

# Using Grey Relational Analysis in Determining the Factors that Affect the Capitalization Rate

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**Abstract** – Agricultural lands, one of the limited natural resources, are essential because they are the lands, on which agricultural production is carried out. The determination of capitalization rate that is valid in the area, where the agricultural land is found, in making agricultural land valuation with respect to revenue method is an important phase of valuation. Rents of agricultural lands in an area and real transaction values recently in determining the capitalization rate, the valuation of characteristics of the land that is not added to those numerical values is required to determine a real value. Those factors that affect the capitalization rate are evaluated by the initiatives of valuation experts, attainment of a real value is not possible most of the time and consequently disagreements occur.

In this study, the capitalization rate valuation was calculated not for only an area but also characteristics of land on a parcel basis by evaluating the factors that affect the capitalization rate with grey relational analysis method. The factors that affect the capitalization rate varied from the proximity to city, the proximity to settlements, the proximity to road and population density to transportation possibilities, health possibilities, market possibilities, irrigation possibilities, land type, land market and rotation change possibility. Although the average capitalization rate of sample area was found as 6.2%, as a result of grey relational analysis, this rate was found between % 5.22-% 5.66 as separately for every parcel. By using this method, the capitalization rate and accordingly land value are determined as realistically.

**Keywords** – Agricultural Lands, Capitalization Rate, Grey Relational Analysis.

## I. INTRODUCTION

Agricultural sector is a sector that provides the production of necessary sustenance for human health. The significance of agricultural land for agricultural enterprises is much more than other enterprises because agricultural lands are the places where agricultural production is carried out. The incremental usage of land in sectors such as transportation, housing and industry day by day increases this significance. Agricultural lands surrounding cities have been a subject in urban settlement with incremental urban regeneration, especially in recent years. This situation increases the significance of agricultural lands' valuation. The issue of agricultural land valuation should be kept up to date and this must be done objectively because of limited agricultural lands, increasing demands towards agricultural lands and unsteady form of inflation in Turkey.

The aim of valuation in evaluating a real estate is to know the legal arrangements and characteristics of the real estate valued in the future. The valuation of agricultural

lands is generally required for specific reasons such as nationalization, land consolidation, agricultural credit, inheritance, agricultural taxation. Different valuation methods are required to be implemented in several situations where the real estate has different characteristics such as land, terrain and structure and consequently this is subjected to different legal arrangements.

Although there are many methods for real estates' valuation, the most known and used of these methods are; a) Comparison (Market) method, b) Income method, c) Cost method. In comparison method, the latest purchase and sale prices in the location of real estate that will be evaluated must be taken into consideration. It is necessary for the properties, which will be compared, to be under same conditions and it is also required to be aware of the latest market prices and free competition must exist[1]. According to income method, the sum of value of a real estate and its future values is equal to its current value[2]-[3]. Cost method is to base a property's cost in its valuation. Cost is the sum of total expenditures of means of production used in a specific amount of property and service production[4].

In Turkey, Income method is implemented in agricultural land valuation because of the legal requirement. The reason to use Income method in valuation process is the 1983 Condemnation Law (Law No. 2942) and another law with no. 4650 that amends some of the articles of 1983 Condemnation Law, which places the obligation to use Income method to lands with respect to their value (Article 11: Determining the net income with respect to location and conditions of real estate or resource in the time of nationalization and under the condition of their usage as they are). In Income method, which is also called as the capitalization of incomes, the value of a real estate equals to the reduction of the sum of incomes to present day.

In order to determine the value of a real estate in Income method, first of all, the average annual net income of real estate and the capitalization rate that is valid in the area of real estate must be known. Furthermore, the analysis of the factors that affect value and their evaluation are required for an objective valuation.

Market value method is used in determination of the capitalization rate[5]. The capitalization rate is found by calculating the annual average net incomes of lands, in which their transaction values are known, and proportioning those two factors to each other[1]. The value of real state increases while the capitalization rate decreases. The capitalization rate, which is the interest of capital invested in the land, is in a lower level comparing to other investments' interests because that land is a secure

investment and its owner loves the land because of gaining a social status, the land is a habitat for family and it provides the valuation of the labor force of all family. Because, interest rate of an investment increases while its venture decreases and its safety increases[6].

An adjustment for an area is required to be made after its capitalization rate was determined in order to make it fit to the valuated land. The determination of the capitalization rate is based on its accessibility to city/town, population and population density of city/town, its transportation possibilities (highway, railway, seaway, airway), health conditions, good condition of buildings, the monolithic formation of land, good topographic condition of soil, the existence of property security, the condition of land whether it is bought and sold freely, the maintenance of life safety of land owner, whether the land survey study of land was already made, whether the current rotation system can be easily changed and it is easy to irrigate if the land is wet. These factors cause the capitalization rate to be low or high by affecting the capitalization rate positively or negatively. For this reason, these factors must be taken into account while determining the capitalization rate for an area. It is necessary to include the impact levels of aforementioned factors to the capitalization rate by determining their impact levels to make the rate more realistic. In this sense, this study provides the inclusion of the factors that affect the capitalization rate to calculations by using Grey relational analysis method. Moreover, the capitalization rate was calculated not only for region but also for every parcel separately.

Grey relational analysis (GRA) as one of subcategories of Grey modeling is an alternative and effective approach to apply for situations, in which Grey system theory, scarce or discontinuous knowledge, abundant data and ambiguity present. Grey theory was put forward for the first time in 1982 by Professor Julong Deng, one of the professors in Thailand Hua Chung Science and Technology University[7]. Basically, Grey system theory is a method often used in prediction and decision problems, model formation and analysis of intersystem relationships[8]. Furthermore, Grey system theory as an alternative method to enumerate the ambiguity is used in areas such as environmental science[9], sale predictions [10]and risk evaluation[11]. In this study, it was used in the area of real estate valuation.

## II. MATERIAL AND METHOD

In this study, due to the data collection by applying questionnaires to owners of parcels that are purchased and sold actually to determine the capitalization rate, sampling unit is transacted parcels (number, width and owner). In this sense, transacted agricultural lands in studied region were determined from the Land Registry and Cadastre Office in order to obtain required data for Market method used in the determination of the capitalization rate. As relevant to aim of the study, while determining transacted lands from the Land Registry and Cadastre Office, it is paid attention whether agricultural lands is outside of

municipality adjacent area, there isn't any transaction among relatives and seller resides in the village where the land is located. The number of samples was determined as 30 in terms of these criteria. By using questionnaires, income and expenditures of owner or operator of an agricultural land in at least one rotation term were determined by interviewing this owner or operator, who sold agricultural lands in transaction.

In the calculation of the capitalization rate [12];

$$f = \frac{R_1 + R_2 + R_3 + \dots + R_n}{V_1 + V_2 + V_3 + \dots + V_n}$$

$f = \sum R / \sum V$  formula used.

R= Annual Average Net Income (Rent)

V= Actual Land Sales Value

f = capitalization rate refers.

Grey relational analysis is a method, which provides a determination of relationship level among every factor and compared factor sequence (reference sequence) in a grey system. Impact level between factors is called as Grey relational grade. The first step of Grey relational analysis is to convert data to same units because factors are coming from different sources and they are measured in different units. Besides, in situations where sequence is valued at vast intervals, standardization can provide data to be moved to a small interval. The magnitude of grey relational grade indicates the product that gained the best value from criterions[13]-[14]. In this study, Grey relational analysis is used for determining grey relational grades of factors that affect the capitalization rate and these grades are included in the capitalization rate calculations. The most ideal values were determined after forming a reference sequence from the factors that affect the capitalization rate.

The calculation steps of Grey relational analysis are as follows[8]-[15]:

1. Step: reference sequence with an n length is as follows  $X_0 = (X_0(1), X_0(2), X_0(3), \dots, X_0(n))$
2. Step: normalization of data

In Grey system theory, normalization process is called as grey relational generating. A crucial point to consider in normalization of factor sequences is that which one among "higher the better", "lower the better" and "Ideal value is better" criterions reflects the characteristic of related sequence. For instance, if having small valued points in a sequence is an ideal characteristic, in linear normalization, small valued points gain values that are close to "1" and large valued points gain values that are close to "0" in normalization.

In "Higher the better" situation, normalization is as follows;

$$X_i(k) = \frac{X_i^0(k) - \min X_i^0(k)}{\max X_i^0(k) - \min X_i^0(k)}$$

$X_i^0(k)$  is the original value in i series and k sequence,  $X_i(k)$  is the value in i series and k sequence after normalization,  $\min X_i^0(k)$  is the minimum value in i series and  $\max X_i^0(k)$  is the maximum value in i series.

3. Step: m units of series are defined by comparing with  $X_0$  sequence.

$$X_i = (X_i(1), X_i(2), X_i(3), \dots, X_i(n))$$

i: 1,2,3,...,m

4. Step:  $k$  shows  $k$  sequence in a series with  $n$  length.  $\varepsilon(X_0(k), X_i(k))$  is Grey relational coefficient and it is calculated with following formula.

$$\varepsilon(X_0(k), X_i(k)) = \frac{\Delta_{\min} + \Delta_{\max}}{\Delta_{0i}(k) + \Delta_{\max}}$$

$$\Delta_{0i}(k) = |X_0(k) - X_i(k)|$$

$$\Delta_{\min} = \min_j \min_k |X_0(k) - X_j(k)|$$

$$\Delta_{\max} = \max_j \max_k |X_0(k) - X_j(k)|$$

5. Step: Finally, Grey relational degree is calculated with following formula.

$$\gamma(X_0, X_i) = \frac{1}{n} \sum_{k=1}^n \varepsilon(X_0(k), X_i(k))$$

$\gamma(X_0, X_i)$  is a measure of a geometric similarity between  $X_i$  sequence and  $X_0$  reference sequence in a grey system. The magnitude of Grey relational degree is the indicator of a strong relation between  $X_i$  and  $X_0$ . If two compared sequences are the same, then Grey relational degree value is found as 1. Grey relational degree indicates how much compared sequence is similar to reference sequence[14]. In this study, the proximity of Grey relational degree to 1 expresses that the factors that affect the capitalization rate are ideally represented in higher degree parcel.

In this study, the capitalization rate for every parcel was calculated by determining Grey relational degree for every studied parcel and subtracting Grey relational degree of every parcel from average capitalization rate found for the studied region.

### III. STUDY RESULTS

#### Calculation of the Capitalization Rate

The capitalization rate is the right of use of the invested capital to land[1]. The meaning of capitalization is the reduction of every income that will be obtained in the future to present day [16]-[17]. The capitalization rate can also be described as the interest on capital, which will be obtained from land in return of its usage by land owner for some time. Due to dealing with net income and characteristics of a land in calculation of the capitalization rate, this rate can vary from region to region, even land to land. Furthermore, repetition of this rate with specific periods and on regional basis is anticipated because this rate can vary with respect to development of region in course of time.

In calculation of the capitalization rate; in calculation of annual net income with respect to triple rotation system common in the study area, binding prices were brought back to June 2009 levels and also real transaction values were brought back to June 2009 levels by taking increases in Producer Prices Index into consideration.

f	Total Rent ( $\Sigma R$ )	Total Land Value ( $\Sigma V$ )	Capitalization Rate (f)
1	299.52	20 862.22	0,062

Total rent obtained from questionnaires was calculated as 1 299.52 Euro in the study region and total land value was calculated as 20 862.22 Euro and the average capitalization rate that is valid for the studied region was

determined as 6.2% by proportioning total income to total land value.

#### The Usage of Grey Relational Analysis in Calculation of the Capitalization Rate

The average capitalization rate determined for a specific region can constitute a reference for the valuation of individual parcels in this region. However, an average rate for a province/county must be adapted to valued land. All characteristics that can affect the capitalization rate of land negatively or positively must be taken into account in the determined average capitalization rate with respect to individual lands. If the land with determined value has negative or positive factors with respect to its region, then an expert can alter the average capitalization rate as needed by taking main factors that are known to cause the capitalization rate to decrease or increase into consideration[18]. The evaluation of this alteration with a mathematical model instead of subjective evaluations provides a realistic rate. For this reason, in this study, the factors that affect the capitalization rate in valuation literature were rated in 1-5 scale for every parcel, then these were converted to values between 0-1 in the matrix that was normalized by Grey relational analysis method and consequently its Grey relational grade was found. The capitalization rates for every parcel were determined by subtracting Grey relational grade found for every parcel from the average capitalization rate.

The factors that affect the capitalization rate positively;

- The proximity of real estate to city or town,
- Excessive population or population density of the closest province/county to real estate,
- Real estate benefitting from transportation opportunities (highway, railway),
- The existence of good health conditions surrounding real estate,
- The existence of market opportunities or the evaluation easiness of products,
- The existence of monolithic land and its smooth form,
- Unproblematic region in terms of life safety,
- Unproblematic region in terms of life safety of land owner and agricultural workers,
- Completed land survey studies in region and registered land,
- Easy convertibility of rotation system applied in land and the possibility of cultivating a lot of products,
- The existence of wet and easily irrigated land,
- The proximity of real estate to touristic facilities, industrial and commercial enterprises, sea, lake and river costs,
- The proximity of real estate to village settlements,
- The existence of building above real estate and whether it is good conditioned and fit for purpose[18]-[19].

Scores given to criteria that affect the capitalization rate with respect to the characteristics of agricultural lands are shown in table 1.

Quantitative values such as proximity to city, settlement, and road and population density were given points in the light of obtained data. Qualitative values such as transportation opportunities, market and irrigation

opportunities, land shape, land market, life safety of workers and possibility of changing rotation were given scores in the light of answers from land owners in survey study (table 2).

12 factors excluding property safety and land survey factors were analyzed because cadastres of all agricultural lands in the studied area were completed and they have land registers. In the first step of Grey relational analysis, reference sequence was generated by taking the highest value of every factor  $X_o = (5,5,5,5,4,5,5,2,4,4,5,5)$ .

In the second step, reference sequence and data were normalized. The aim of normalization process is to convert factors with different units that are coming from different sources to same units and to move data to a small interval by using standardization in situations when sequence gains

values at vast intervals[14]. In this study, “higher the better” criterion was used.

In the third step, distances between normalized values and reference sequence were calculated.

In the fourth step, Grey relational coefficient was calculated for every unit (table 3).

These coefficients show significance degree of every factor for every parcel. For instance, for the first parcel; the proximity to city, health opportunities and rotation change opportunity are important at the rate of 66.7%, the proximity to settlement and excessive population density are important at the rate of 80%, the proximity to road, monolithic and smooth land and life safety of workers are significant at the rate of 100%, market and irrigation opportunities are significant at the rate of 75% and land market is important at the rate of 50%.

Table 1: Rating scale for the factors that affect the capitalization rate

Scores		Proximity to City	Proximity to Settlement	Proximity to Road	Population Density (People)
5	Very Good	0-5 km	0-1,5 km	0-200 m	2820
4	Good	6-7 km	2-2,5 km	300-500 m	1500
3	Neutral	8-10 km	3-4 km	600 m-700 m	970-1000
2	Bad	11-13 km	5 km	800 m-900 m	-
1	Very Bad	14-+ km	6-+ km	1-1,5 km	100

Table 2: Scores for the factors that affect the capitalization rate

Enterprise No	proximity to city	proximity to settlement	proximity to road	transportation opportunities	health opportunities	market opportunities	monolithic and smooth form	land market	life safety of workers	possibility of changing rotation	irrigation opportunities	population density	property safety	cadastres
1	3	4	5	5	3	4	5	1	4	4	4	4	5	5
2	3	3	4	4	3	4	4	2	4	4	5	5	5	5
3	3	1	4	3	3	2	4	2	3	4	4	5	5	5
4	3	5	5	5	3	3	4	1	4	4	4	3	5	5
5	3	4	5	5	3	4	4	1	4	3	4	1	5	5
6	2	3	4	3	3	3	5	1	4	3	3	1	5	5
7	3	5	5	5	3	3	4	1	4	4	4	1	5	5
8	4	5	5	4	3	3	4	1	4	3	4	1	5	5
9	3	2	1	2	3	2	3	1	3	4	3	4	5	5
10	2	2	1	1	2	2	3	1	3	3	2	4	5	5
11	3	3	1	2	2	3	3	1	3	3	2	4	5	5
12	2	3	2	3	3	3	3	1	4	3	4	3	5	5
13	1	3	3	3	2	2	4	1	3	3	3	4	5	5
14	4	4	5	4	4	4	5	2	4	4	4	4	5	5
15	3	3	3	3	3	2	4	2	4	3	3	4	5	5
16	3	3	3	3	3	3	4	2	4	3	3	4	5	5
17	5	4	5	5	4	5	5	2	4	4	5	5	5	5
18	4	5	5	5	4	5	4	2	4	4	5	5	5	5
19	5	5	5	5	4	5	4	1	4	5	4	5	5	5
20	5	5	5	5	4	4	5	2	4	5	5	5	5	5
21	3	4	4	4	3	3	4	1	4	4	4	5	5	5
22	1	3	3	3	2	3	3	1	3	3	3	4	5	5
23	1	3	3	3	3	2	3	1	4	3	2	4	5	5
24	1	2	3	2	3	2	3	1	3	3	3	4	5	5
25	2	1	1	1	2	3	3	1	3	3	3	4	5	5

26	5	4	5	5	4	4	4	1	4	4	4	5	5	5
27	4	3	4	4	3	4	4	2	4	4	4	5	5	5
28	5	4	5	5	4	5	5	1	4	5	4	4	5	5
29	5	5	5	5	4	5	5	2	4	5	5	4	5	5
30	4	4	5	5	3	5	4	1	4	4	4	3	5	5

Table 3: Grey relational coefficient

Enterprise No	proximity to city	proximity to settlement	proximity to road	transportation opportunities	health opportunities	market opportunities	monolithic and smooth form	land market	life safety of workers	possibility of changing rotation	irrigation opportunities	population density
Reference	1	1	1	1	1	1	1	1	1	1	1	1
1	0.667	0.800	1.000	1.000	0.667	0.750	1.000	0.500	1.000	0.667	0.750	0.800
2	0.667	0.667	0.800	0.800	0.667	0.750	0.667	1.000	1.000	0.667	1.000	1.000
3	0.667	0.500	0.800	0.667	0.667	0.500	0.667	1.000	0.500	0.667	0.750	1.000
4	0.667	1.000	1.000	1.000	0.667	0.600	0.667	0.500	1.000	0.667	0.750	0.667
5	0.667	0.800	1.000	1.000	0.667	0.750	0.667	0.500	1.000	0.500	0.750	0.500
6	0.571	0.667	0.800	0.667	0.667	0.600	1.000	0.500	1.000	0.500	0.600	0.500
7	0.667	1.000	1.000	1.000	0.667	0.600	0.667	0.500	1.000	0.667	0.750	0.500
8	0.800	1.000	1.000	0.800	0.667	0.600	0.667	0.500	1.000	0.500	0.750	0.500
9	0.667	0.571	0.500	0.571	0.667	0.500	0.500	0.500	0.500	0.667	0.600	0.800
10	0.571	0.571	0.500	0.500	0.500	0.500	0.500	0.500	0.500	0.500	0.500	0.800
11	0.667	0.667	0.500	0.571	0.500	0.600	0.500	0.500	0.500	0.500	0.500	0.800
12	0.571	0.667	0.571	0.667	0.667	0.600	0.500	0.500	1.000	0.500	0.750	0.667
13	0.500	0.667	0.667	0.667	0.500	0.500	0.667	0.500	0.500	0.500	0.600	0.800
14	0.800	0.800	1.000	0.800	1.000	0.750	1.000	1.000	1.000	0.667	0.750	0.800
15	0.667	0.667	0.667	0.667	0.667	0.500	0.667	1.000	1.000	0.500	0.600	0.800
16	0.667	0.667	0.667	0.667	0.667	0.600	0.667	1.000	1.000	0.500	0.600	0.800
17	1.000	0.800	1.000	1.000	1.000	1.000	1.000	1.000	1.000	0.667	1.000	1.000
18	0.800	1.000	1.000	1.000	1.000	1.000	0.667	1.000	1.000	0.667	1.000	1.000
19	1.000	1.000	1.000	1.000	1.000	1.000	0.667	0.500	1.000	1.000	0.750	1.000
20	1.000	1.000	1.000	1.000	1.000	0.750	1.000	1.000	1.000	1.000	1.000	1.000
21	0.667	0.800	0.800	0.800	0.667	0.600	0.667	0.500	1.000	0.667	0.750	1.000
22	0.500	0.667	0.667	0.667	0.500	0.600	0.500	0.500	0.500	0.500	0.600	0.800
23	0.500	0.667	0.667	0.667	0.667	0.500	0.500	0.500	1.000	0.500	0.500	0.800
24	0.500	0.571	0.667	0.571	0.667	0.500	0.500	0.500	0.500	0.500	0.600	0.800
25	0.571	0.500	0.500	0.500	0.500	0.600	0.500	0.500	0.500	0.500	0.600	0.800
26	1.000	0.800	1.000	1.000	1.000	0.750	0.667	0.500	1.000	0.667	0.750	1.000
27	0.800	0.667	0.800	0.800	0.667	0.750	0.667	1.000	1.000	0.667	0.750	1.000
28	1.000	0.800	1.000	1.000	1.000	1.000	1.000	0.500	1.000	1.000	0.750	0.800
29	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	0.800
30	0.800	0.800	1.000	1.000	0.667	1.000	0.667	0.500	1.000	0.667	0.750	0.667

Finally in the fifth step, Grey relational degree was calculated.

As can be seen in table 4, Grey relational degree of the parcel 29 was found as 0.983 and it was determined that this parcel ideally represents the factors that affect the capitalization rate.

Table 4: Addition of Grey Relational Degree Capitalization Rate Account

Enterprise No	Average Capitalization Rate (%)	Grey Relational Degree	Capitalization Rate (%)
1	6.2	0.800	5.40
2		0.807	5.39
3		0.699	5.50
4		0.765	5.43
5		0.733	5.47
6		0.673	5.53
7		0.751	5.45
8		0.732	5.47
9		0.587	5.61
10		0.537	5.66
11		0.567	5.63
12		0.638	5.56
13		0.589	5.61
14		0.864	5.34
15		0.700	5.50
16		0.708	5.49
17		0.956	5.24
18		0.928	5.27
19		0.910	5.29
20		0.979	5.22
21		0.743	5.46
22		0.583	5.62
23		0.622	5.58
24		0.573	5.63
25		0.548	5.65
26		0.844	5.36
27		0.797	5.40
28		0.904	5.30
29		0.983	5.22
30		0.793	5.41

Grey relational degrees show the degree of the factors that affect the capitalization rate and having a high degree (proximity to 1) impacts the capitalization rate positively. The positive aspects of land increase while the capitalization rate inversely proportional to land value decreases. For this reason, the capitalization rates for every parcel were determined by subtracting Grey relational degrees that were found for every parcel from the average capitalization rate. As a result of completed calculations, the capitalization rates for the studies agricultural lands vary between 5.22%- 5.66%. The capitalization rate found for every parcel was found lower than the average capitalization rate by including Grey relational degrees to calculation of the capitalization rate. Eventually, the parcel with high Grey relational degree that shows the degree of the factors that positively affect value correspondingly with the low capitalization rate will increase the value of land.

#### IV. CONCLUSION

The determination of the capitalization rate, which is the right of use of capital invested in land, is required for respective region in the determination of agricultural lands

with respect to Income method. In this study, it was calculated that the average rate is 6.2% for the study area, but this rate should not be same for every parcel. Positive and negative aspects of every parcel must be taken into account in order to adapt the capitalization rate determined for a specific region to individual parcels. These factors that reflect respective characteristics of every parcel cause the capitalization rate to decrease or increase. Because this change in rate significantly affects the value of land, in valuation studies, the evaluation of the factors that affect the capitalization rate is a great deal of importance. In valuation practices, these procedures are realized with the initiative of experts and consequently, determining an objective value cannot be possible.

Grey relational degree that is obtained as a result of Grey relational analysis provides an opportunity to evaluate the factors that affect the capitalization rate for every parcel separately. So, the capitalization rate can be calculated not only for a region but also for every parcel specifically. Calculation of the real land value is possible with the capitalization rate that is determined for every parcel according to their respective characteristics. When this calculation method will be put into practice, the valuation processes by experts will be more realistic and disagreements regarding value determination will be prevented from happening. Yet, the capitalization rate cannot be understood thoroughly by valuation experts, public, private organizations and real estate owners can suffer in procedures carried out with respect to value that will be found according to Income method because scientific approaches are not applied in the determination of that rate in literal sense. The method recommended in this study will assist to a great extent regarding rational determination of price in valuation procedures of agricultural lands and solution of disagreements that are seen even in administrative bodies.

#### ACKNOWLEDGEMENTS

This paper is presented from the Ph.D. thesis of Zuhul Karakayaci. This study was supported by Selcuk University Scientific Research Projects Coordination.

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