



**TÜRKİYE CUMHURİYETİ
ADANA ALPARSLAN TÜRKESİ SCIENCE AND TECHNOLOGY
UNIVERSITY**

**GRADUATE SCHOOL OF NATURAL AND APPLIED SCIENCES
DEPARTMENT OF INDUSTRIAL ENGINEERING**

**DETERMINING THE OPTIMAL SCHOOL LOCATION
USING CRITIC-BASED TOPSIS AND PROMETHEE II METHODS
THE CASE OF KİLİS**

**Dilan TAŞCI
MSC THESIS**



**TÜRKİYE CUMHURİYETİ
ADANA ALPARSLAN TÜRKERŞ SCIENCE AND TECHNOLOGY
UNIVERSITY**

**GRADUATE SCHOOL OF NATURAL AND APPLIED SCIENCES
DEPARTMENT OF INDUSTRIAL ENGINEERING**

**DETERMINING THE OPTIMAL SCHOOL LOCATION
USING CRITIC-BASED TOPSIS AND PROMETHEE II METHODS
THE CASE OF KİLİS**

Dilan TAŞCI

MSC THESIS

THESIS ADVISOR

PROF. DR. TOLUNAY GÖÇKEN

ADANA, 2024

DECLARATION OF CONFORMITY

In this thesis study, which was prepared following the thesis writing rules of Adana Alparslan Türkeş Science and Technology University Institute of Graduate School, I declare that I provide all the information, documents, evaluations and results in accordance with scientific ethics and moral codes without resorting to any means or assistance that would be contrary to scientific ethics and traditions. I also declare that I refer to all of the articles I used in this study with appropriate references and accept all moral and legal consequences if a situation is found contrary to my statement regarding my work.

.../.../20..

[Signature]

Dilan TAŞÇI

ÖZET

CRITIC TABANLI TOPSIS VE PROMETHEE II YÖNTEMLERİ İLE OPTİMAL OKUL YERİ SEÇİMİ: KİLİS İLİ ÖRNEĞİ

Çalışmamızda 6 Şubat Kahramanmaraş depreminden etkilenen 11 ilden biri olan Kilis ili Merkez ilçesinde depremden ağır hasar alarak yıkımı gerçekleştirilen okulların yeniden yapılması için okul yeri seçimi problemi ele alınmıştır. Yapılan incelemeler sonucunda ortaokul seviyesindeki okul sayısının potansiyel öğrenci nüfusunu karşılayamayacak durumda olduğu tespit edilmiş olup bundan dolayı çalışma amacı açılması planlanan ortaokul için en uygun yerin seçilmesi olarak kararlaştırılmıştır.

Okul yeri seçimi yapılırken birçok kriterin birlikte değerlendirilmesi gerektiğinden dolayı çok kriterli karar verme yöntemlerinden Kriterler arası Korelasyon Yoluyla Kriterlerin Önem Tespiti (CRITIC), İdeal Çözüme Benzerliğine Göre Tercih Sıralama Tekniği (TOPSIS) ve Tercih Sıralaması Organizasyonu Değerlendirme Zenginleştirme Yöntemi (PROMETHEE II) yöntemleri uygulanmıştır.

Çalışmada ilk olarak Kilis ilinde ortaöğretim kademesi için eğitim alanı olarak tahsis edilen araziler tespit edilmiş ve bu araziler çalışmanın alternatif verileri olarak kullanılmıştır. Kriter tespiti için uzman görüşleri ve literatürdeki çalışmalardan faydalanılmış ve belirlenen kriterlerin ağırlıkları CRITIC yöntemi ile hesaplanmış ve alternatif eğitim alanı olarak tahsis edilen araziler TOPSIS ve PROMETHEE II yöntemleri ile sıralanmış ve bu iki yöntemin sonuçları karşılaştırılmıştır. Çalışmada okul yeri seçiminde 5 alternatif eğitim tahsis alanı için 5 farklı kriter değerlendirilmiştir. Sonuç olarak erişilebilirlik kriteri en önemli kriter seçilmiş ve TOPSIS yöntemi sonucuna göre Rıfat Kazancıoğlu eğitim tesis alanı ve PROMETHEE II yöntemi sonucuna göre de Kazım Karabekir eğitim tesis alanı en iyi alternatif olarak belirlenmiştir.

Dilan TAŞÇI

Yüksek Lisans, Endüstri Mühendisliği Anabilim Dalı

Danışman: Prof. Dr. Tolunay GÖÇKEN

Haziran 2024, 54 sayfa

Anahtar Kelimeler: Okul yeri seçimi, ÇKKV, CRITIC, TOPSIS, PROMETETHEE

ABSTRACT

DETERMINING THE OPTIMAL SCHOOL LOCATION WITH CRITIC-BASED TOPSIS AND PROMETHEE II METHODS THE CASE OF KİLİS

Dilan TAŞÇI

M.Sc., Department of Industrial Engineering

Supervisor: Prof. Dr. Tolunay GÖÇKEN

June 2024, 54 pages

In our study, the problem of school site selection for the reconstruction of schools that are heavily damaged and demolished in Kilis province, which is one of the 11 provinces affected by the February 6 Kahramanmaraş earthquake is handled. As a result of the investigations, it has been determined that the number of schools at the secondary school level cannot meet the potential student population, and therefore, the purpose of the study is to select the most suitable location for reconstruction of a the secondary school. Since many criteria should be evaluated together in the selection a school site, the Criteria Importance Determination Through Correlation Between Criteria (CRITIC) is used for determining weights of the criteria and then ,The Preference Ranking Technique According to Similarity to Ideal Solution (TOPSIS) methods, and The Preference Ranking Organization Method for Enrichment Evaluation which are multi-criteria decision-making methods, were applied for site selection. In the study, firstly, the lands allocated as educational areas for secondary education in Kilis province were determined and these lands were used as alternative data of the study. For the determination of criteria, expert opinions and studies in the literature were used and the weights of the determined criteria were calculated with the CRITIC method and the lands allocated as alternative educational areas were ranked with the TOPSIS and PROMETHEE II methods and the results of these two methods were compared. In the study, 5 different criteria were evaluated for 5 alternative educational allocation areas in the school site selection. As a result, the accessibility criterion was selected as the most important criterion and according to the TOPSIS method result, the Rıfat Kazancıoğlu educational facility area was determined as the best alternative and according to the PROMETHEE II method result, the Kazım Karabekir educational facility area was determined as the best alternative.

Keywords: School Site Selection, MCDM, CRITIC, TOPSIS, PROMETHEE.

To my family and my father who is always with me..



ACKNOWLEDGEMENTS

Firstly, I would like to thank my advisor and valuable teacher Prof. Dr. Tolunay GÖÇKEN, who patiently supported and helped me in determining and planning my thesis,

Secondly, I would like to thank Merve KARAKOCA, who was there for me when I needed their support, and Ahmet YILDIRIM, The Chef of the Construction and Real Estate Unit of the Kilis Provincial Directorate of National Education

Finally, I would like to thank my family who supported me throughout my life and my brother Yunus Emre TAŞÇI for his belief in me.



INGREDIENTS

ÖZET	i
ABSTRACT	ii
INGREDIEDNTS	iii
LIST OF TABLE	iv
1.INTRODUCTION	1
2.LITERATURE REVIEW	2
3.MATERIAL AND METHODS	5
3.1. General Analysis Of The Implementation Area	5
3.2. Selection Of Criteria To Be Used In The MCDM	6
3.2.1. District Size	6
3.2.2. Number Of Students Per Street	7
3.2.3. Infrastructure Of Street	7
3.2.4. Accessibility	7
3.2.5. Loudness Level	7
3.3. Determination of Criteria Weights	7
3.3.1. CRITIC Method	8
3.3.2. Application of CRITIC Method	10
3.4. Selection Of Alternatives	13
3.5. TOPSIS Method	18
3.5.1. Application of TOPSIS Method	21
3.6. PROMETHEE II Method	24
3.6.1. Steps of PROMETHEE II Method	25
3.6.2. Application of PROMETHEE II Method	29
3.7. Comparison of the Results Obtained from the TOPSIS and PROMETHEE II Methods	37
4. RESULTS AND DISCUSSION	38
REFERENCES	

LIST OF FIGURES

Figure 3.1: General view of Kilis from GBS	14
Figure 3.2: The view of Rıfat Kazancıođlu Street via GIS	15
Figure 3.3: The view of İslambey Street via GIS	15
Figure 3.4: The view of Kazım Karabekir Street via GIS	16
Figure 3.5: The view of Şıh Abdullah Street via GIS	16
Figure 3.6: The view of Bilali Habeş Street via GIS	17
Figure 3.7: Preference Functions	26



LIST OF TABLES

Table 3.1: Criterias of The Study	6
Table 3.2: Decision Matrix	10
Table 3.3: Normalized Decision Matrix	11
Table 3.4: Intercriteria Correlations Matrix	11
Table 3.5: 1- p_j Value for each criterion	12
Table 3.6: Standard Deviation	12
Table 3.7: C_j Coefficient Variables	13
Table 3.8: W_j Values	13
Table 3.9: Alternatives of The Study	14
Table 3.10: Decision Matrix of TOPSIS Method	21
Table 3.11: Normalized Decision Matrix of TOPSIS Method	22
Table 3.12: Weighted Normalized Matrix	22
Table 3.13: Positive and Negative Ideal Value	23
Table 3.14: Summary of the results of the topsis method	23
Table 3.15: Decision Matrix of PROMETHEE II Method	29
Table 3.16: Normalized Decision Matrix of PROMETHEE II Method	30
Table 3.17: Evaluative Difference Of Alternatives With Respect Other Alternatives	31
Table 3.18 : Prefence Function	33
Table 3.19: Prefence Function Continuation Table	34
Table 3.20: Aggregated Prefence Function Matrix	35

Table 3.21: Leaving Flow And Entering Flow Of The Alternatives	35
Table 3.22: Net Flow and Ranking	36
Table 3.23: Comparison of the Results	37



ABBREVIATIONS

MCDM : Multi Criteria Decision Making

CRITIC: Criteria Importance Determination Through Correlation Between Criteria

TOPSIS: The Preference Ranking Technique According to Similarity to Ideal Solution

PROMETHEE: The Preference Ranking Organization Method for Enrichment Evaluation



1. INTRODUCTION

Education is the most important factor in the development of countries. Keeping the quality of education at the highest level will be effective in moving the country forward in the long term. There are many factors affects the quality of education, and special care must be taken for all of them. One of these factors is the selection of school location. The places where schools will be established can be evaluated in terms of multiple criteria, including infrastructure, number of students, environmental safety and location.

Making the right decisions in establishing an educational facility is a major responsibility of educational managers. For the facility to be established at the right time and in the right place, many comparable criteria must be evaluated. The large number of alternatives and criteria to be considered necessitates resorting to multi-criteria decision making. The fact that the facility is immovable and its construction cost is high cost is one of the most important criteria to be evaluated for optimum location selection. (Arslan, 2015).

Schools provide the most important contribution to the development of society by transferring cultural, technological and economic developments to the new generation. This is possible with the dynamic structure of schools and with schools having sufficient physical space in a dynamic structure. When educational areas provide the necessary environment and criteria, the quality of education and training increases, and the improvements in the internal and external environment positively affect the success rate. (Başegmez, Taşdemir, 2017).

The thesis consists of five chapters. In the introduction part of the study, information about the general structure of the study and school location selection is explained. In the second part, the literature review is given. Studies conducted with the multi-criteria decision-making methods we used in our study are examined. In the third part, the methods and materials used in the study are explained and the application is presented and obtained solutions are given part is included. In the fourth section, the entire study is summarized and the results obtained results.

2. LITERATURE REVIEW

Many studies have been conducted on determining the optimum school location, multi-criteria decision-making methods have been used in the decision-making process. In some studies in the literature, a single multi-criteria decision-making method is used to solve the problem, while in some studies, several methods is integrated . Some of these studies are as follows.

Keleş (2022) focused on determining the importance of the criteria used for school selection and applied for Kayseri province. She tried to determine the importance by making binary comparisons for 8 criteria for school selection. She used AHP method in her study and found that noise level is the most important criteria.

Uslu, et al. (2016) used Multi -criteria decision -making methods based on CBS in their study .The aim of their study is to choose the most appropriate school place in Ankara. For this purpose, they calculated the weights of the criteria with AHP and ranked the alternative school places using TOPSIS. They set the most important criterion as the population and chose the 16th place among the alternatives as best.

In his study, Khalid (2018) studied school location selection for the primary school level by integrating with GIS. By conducting spatial analysis, he examined the regional suitability of the alternatives with a multi-criteria decision-making model. While looking at the suitability of school areas, he evaluated the suitability of the four selected regions in terms of four criteria.

In her study, AYÇİN (2020) used the CRITIC method and MAIRCA in an integrated manner. She made an exemplary study on solving personnel selection processes using multi-criteria decision-making methods. She used five criteria to evaluate seven alternatives in her study. She calculated the criterion weights with the Critic method and then ranked them with MAIRCA.

Bulğurcu (2019) aimed to find the brand that provides the most benefit to the user by integrating the CRITIC method with the MAUT method in the smart watch selection problem. The evaluation phase was strengthened by applying a survey to experts in the sector.

Arslan and Yıldız (2015) worked on the selection of sports high school locations in Düzce. Since the criteria contained verbal uncertainties, they used a fuzzy method and made them comparable by using fuzzy numbers. They ranked and evaluated 4 alternative sports locations using TOPSIS method, one of the multi-criteria decision-making methods.

Başığmez, et al. (2017) investigated the criteria that should be examined in the zoning plans of school areas and tried to determine the problems in school site selection and find solutions to them by investigating the studies in different countries and in our country. As a result of their study, they suggested that a new legislation should be created for our country in school site selection and that decision-making should be integrated with GIS systems.

Başığmez, et al. (2019) integrated the GIS and AHP methods and tried to determine the most suitable educational facility area for the Central District of Uşak province. The weights of the criteria were determined with AHP and these criteria were transferred to the GIS system and the most suitable place was selected using the software in the GIS. The suitability rates of 132 educational areas in the study were determined and 2% of these areas were determined as more suitable and the suitability of the existing educational facility areas was interpreted according to the results.

Maman (2023) evaluated six insurance companies with multi-criteria decision-making methods. While evaluating the alternatives, by using the criteria of reliability, comprehensiveness of the policy, ease of payment, replacement vehicle coverage and the policy reflecting the value of the insured vehicle determined weights of the criteria using Analytical Hierarchy Process (AHP). In his study, Maman, who aims to provide a different perspective on insurance companies selection, used TOPSIS and PROMETHEE methods to evaluate the alternatives.

ŞAHİN(2022) applied the multi-criteria decision-making method to investigate the effectiveness and weight of developing digital technology alternatives in the marketing management process stages. She made predictions about selecting appropriate marketing strategies for companies and making technological investments in marketing processes by making evaluations with CRITIC analysis and TOPSIS and PROMETHEE methods. The study was applied to two companies operating in the Automotive and Textile sectors in Turkey and

the numerical data of the study were obtained according to the survey answers directed to the company managers.



3. MATERIAL AND METHODS

In this section of the study, the area where the study is applied, the determination of criteria and alternatives, and the determination of allocated areas through the GIS system are explained. The methods used in the study are explained and the application part of the study is presented. Five criteria were identified for school site selection. In determining these criteria, studies and theses in the literature were meticulously examined and the title 4.3 Site selection criteria of the Minimum Design Standards Guidelines for Educational Buildings published by the Ministry of National Education was utilized. The details of the criteria are presented in the following pages. The alternatives to be evaluated based on these criteria were determined by expert opinions and recommendations among the Education allocated areas. In this study, the CRITIC method was used to calculate the weights of the criteria and then the alternatives were ranked with TOPSIS and PROMETHEE II method .

3.1. General Analysis Of The Implementation Area

The study is conducted in the central district of Kilis. There are 77 streets in Kilis, which has a surface area of 1520.00 km² . Since the borders between streets are very narrow, a single school provides education to students in more than one neighborhood.

Kilis has received intense migration in the last 10 years due to wars in neighboring countries and the recent earthquake in Kahramanmaraş on February 6. The high density of young people of school age among the immigrant population has created a sensitivity in the conduct of the education system more meticulously than in previous years .

The high number of school-age children and the transfer of students from earthquake-damaged schools to different schools have caused the number of students in classrooms to exceed the potential.

Since the number of class sizes above the number determined by the Ministry of National Education is a factor that will decrease the quality of education, the damaged schools should be restarted to education. For this purpose, the study is conducted in the central district of Kilis.

3.2. Selection Of Criteria To Be Used In The MCDM

Since school construction is costly and difficult in every aspect, site selection is very important. The criteria that will be to be used to achieve better results in location selection are very important. Therefore, it is necessary to be very careful when determining the criteria.

In this section, the criteria used in the study are mentioned in detail. In the study, 5 criteria were determined for school location selection for Kilis province. The determination of the criteria, studies in the literature and the title 4.3 Site selection criteria of the Educational Buildings Minimum Design Standards Guide published by the Ministry of National Education were used. The criteria are determined as follows; District size, Number of student per district, Infrastructure of district, Accessibility and Loudness level.

Tablo 3.1: Criteria of The Study

Decision Variables Name	Decision Variables Directions
District size	Max
Number of student per district	Max
Infrastructure of district	Max
Accessibility	Min
Loudness level	Min

3.2.1. District Size

When choosing a school location, the areas where the school will be built are determined between education allocated areas by the Ministry of National Education. The size of the areas varies depending on the level of education, such as primary school, secondary school or high school. The reason why area size was taken as a criterion in our study is that the neighborhood to be established must have the physical capacity to provide education to students of educational age living in the surrounding neighborhoods. Because the neighborhood boundaries in Kilis are very narrow, a single school is used as an education area for more than one neighborhood. In our study, area sizes are determined for 5 of the places designated as education allocated areas by the Kilis Provincial Directorate of National Education. Since it is important that the training area is wide, the criterion has been determined as maximum.

3.2.2. Number Of Students Per Street

Knowing the number of students in each neighborhood is an important numerical data that can be used to determine the number of schools needed. The number of students at different education levels in each neighborhood means potential students for the next level of education. In other words, students at the primary school level are potential students at the secondary education level. This is also called age population calculation. In this way, more accurate decisions can be made in future strategic education planning. In our study, the number of students for each neighborhood determined as an alternative is obtained through the E-school system. Since the neighborhood boundaries are narrow, the closest few neighborhoods around the alternative neighborhoods are included when calculating the number of students. Since it is important to provide education to the largest number of students, the criterion direction has been determined as maximum.

3.2.3. Infrastructure Of Street

The infrastructure criterion refers to the equipment such as electricity, internet and natural gas in the area where the school is planned to be established.

The infrastructure criterion value for each alternative was determined by expert opinions based on a scale of 1-5. In the age of technology, infrastructure criteria such as the internet will affect the quality of education, therefore the infrastructure needs to be optimized and the criterion direction has been determined as maximum.

3.2.4. Accessibility

Accessibility refers to the ease with which students can reach the school. In our study, the walking distance to the nearest bus and minibus stop is taken as basis for each alternative school location. In order for students to have easy access to school and to reduce the walking distance, the accessibility criterion must be minimized and the criterion direction has been determined as min.

3.2.5. Loudness Level

Since noise pollution around the school will reduce the quality of education, noise pollution is another important criterion in choosing a school location. The noise criterion value for each alternative is determined by expert opinions based on a scale of 1-10. Since it would be

advantage to have low noise pollution, this criterion should be minimized and the criterion direction was determined as min.

3.3. Determination of Criteria Weights

Determination of the criteria weights are done using CRITIC method.

3.3.1. CRITIC Method

The Critic method allows objective evaluation of criterion weights in Multi-Criteria decision-making processes without need for an expert opinion. In 1995, Diakoulaki et al. has been added to the literature with his studies. The steps of CRITIC are given below (Jahan vd. 2012, s.413).

Step 1: Constructing of the decision matrix

$$X = [x_{ij}]_{m \times n} = \begin{bmatrix} x_{11} & \cdots & x_{1n} \\ \vdots & \ddots & \vdots \\ x_{m1} & \cdots & x_{mn} \end{bmatrix}$$

$$i = (1, \dots, m) \text{ ve } j = (1, \dots, n)$$

(3.1)

Step 2: Calculate normalized decision matrix

In this step there are two different calculations according to direction of criteria. If the direction of the criterion is maximization, the equation (2) is applied and if it is minimization, equation (3) is applied and the normalization matrix is created.

$$\text{where } r_{ij} = \frac{x_{ij} - x_j^{\min}}{x_j^{\max} - x_j^{\min}} \quad i = 1, \dots, m; \quad j = 1, \dots, n$$

$$r_{ij} = \frac{x_j^{\max} - x_{ij}}{x_j^{\max} - x_j^{\min}} \quad i = 1, \dots, m; \quad j = 1, \dots, n$$

(3.3)

r_{ij} is the normalized criterion value.

Step 3: Calculate the intercriteria correlations

After the normalized values are calculated, the correlation coefficients between pairs of criteria are calculated to see the relationship between the criteria. Equations (3.4) used for calculating the correlation.

$$\rho_{jk} = \frac{\sum_{i=1}^m (r_{ij} - \bar{r}_j)(r_{ik} - \bar{r}_k)}{\sqrt{\sum_{i=1}^m (r_{ij} - \bar{r}_j)^2 \sum_{i=1}^m (r_{ik} - \bar{r}_k)^2}} \quad j, k = 1, \dots, n \quad (3.4)$$

Step 4: Calculate the C_{ij} Coefficient

The standard deviation of each column is used when calculating the coefficient value. Equations (3.5) include the calculation of standard deviation and C_{ij} value.

$$\sigma_j = \sqrt{\frac{\sum_{i=1}^m (r_{ij} - \bar{r}_j)^2}{m}}$$

$$C_j = \sigma_j \sum_{k=1}^n (1 - \rho_{jk}) \quad (j = 1, 2, \dots, n) \quad (3.5)$$

Step 5: Identification of importance weight of criteria

In this last step, the objective weights of the criteria are calculated and when the results are ranked from largest to smallest, the criterion with the highest weight is determined as the most important criterion.

$$w_j = \frac{c_j}{\sum_{k=1}^n (c_k)} \quad (j, k = 1, 2, \dots, n) \quad (3.6)$$

3.3.2. Application of CRITIC Method

The decision matrix is given in Table 3.2

The values in the decision matrix are objective values. Criterion values for each alternative were determined according to the calculations, 1-5 and 1-10 scales.

Table 3.2: Decision Matrix

DECISION MATRIX						
NO	Decision Variables Alternatives / Variables Directions	District size Max	Number of student per district Max	Infrastructure of district Max	Accessibility Min	Loudness level Min
1	Rifat Kazancıoğlu Street School Allocated Area	10.000	4544	5	196	6
2	İslambey Street School Allocated Area	2.800	1099	3	125	7
3	Kazım Karabekir Street School Allocated Area	11.000	3435	4	15	7
4	Şih Abdullah Street School Allocated Area	7.000	1363	3	200	8
5	Bilali Habeş Street School Allocated Area	3.800	1184	3	300	9

Table 3.3: Normalized Decision Matrix

NORMALIZED DECISION MATRIX						
	Decision Variables	District size	Number of student per district	Infrastructure of district	Accessibility	Loudness level
NO	Alternatives / Variables Directions	Max	Max	Max	Min	Min
1	Rıfat Kazancıoğlu Street School Allocated Area	0,88	1,00	1,00	0,36	1,00
2	İslambey Street School Allocated Area	0,00	0,00	0,00	0,61	0,67
3	Kazım Karabekir Street School Allocated Area	1,00	0,68	0,50	1,00	0,67
4	Şih Abdullah Street School Allocated Area	0,51	0,08	0,00	0,35	0,33
5	Bilali Habeş Street School Allocated Area	0,12	0,02	0,00	0,00	0,00

Table 3.4: Intercriteria Correlations Matrix

INTERCRITERIA CORRELATIONS						
NO	Alternatives	District size	Number of student per district	Infrastructure of district	Accessibility	Loudness level
1	District size	1,00	0,87	0,79	0,50	0,56
2	Number of student per district	0,87	1,00	0,99	0,36	0,76
3	Infrastructure of district	0,79	0,99	1,00	0,25	0,78
4	Accessibility	0,50	0,36	0,25	1,00	0,56
5	Loudness level	0,56	0,76	0,78	0,56	1,00

In order to calculate the C_{ij} value, “1-pj” calculation must be made for each value in the correlation matrix and then the sum of these values is calculated for each column. These values are shown in Table 3.4.

Table 3.5: 1- pj Value for each criterion

		1-pjk				
NO	Alternatives	District size	Number of student per district	Infrastructure of district	Accessibility	Loudness level
1	District size	0,00	0,13	0,21	0,50	0,44
2	Number of student per district	0,13	0,00	0,01	0,64	0,24
3	Infrastructure of district	0,21	0,01	0,00	0,75	0,22
4	Accessibility	0,50	0,64	0,75	0,00	0,44
5	Loudness level	0,44	0,24	0,22	0,44	0,00
COLUMN SUM		1,28	1,02	1,19	2,33	1,34

Table 3.6: Standard Deviation

	District size	Number of student per district	Infrastructure of district	Accessibility	Loudness level
STANDARD DEVIATION σ	0,44	0,46	0,45	0,37	0,38

After calculating “ 1- pj “ Value and Standard Deviation , C_{ij} value are calculated using Eq.(3.5).

Table 3.7: Cj Coefficient Variables

	District size	Number of student per district	Infrastructure of district	Accessibility	Loudness level
Cj COEFFICIENT	0,57	0,47	0,53	0,86	0,51

The last step is calculating Wj values of criteria.

Table 3.8: Wj Values

	District size	Number of student per district	Infrastructure of district	Accessibility	Loudness level
Wj COEFFICIENT IMPORTANCE WEIGHT OF DECISION VARIABLES	0,19	0,16	0,18	0,29	0,17

After all steps of the CRITIC method are applied to five criteria, in the selection of the school site ,it is found that the most important criterion is accessibility.

3.4. Selection Of Alternatives

Five alternative education allocation areas are determined to be used in the study. The regions evaluated as alternatives in our study are the regions previously determined as educational facility locations by the Ministry of National Education, and these areas are determined through the GIS system. Five of these areas, which are suitable for secondary school level, are selected for use in the study. The nearby neighborhoods around each alternative are also determined in GIS and included in the alternatives. Due to the narrow neighborhood boundaries, some neighborhoods are included in more than one alternative. Some of these spaces are included in one alternative, while the other part are included in a different alternative. In other words, the

same parts of the neighborhood were not used for different alternatives. For example, Hürriyet and Zeytinli neighborhoods

The alternatives are as follows;

Table 3.9. Alternatives of The Study

1	Rıfat Kazancıoğlu Street School Allocated Area
2	İslambey Street School Allocated Area
3	Kazım Karabekir Street School Allocated Area
4	Şih Abdullah Street School Allocated Area
5	Bilali Habeş Street School Allocated Area

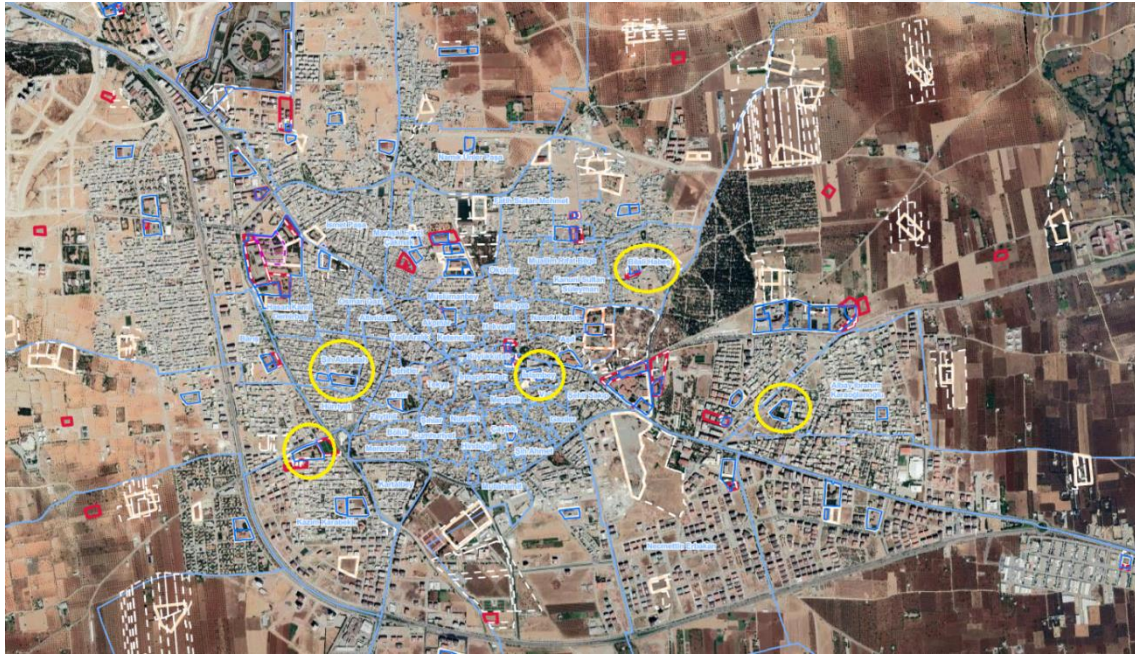


Figure 3.1: General view of Kilis from GBS

Figure 3.1 Shows the general view of Kilis via GPS and the areas allocated for education are marked.

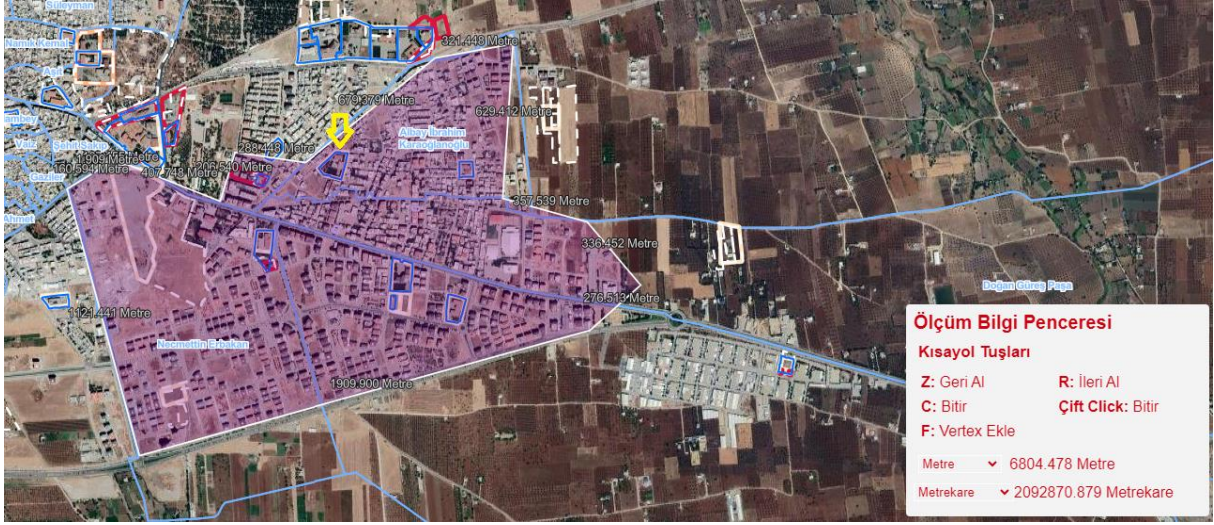


Figure 3.2: The view of Rıfat Kazancıoğlu Street via GIS

Figure 3.2 shows the view of Rıfat Kazancıoğlu Street and also indicates the education allocation area chosen for this alternative. Neighborhoods in the immediate vicinity of this street were included in the study. Nearby neighborhoods are as follows; Necmettin Erbakan and Albay İbrahim Karaoğlanoğlu.

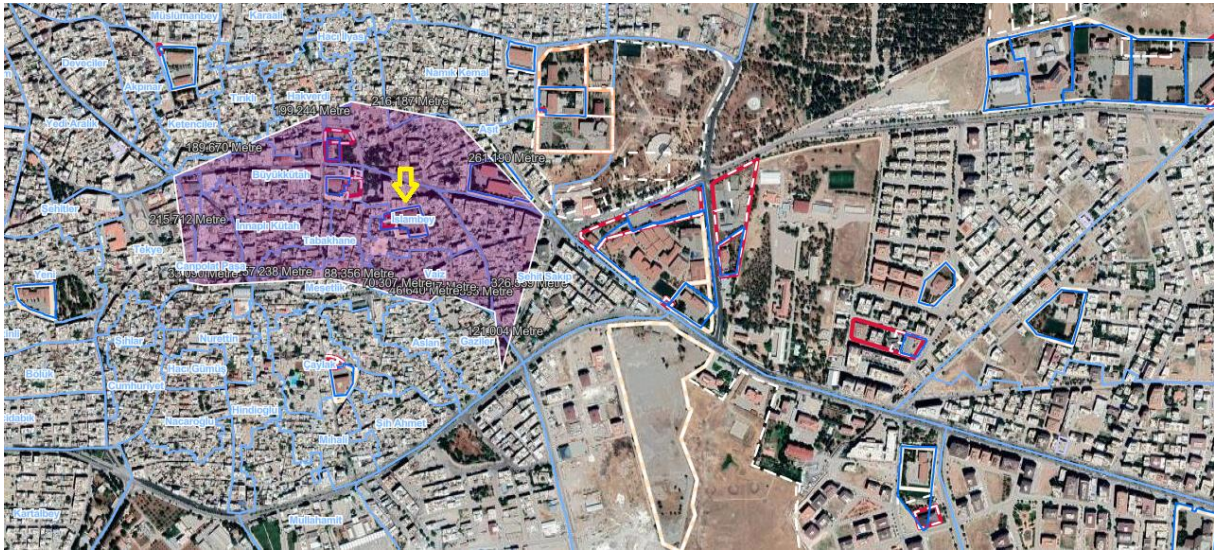


Figure 3.3: The view of İslambey Street via GIS

Figure 3.3 shows the view of İslambey Street and also indicates the education allocation area chosen for this alternative. Neighborhoods in the immediate vicinity of this street were included

in the study. Nearby neighborhoods are as follows; Şehit Sakıp, Tabakhane, Canpolat Paşa, İnaplıkütah, Büyükkütah and Vaiz.



Figure 3.4: The view of Kazım Karabekir Street via GIS

Figure 3.4 shows the view of Kazım Karabekir Street and also indicates the education allocation area chosen for this alternative. Neighborhoods in the immediate vicinity of this street were included in the study. Nearby neighborhoods are as follows; Kartal Bey, Merçidabık, Bölük, Zeytinli and Hürriyet.

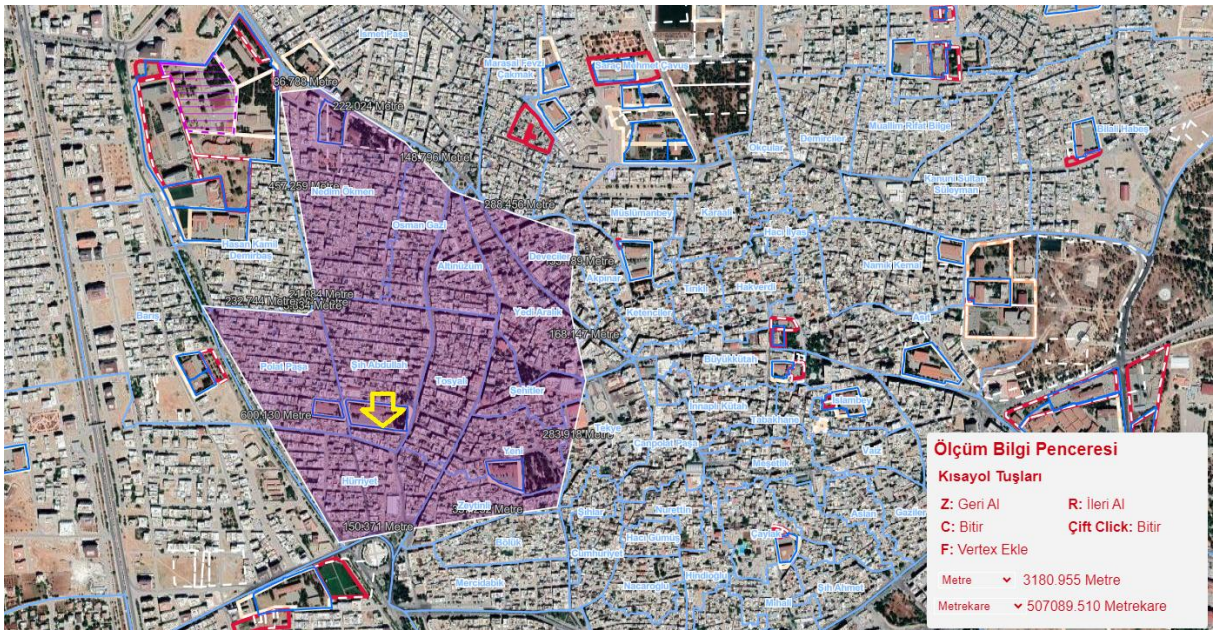


Figure 3.5: The view of Şih Abdullah Street via GIS

Figure 4.5 shows the view of Şıh Abdullah Street and also indicates the education allocation area chosen for this alternative. Neighborhoods in the immediate vicinity of this street were included in the study. Nearby neighborhoods are as follows; Polat Paşa, Tosyalı, Şehitler, Yedi Aralık, Deveciler, Altınüzüm ,Osman Gazi, Nedim Ökmen, Zeytinli and Hürriyet.

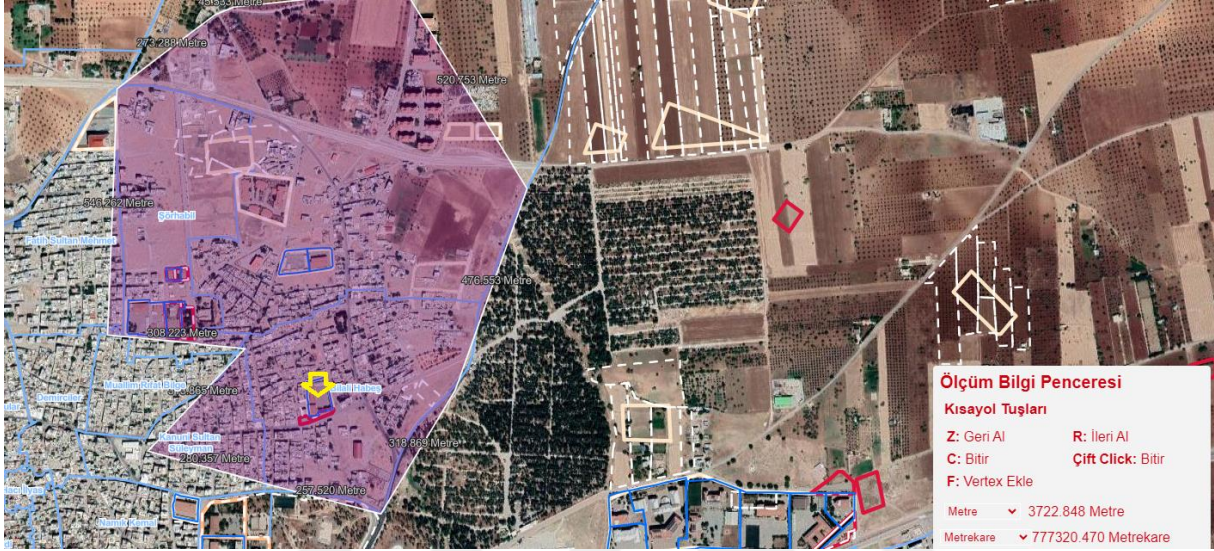


Figure 3.6: The view of Bilali Habeş Street via GIS

Figure 3.6 shows the view of Şıh Abdullah Street and also indicates the education allocation area chosen for this alternative. Neighborhoods in the immediate vicinity of this street were included in the study. Nearby neighborhoods are as follows; Kanuni Sultan Süleyman and Şörhabil.

3.5. TOPSIS Method

First method to be used in the ranking of alternatives is TOPSIS method.

TOPSIS (Order Preference Technique Based on Ideal Similarity Solution) method was first added to the literature by Hwang and Yoon (1981) and has been used in many studies. This method is based on determining the shortest distance of the alternatives to the positive ideal solution and the longest distance to the negative ideal solution. And also ranking the alternatives according to decision variables. The following steps should be followed when applying the TOPSIS method.

Step 1: Constructing the Decision Matrix

$$A_{ij} = \begin{bmatrix} a_{11} & a_{12} & \dots & a_{1p} \\ a_{21} & a_{22} & \dots & a_{2p} \\ \vdots & \vdots & \ddots & \vdots \\ a_{m1} & a_{m2} & \dots & a_{mp} \end{bmatrix} \quad (3.7)$$

Step 2: Calculate Normalized Decision Matrix

In this step each criterion value is normalized with equations (3.2) and normalized decision matrix will be created as follows

r_{ij} : Normalized value of criteria

$$r_{ij} = \frac{a_{ij}}{\sqrt{\sum_{k=1}^m a_{kj}^2}} \quad (3.8)$$

$$R_{ij} = \begin{bmatrix} r_{11} & r_{12} & \dots & r_{1n} \\ r_{21} & r_{22} & \dots & r_{2n} \\ \vdots & \vdots & \ddots & \vdots \\ r_{m1} & r_{m2} & \dots & r_{mn} \end{bmatrix} \quad (3.9)$$

Step 3: Calculate Weighted Normalized Decision Matrix

When creating the weighted decision matrix, the weights of each criterion must be known. Criterion weights can be calculated with a different multi-criteria decision-making method and topsis can also be used. The r_{ij} values obtained with the normalized matrix are multiplied by the w_i weights. Thus, the weighted normalized matrix (V matrix) is obtained.

W_i ; Weight of criteria

$$V_{ij} = \begin{bmatrix} w_1 r_{11} & w_2 r_{12} & \dots & w_n r_{1n} \\ w_1 r_{21} & w_2 r_{22} & \dots & w_n r_{2n} \\ \vdots & \vdots & \ddots & \vdots \\ w_1 r_{m1} & w_2 r_{m2} & \dots & w_n r_{mn} \end{bmatrix} \quad (3.10)$$

Step 4: Calculate Positive/ Negative Ideal Solutions (PIS/NIS)

In this step there are two different calculations according to objective. If the objective is maximization, the equation (3.11) is applied and if it is minimization, equation (3.12) is applied.

$$A^* = \{\max v_{ij} \mid j=1, \dots, p ; i=1, \dots, m\} \quad (3.11)$$

$$A^- = \{v_1^-, v_2^-, \dots, v_n^-\}$$

$$A^- = \{(\min v_{ij})\} \quad (3.12)$$

$$\rightarrow A^- = \{v_1^-, v_2^-, \dots, v_n^-\}$$

Step 5: Calculate The Distance From Each Alternative to The PIS and NIS

$$d_{ij} = \sqrt{\sum (x_{ik} - x_{jk})^2}$$

(3.13)

Step 6: Calculate the Closeness Coefficient(CC) for Alternatives

This final stage, closeness to the ideal solution is calculated and alternatives are ranked.

$$S_i^+ = \sqrt{\sum_{j=1}^n (v_{ij} - v_j^+)^2} \quad S_i^- = \sqrt{\sum_{j=1}^n (v_{ij} - v_j^-)^2}$$

(3.14)

$$C_i^+ = \frac{S_i^-}{S_i^- + S_i^+}$$

(3.15)

3.5.1 Application of TOPSIS Method

Topsis steps are applied in Excel for the determined criteria and alternatives, and the steps are as follows, respectively.

Table 3.10 Decision Matrix of TOPSIS Method

DECISION MATRIX						
Decision Variables		District size	Number of student per district	Infrastructure of district	Accessibility	Loudness level
WEIGHTS		0,19	0,16	0,18	0,29	0,17
NO	Alternatives / Variables Directions	Max	Max	Max	Min	Min
1	Rifat Kazancıoğlu Street School Allocated Area	10.000	4544	5	196	6
2	İslambey Street School Allocated Area	2.800	1099	3	125	7
3	Kazım Karabekir Street School Allocated Area	11.000	3435	4	15	7
4	Şih Abdullah Street School Allocated Area	7.000	1363	3	200	8
5	Bilali Habeş Street School Allocated Area	3.800	1184	3	300	9
SQUARE ROOT		17096,20	6075,74	8,25	429,26	16,70

Criterion values for each alternative were determined according to the calculations, 1-5 and 1-10 scales. The criterion weights are calculated with the CRITIC method in the previous stage.

Table 3.11: Normalized Decision Matrix of TOPSIS Method

NORMALIZED DECISION VARIABLES						
Decision Variables		District size	Number of student per district	Infrastructure of district	Accessibility	Loudness level
	WEIGHTS	0,19	0,16	0,18	0,29	0,17
NO	Alternatives / Variables Directions	Max	Max	Max	Min	Min
1	Rifat Kazancıoğlu Street School Allocated Area	0,58	0,75	0,61	0,46	0,36
2	İslambey Street School Allocated Area	0,16	0,18	0,36	0,29	0,42
3	Kazım Karabekir Street School Allocated Area	0,64	0,57	0,49	0,03	0,42
4	Şih Abdullah Street School Allocated Area	0,41	0,22	0,36	0,47	0,48
5	Bilali Habeş Street School Allocated Area	0,22	0,19	0,36	0,70	0,54

Table 3.12: Weighted Normalized Matrix

WEIGHTED NORMALIZED DECISION VARIABLES						
Decision Variables		District size	Number of student per district	Infrastructure of district	Accessibility	Loudness level
	WEIGHTS	0,19	0,16	0,18	0,29	0,17
NO	Alternatives / Variables Directions	Max	Max	Max	Min	Min
1	Rifat Kazancıoğlu Street School Allocated Area	0,11	0,12	0,11	0,13	0,06
2	İslambey Street School Allocated Area	0,03	0,03	0,07	0,09	0,07
3	Kazım Karabekir Street School Allocated Area	0,12	0,09	0,09	0,01	0,07
4	Şih Abdullah Street School Allocated Area	0,08	0,04	0,07	0,14	0,08
5	Bilali Habeş Street School Allocated Area	0,04	0,03	0,07	0,21	0,09

Table 3.13: Positive and Negative Ideal Value

	District size	Number of student per district	Infrastructure of district	Accessibility	Loudness level
A*	0,12	0,12	0,11	0,01	0,06
A-	0,03	0,03	0,07	0,21	0,09

Table 3.14: Summary of the results of the topsis method

NO	Alternatives	Si+	Si-	Ci*	Ranking
1	Rıfat Kazancıođlu Street School Allocated Area	0,12	0,15	5,68	1
2	İslambey Street School Allocated Area	0,16	0,12	-3,47	5
3	Kazım Karabekir Street School Allocated Area	0,04	0,23	1,20	2
4	Şih Abdullah Street School Allocated Area	0,17	0,08	-1,04	4
5	Bilali Habeş Street School Allocated Area	0,24	0,01	-0,05	3

After all steps of the TOPSIS method are applied to five alternative, it is found that the best alternative is Rıfat Kazancıođlu Street school.

3.6. PROMETHEE II Method

In cases where decision-making processes such as industry, settlement, planning, health are effective and the decision-making process is complicated by problem inputs, multi-criteria decision-making methods are used. There are multiple multi-criteria decision-making methods in the literature such as MOORA, AHP, ELECTRE AND VIKOR, which differ in terms of calculation time, result reliability and used data types. PROMETHEE (Preference Ranking Organization Method For Enrichment Evaluation) is also used as one of these multi-criteria decision-making methods. PROMETHEE method provides convenience to the decision maker in terms of making more accurate decisions according to the desired purpose. Unlike other methods, it gives reasonable outputs in terms of result reliability and allows the decision maker to work with mixed data types such as quantitative and qualitative in the problem.

PROMETHEE method is suitable in cases where the aspects of the criteria included in the decision-making process differ as maximization and minimization. It includes each criterion in the decision-making process by making different calculations according to its aspect. In this respect, it is not limited to a single criterion type and allows for a variety of criteria. And also with this method, a correct prioritization can be made by making a partial or full ranking among the alternatives.

In multi-criteria decision-making problems where the PROMETHEE method will be used, the weights of the criteria for which the alternatives will be evaluated should be calculated with different methods such as AHP, SWARA, ENTROPI AND CRITIC, and the criterion weights obtained as a result of the calculations will be used in the solution steps of the PROMETHEE method and also when comparing alternatives, preference functions must be determined for the criteria, and these preference functions change depending on whether the criteria have superiority over each other.

3.6.1. Steps of PROMETHEE II Method

The following steps should be followed when applying the PROMETHEE method.

Step 1: Creation of a decision matrix by determining the criteria and alternatives to be used in decision making for the problem to be decided. The number of criteria may vary depending on the type of problem.

Step 2: Determination of criterion weights, which express the importance levels of the criteria in problem solving. In this step, weighting can be done using one of the criterion weighting methods such as AHP, ENTROPI, CRITIC and SWARA.

Step 3: In the normalization process of the decision matrix, different formulas are applied according to the direction of the criteria to create a normal decision matrix. If the direction of the criterion is maximization, equation (3.16) is applied, and if it is minimization, equation (3.17) is applied and the normalization matrix is created.

$$R_{ij} = \frac{[x_{ij} - \text{Min}(x_{ij})]}{[\text{Max}(x_{ij}) - \text{Min}(x_{ij})]} \quad \text{BENEFIT CRITERIA} \quad (3.16)$$

$$R_{ij} = \frac{[\text{Max}(x_{ij}) - x_{ij}]}{[\text{Max}(x_{ij}) - \text{Min}(x_{ij})]} \quad \text{COST CRITERIA} \quad (3.17)$$

where

R_{ij} is the normalized criterion value.

Step 4: Defining Preference Functions For Criteria

Preference functions are used to show the relationships between criteria. There are 6 different preference functions. The preference functions are as follows;

- Regular Type
- U Shape
- V Shape
- Leveled Gradual
- Linear
- Gauss preference functions.

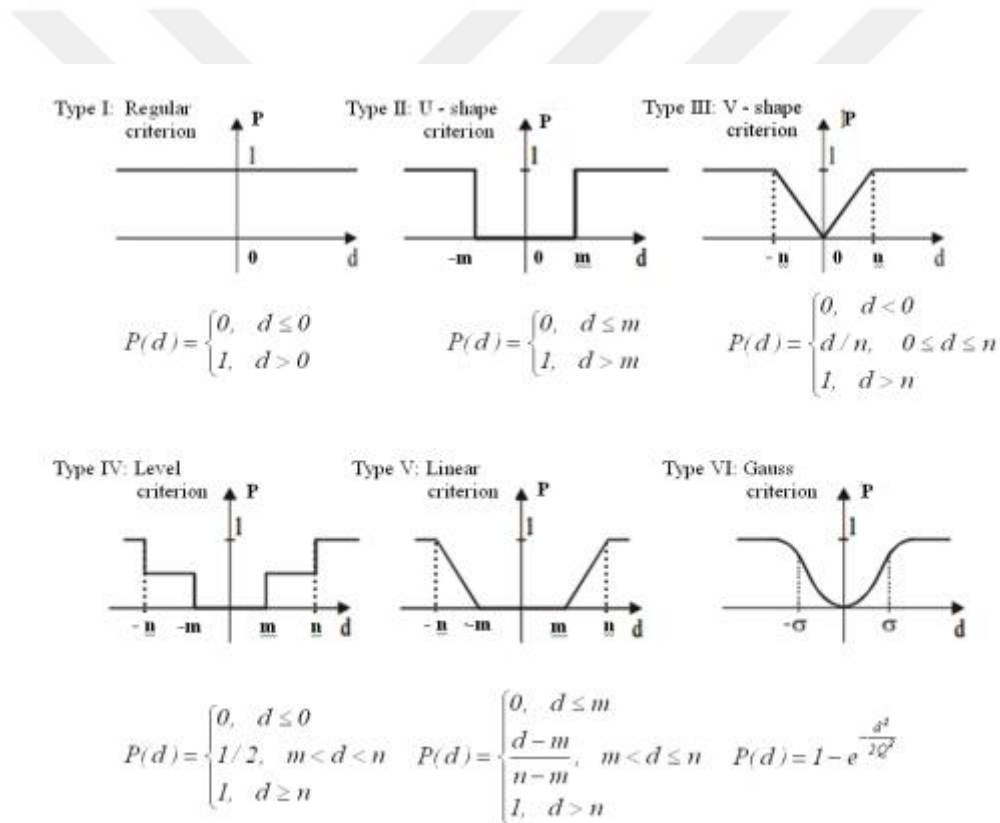


Figure 3.7: Preference Functions

Reference: Tomić, Marinković, Janošević, 2011.

Step 5: Determining Common Preference Functions

Depending on the preference functions determined for the criteria, pairwise comparisons of decision alternatives are made for each evaluation criterion and common preference functions are determined.

The preference function for alternatives is as follows;

$$d_j(a, b) = g_j(a) - g_j(b) \quad (3.18)$$

This formula shows the difference between the values of decision alternatives a and b for the jth criterion.

Step 6: Determination of Preference Indexes

After common preference functions are determined for each alternative, preference indices are calculated and thus, the superiority of alternatives over each other is determined by calculating preference functions. The preference indices of the alternatives are calculated with the following formulas.

$$\begin{aligned} \pi(a, b) &= \sum_{i=1}^k P_i(a, b) \cdot w_i \\ \pi(b, a) &= \sum_{i=1}^k P_i(b, a) \cdot w_i \end{aligned} \quad (3.19)$$

w_i : Importance weights of criteria..

k : Number of criteria.

$\pi(a, b)$ and $\pi(b, a)$: Degree of preference of alternatives over each other.

Step 7: Determine The Leaving and Entering Flow

In order to rank the decision alternatives and select the best one, leaving and entering flows must be calculated. Leaving and entering flows are calculated using the following formulas.

$$\begin{aligned} \phi^+(a) &= \frac{1}{n-1} \sum_{x \in A} \pi(a, x) \\ \phi^-(a) &= \frac{1}{n-1} \sum_{x \in A} \pi(x, a) \end{aligned} \quad (3.20)$$

$\phi^+(a)$: Leaving Flow

$\phi^-(a)$: Entering Flow

Leaving Flow value $\Phi^+(a)$, (a) expresses how much better the alternative a is than the other alternatives. The high value of this value shows that the alternative is a better option than the others.

Entering Flow value $\Phi^-(a)$ (a) expresses how weak the alternative a is compared to the other alternatives. The low value of this value shows that the alternative is a better option than the others.

Step 8: Calculate The Net Flow Values and Rank Accordingly

In order to make a complete ranking among the alternatives, net flow values are calculated. This value is obtained by finding the difference between leaving and entering flow for all alternatives. With the calculated net flow values, all decision alternatives are evaluated in the same way and a clear ranking can be made.

$$\Phi(a) = \Phi^+(a) - \Phi^-(a) \quad (3.21)$$

3.6.2. The Application of PROMETHEE II Method

During the PROMETHEE II analysis, as in the previous model TOPSIS, pairwise comparisons were made using the criterion weights obtained with the CRITIC method and the alternatives were analyzed according to their preference functions. In this analysis, the criterion weights calculated as a result of the CRITIC method and found in Table 3.8 were used. No changes were made to the criterion and alternative matrix, and the decision matrix used in TOPSIS and CRITIC was used. All calculations made during the analysis were created using the Microsoft Excel program.

The values in the decision matrix are objective values. Criterion values for each alternative were determined according to the calculations, 1-5 and 1-10 scales. Decision matrix given in Table 3.15.

Table 3.15: Decision Matrix of PROMETHEE II Method

		DECISION MATRIX				
Decision Variables		District size	Number of student per district	Infrastructure of district	Accessibility	Loudness level
	WEIGHTS	0,19	0,16	0,18	0,29	0,17
NO	Alternatives / Variables Directions	Max	Max	Max	Min	Min
1	Rifat Kazancıoğlu Street School Allocated Area	10.000	4544	5	196	6
2	İslambey Street School Allocated Area	2.800	1099	3	125	7
3	Kazım Karabekir Street School Allocated Area	11.000	3435	4	15	7
4	Şih Abdullah Street School Allocated Area	7.000	1363	3	200	8
5	Bilali Habeş Street School Allocated Area	3.800	1184	3	300	9
	MAX	11.000	4.544	5	300	9
	MIN	2.800	1.099	3	15	6
	MAX-MIN	8.200	3.445	2	285	3

Table 3.16: Normalized Decision Matrix of PROMETHEE II Method

		NORMALIZED DECISION MATRIX				
	Decision Variables	District size	Number of student per district	Infrastructure of district	Accessibility	Loudness level
NO	Alternatives / Variables Directions	Max	Max	Max	Min	Min
1	Rıfat Kazancıođlu Street School Allocated Area	0,88	1,00	1	0,36	1
2	İslambey Street School Allocated Area	0,00	0,00	0	0,61	0,67
3	Kazım Karabekir Street School Allocated Area	1,00	0,68	0,5	1,00	0,67
4	Şıh Abdullah Street School Allocated Area	0,51	0,08	0	0,35	0,33
5	Bilali Habeş Street School Allocated Area	0,12	0,02	0	0,00	0

Table 3.17 contains the results of pairwise comparisons made to determine common preference functions. The calculation made using the equation (3.18) has been applied to all alternative pairs.

D(1-2) value expresses the difference between the values of the 1st alternative and the 2nd alternative for the District size criterion.

Table 3.17: Evaluative Difference Of Alternatives With Respect Other Alternatives

EVALUATIVE DIFFERENCE OF ALTERNATIVES WITH RESPECT OTHER ALTERNATIVES						
	District size	Number of student per district	Infrastructure of district	Accessibility	Loudness level	
A(1-2)	0,88	1,00	1,00	-0,25		0,33
A(1-3)	-0,12	0,32	0,50	-0,64		0,33
A(1-4)	0,37	0,92	1,00	0,01		0,67
A(1-5)	0,76	0,98	1,00	0,36		1,00
A(2-1)	-0,88	-1,00	-1,00	0,25		-0,33
A(2-3)	-1,00	-0,68	-0,50	-0,39		0,00
A(2-4)	-0,51	-0,08	0,00	0,26		0,33
A(2-5)	-0,12	-0,02	0,00	0,61		0,67
A(3-1)	0,12	-0,32	-0,50	0,64		-0,33
A(3-2)	1,00	0,68	0,50	0,39		0,00
A(3-4)	0,49	0,60	0,50	0,65		0,33
A(3-5)	0,88	0,65	0,50	1,00		0,67
A(4-1)	-0,37	-0,92	-1,00	-0,01		-0,67
A(4-2)	0,51	0,08	0,00	-0,26		-0,33
A(4-3)	-0,49	-0,60	-0,50	-0,65		-0,33
A(4-5)	0,39	0,05	0,00	0,35		0,33
A(5-1)	-0,76	-0,98	-1,00	-0,36		-1,00
A(5-2)	0,12	0,02	0,00	-0,61		-0,67
A(5-3)	-0,88	-0,65	-0,50	-1,00		-0,67
A(5-4)	-0,39	-0,05	0,00	-0,35		-0,33

In this step where preference functions will be calculated, operations will be performed according to the type of preference function previously decided for the criteria and a matrix will be created. The 6 types of preference functions mentioned for the criteria are mentioned in Figure 3.7.

For this type of problem, since the decision maker did not have any preference for a criterion, the usual type preference function was decided upon and the calculations proceeded according to this regular function.

According to the regular preference function formulation, values less than “0” in the pairwise comparison matrix should be defined as “0” and no action should be taken on other values.

The formula is as follows:

$$P(d) = \begin{cases} 0, & d \leq 0 \\ 1, & d > 0 \end{cases} \quad (3.22)$$

When we re-evaluate the pairwise comparison values in the table 3.17 according to the regular preference function formula Equation 3.22.

Table 3.18 : Prefence Function

PREFENCE FUNCTION					
	District size	Number of student per district	Infrastructure of district	Accessibility	Loudness level
WEIGHTS	0,19	0,16	0,18	0,29	0,17
A(1-2)	0,88	1,00	1,00	0,00	0,33
A(1-3)	0,00	0,32	0,50	0,00	0,33
A(1-4)	0,37	0,92	1,00	0,01	0,67
A(1-5)	0,76	0,98	1,00	0,36	1,00
A(2-1)	0,00	0,00	0,00	0,25	0,00
A(2-3)	0,00	0,00	0,00	0,00	0,00
A(2-4)	0,00	0,00	0,00	0,26	0,33
A(2-5)	0,00	0,00	0,00	0,61	0,67
A(3-1)	0,12	0,00	0,00	0,64	0,00
A(3-2)	1,00	0,68	0,50	0,39	0,00
A(3-4)	0,49	0,60	0,50	0,65	0,33
A(3-5)	0,88	0,65	0,50	1,00	0,67
A(4-1)	0,00	0,00	0,00	0,00	0,00
A(4-2)	0,51	0,08	0,00	0,00	0,00
A(4-3)	0,00	0,00	0,00	0,00	0,00
A(4-5)	0,39	0,05	0,00	0,35	0,33
A(5-1)	0	0	0	0	0
A(5-2)	0,12	0,02	0,00	0,00	0,00
A(5-3)	0,00	0,00	0,00	0,00	0,00
A(5-4)	0,00	0,00	0,00	0,00	0,00

While the value of A(1-3) in the table is “-0.12” , it is transferred to the preference function matrix as “0” because according to the usual preference function formulation, values smaller than “0” should be assigned the value “0”.

Another part of the preference function calculation step is to multiply the criterion weight values with the alternative comparison values and to sum these values. The formula for this process is as follows.

$$\begin{aligned}\pi(a, b) &= \sum_{i=1}^k P_i(a, b) \cdot w_i \\ \pi(b, a) &= \sum_{i=1}^k P_i(b, a) \cdot w_i\end{aligned}\quad (3.23)$$

The preference function obtained as a result of the calculations is as follows.

Table 3.19: Prefence Function Continuation Table

	PREFENCE FUNCTION					
	District size	Number of student per district	Infrastructure of district	Accessibility	Loudness level	
WEIGHTS	0,19	0,16	0,18	0,29	0,17	SUM
A(1-2)	0,17	0,16	0,18	0,00	0,06	0,57
A(1-3)	0,00	0,05	0,09	0,00	0,06	0,20
A(1-4)	0,07	0,15	0,18	0,00	0,12	0,52
A(1-5)	0,15	0,16	0,18	0,11	0,17	0,76
A(2-1)	0	0	0	0,07	0	0,07
A(2-3)	0,00	0,00	0,00	0,00	0,00	0,00
A(2-4)	0,00	0,00	0,00	0,08	0,06	0,13
A(2-5)	0,00	0,00	0,00	0,18	0,12	0,30
A(3-1)	0,02	0,00	0,00	0,19	0,00	0,21
A(3-2)	0,19	0,11	0,09	0,11	0,00	0,51
A(3-4)	0,09	0,10	0,09	0,19	0,06	0,53
A(3-5)	0,17	0,10	0,09	0,29	0,12	0,77
A(4-1)	0,00	0,00	0,00	0,00	0,00	0,00
A(4-2)	0,10	0,01	0	0	0	0,11
A(4-3)	0,00	0,00	0,00	0,00	0,00	0,00
A(4-5)	0,08	0,01	0,00	0,10	0,06	0,24
A(5-1)	0,00	0,00	0,00	0,00	0,00	0,00
A(5-2)	0,02	0,00	0,00	0,00	0,00	0,03
A(5-3)	0,00	0,00	0,00	0,00	0,00	0,00
A(5-4)	0,00	0,00	0,00	0,00	0,00	0,00

The matrix in Table 3.20 is obtained by using the total values in Table 19

Table 3.20: Aggregated Preference Function Matrix

AGGREGATED PREFERENCE FUNCTION MATRIX						
	A1	A2	A3	A4	A5	SUM
A1	-	0,57	0,2	0,52	0,76	2,05
A2	0,07	-	0	0,13	0,3	0,5
A3	0,21	0,51	-	0,53	0,77	2,02
A4	0	0,11	0	-	0,24	0,35
A5	0	0,03	0	0	-	0,03
SUM	0,28	1,22	0,2	1,18	2,07	

After calculating the total preference functions, the positive and negative flow values of the alternatives are calculated by Equation 3.20 and shown in the table below.

Table 3.21: Leaving Flow And Entering Flow Of The Alternatives

LEAVING FLOW AND ENTERING FLOW OF THE ALTERNATIVES		
	LEAVING FLOW	ENTERING FLOW
A1	0,51	0,07
A2	0,13	0,31
A3	0,51	0,05
A4	0,09	0,30
A5	0,01	0,52

According to the Equation 3.21, the $\Phi(i)$ values of the alternatives were calculated and ranked according to the PROMETHEE II method.

The ranking result is given in the table 3.22 .As a result of the ranking, the best alternative was Kazım Karabekir Street School Allocated Area.

The ranking order is as follows; Kazım Karabekir Street School Allocated Area, Rıfat Kazancıoğlu Street School Allocated Area, İslambey Street School Allocated Area, Şih Abdullah Street School Allocated Area, and Bilali Habeş Street School Allocated Area, respectively.

Table 3.22: Net Flow and Ranking

NET FLOW /RANKING		
Alternatives / Variables Directions	NET FLOW	RANK
Rıfat Kazancıoğlu Street School Allocated Area	0,44	2
İslambey Street School Allocated Area	- 0,18	3
Kazım Karabekir Street School Allocated Area	0,46	1
Şih Abdullah Street School Allocated Area	- 0,21	4
Bilali Habeş Street School Allocated Area	- 0,51	5

3.7. Comparison of the Results Obtained from the TOPSIS and PROMETHEE II Methods

When the results of the two methods used in the school site selection problem in Kilis province are evaluated, it is seen that the most suitable school site that can be selected is different in the two methods. The results obtained from the two methods are shown in Table 23.

Table 3.23: Comparison of the Results

Ranking	1	2	3	4	5
TOPSIS	Rifat Kazancıoğlu Street School Allocated Area	Kazım Karabekir Street School Allocated Area	Bilali Habeş Street School Allocated Area	Şih Abdullah Street School Allocated Area	İslambey Street School Allocated Area
PROMETHEE II	Kazım Karabekir Street School Allocated Area	Rifat Kazancıoğlu Street School Allocated Area	İslambey Street School Allocated Area	Şih Abdullah Street School Allocated Area	Bilali Habeş Street School Allocated Area

The area selected as the second best alternative in the TOPSIS method was selected as the best alternative in the PROMETHEE II method and similarly, the alternative ranked second in the PROMETHEE II method was selected as the first best alternative in the TOPSIS method.

A difference in ranking was observed between these two methods, but still these two best alternatives follow each other in the ranking in the two applied methods.

According to the ranking result, the alternatives ranked 3rd and 5th are observed to have changed places in the ranking between the two methods and also the x region is ranked 4th in both methods.

4. RESULTS AND DISCUSSION

This study is an example of the use of the CRITIC-based TOPSIS AND PROMETHEE II method for school site selection.

The study was applied to the secondary school level in the central district of Kilis. In the first stage of the study, school allocation areas were determined through GBS and 5 of them were determined as alternatives for the study. The criterion values of the alternatives were calculated objectively.

The CRITIC method was used to determine the criterion weights and TOPSIS and PROMETHEE II methods, which are multi-criteria decision-making methods, were used for the best school site selection with these weights obtained. The results of the methods used were compared and their similarities and differences were stated.

In the study, five criteria were used, namely district size, number of students per district, accessibility infrastructure of the district and noise level, and five alternatives were used, namely Rıfat Kazancıođlu Street school allocation area, İslambey Street school allocation area, Kazım Karabekir Street school allocation area, Şıh Abdullah Street school allocation area, Bilali Habeş Street school allocation area.

First, the CRITIC method used to determine the importance weight of each criterion, the accessibility criterion was determined as the most important criterion.

As a result of the evaluation of the alternatives with the TOPSIS method, The Rıfat Kazancıođlu Neighborhood school education area was selected as the best alternative school location. The next best option is The Kazım Karabekir Street School Allocated Area.

As a result of the ranking made depending on the $\Phi(i)$ values in the PROMETHEE II method, it is seen that The Kazım Karabekir Street School Allocated Area ranks first.

REFERENCES

KELEŞ, N. (2022). OKUL YERİ SEÇİMİNDE KULLANILAN KRİTERLERİN ANALİTİK HİYERARŞİ PROSESİ YÖNTEMİYLE ÖNEMLERİNİN BELİRLENMESİ. *Artuklu Kaime Uluslararası İktisadi ve İdari Araştırmalar Dergisi*, 135-154.

Uslu, A., Kızıloğlu, K., İşleyen, S. K., & Kahya, E. (2017). Okul yeri seçiminde coğrafi bilgi sistemine dayalı AHP-TOPSIS yaklaşımı: Ankara ili örneği. *Politeknik Dergisi*, 20(4), 933-943.

Ahmed Ali, K. (2018). Multi-criteria decision analysis for primary school site selection in Al-Mahaweel district using GIS technique. *journal of kerbala university*, 14(1), 342-350.

Ayçin, E. (2020). Personel seçim sürecinde CRITIC ve MAIRCA yöntemlerinin kullanılması. *İşletme*, 1(1), 1-12.

Bulğurcu, B. (2019). Çok nitelikli fayda teorisi ile CRITIC yöntem entegrasyonu: Akıllı teknoloji tercih örneği. *OPUS International Journal of Society Researches*, 13(19), 1930-1957.

Arslan H.M., & Yıldız, M.S. (2015). "Eğitim Tesislerinin Kuruluş Yeri Seçiminde Bulanık Topsis Yönteminin Uygulanması: Düzce'de Bir Lokasyon Analizi. "The Journal of International Social Research, 8(36): 763-774

BAŞEĞMEZ, Murat; TAŞDEMİR, İbrahim; GÜL, Çağrı. Eğitim alanlarının yer seçim kriterlerinin belirlenmesinde yaşanan problemler ve çözüm önerileri. TMMOB Harita ve Kadastro Mühendisleri Odası, 2017, 16: 188-194.

Başeğmez, M., Taşdemir, İ., & Gül, Ç. (2017). Eğitim alanlarının yer seçim kriterlerinin belirlenmesinde yaşanan problemler ve çözüm önerileri. TMMOB Harita ve Kadastro Mühendisleri Odası, 16, 188-194.

BAŞEĞMEZ, Murat; YILDIRIM, Volkan; BEDİROĞLU, Şevket. CBS ve AHP yöntemiyle en uygun okul yer seçimi analizi: Uşak-Merkez örneği. TMMOB, 2019, 6: 122-132.

Maman, İ. (2023). *Araç Kasko Şirketlerinden Ahp Temelli Ağırlıklandırma Yöntemi Üzerinden Topsis Ve Promethee Yöntemleri İle Seçimi*. Yüksek Lisans Tezi. Iğdır Üniversitesi Matematik Ana Bilim Dalı, Iğdır.

PEYK, P. (2023). *Çok Kriterli Karar Verme Tekniği Yardımıyla Portföy Seçimi: Gelişmiş Ve Gelişmekte Olan Ülkelerin Pay Piyasasında Promethee Yöntemi Üzerine Bir Uygulama*. Doktora Tezi İstanbul Ticaret Üniversitesi Sosyal Bilimler Enstitüsü, İstanbul.

Şahin, A. (2022). *Çok Kriterli Karar Verme Tekniği Yardımıyla Portföy Seçimi: Gelişmiş Ve Gelişmekte Olan Ülkelerin Pay Piyasasında Promethee Yöntemi Üzerine Bir Uygulama*. Doktora Tezi. Dokuz Eylül Üniversitesi Sosyal Bilimler Enstitüsü, İzmir.