



IE 251 – LINEAR PROGRAMMING

Fall 2024-2025, METU

CASE STUDY II

IE-Tech is a manufacturing company, specializing in producing high-quality components for robotics enthusiasts and the pre-assembled robotic kit. The company's product line includes five key components: aluminum frames, carbon fiber frames, manual modules, advanced control modules, and advanced sensor modules. These components are manufactured at three plants located in Istanbul, Ankara, and Izmir. While all three plants can produce every component, the production processes and resource requirements differ at each plant. Labor and packing time requirements for each component-plant combination and available times at each plant are provided in Tables 1-3.

Table 1. Resources for Istanbul

Components	Resources	
	Labor (Minutes/unit)	Packing (Minutes/unit)
Aluminum frames	1	4
Carbon fiber frames	1.5	4
Manual modules	1.5	5
Advanced control modules	3	6
Advanced sensor modules	4	6
Monthly Availability (Minutes)	12,000	20,000

Table 2. Resources for Ankara

Components	Resources	
	Labor (Minutes/unit)	Packing (Minutes/unit)
Aluminum frames	3.5	7
Carbon fiber frames	3.5	7
Manual modules	4.5	8
Advanced control modules	4.5	9
Advanced sensor modules	5	7
Monthly Availability (Minutes)	15,000	40,000

Table 3. Resources for Izmir

Components	Resources	
	Labor (Minutes/unit)	Packing (Minutes/unit)
Aluminum frames	3	7.5
Carbon fiber frames	3.5	7.5
Manual modules	4	8.5
Advanced control modules	4.5	8.5
Advanced sensor modules	5.5	8
Monthly Availability (Minutes)	22,000	35,000

The company also manages carbon fiber. Each carbon fiber frame requires 0.25 pounds of carbon fiber, and 1,000 pounds of carbon fiber are available per month.

In addition to selling individual components, IE-Tech assembles robotic kits. A robotic kit requires 13 aluminum frames, 13 carbon fiber frames, 10 manual modules, 3 advanced control modules, and 3 advanced sensor modules. Assembly times for the robotic kit vary by plant and are given in Table 4. The total time available for assembly is also given for each plant in Table 4.

Table 4. Assembly Times

Plant	Time (Minutes per set)	Total Time Available (Minutes)
Istanbul	65	5500
Ankara	60	5000
Izmir	65	6000

Each plant supplies its retail outlet. Minimum and maximum demands for each product at each retail outlet are given in Table 5. The minimum demand must be met, but the maximum demand does not need to be fully supplied.

Planning horizon is two months. Production costs for the first month are presented in Table 6. In the second month, the production costs increase by 12%, while production times remain the same. Inventory costs are calculated based on the end-of-period inventory for each product and are 8% of the costs in Table 6. Table 7 shows the selling price for each product. In the beginning, there is no inventory.

Table 5. Minimum and Maximum Product Demand per Month

Products	Plants					
	İstanbul		Ankara		İzmir	
	min	max	min	max	min	max
Aluminum frames	0	2000	0	2000	0	2000
Carbon fiber frames	100	2000	100	2000	50	2000
Manual modules	200	2000	200	2000	100	2000
Advanced control modules	30	2000	30	2000	15	2000
Advanced sensor modules	100	2000	100	2000	100	2000
Robotic kit	0	200	0	200	0	200

Table 6. Production Costs (\$)

Products	Plants		
	İstanbul	Ankara	İzmir
Aluminum frames	6	5	7
Carbon fiber frames	19	18	20
Manual modules	4	5	5
Advanced control modules	10	11	12
Advanced sensor modules	26	24	27
Robotic kit	178	175	180

Table 7. Selling Price (\$)

Products	Plants		
	İstanbul	Ankara	İzmir
Aluminum frames	10	10	12
Carbon fiber frames	25	25	30
Manual modules	8	8	10
Advanced control modules	18	18	22
Advanced sensor modules	40	40	45
Robotic kit	290	290	310

Your task is to find the optimal production and sales plan and perform a complete sensitivity analysis to make a recommendation for the company. Sensitivity analysis should include your evaluation on product prices and resource availabilities.

Your recommendation should also address the following questions:

- If more carbon fiber were available, how much would you need, how would you use it, and what would you be willing to pay for it?
- At which plant(s) would you add extra packing machine hours, assembly hours, or labor hours? How many additional hours would you need, and how much would you be willing to pay per hour?

Prepare a report for the company to present your results and feedback on their problem.