IE 479 Fall 2025 Project 1

Facility Planning for UMKE Field Health Facilities

Due Date: October 20, 23:59

1 General Information

Approximately 66% of our country lies in 1^{st} and 2^{nd} degree earthquake risk zones. In addition to earthquakes, Türkiye is also at high risk for floods, landslides, rockfalls, avalanches, as well as technological or anthropogenic disasters. Because disasters are so varied and frequent in our country, they cause significant numbers of deaths, direct and indirect economic losses, and social and physical damage. To enable rapid medical rescue services at debris sites in both domestic and international disasters (especially earthquakes), the "Disaster Health Organization Project" was launched by the Ministry of Health on 30 December 2003. Through this project, **UMKE (Ulusal Medikal Kurtarma Ekibi, National Medical Rescue Teams)** were created[1].

UMKE is a medical rescue team composed of health personnel who have received basic and advanced training and are equipped as needed, in order to provide medical rescue and emergency health services from the disaster site itself, through ambulance transport, until delivery to a health facility. Beyond medical rescue, depending on the scale of the disaster, UMKE can establish surgical units, emergency response units, mobile hospitals, staff accommodation units, mobile command centers, and mobile incident management centers.

UMKE teams act as first responders, working with search and rescue units directly in debris areas to prevent conditions like crush syndrome and to provide emergency stabilization. As they work with search and rescue units, it is planned to establish emergency response units near each debris to respond as soon as possible. However, when destruction is widespread, it becomes impossible to position a UMKE unit at every debris site. Instead, temporary field health facilities (such as medical tents or mobile clinics) must be established at strategic locations near major roads, where rescued victims can be quickly transported for immediate treatment.

[1] General Directorate of Emergency Health Services, 2023

2 Problem Definition

A devastating and large-scale earthquake has struck the country, causing extensive destruction across multiple provinces. Due to the vast magnitude of the disaster, the number of collapsed structures and debris sites is extremely high. As a result, it is impossible to establish a dedicated emergency response unit at every single debris site.

Hence, to ensure that medical care can still be delivered efficiently, UMKE must establish a network of strategically located field health centers. These centers will serve as medical hubs where rescued victims can be transported after initial extraction from the debris, enabling rapid stabilization, treatment of crush syndrome, and life-saving interventions within the critical hours.

To maximize effectiveness, these facilities should:

- Be accessible via major roads for ambulances and rescue vehicles,
- Cover all affected districts within a medical response radius, and
- Serve the largest possible population if resources are limited.

The planning problem is to determine where to locate UMKE field facilities after a major earthquake.

3 Case Questions

In light of the scenario above, UMKE must develop a strategic plan for placing field health facilities after the earthquake. Using the provided dataset, you are asked to solve the following problems:

1. Each **UMKE Field Health Facility** must be established near a major road or a district to ensure accessibility for ambulances and rescue vehicles. Considering the medical response requirements, determine the **minimum number** and **locations** of facilities required to ensure that every affected district is within a certain medical service radius.

   Analyze the system for radii of **2 km**, **3 km**, **4 km**, **5 km**, and **6 km**.

   - For each radius, where should UMKE Field Health Facilities be placed?
   - How many facilities are required to cover all districts?

2. Suppose UMKE has limited resources and can establish a maximum of **4 Field Health Facilities** (4 is an upper limit as a result of budget and staff constrains, you may reach the solution by establishing less facilities). In this case, the goal is to cover as many people as possible within each service radius.

   Analyze the system for the same radius values (**2 km**, **3 km**, **4 km**, **5 km**, **6 km**).

   - Which 4 locations should be selected for each radius?
   - What percentage of the total population can be served under each scenario?

3. In addition to coverage, UMKE aims to minimize the overall travel distance between districts and their assigned health facilities, ensuring faster patient transport and improved response times. The objective is to select **4 facilities** that minimize the total patient transport distance while ensuring each district is within the specified service radius.

   Analyze this for radii of **3 km**, **4 km**, **5 km**, and **6 km**.

   - Which facility locations minimize the total travel distance?
   - What is the total population-weighted distance for each radius?

Some Useful Information About the Case and Reports

1. In the provided dataset, you have three sheets named *District Population*, *District Distance*, and *Distance - 25x20.* The dataset includes **20 affected districts** from the earthquake:

    - The first sheet provides the **population** of each district (this represents total population, not number of victims — since rescue efforts are still ongoing). You will use this data in population-based optimization.
    - The second sheet shows the **pairwise distances** between districts.
    - The third sheet provides the **distances from districts to major road locations**, which serve as the **candidate sites** for UMKE field facilities.

2. You will be solving a **site selection problem**, not a site generation problem. This means you will **choose locations** for UMKE field health facilities **from among the candidate sites** provided in the dataset (districts or road locations), rather than generating new ones.

3. When writing your mathematical models:

    - Clearly state all **assumptions**,
    - Define **parameters**, **decision variables**, **objective function**, and **constraints**,
    - Provide the **full mathematical formulation**,
    - Include **explanations** for the objective function and each constraint.

4. Include an **Introduction / Executive Summary** in your report summarizing the purpose, data, and overall findings.

5. Structure your report into clear sections corresponding to each case question (**Q1, Q2, Q3**) for readability and logical flow.

6. Before starting your report, read the documentation titled *Report Format and Rules of Submission* available under the **Projects** page on the course website.

7. You do **not need to include any code** in your report (nor screenshots), unless you believe they are essential for understanding your approach.

Prepared for IE 479 – Facility Planning for UMKE Field Health Facilities, Fall 2025.

8. Submit your project as a **single ZIP file** containing:
    - Your **Report (PDF format)**,
    - Your **code(s)**,
    - And any other materials you wish to include.

    Ensure your code is runnable on other computers. If you use external data files (e.g., `.dat` for CPLEX), include them in your ZIP.

9. Name your ZIP and PDF files as `GroupNumber_Project1`. For example, if your group number is 13, name the files: `Group13_Project1.pdf` and `Group13_Project1.zip`. You can find your group number on the course website.

10. If you encounter any issues or have questions, do not hesitate to contact with Egehan Uğraş and Alkım Abanuz.