

IE479 Spring 2023
Cargo Project
Due Date: December 20, 17.30

1 Introduction

The aim of the project is to provide a solution to one of the general problems of cargo delivery systems. In Turkey, firms of cargo sector generally provide ground transportation based parcel delivery services; they utilize highways and roads with vehicles like trucks.

The main characteristics of operating structure of cargo sector can be stated as follows:

A delivery network of cargo firm consists of two types of nodes, branch offices and operation centers and routes of a ground transportation system connecting these nodes. Branch offices are the points of contact with the customers where the cargo is picked up or delivered by the consignee at the final destination. Operation centers are processing centers where incoming cargo are collected and rerouted to their destinations. They are also pick-up and delivery points for the customers.

When a customer wishes to send a parcel, he calls the nearest branch office to request pick-up or takes the parcel to the branch office himself. At the branch office, a bar code is placed on the parcel that designates the specific operation center from which the parcel will get delivered to the destined branch office. The journey of the parcel from the originating branch office to the destination branch office consists of three legs: the first leg from the originating branch office to an operation center; the second leg from this operation center to the next operation center which is the designated on the bar code; and the third leg from the second operation center to the destination branch office. Sometimes, first and second operation centers may coincide.

In the first leg, the parcel, together with other parcels originating at the same branch office, are collectively delivered from the originating branch office to an operation center that handles the deliveries of this branch office. There is exactly one such operation center for each branch office. When the truck arrives at the assigned operation center, all parcels are unloaded and this completes the first leg of the journey. The unloaded parcels at the operation center are sorted into groups according to the names of the operation centers printed on the bar codes.

The second leg of the journey consists of the direct delivery from this operation center to the next operation center. The delivery between the two operation centers is done by means of larger trucks operating on express links. The second leg of the journey is completed when the express truck arrives at its designated operation center. Parcels arriving on express trucks ending in the same operation center are unloaded, upon arrival, and sorted out according to their final branch offices.

The third leg of the parcel's journey is completed when the delivery truck arrives at the destination branch office. When the parcel under consideration arrives at its destination branch office, it is either delivered to the address of the consignee or a call is placed to notify the customer. It will be convenient to refer to trips that connect branch offices to operation centers as main lines and to trips that connect two operation centers as express lines.

A specific cargo firm that we are dealing with may also carry perishable products. Therefore, the parcels are stored in specific conditions while they are at the branch offices

or operation centers. However, during their journey on trucks, these storing conditions cannot be provided fully. As a result, the travel time spent on each route wanted to be minimized for preserving the quality of the parcels.

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2 Case Questions

Part 1: As it is explained above, we have a network consisting of main lines and express lines. The network consists of all cities of Ege, Marmara, Akdeniz and İç Anadolu Regions (40 cities). However, because of the logistics constraints, the operation centers can be located only in Adana, Ankara, Antalya, Bursa, Edirne, Eskişehir, Mersin, İstanbul, İzmir, Kocaeli, Konya and Muğla (12 cities). Assume that every city in the network has one branch office. You can reach the distance between any city pair from: <http://www.kgm.gov.tr/Sayfalar/KGM/SiteTr/Root/Uzakliklar.aspx>. Design issues related to this network include the selection of the location of operation centers and the assignment of branch offices to operation centers. Assume that there is no fleet size restriction and an express line truck is available for every operation center pair. Trucks for main lines travel at 100km/hrs. Trucks for express lines travel 1.1 times faster than main lines. Construct a delivery network with 4 operation centers while minimizing the maximum travel time spent on one trip. (Please note that trip means either the route connecting branch offices to operation centers or routes between two operation centers, NOT the whole route that connects the origin branch office and the destination branch office). Report the locations of these centers, their related assignments and your objective value.

Part 2: During its journey from the branch office to the assigned operation center, the delivery truck may stop at various other branch offices, which are also assigned to the same operation center, to pick up their parcels. Similarly, during its journey from the operation center to the branch office, the delivery truck may stop at various other branch offices, which are also assigned to the same operation center, to deliver the parcels. There is no capacity restriction for the trucks. However, one thing to consider is the duration of these trips. Since the working hours of a driver is between 6.00pm and 6.00am, a truck on the main lines can work at most 12 hours. Locate 4 operation centers as you found in Part 1. The cargo firm wants to minimize the number of trucks to utilize in order to satisfy the demand of each customer. Provide your results and routes clearly.

Part 3:

- Assume that you found X^* trucks in the previous part; however, the cargo firm can afford only $X < X^*$ trucks. Provide a feasibility analysis on how much more a truck driver has to work in one day.
- Assume that you found X^* trucks in the previous part; however, the cargo firm already has $X' > X^*$ trucks. Provide an analysis on how much the total travel distance will change (when it is minimized for X' trucks).
- It is enough to provide an analysis with 3 steps for each case.

Part 4: (Bonus) Assume that you have to give the location and routing decisions at the same time. The objective of the problem is to construct a network such that the longest delivery time is as small as possible (our objective). There are 20 trucks available on the

main lines and there is no bound on the number of trucks for the express lines. The trucks on the main line can work up to 8 hours, and additionally the trucks on the express lines cannot travel longer than 12 hours. Other data utilized in Part 1 are valid here too.

How would you model the problem? What would be your results while locating 4 operation centers? What would be your comments? How would you compare the results with the previous parts?

About Grading:

- Report Format: 20%
 - Executive summary
 - Overall explanation and language
 - Clarity
- Quality of workmanship: 40%
 - Stating the assumptions if any
 - Explanation of methodology and technique
- Quality of the solution: 40%
 - Correctness
 - Objective values