KYAS	KCEPHE	KALAN	ODASAY	BANSAY	MANZARA	SİYON	OTOPARK	GÜVENLİK	BGYOLGEN
C1	Property's date	1.00 1.00 1.00	0.25 0.33 0.50	1.00 2.00 3.00	1.00 2.00 3.00	4.00 5.00 6.00	1.00 1.00 1.00	1.00 2.00 3.00	2.00 3.00 4.00	2.00 3.00 4.00	3.00 4.00 5.00
C2	Property's exterior façade	2.00 3.00 4.00	1.00 1.00 1.00	3.00 4.00 5.00	3.00 4.00 5.00	5.00 6.00 7.00	2.00 3.00 4.00	3.00 4.00 5.00	4.00 5.00 6.00	3.00 4.00 5.00	4.00 5.00 6.00
C3	Property's area	0.33 0.50 1.00	0.20 0.25 0.33	1.00 1.00 1.00	1.00 1.00 1.00	3.00 4.00 5.00	0.33 0.50 1.00	1.00 1.00 1.00	1.00 2.00 3.00	1.00 2.00 3.00	1.00 2.00 3.00
C4	Number of rooms	0.33 0.50 1.00	0.20 0.25 0.33	1.00 1.00 1.00	1.00 1.00 1.00	3.00 4.00 5.00	0.33 0.50 1.00	1.00 1.00 1.00	1.00 1.00 1.00	1.00 2.00 3.00	1.00 2.00 3.00
C5	Number of bathrooms	0.17 0.20 0.25	0.14 0.17 0.20	0.20 0.25 0.33	0.20 0.25 0.33	1.00 1.00 1.00	0.17 0.20 0.25	0.20 0.25 0.33	0.25 0.33 0.50	0.25 0.33 0.50	0.25 0.33 0.50
C6	View	1.00 1.00 1.00	0.25 0.33 0.50	1.00 2.00 3.00	1.00 2.00 3.00	4.00 5.00 6.00	1.00 1.00 1.00	1.00 2.00 3.00	2.00 3.00 4.00	2.00 3.00 4.00	2.00 3.00 4.00
C7	Whether in the complex	0.33 0.50 1.00	0.20 0.25 0.33	1.00 1.00 1.00	1.00 1.00 1.00	3.00 4.00 5.00	0.33 0.50 1.00	1.00 1.00 1.00	1.00 2.00 3.00	1.00 2.00 3.00	1.00 2.00 3.00
C8	Car park	0.25 0.33 0.50	0.17 0.20 0.25	0.33 0.50 1.00	1.00 1.00 1.00	2.00 3.00 4.00	0.25 0.33 0.50	0.33 0.50 1.00	1.00 1.00 1.00	1.00 1.00 1.00	1.00 1.00 1.00
C9	Security system	0.25 0.33 0.50	0.20 0.25 0.33	0.33 0.50 1.00	0.33 0.50 1.00	2.00 3.00 4.00	0.25 0.33 0.50	0.33 0.50 1.00	1.00 1.00 1.00	1.00 1.00 1.00	1.00 1.00 1.00
C10	Road width of the main entrance	0.20 0.25 0.33	0.17 0.20 0.25	0.33 0.50 1.00	0.33 0.50 1.00	2.00 3.00 4.00	0.25 0.33 0.50	0.33 0.50 1.00	1.00 1.00 1.00	1.00 1.00 1.00	1.00 1.00 1.00

Step 1 has been used in the Chang's (1992) widened analysis method and fuzzy artificial greatness value matrix has been calculated by using equation 2 and Microsoft Excel tables (Table 4)

Table 4. Fuzzy artificial greatness values

Sc1	35,25	50,33	65,50		0,0013	0,0017	0,0024		0,046	0,087	0,157
Sc2	61,00	80,00	99,00		0,0013	0,0017	0,0024		0,079	0,138	0,237
Sc3	20,20	28,75	38,33		0,0013	0,0017	0,0024		0,026	0,049	0,092
Sc4	20,20	27,75	36,33		0,0013	0,0017	0,0024		0,026	0,048	0,087
Sc5	5,13	6,35	8,78		0,0013	0,0017	0,0024		0,007	0,011	0,021
Sc6	32,25	48,33	64,50		0,0013	0,0017	0,0024		0,042	0,083	0,155
Sc7	20,20	28,75	38,33		0,0013	0,0017	0,0024		0,026	0,049	0,092
Sc8	13,25	16,70	22,75		0,0013	0,0017	0,0024		0,017	0,029	0,055
Sc9	12,62	16,25	22,83		0,0013	0,0017	0,0024		0,016	0,028	0,055
Sc10	12,53	16,12	22,58		0,0013	0,0017	0,0024		0,016	0,028	0,054
Sc11	20,87	29,25	38,33		0,0013	0,0017	0,0024		0,027	0,050	0,092
Sc12	20,12	28,58	37,83		0,0013	0,0017	0,0024		0,026	0,049	0,091
Sc13	32,25	48,33	64,50		0,0013	0,0017	0,0024		0,042	0,083	0,155
Sc14	20,20	28,75	38,33		0,0013	0,0017	0,0024		0,026	0,049	0,092
Sc15	19,12	27,58	36,83		0,0013	0,0017	0,0024		0,025	0,047	0,088
Sc16	12,53	16,12	22,58		0,0013	0,0017	0,0024		0,016	0,028	0,054
Sc17	20,20	28,75	38,33		0,0013	0,0017	0,0024		0,026	0,049	0,092
Sc18	20,12	28,58	37,83		0,0013	0,0017	0,0024		0,026	0,049	0,091
Sc19	12,52	16,08	21,83		0,0013	0,0017	0,0024		0,016	0,028	0,052
Sc20	6,70	9,52	15,08	*	0,0013	0,0017	0,0024	=	0,009	0,016	0,036

∑	417,24	580,88	770,45
1/∑	0,0024	0,0017	0,0013

Fuzzy artificial greatness values obtained per each factor have been pairwise compared by using the equation 3 and intersection probability of the factors have been calculated (Table 5).

Table 5. Intersection probability of the factors

Factors	$V(M_2 \geq M_1)$	Sc1	Sc2	Sc3	Sc4	Sc5	Sc6	Sc7	Sc8	Sc9	Sc10	Sc11	Sc12	Sc13	Sc14	Sc15	Sc16	Sc17	Sc18	Sc19	Sc20	
Property's date	**Sc1**		1.000	0.554	0.515	0.000	0.969	0.554	0.132	0.133	0.124	0.498	0.483	0.969	0.493	0.455	0.124	0.493	0.545	0.100	0.000	
Property's exterior façade	**Sc2**	0.604		0.126	0.081	0.000	0.580	0.126	0.000	0.000	0.000	0.127	0.115	0.580	0.126	0.092	0.000	0.126	0.115	0.000	0.000	
Property's area	**Sc3**	1.000	1.000		0.972	0.000	1.000	1.000	0.577	0.570	0.562	1.000	0.996	1.000	1.000	0.969	0.562	1.000	0.996	0.545	0.231	
Number of rooms	**Sc4**	1.000	1.000	1.000		0.000	1.000	1.000	0.598	0.590	0.582	1.000	1.000	1.000	1.000	0.995	0.582	1.000	1.000	0.565	0.240	
Number of bathrooms	**Sc5**	1.000	1.000	1.000	1.000		1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	
View	**Sc6**	1.000	1.000	0.597	0.561	0.000		0.597	0.189	0.189	0.181	0.604	0.589	1.000	0.597	0.565	0.181	0.597	0.589	0.159	0.000	
Whether in the complex	**Sc7**	1.000	1.000	1.000	0.972	0.000	1.000		0.577	0.570	0.562	1.000	0.996	1.000	1.000	0.969	0.562	1.000	0.996	0.545	0.231	
Car park	**Sc8**	1.000	1.000	1.000	1.000	0.178	1.000	1.000		0.980	0.974	1.000	1.000	1.000	1.000	1.000	0.974	1.000	1.000	0.971	0.605	
Security system	**Sc9**	1.000	1.000	1.000	1.000	0.215	1.000	1.000	1.000		0.994	1.000	1.000	1.000	1.000	1.000	0.994	1.000	1.000	0.992	0.630	
Road width of the main entrance	**Sc10**	1.000	1.000	1.000	1.000	0.221	1.000	1.000	1.000	1.000		1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	0.998	0.636	
Floor of the property	**Sc11**	1.000	1.000	0.987	0.959	0.000	1.000	0.987	0.559	0.553	0.545		0.982	1.000	0.987	0.955	0.545	0.987	0.982	0.527	0.211	
Distance to school	**Sc12**	1.000	1.000	1.000	0.977	0.000	1.000	1.000	0.581	0.574	0.566	1.000		1.000	1.000	0.973	0.566	1.000	1.000	0.549	0.234	
Construction quality of exterior	**Sc13**	1.000	1.000	0.597	0.561	0.000	1.000	0.597	0.189	0.189	0.181	0.604	0.589		0.597	0.565	0.181	0.597	0.589	0.159	0.000	
Heating type	**Sc14**	1.000	1.000	1.000	0.972	0.000	1.000	1.000	0.577	0.570	0.562	1.000	0.996	1.000		0.969	0.562	1.000	0.996	0.545	0.231	
Fuel type	**Sc15**	1.000	1.000	1.000	1.000	0.000	1.000	1.000	0.613	0.605	0.598	1.000	1.000	1.000	1.000		0.598	1.000	1.000	0.582	0.267	
Maintenance fee	**Sc16**	1.000	1.000	1.000	1.000	0.221	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000		1.000	1.000	0.998	0.636	
Rental income	**Sc17**	1.000	1.000	1.000	0.972	0.000	1.000	1.000	0.577	0.570	0.562	1.000	0.996	1.000	1.000	0.969	0.562		0.996	0.545	0.231	
Distance to the city center	**Sc18**	1.000	1.000	1.000	0.977	0.000	1.000	1.000	0.581	0.574	0.566	1.000	1.000	1.000	1.000	0.973	0.566	1.000		0.549	0.234	
Distance to the shopping center	**Sc19**	1.000	1.000	1.000	1.000	0.223	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000		0.638	
Topographical structure of the land	**Sc20**	1.000	1.000	1.000	1.000	0.694	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000		
	MinV(M2≥M	0.604	1.000	0.126	0.081	0.000	0.580	0.126	0.000	0.000	0.000	0.127	0.115	0.580	0.126	0.092	0.000	0.126	0.115	0.000	0.000	3.798
	W	**0.159**	**0.263**	**0.033**	**0.021**	**0.000**	**0.153**	**0.033**	**0.000**	**0.000**	**0.000**	**0.033**	**0.030**	**0.153**	**0.033**	**0.024**	**0.000**	**0.033**	**0.030**	**0.000**	**0.000**	**1.000**

In the widened analysis method, the minimum value, which has been found by pairwise comparison of the factors and the intersection probability status obtained by using equation 5 is the weight vector of such factor. Minimum value of each factor in the fuzzy weight vector is divided by total minimum value and thus, the normalized weight vector, which has been shown as equation 7, is calculated (Table 6).

Table 6. Normalized weight vector

Factor name	Code	Weight vector not normalized	Weight vector normalized
Property's date	Sc1	0.604	0.159
Property's exterior façade	Sc2	1.000	0.263
Property's area	Sc3	0.126	0.033
Number of rooms	Sc4	0.081	0.021
Number of bathrooms	Sc5	0.000	0.000
View	Sc6	0.580	0.153
Whether in the complex	Sc7	0.126	0.033
Car park	Sc8	0.000	0.000
Security system	Sc9	0.000	0.000
Road width of the main entrance	Sc10	0.000	0.000
Floor of the property	Sc11	0.127	0.033
Distance to school	Sc12	0.115	0.030
Construction quality of exterior	Sc13	0.580	0.153
Heating type	Sc14	0.126	0.033
Fuel type	Sc15	0.092	0.024
Maintenance fee	Sc16	0.000	0.000
Rental income	Sc17	0.126	0.033
Distance to the city center	Sc18	0.115	0.030
Distance to the shopping center	Sc19	0.000	0.000
Topographical structure of the land	Sc20	0.000	0.000
Total		**3.798**	**1.000**

Weights obtained by using fuzzy AHP have been applied to the data collected for 570 houses and nominal value (NV) of the first 10 houses has been found on 10 as follows (Table 7).

Table 7. NV points for the first 10 houses

ID	DK0D	District	Street	X	Y	Total point	NV (Fuzzy AHP)	NV2 (Av.Meth)
704	HUN36	HUNAT	Uçak Sok.	4287722.04	456003.09	161	9.271	8.184
775	GLT36	Gültepe	Sht.Mustafa Simsek Blv	4287618.07	456787.28	156	9.127	7.917
867	MEL18	MELİKGAZİ	KIZILIRMAK CD.	4288467.00	458219.00	165	9.060	8.286
988	ANA13	Mevlana	Mehmet Akif Ersoy	4285447.90	461154.26	146	9.044	7.441
761	GLT02	Gültepe	M.Kemal Paşa Blv	4287043.85	456646.45	159	9.023	8.048
358	YEN21	YENİKÖY	Susam Sok.	4287017.96	452254.88	144	9.023	7.397
415	ÇOR10	çorakçılar	Fulya Sok.	4287319.61	453927.76	149	8.941	7.622
1030	ANA19	Mevlana	75. Yil	4285771.22	461647.18	131	8.889	6.800
1027	ANA56	Mevlana	Mehmet Timucin	4286142.14	461621.12	135	8.875	6.956

Considering each real-estate as a point layer, NV map created by using Kriging interpolation Method in the ArcGIS Geostatistical Analyze module shown in Figure 3.

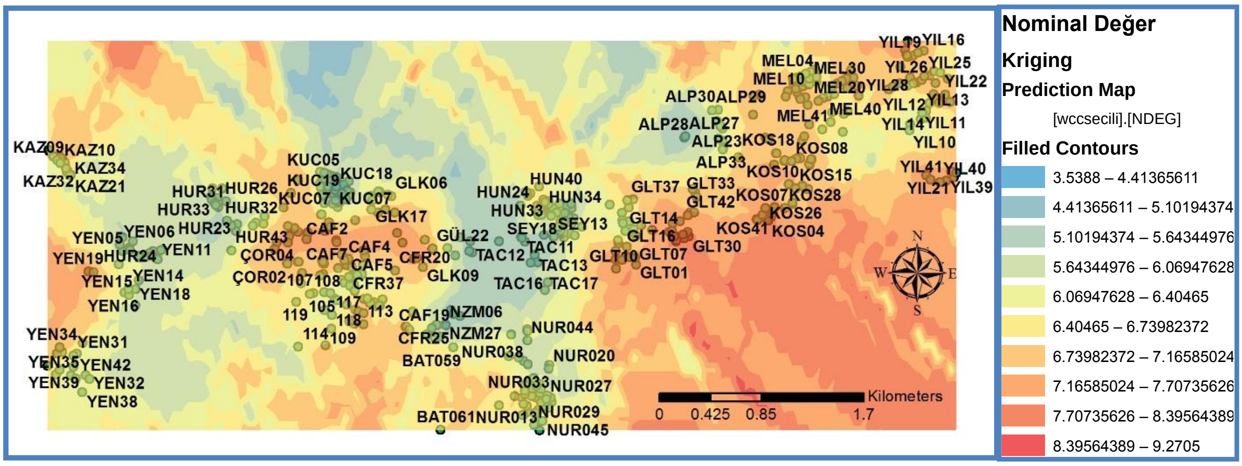

Figure 3. NV map created by using Kriging interpolation method based on fuzzy AHP weights

Köşk District and Gültepe District have been found as the most valuable avenues according to the nominal appraisal map created by using fuzzy AHP weights when the Property feature table is examined. It may be stated as compatible with the actual sales value when compared.

5. Results and Recommendations

1. In this study, questionnaire points obtained from 10 realtors have been converted into fuzzy figures according to the fuzzy AHP importance scale and factor weights have been obtained by using the fuzzy AHP method for the purpose of nominal appraisal. Accuracy of the factor points to be obtained from the realtors through questionnaire will allow creating both weight and nominal value maps accurately.
2. Verbal and quantitative data should be evaluated together in the real-estate appraisal area. It is observed that fuzzy decision-making methods are practicable for the cases verbal and quantitative data are used together.
3. Questionnaire average points obtained from 10 realtors have been expressed not by the certain figures but by the linguistic variety under the fuzzy group logic due to fuzzy logic used.
4. Nominal appraisal points obtained shall be multiplied by the average nominal unit price to be obtained from the area in order to calculate the estimated sales value.
5. Different nominal value maps may be created by applying different interpolation techniques on the real-estate values obtained by using nominal appraisal method. Interpolation methods may be verified by using estimated errors (root mean square error, etc).
6. Factor weights may also be used in the real-estate appraisal problems to be obtained by different decision-making methods (Fuzzy Entropy, Fuzzy Dematel).

REFERENCES

Baysal, G. and Tecim, V. (2006). Katı atık depolama sahası uygunluk analizinin coğrafi bilgi sistemleri (CBS) tabanlı çok kriterli karar yöntemleri ile uygulaması. 4. Coğrafi Bilgi Sistemleri Bilişim Günleri. Fatih Üniversitesi. İstanbul.

Bostancı, B. (2008) Forecasting analysis on real estate development and application of housing
area model in İstanbul. Yıldız Technical University, *Ph.D. Thesis*, Istanbul, 217 pages.

Chang, D.Y., (1992). Extent Analysis and Synthetic Decision, Optimization Techniques and Applications, World Scientific, Singapore, Vol. 1p. 352.

Çanlı, H., Kandakoğlu, A. (2007) Hava gücü mukayesesi için Bulanık AHP modeli, Havacılık ve Uzay Teknolojileri Dergisi, 3(1), 71-82.

Erbil, E.H., (2014) Taşınmaz Mal Değerleme Amaçlı Coğrafi Bilgi Sistemi Tasarımı, 5. Uzaktan Algılama, CBS Sempozyumu (UZAL-CBS 2014), 14-17 Ekim 2014, İstanbul.

Öztürk B.A. and Başkaya Z., (2012) Bulanık Analitik Hiyerarşi Süreci ile Bir Ekmek Fabrikasında Un Tedarikçisinin Seçimi, Business and Economics Research Journal 3(1), 131-159.

Saaty, T.L., (2008) Decision Making With the Analy tic Hierarchy Process, Internatio nal Journal of . Services Sciences, Vol. 1, No. 1.

Taha, H.A., (1982) Operations Research- An Introduction, Macmillan Publishing Co. New York.

Tekin, M. (2008) Sayısal Yöntemler, Selçuk Üniversitesi İktisadi ve İdari Bilimler Fakültesi, Konya.

Timor, M. (2011) Analitik Hiyerarşi Prosesi, İstanbul: Türkmen Kitabevi.

Yomralioglu, T. (1993) The Investigation of a Value-based Urban Land Readjustment Model and its Implementation Using Geographical Information Systems, PhD. Thesis, Dep. of Surveying University of Newcastle upon Tyne, UK.

Yomralıoğlu, T., Nişanci R. and Uzun B. (2007) Raster Tabanlı Nominal Değerleme yöntemine
dayalı arsa-arazi düzenlemesi uygulaması, TMMOB Harita ve Kadastro Mühendisleri Odası, 11. Türkiye Harita Bilimsel ve Teknik Kurultayı, 2 – 6 Nisan 2007, Ankara.

Web reference:

http://www.yarbis1.yildiz.edu.tr/web/userCourseMaterials/hudemir_24efafad4d113f95c5a3ba0356d2564a.ppt (Accessed Date:02.03.2015)

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