ESKİŞEHİR TEKNİK ÜNİVERSİTESİ
ESKİŞEHİR TECHNICAL UNIVERSITY

THE PROBLEM OF IMPROVING ACCESSIBILITY AND PLACEMENT OF SMART DELIVERY LOCKERS IN ESKİŞEHİR TEPEBAŞI DISTRICT

GROUP 10

ADVISOR: Assoc. Prof. Dr. Gülçin Dinç YALÇIN

GROUP MEMBERS

Erhan ŞİMŞEKER

Zeynep Tuana ERKUL

Selin OĞUZMAN

CONTENTS OF THE PRESENTATION

ESKİŞEHİR TEKNİK ÜNİVERSİTESİ
ESKİŞEHİR TECHNICAL UNIVERSITY

SUMMARY

The increasing population and urban development in the Tepebaşı district of Eskişehir are placing pressure on the delivery infrastructure. In particular, neighborhoods with high concentrations of apartment buildings frequently experience issues such as delays in traditional parcel deliveries, repeated delivery attempts, and customer dissatisfaction.

Delivery traffic, especially during peak hours, complicates urban transportation and extends delivery times. This situation reduces the efficiency of logistics processes and negatively impacts urban life.

The project we carried out aims to increase user accessibility and enhance operational efficiency by determining the most suitable locations for smart parcel lockers in the Tepebaşı district. At the same time, this strategy also aims to deliver environmental and social benefits by reducing carbon emissions..

ESKİŞEHİR TEKNİK ÜNİVERSİTESİ
ESKİŞEHİR TECHNICAL UNIVERSITY

AREA OF STUDY

Within the scope of our project, we conducted our study on a total of 21 neighborhoods located in the Eskişehir/Tepebaşı region: **Bahçelievler, Batıkent, Cumhuriye, Çamlıca, Ertuğrulgazi, Esentepe, Eskibağlar, Fatih, Güllük, Hoşnudiye, Kumlubel, Ömerağa, Sütlüce, Şarhöyük, Şeker, Şirintepe, Tunalı, Uluönder, Yenibağlar, Yeşiltepe,** and **Zafer.**

Map Illustration of Our Study Area

In order to determine the coordinate data and neighborhood boundaries of our study area, we used Scribblemaps.com to create drawings, which we then converted into a .shp (shapefile) and processed to make the data usable for our project.

```python
with fiona.Env():
    gdf = gpd.read_file("C:/Users/erhan/Desktop/tez/mahalleler/mahalleler_point.shp", encoding='windows-1254')

isim_duzeltme = {
    'Çaml?ca': 'Çamlıca',
    'Zaf\ner': 'Zafer',
    '?arhöyük': 'Şarhöyük',
    '?eker': 'Şeker',
    '?irintepe': 'Şirintepe',
    'Ertu?rulgazi': 'Ertuğrulgazi',
    'Eskiba?lar': 'Eskibağlar',
    'Ho?nudiye': 'Hoşnudiye',
    'Sütl?ce': 'Sütlüce',
    'Yeniba?lar': 'Yenibağlar',
    'Bat?kent': 'Batıkent',
    'Ye?iltepe': 'Yeşiltepe',
    'Ömera?a': 'Ömerağa',
    'Tunal?': 'Tunalı',
}
gdf["name"] = gdf["name"].replace(isim_duzeltme)
gdf["lat"] = gdf.geometry.y
gdf["lon"] = gdf.geometry.x
```

First, we corrected the errors in the neighborhood names identified within the file. Then, by integrating this file into our system and processing the coordinates (x = lat, y = lon) of each region within the boundaries we had drawn, we laid the foundation of our decision support system.

Scribble Maps

QGIS

ESKİŞEHİR TEKNİK ÜNİVERSİTESİ
ESKİŞEHİR TECHNICAL UNIVERSITY

NEIGHBORHOOD DATA

Neighborhood	Population	Young Age Population (0–24) (%)	Middle Age Population (25–59) (%)	University Graduates (%)	Population Density (people/km²)
Bahçelievler	10904	30	56	35	31224
Batıkent	32066	33	54	40	3206
Cumhuriye	4277	27	50	28	30281,1
Çamlıca	49668	37	52	18	12417
Ertuğrulgazi	17239	28	53	31	8619
Esentepe	9258	31	51	11	9258
Eskibağlar	6061	31	56	37	24188
Fatih	12757	37	50	21	42992
Güllük	5262	28	55	31	36965,59
Hoşnudiye	5663	23	52	42	5663
Kumlubel	10956	31	55	21	25821
Ömerağa	9562	29	53	21	39214,51
Sütlüce	14717	35	53	16	14717
Şarhöyük	9729	38	47	13	9729
Şeker	8307	35	50	32	692,25
Şirintepe	40286	34	51	18	20143
Tunalı	9647	27	54	22	36.378,26
Uluönder	15716	27	50	24	7858
Yenibağlar	15192	38	49	37	15192
Yeşiltepe	13259	40	39	10	4419
Zafer	14179	31	54	17	14179

Table of Demographic Data of Neighborhoods

The data were sourced from endeksa.com.

ESKİŞEHİR TEKNİK ÜNİVERSİTESİ
ESKİŞEHİR TECHNICAL UNIVERSITY

NEIGHBORHOOD DATA

Why did we collect these data?

Since we aimed to determine service priority in a scientific and data-driven manner, we wanted to optimize the placement of smart parcel lockers in the selected area not only based on geographical proximity but also by taking into account social factors such as population structure, education level, and age distribution.

In this context:

TOTAL POPULATION AND POPULATION DENSITY

- Helped estimate the potential number of users for the lockers.

YOUNG POPULATION RATE (AGES 0–24)

- Used to identify neighborhoods with a high concentration of groups that could use technology more actively.

MIDDLE-AGE RATE (25–59)

- The middle-age group (25–59) was important due to the presence of working and active individuals.

UNIVERSITY GRADUATION RATE (%)

- The education level of neighborhood residents indirectly reflects their technology adaptation, e-commerce usage, and tendency to adopt smart delivery systems. Therefore, neighborhoods with higher rates of university graduates are expected to more easily accept and actively use smart lockers. For this reason, this metric was considered a key priority indicator in site selection.

ESKISEHIR TECHNICAL UNIVERSITY

SET COVERING

The problem addressed in our project is a location optimization problem that aims to ensure maximum user coverage within the city using a limited number of smart delivery lockers. The objective is to ensure that every user can reach at least one delivery locker—on foot or by bicycle—within a specified access time. This type of coverage-based decision problem aligns with classical deterministic optimization models and is referred to as the Set Covering Problem.

```
from pulp import LpProblem, LpMinimize, LpVariable, lpSum, LpBinary
```

```
model = LpProblem("Set_Covering", LpMinimize)
facility_vars = {loc: LpVariable(f"Open_{loc}", cat=LpBinary) for loc in dist_matrix.index}
for mahalle in dist_matrix.index:
    model += lpSum(facility_vars[loc] for loc in dist_matrix.columns if coverage_matrix.loc[mahalle, loc]) >= 1
for i in dist_matrix.index:
    for j in dist_matrix.index:
        if i < j:
            if abs(dist_matrix.at[i, j] - max_distance_constraint) > 0.0001:
                model += facility_vars[i] + facility_vars[j] <= 1, f"DistanceConstraint_{i}_{j}"
model += lpSum(facility_vars[loc] for loc in facility_vars)
model.solve()
```

Set Covering Problem in Python using the PuLP library and its modules

$$\min \sum_{j \in J} x_j$$

s.t.

$$\sum_{j \in J} a_{ij}\, x_j \geq 1, \ \forall i \in I$$

$$x_j \in \{0,1\}, \ \forall j \in J$$

Objective Function defined to select the minimum number of service locations.

J: The set of potential service locations (coverage centers)..

I: The set of elements to be covered (neighborhoods), with the constraint that **each neighborhood must be covered by at least one center.**

- **Decision Variable:** x_j
- **Parameter:** a_{ij}

Mathematical Model of the Set Covering Problem

ESKİŞEHİR TEKNİK ÜNİVERSİTESİ
ESKİŞEHİR TECHNICAL UNIVERSITY

TOPSIS (TECHNIQUE FOR ORDER PREFERENCE BY SIMILARITY TO IDEAL SOLUTION)

TOPSIS (Technique for Order Preference by Similarity to Ideal Solution) is one of the multi-criteria decision-making methods.

First, all criteria are normalized, and then weights are assigned based on their importance.

Then, the Euclidean distance of each alternative from the ideal and negative ideal solutions is calculated.

These distances are used to calculate the TOPSIS score. The higher the score, the more preferable the alternative.

elbow

The scores are ranked, and the point with the largest jump (elbow point) is accepted as the threshold. Those above it are considered high priority. (Elbow Method)

Weights Assigned to Criteria in This Study:

- **Young Population (0–24):** 0.4
- **University Graduates (%):** 0.25
- **Total Population:** 0.2
- **Population Density (people/km²):** 0.15
- **Middle Age (25–59):** 0.1

Why did we choose it?

Using TOPSIS, relative priority scores of neighborhoods were calculated based on a normalized decision matrix that included criteria such as age distribution, education level, population density, and parcel demand. Since our goal was not only to ensure coverage but also to identify high-priority and high-impact areas, TOPSIS proved highly helpful in achieving this.

$$\frac{\text{Negative Ideal Distance}}{\text{Ideal Distance} + \text{Negative Ideal Distance}}$$

TOPSIS Score Formula

ESKİŞEHİR TEKNİK ÜNİVERSİTESİ
ESKİŞEHİR TECHNICAL UNIVERSITY

DECISION SUPPORT SYSTEM

In line with the objectives of our project, the decision support system we developed for data-based and user-oriented decision-making includes both Python and HTML file and software languages. The functions of these files are carried out in the following order:

HTML

- Provides a selection menu for coverage radius (e.g., 0.8, 1.0, 1.2, 1.5 km).
- Saves the selected radius to a text file and executes the Python script.
- Offers buttons to display the distance matrix, results, and TOPSIS scores.
- A user-friendly input screen and panel are provided.

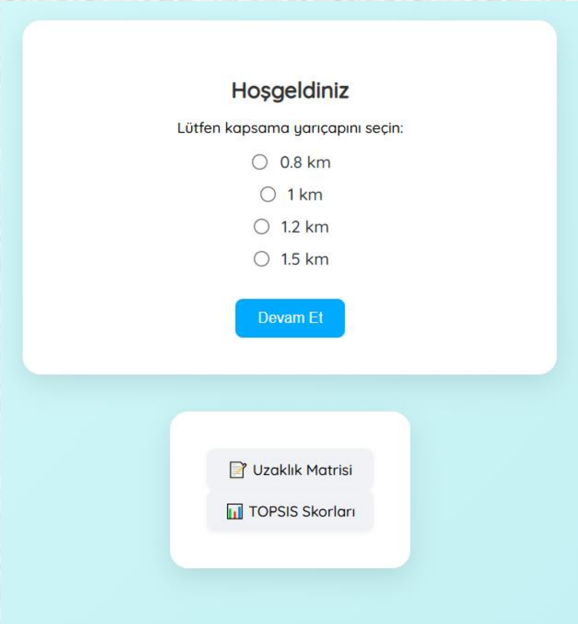
Python

- The coordinates of the neighborhoods are read from a .shp file, and demographic data is read from an Excel file. These are edited, and coordinate outputs are generated.
- Using data on youth population, university graduates, total population, population density, and middle age ratio, TOPSIS scores are calculated, and neighborhoods are ranked accordingly.
- Distances between neighborhoods are calculated as walking distances, and coverage matrices are created based on the selected radius value.
- The objective function and coverage constraints are defined, and the optimization model is solved to ensure that all neighborhoods are covered with a minimum number of centers.
- Selected locations are matched with the most relevant neighborhoods. Based on TOPSIS scores, less prioritized locations and clusters are filtered out.
- Clusters and coverage areas are visualized on a Folium map. Street View links and matrices of distances between clusters are prepared.
- Final outputs such as TOPSIS scores, coverage maps, inter-cluster distances, and Street View links are saved in both HTML and Excel formats.

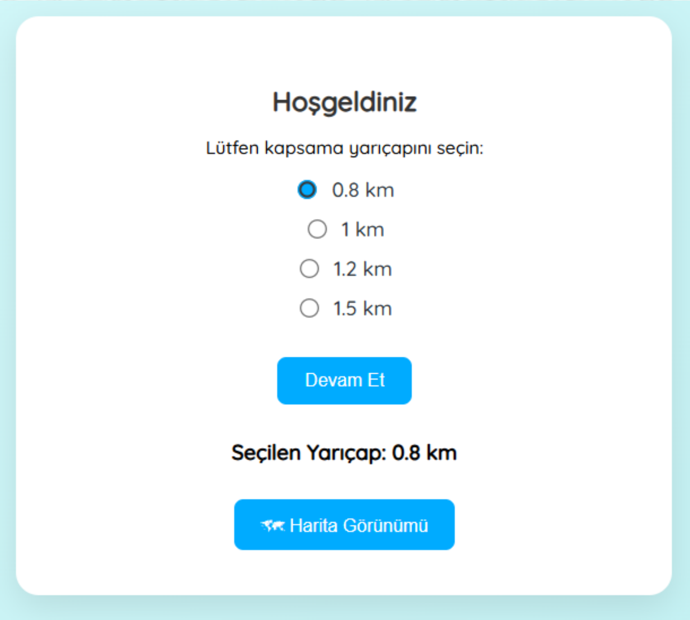
ESKİŞEHİR TEKNİK ÜNİVERSİTESİ
ESKİŞEHİR TECHNICAL UNIVERSITY

INTERFACE ENTRY

Our interface opens with an animation screen that includes a map drawing of our study area, the project title, and our university logo.This image is displayed for 3.5 seconds and then transitions to the selection screen with a 0.8-second fade effect.

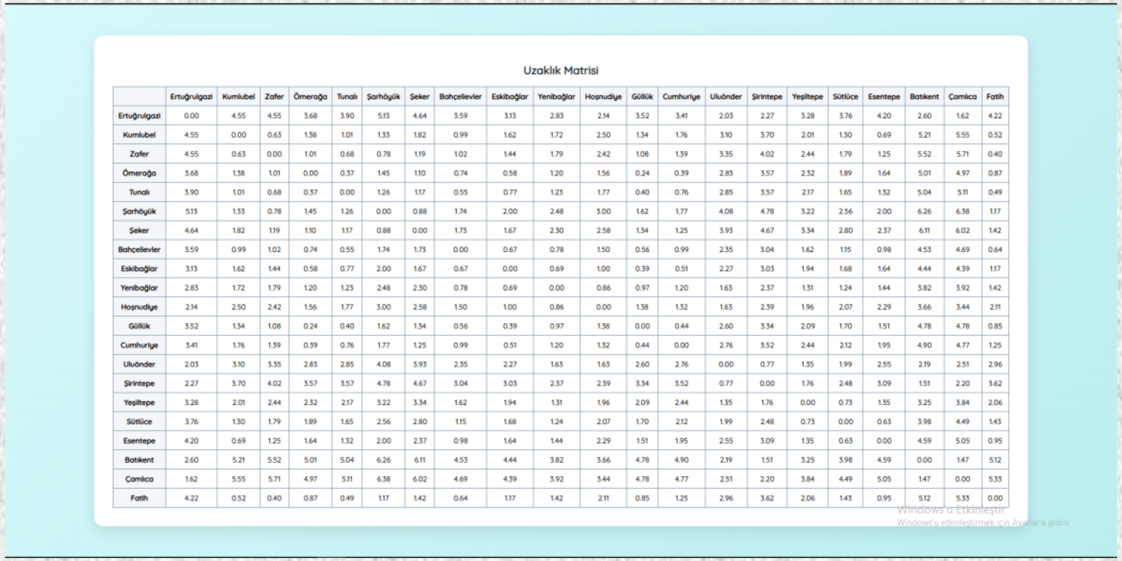


The user is asked to select a coverage radius.Additionally, if desired, buttons are available in this section to view the Distance Matrix — which shows the straight-line distances between neighborhoods — and the TOPSIS Scores and their calculations.



When the user makes a selection in this section, the selected value is saved to the computer as a file named threshold.txt.This allows the Python code to recognize the user's selection.

INTERFACE TABS



Uzaklık Matrisi

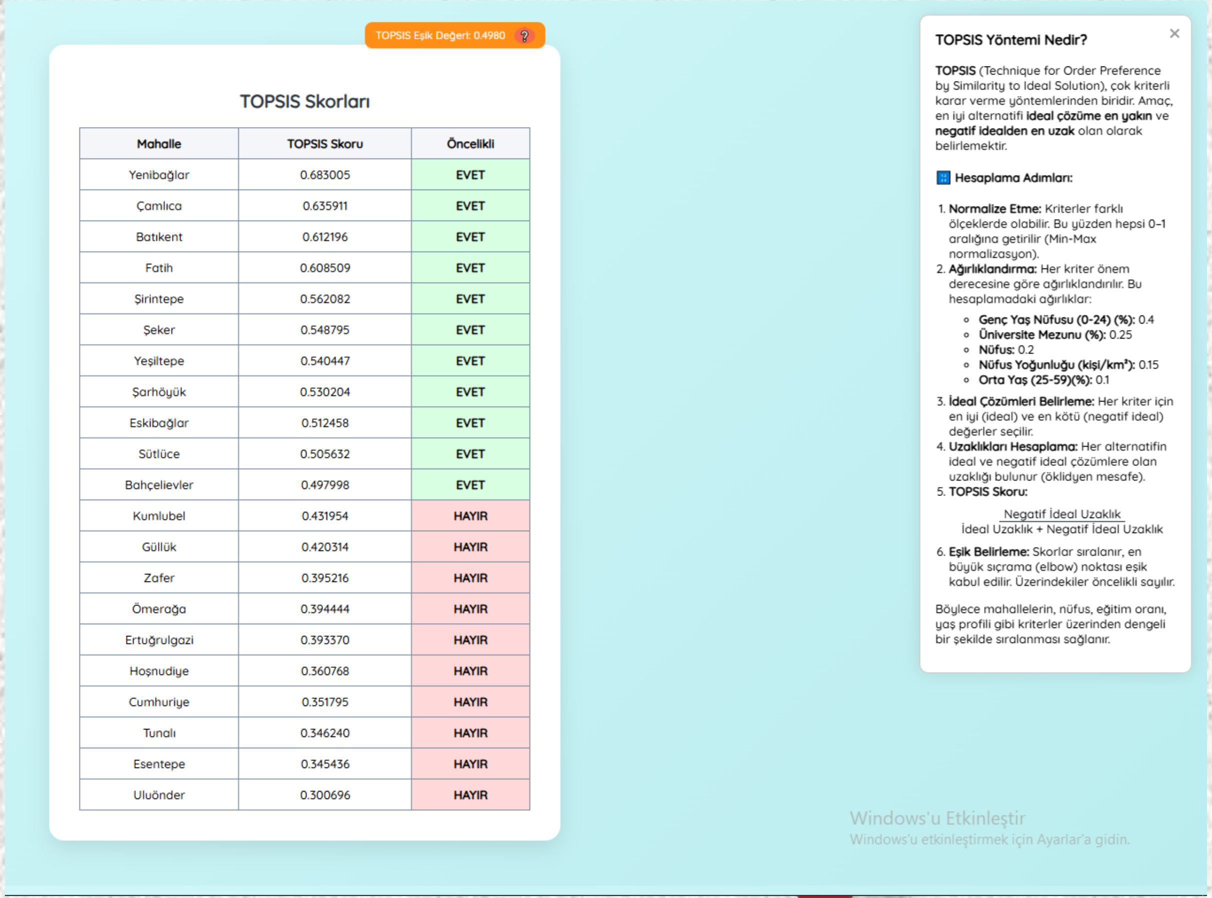
	Ertuğrulgazi	Kumlubel	Zafer	Ömerağa	Tunalı	Şarhöyük	Şeker	Bahçelievler	Eskibağlar	Yenibağlar	Hoşnudiye	Güllük	Cumhuriye	Uluönder	Şirintepe	Yeşiltepe	Sütlüce	Esentepe	Batıkent	Çamlıca	Fatih
Ertuğrulgazi	0.00	4.55	4.55	3.68	3.90	5.13	4.64	3.59	3.13	2.83	2.14	3.52	3.41	2.03	2.27	3.28	3.76	4.20	2.60	1.62	4.22
Kumlubel	4.55	0.00	0.63	1.38	1.01	1.33	1.82	0.99	1.62	1.72	2.50	1.34	1.76	3.10	3.70	2.01	1.30	0.69	5.21	5.55	0.52
Zafer	4.55	0.63	0.00	1.01	0.68	0.78	1.19	1.02	1.44	1.79	2.42	1.08	1.39	3.35	4.02	2.44	1.79	1.25	5.52	5.71	0.40
Ömerağa	3.68	1.38	1.01	0.00	0.37	1.45	1.10	0.74	0.58	1.20	1.56	0.24	0.39	2.83	3.57	2.32	1.89	1.64	5.01	4.97	0.87
Tunalı	3.90	1.01	0.68	0.37	0.00	1.26	1.17	0.55	0.77	1.23	1.77	0.40	0.76	2.85	3.57	2.17	1.65	1.32	5.04	5.11	0.49
Şarhöyük	5.13	1.33	0.78	1.45	1.26	0.00	0.88	1.74	2.00	2.48	3.00	1.62	1.77	4.08	4.78	3.22	2.56	2.00	6.26	6.38	1.17
Şeker	4.64	1.82	1.19	1.10	1.17	0.88	0.00	1.73	1.67	2.30	2.58	1.34	1.25	3.93	4.67	3.34	2.80	2.37	6.11	6.02	1.42
Bahçelievler	3.59	0.99	1.02	0.74	0.55	1.74	1.73	0.00	0.67	0.78	1.50	0.56	0.99	2.35	3.04	1.62	1.15	0.98	4.53	4.69	0.64
Eskibağlar	3.13	1.62	1.44	0.58	0.77	2.00	1.67	0.67	0.00	0.69	1.00	0.39	0.51	2.27	3.03	1.94	1.68	1.64	4.44	4.39	1.17
Yenibağlar	2.83	1.72	1.79	1.20	1.23	2.48	2.30	0.78	0.69	0.00	0.86	0.97	1.20	1.63	2.37	1.31	1.24	1.44	3.82	3.92	1.42
Hoşnudiye	2.14	2.50	2.42	1.56	1.77	3.00	2.58	1.50	1.00	0.86	0.00	1.38	1.32	1.63	2.39	1.96	2.07	2.29	3.66	3.44	2.11
Güllük	3.52	1.34	1.08	0.24	0.40	1.62	1.34	0.56	0.39	0.97	1.38	0.00	0.44	2.60	3.34	2.09	1.70	1.51	4.78	4.78	0.85
Cumhuriye	3.41	1.76	1.39	0.39	0.76	1.77	1.25	0.99	0.51	1.20	1.32	0.44	0.00	2.76	3.52	2.44	2.12	1.95	4.90	4.77	1.25
Uluönder	2.03	3.10	3.35	2.83	2.85	4.08	3.93	2.35	2.27	1.63	1.63	2.60	2.76	0.00	0.77	1.35	1.99	2.55	2.19	2.51	2.96
Şirintepe	2.27	3.70	4.02	3.57	3.57	4.78	4.67	3.04	3.03	2.37	2.39	3.34	3.52	0.77	0.00	1.76	2.48	3.09	1.51	2.20	3.62
Yeşiltepe	3.28	2.01	2.44	2.32	2.17	3.22	3.34	1.62	1.94	1.31	1.96	2.09	2.44	1.35	1.76	0.00	0.73	1.35	3.25	3.84	2.06
Sütlüce	3.76	1.30	1.79	1.89	1.65	2.56	2.80	1.15	1.68	1.24	2.07	1.70	2.12	1.99	2.48	0.73	0.00	0.63	3.98	4.49	1.43
Esentepe	4.20	0.69	1.25	1.64	1.32	2.00	2.37	0.98	1.64	1.44	2.29	1.51	1.95	2.55	3.09	1.35	0.63	0.00	4.59	5.05	0.95
Batıkent	2.60	5.21	5.52	5.01	5.04	6.26	6.11	4.53	4.44	3.82	3.66	4.78	4.90	2.19	1.51	3.25	3.98	4.59	0.00	1.47	5.12
Çamlıca	1.62	5.55	5.71	4.97	5.11	6.38	6.02	4.69	4.39	3.92	3.44	4.78	4.77	2.51	2.20	3.84	4.49	5.05	1.47	0.00	5.33
Fatih	4.22	0.52	0.40	0.87	0.49	1.17	1.42	0.64	1.17	1.42	2.11	0.85	1.25	2.96	3.62	2.06	1.43	0.95	5.12	5.33	0.00

TOPSIS Eşik Değeri: 0.4980

TOPSIS Skorları

Mahalle	TOPSIS Skoru	Öncelikli
Yenibağlar	0.683005	EVET
Çamlıca	0.635911	EVET
Batıkent	0.612196	EVET
Fatih	0.608509	EVET
Şirintepe	0.562082	EVET
Şeker	0.548795	EVET
Yeşiltepe	0.540447	EVET
Şarhöyük	0.530204	EVET
Eskibağlar	0.512458	EVET
Sütlüce	0.505632	EVET
Bahçelievler	0.497998	EVET
Kumlubel	0.431954	HAYIR
Güllük	0.420314	HAYIR
Zafer	0.395216	HAYIR
Ömerağa	0.394444	HAYIR
Ertuğrulgazi	0.393370	HAYIR
Hoşnudiye	0.360768	HAYIR
Cumhuriye	0.351795	HAYIR
Tunalı	0.346240	HAYIR
Esentepe	0.345436	HAYIR
Uluönder	0.300696	HAYIR

When the ‘**Distance’ Matrix** and ‘**TOPSIS Scores’** buttons on the entry screen are clicked, the corresponding tabs open as displayed in the images.



TOPSIS Eşik Değeri: 0.4980

TOPSIS Skorları

Mahalle	TOPSIS Skoru	Öncelikli
Yenibağlar	0.683005	EVET
Çamlıca	0.635911	EVET
Batıkent	0.612196	EVET
Fatih	0.608509	EVET
Şirintepe	0.562082	EVET
Şeker	0.548795	EVET
Yeşiltepe	0.540447	EVET
Şarhöyük	0.530204	EVET
Eskibağlar	0.512458	EVET
Sütlüce	0.505632	EVET
Bahçelievler	0.497998	EVET
Kumlubel	0.431954	HAYIR
Güllük	0.420314	HAYIR
Zafer	0.395216	HAYIR
Ömerağa	0.394444	HAYIR
Ertuğrulgazi	0.393370	HAYIR
Hoşnudiye	0.360768	HAYIR
Cumhuriye	0.351795	HAYIR
Tunalı	0.346240	HAYIR
Esentepe	0.345436	HAYIR
Uluönder	0.300696	HAYIR

TOPSIS Yöntemi Nedir?

TOPSIS (Technique for Order Preference by Similarity to Ideal Solution), çok kriterli karar verme yöntemlerinden biridir. Amaç, en iyi alternatifi **ideal çözüme en yakın** ve **negatif idealden en uzak** olan olarak belirlemektir.

Hesaplama Adımları:

1. **Normalize Etme:** Kriterler farklı ölçeklerde olabilir. Bu yüzden hepsi 0–1 aralığına getirilir (Min-Max normalizasyon).
2. **Ağırlıklandırma:** Her kriter önem derecesine göre ağırlıklandırılır. Bu hesaplamadaki ağırlıklar:
   - **Genç Yaş Nüfusu (0-24) (%):** 0.4
   - **Üniversite Mezunu (%):** 0.25
   - **Nüfus:** 0.2
   - **Nüfus Yoğunluğu (kişi/km²):** 0.15
   - **Orta Yaş (25-59)(%):** 0.1
3. **İdeal Çözümleri Belirleme:** Her kriter için en iyi (ideal) ve en kötü (negatif ideal) değerler seçilir.
4. **Uzaklıkları Hesaplama:** Her alternatifin ideal ve negatif ideal çözümlere olan uzaklığı bulunur (öklidyen mesafe).
5. **TOPSIS Skoru:**

$$\frac{\text{Negatif İdeal Uzaklık}}{\text{İdeal Uzaklık + Negatif İdeal Uzaklık}}$$

6. **Eşik Belirleme:** Skorlar sıralanır, en büyük sıçrama (elbow) noktası eşik kabul edilir. Üzerindekiler öncelikli sayılır.

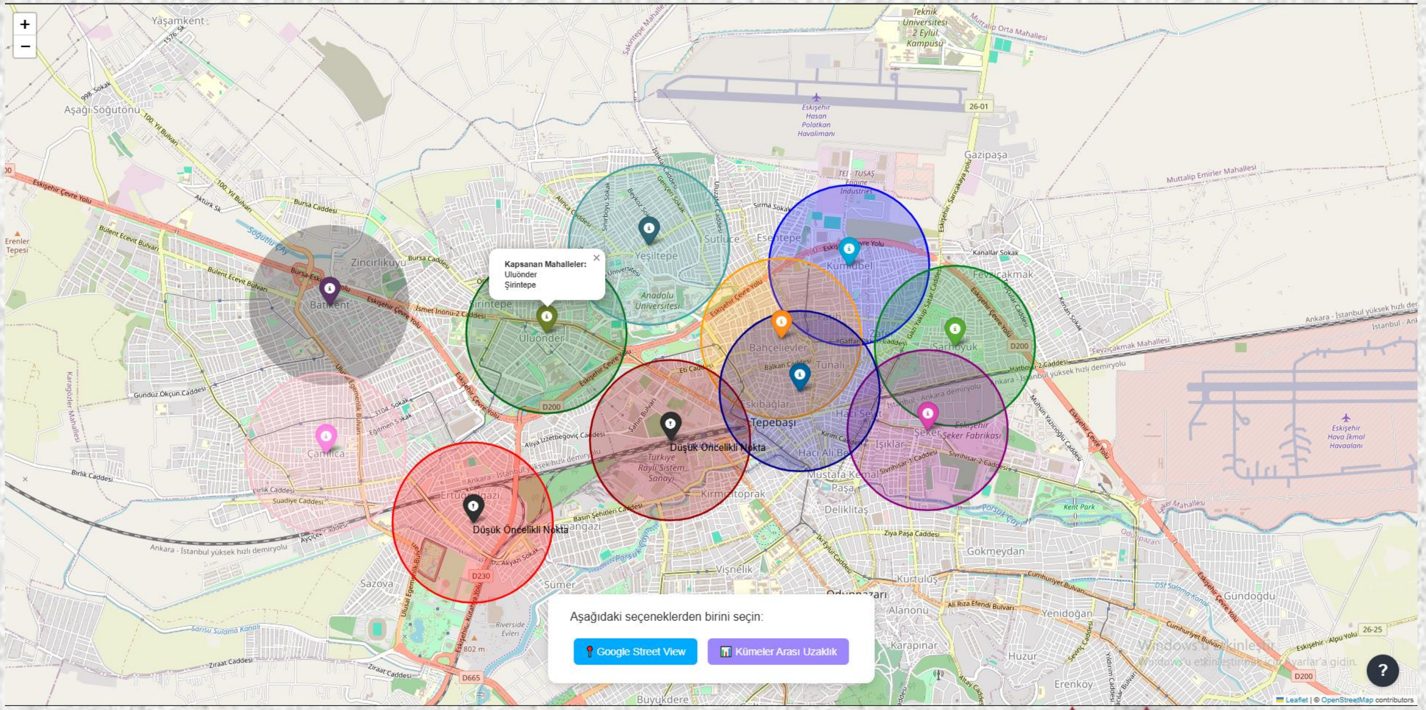
Böylece mahallelerin, nüfus, eğitim oranı, yaş profili gibi kriterler üzerinden dengeli bir şekilde sıralanması sağlanır.

Windows'u Etkinleştir
Windows'u etkinleştirmek için Ayarlar'a gidin.

In the TOPSIS Scores tab, when the user clicks on the ‘?’ icon located in the section where the threshold value is calculated and displayed with a yellow template, a panel opens providing information about TOPSIS and its calculations.

ESKİŞEHİR TEKNİK ÜNİVERSİTESİ
ESKİŞEHİR TECHNICAL UNIVERSITY

INTERFACE TABS

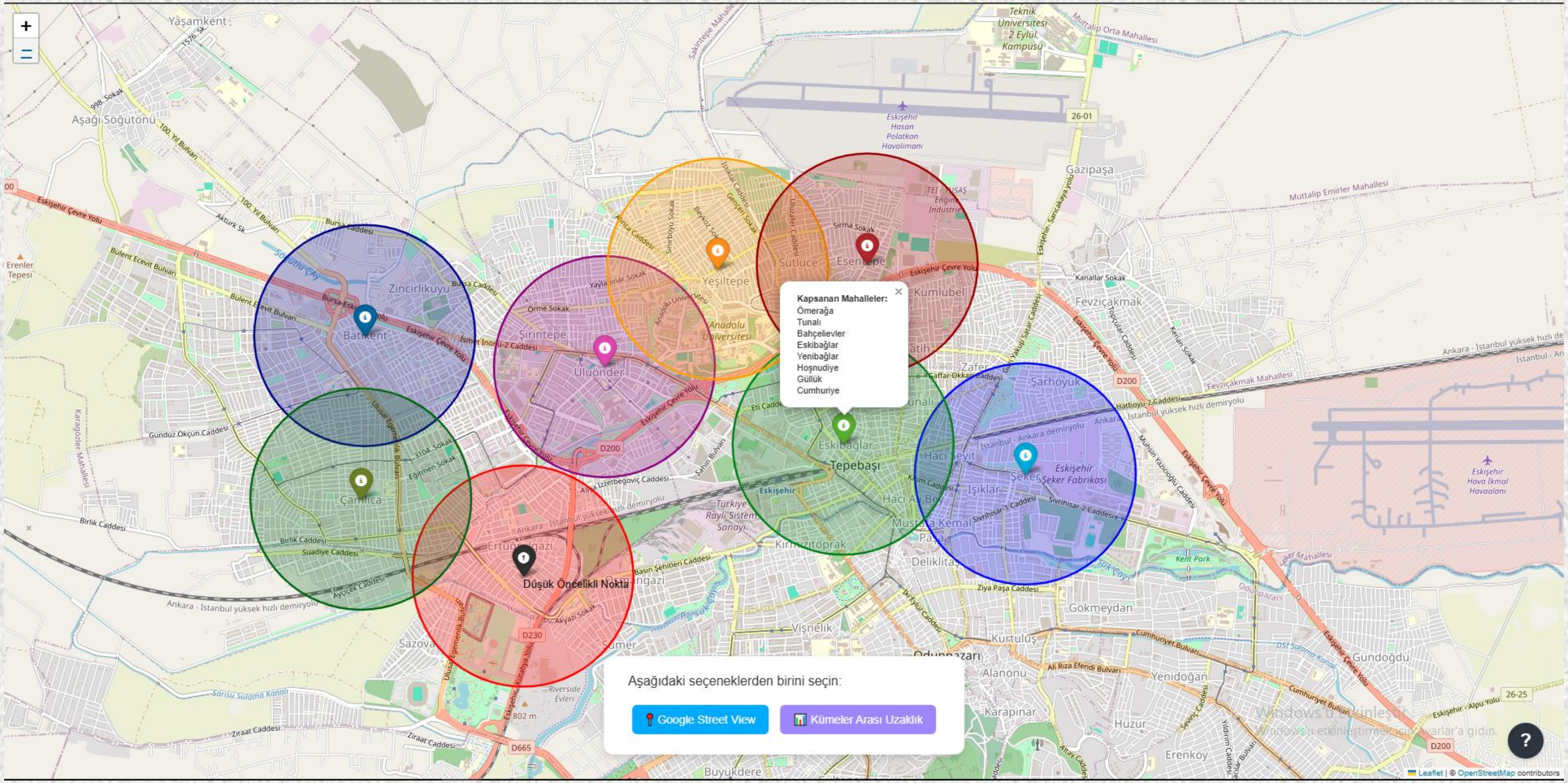


After making a selection, clicking on the map view opens a new tab displaying the map for the selected coverage radius. For the sample selection of 0.8 km, the map view appears as shown in the image.

In this image, circular clusters with a coverage radius of 0.8 kilometers are drawn within the boundaries of our study area, and the centers of these clusters — that is, the locations determined under the constraints of the Set Covering Problem and TOPSIS Method — are marked with location pins. These pins indicate the positions where smart parcel lockers should be placed.

ESKİŞEHİR TEKNİK ÜNİVERSİTESİ
ESKİŞEHİR TECHNICAL UNIVERSITY

INTERFACE TABS

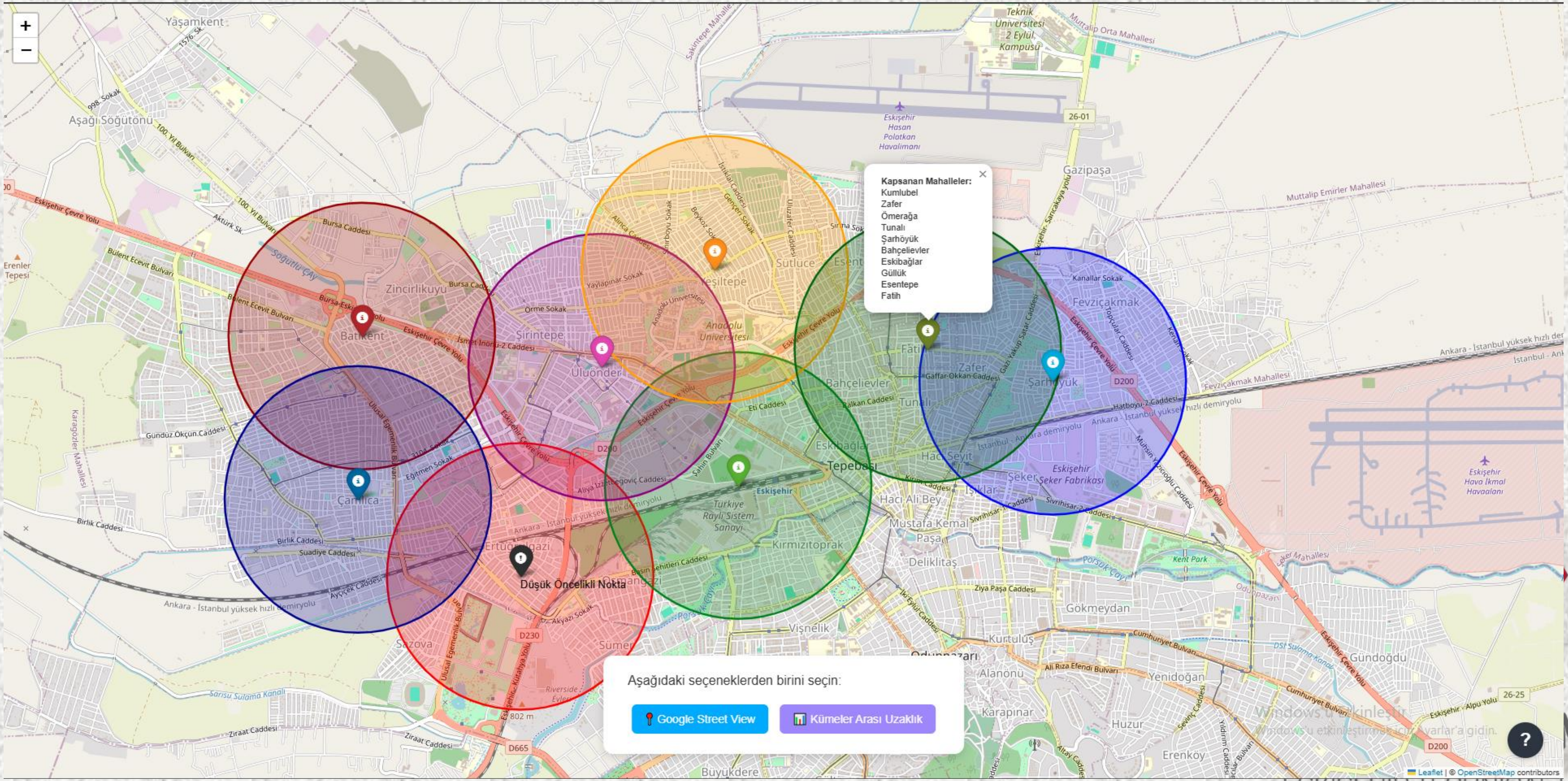


In this image, the clusters formed for a **1-kilometer coverage radius,** and the locations of the delivery lockers are displayed.

Additionally, when each location pin is clicked, the coverage area of the corresponding cluster — that is, the neighborhoods covered by each cluster — is shown.

ESKİŞEHİR TEKNİK ÜNİVERSİTESİ
ESKİŞEHİR TECHNICAL UNIVERSITY

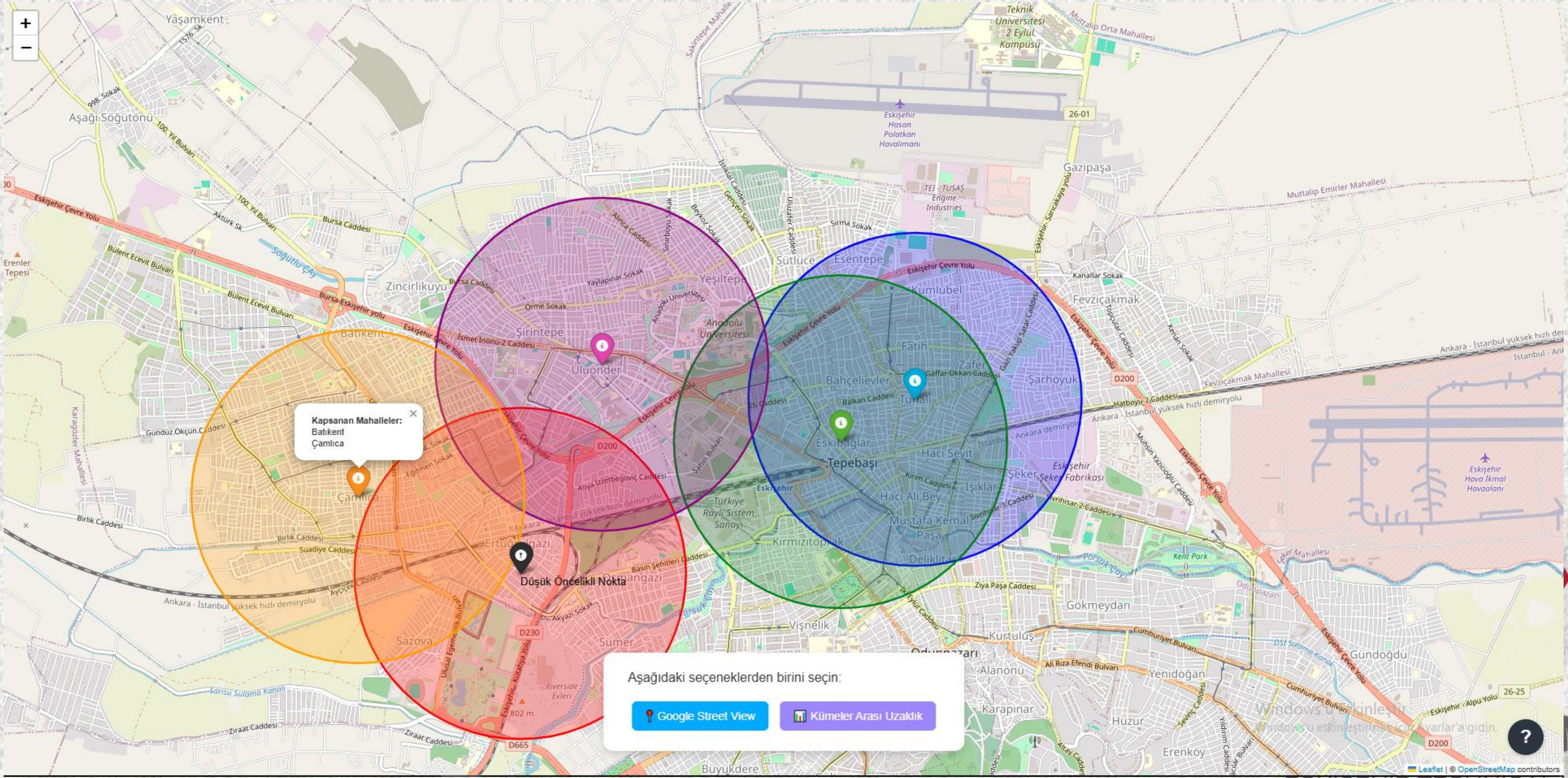
INTERFACE TABS



Map View for a 1.2 km Cluster Radius

ESKİŞEHİR TECHNICAL UNIVERSITY

INTERFACE TABS



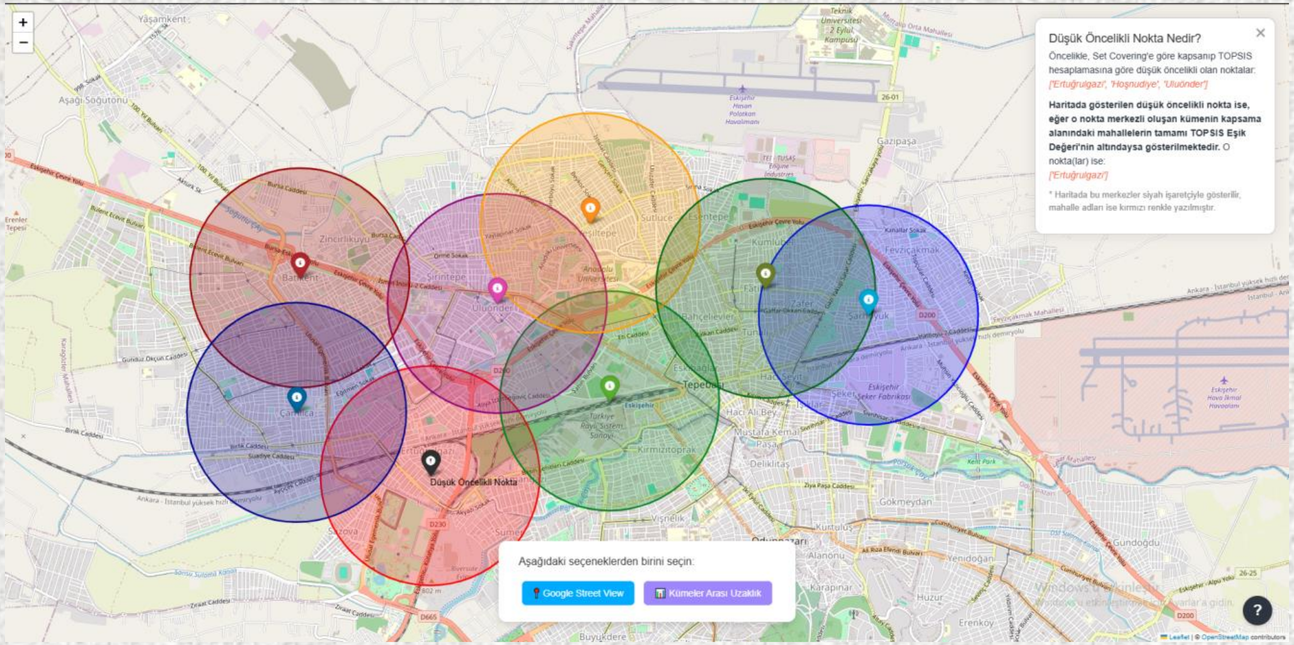
Map View for a 1.5 km Cluster Radius

ESKIŞEHIR TECHNICAL UNIVERSITY

INTERFACE TABS

When the **black '?' button** located at the bottom right corner of each map is clicked, a panel opens displaying information about the cluster(s) marked as **'Low-Priority Point'** on the respective map.

In the TOPSIS calculations found in the entry tab, all neighborhoods are ranked, and the distinction between high and low priority was determined based on the calculated threshold value (0.4980).



TOPSIS Eşik Değeri: 0.4980

TOPSIS Skorları

Mahalle	TOPSIS Skoru	Öncelikli
Yenibağlar	0.683005	EVET
Çamlıca	0.635911	EVET
Batıkent	0.612196	EVET
Fatih	0.608509	EVET
Şirintepe	0.562082	EVET
Şeker	0.548795	EVET
Yeşiltepe	0.540447	EVET
Şarhöyük	0.530204	EVET
Eskibağlar	0.512458	EVET
Sütlüce	0.505632	EVET
Bahçelievler	0.497998	EVET
Kumlubel	0.431954	HAYIR
Güllük	0.420314	HAYIR
Zafer	0.395216	HAYIR
Ömerağa	0.394444	HAYIR
Ertuğrulgazi	0.393370	HAYIR
Hoşnudiye	0.360768	HAYIR
Cumhuriye	0.351795	HAYIR
Tunalı	0.346240	HAYIR
Esentepe	0.345436	HAYIR
Uluönder	0.300696	HAYIR

For example, in the map view shown for the 1.2-kilometer cluster radius, the only neighborhoods classified as low-priority based on their TOPSIS scores are: Ertuğrulgazi, Hoşnudiye, and Uluönder. However, only the Ertuğrulgazi area is marked as a 'Low-Priority Point'.

This is because, in order for a location to be marked as a **'Low-Priority Point', all neighborhoods within its coverage area must be classified as low-priority**.

ESKİŞEHİR TEKNİK ÜNİVERSİTESİ

ESKİŞEHİR TECHNICAL UNIVERSITY

INTERFACE TABS

Additionally, there are two more buttons located at the bottom center of the map tab:

- Google Street View
- Inter-Cluster Distance

When the ‘Inter-Cluster Distance’ button is clicked, a new tab opens displaying a matrix that shows the distances between the centers of the clusters — that is, the locations identified for each smart parcel locker — created for the selected coverage radius.

The matrices for each coverage radius appear as shown in the images.

Kümeler Arası Uzaklık Matrisi (0.8 km)

	Ertuğrulgazi	Kumlubel	Şarhöyük	Şeker	Bahçelievler	Hoşnudiye	Güllük	Uluönder	Yeşiltepe	Batıkent	Çamlıca
Ertuğrulgazi	0.00	4.55	5.13	4.64	3.59	2.14	3.52	2.03	3.28	2.60	1.62
Kumlubel	4.55	0.00	1.33	1.82	0.99	2.50	1.34	3.10	2.01	5.21	5.55
Şarhöyük	5.13	1.33	0.00	0.88	1.74	3.00	1.62	4.08	3.22	6.26	6.38
Şeker	4.64	1.82	0.88	0.00	1.73	2.58	1.34	3.93	3.34	6.11	6.02
Bahçelievler	3.59	0.99	1.74	1.73	0.00	1.50	0.56	2.35	1.62	4.53	4.69
Hoşnudiye	2.14	2.50	3.00	2.58	1.50	0.00	1.38	1.63	1.96	3.66	3.44
Güllük	3.52	1.34	1.62	1.34	0.56	1.38	0.00	2.60	2.09	4.78	4.78
Uluönder	2.03	3.10	4.08	3.93	2.35	1.63	2.60	0.00	1.35	2.19	2.51
Yeşiltepe	3.28	2.01	3.22	3.34	1.62	1.96	2.09	1.35	0.00	3.25	3.84
Batıkent	2.60	5.21	6.26	6.11	4.53	3.66	4.78	2.19	3.25	0.00	1.47
Çamlıca	1.62	5.55	6.38	6.02	4.69	3.44	4.78	2.51	3.84	1.47	0.00

Kümeler Arası Uzaklık Matrisi (1.0 km)

	Ertuğrulgazi	Şeker	Eskibağlar	Uluönder	Yeşiltepe	Esentepe	Batıkent	Çamlıca
Ertuğrulgazi	0.00	4.64	3.13	2.03	3.28	4.20	2.60	1.62
Şeker	4.64	0.00	1.67	3.93	3.34	2.37	6.11	6.02
Eskibağlar	3.13	1.67	0.00	2.27	1.94	1.64	4.44	4.39
Uluönder	2.03	3.93	2.27	0.00	1.35	2.55	2.19	2.51
Yeşiltepe	3.28	3.34	1.94	1.35	0.00	1.35	3.25	3.84
Esentepe	4.20	2.37	1.64	2.55	1.35	0.00	4.59	5.05
Batıkent	2.60	6.11	4.44	2.19	3.25	4.59	0.00	1.47
Çamlıca	1.62	6.02	4.39	2.51	3.84	5.05	1.47	0.00

Kümeler Arası Uzaklık Matrisi (1.2 km)

	Ertuğrulgazi	Şarhöyük	Hoşnudiye	Uluönder	Yeşiltepe	Batıkent	Çamlıca	Fatih
Ertuğrulgazi	0.00	5.13	2.14	2.03	3.28	2.60	1.62	4.22
Şarhöyük	5.13	0.00	3.00	4.08	3.22	6.26	6.38	1.17
Hoşnudiye	2.14	3.00	0.00	1.63	1.96	3.66	3.44	2.11
Uluönder	2.03	4.08	1.63	0.00	1.35	2.19	2.51	2.96
Yeşiltepe	3.28	3.22	1.96	1.35	0.00	3.25	3.84	2.06
Batıkent	2.60	6.26	3.66	2.19	3.25	0.00	1.47	5.12
Çamlıca	1.62	6.38	3.44	2.51	3.84	1.47	0.00	5.33
Fatih	4.22	1.17	2.11	2.96	2.06	5.12	5.33	0.00

Kümeler Arası Uzaklık Matrisi (1.5 km)

	Ertuğrulgazi	Tunalı	Eskibağlar	Uluönder	Çamlıca
Ertuğrulgazi	0.00	3.90	3.13	2.03	1.62
Tunalı	3.90	0.00	0.77	2.85	5.11
Eskibağlar	3.13	0.77	0.00	2.27	4.39
Uluönder	2.03	2.85	2.27	0.00	2.51
Çamlıca	1.62	5.11	4.39	2.51	0.00

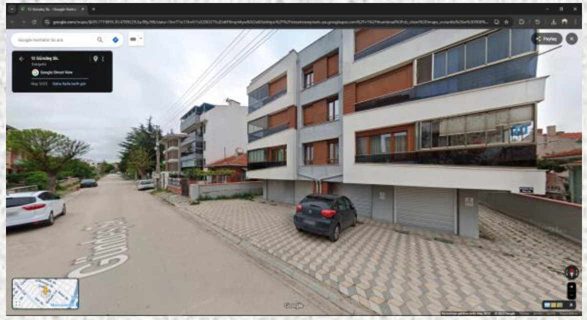
ESKİŞEHİR TEKNİK ÜNİVERSİTESİ
ESKİŞEHİR TECHNICAL UNIVERSITY

INTERFACE TABS

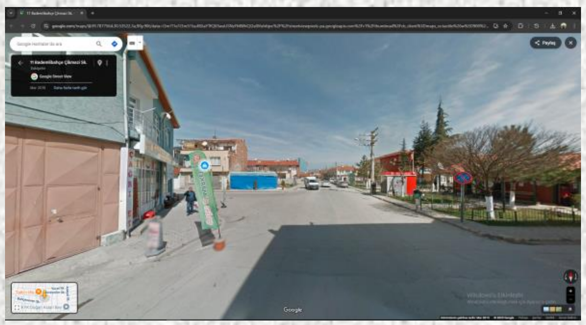
When the Google Street View button is clicked, each identified location on the map opens in a separate tab and is displayed with its street view via Google Maps.

For decision-makers, this feature provides the opportunity to manually evaluate and select points without physically visiting the locations — saving significant time, effort, and cost if a suggested point is found unsuitable.

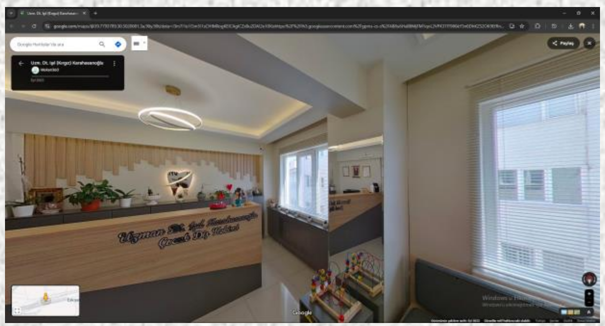
For users, it offers practical benefits by allowing them to better visualize and understand the areas.



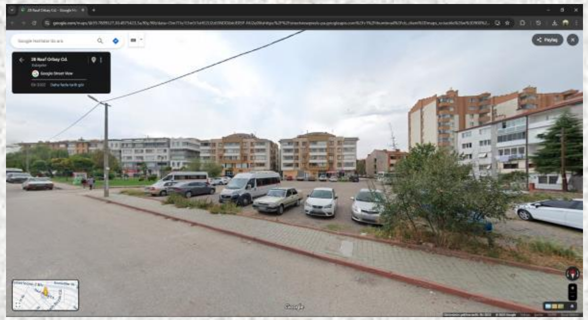
Gündeş Street, No:12, Ertuğrulgazi



Bademlibahçe Çıkmazı Street, No:11, Şarhöyük

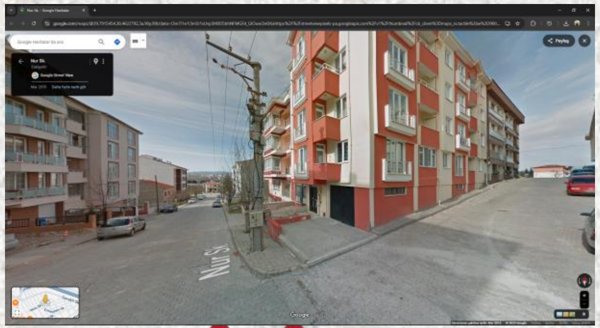


Doktorlar Street, Nayman Street, Selka Apt. Dr. Dt. Işıl (Kırgız) Karahasanoğlu, Hoşnudiye



Rauf Orbay Street, No:28, Uluönder

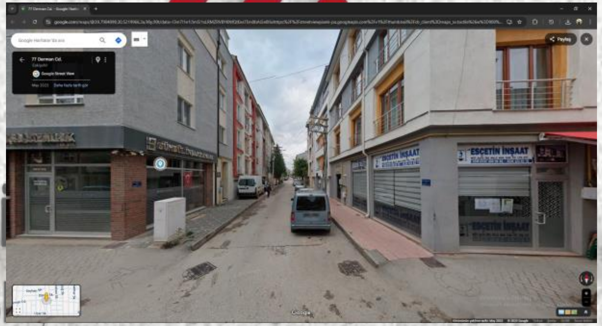
Bilgeç Street, No:50, Yeşiltepe



Nur Street, Batıkent

Google Street View Images of the Selected Locations for the 1.2 km Radius

Cihangül Street, No:8, Çamlıca



Derman Street, No:77, Esentepe

RESULTS OBTAINED

The location selection problem was solved separately for four different coverage thresholds (0.8, 1.0, 1.2, and 1.5 km). In order to evaluate the strategic suitability of the selected centers, a multi-criteria scoring of neighborhoods was conducted using the TOPSIS method, and an analysis was performed to determine whether the selected centers aligned with these scores.

As a result of the analysis, it was determined that only one center located in the **Ertuğrulgazi** neighborhood **was weaker in terms of priority** due to the **low TOPSIS scores** of the neighborhoods it covered. This analysis revealed that **mathematical coverage alone is not sufficient; demographic, logistical,** and **operational** factors must also be taken into account.

In light of these findings, it is recommended that in the future, in addition to coverage optimization, factors such as **inter-center distance constraints, cost analyses**, and **dynamic demand density** be incorporated. This would enable the model to become more compatible with **real-world field applications.**

ESKİŞEHİR TEKNİK ÜNİVERSİTESİ
ESKİŞEHİR TECHNICAL UNIVERSITY

QUANTITATIVE RESULTS

0.8 KM COVERAGE RADIUS

- Total Number of Identified Centers: 11
- Low Priority Centers: Ertuğrulgazi, Kumlubel, Hoşnudiye, Güllük, Uluönder
- Centers Covering Only Low Priority Neighborhoods: Ertuğrulgazi, Hoşnudiye

1 KM COVERAGE RADIUS

- Total Number of Identified Centers: 8
- Low Priority Centers: Ertuğrulgazi, Uluönder, Esentepe
- Centers Covering Only Low Priority Neighborhoods: Ertuğrulgazi

1.2 KM COVERAGE RADIUS

- Total Number of Identified Centers: 8
- Low Priority Centers: Ertuğrulgazi, Hoşnudiye, Uluönder
- Centers Covering Only Low Priority Neighborhoods: Ertuğrulgazi

1.5 KM COVERAGE RADIUS

- Total Number of Identified Centers: 5
- Low Priority Centers: Ertuğrulgazi, Tunalı, Uluönder
- Centers Covering Only Low Priority Neighborhoods: Ertuğrulgazi

ESKİŞEHİR TEKNİK ÜNİVERSİTESİ
ESKİŞEHİR TECHNICAL UNIVERSITY

CONCLUSION

- As part of this study, the neighborhoods in Eskişehir’s Tepebaşı district were analyzed by considering both geographical distances and demographic characteristics. Priority areas were identified using the TOPSIS method, and a minimum number of smart delivery locker locations were determined through the Set Covering model. The results obtained serve as a guide for improving service efficiency and establishing a location plan that is responsive to social needs. In conclusion, a system design that provides both analytical and visual support to decision-makers was developed.

- As a result, this thesis offers a systematic, data-driven, and multi-criteria decision support mechanism for the strategic placement of smart delivery lockers and proposes a method that can be applied in similar urban logistics planning contexts.

ESKİŞEHİR TEKNİK ÜNİVERSİTESİ
ESKİŞEHİR TECHNICAL UNIVERSITY