

IE 313
Supply Chain Management
Spring 2020

Assignment 1
Due Date: 16 March 2020, 10:00

A house appliances company manufactures 92 different models of refrigerators, which differ in size, door configuration and cooling capacity. For strategic planning purposes, these models are grouped under three main families, namely *Single70* (i.e. single door, 70 cm width), *Double70* and *Double80*. In this assignment, you are going to develop an aggregate plan for this company for the next twelve months and perform various scenario analyses.

To develop the aggregate plan, you will need to construct and solve a linear programming problem minimizing the overall cost comprised of production, holding inventory and workforce related (regular time and overtime) costs. You should keep a constant workforce throughout the planning horizon. You can use overtime when it is necessary. Shortages are not allowed in the plan. The demand forecast for the three families of refrigerators and the unit production cost of each family are given as follows:

	Single70		Double70		Double80	
Months	Sales Forecast (Units)	Production Cost (\$/unit)	Sales Forecast (Units)	Production Cost (\$/unit)	Sales Forecast (Units)	Production Cost (\$/unit)
Jan	25000	450	18500	650	9500	810
Feb	25000	450	19000	650	9500	810
Mar	26000	450	20000	650	9500	880
Apr	26000	475	21000	625	7500	880
May	27000	475	20000	600	7500	880
Jun	27000	475	19000	590	7500	880
Jul	28000	500	18000	580	6500	880
Aug	29000	500	17000	550	6500	840
Sep	30000	500	19000	550	6500	840
Oct	30000	400	20000	550	6500	840
Nov	30000	400	20500	610	6500	880
Dec	30000	400	21000	640	6500	880

- Monthly inventory carrying rate is estimated as 1% of the production cost for the first six months (until and including June). It is estimated as 1.3% for the remaining months.
- Standard times to produce one unit is 1.65 hours for *Single70*, 2.15 for *Double70* and 2.68 for *Double80* refrigerators.
- The total workforce available per month is 90000 man-hours for regular time in the first half of the year. In the second half, an increase of 10000 man-hours is planned.
- During a month, overtime can be up to 25% of regular time.

- Cost of regular man-hour is 30 TL until and including June after which it becomes 35 TL. Cost of overtime man-hour is 50% higher than the regular man-hour cost.
- The initial inventories in the beginning of January are 6500 units for *Single70*, 12000 units for *Double70*, and 3000 units for *Double80*.

Base Problem: Formulate and solve the aggregate production planning problem. Draw a bar chart of monthly production and inventory for the board meeting. Comment on your plan including the total production, inventory, workforce used, and related costs.

Consider the following extensions on the base problem, independently. Analyze each case and report your conclusions.

Extension 1: During the months of June, July and August you have the option increasing your regular man-hour capacity by bringing skilled workers from another plant. Therefore, there is no hiring cost. Including the relocation cost, the total cost of extra regular man-hours will be 38 TL. Do you find this option viable? Why/why not?

Extension 2: The logistics department warns you that the total storage capacity in the finished goods warehouse for each month cannot be more than a total of 25000 units. Solve your model again under this constraint. How does your base plan change?

Extension 3: Does your plan in the extra workforce scenario (Base + Ext 1) change under the storage constraint given in the extension 2? Why/Why not?

Extension 4: Inventory carrying rate is expected to increase to 2% per month during the second half of the year (July-December). How is this going to change your base plan?

Extension 5: Production Engineering and Work Study Department warns you that the standard hours are measured with an error of 10% (i.e., all labor requirement values can change by 10%). Assuming that the storage constraint from Extension 2 is active, how sensitive is your optimal plan for (BASE + Ext 2) scenario to changes in the estimation of labor requirements? Interpret your findings.

Extension 6: The marketing department increases the forecasts of *Double80* demand in April, May and June to 17500 units per month. Assuming that the warehouse constraint is active (Ext 2), are there any months with shortages? What action do you propose to change in your plan so that there is a feasible production under this increase?