

DS 806 Spring 2024, Term Project

This is an individual project. You should not discuss or share any part of your project with anyone. Use of ChatGPT or similar tools are NOT allowed. Any evidence of cheating/plagiarizing or outside help will result with a grade of 0 on the project and potentially a grade of F for the course.

It is the middle of summer, and Elizabeth has some decisions to make for the next Fall clothes line up for her clothing line Chakra. She has a meeting with her production manager Eddy, and they will finalize next month's production plan. She has already gotten most of the work completed. She has paid 8 designers \$850,000 for the design of next season's line up. She has also spent \$2,900,000 for the four fashion shows where the new line will be displayed. This includes all the costs from the models, to choreographers, to make-up and hair artists to music and lighting and venue costs. The designs, the prices the products will sell at, their material and production costs have also been determined by her team.

	Material requirements	Price	Labor & equipment costs
Wool pants	3 yard wool	\$300	\$160
Wool Jacket	2.5 yard wool 1.5 yard lining	\$320	\$140
Cashmere long sleeve	1.5 yard cashmere	\$450	\$150
Silk Shirt	1.5 yard silk	\$180	\$100
Silk cami	0.5 yard silk	\$120	\$60
Rayon Skirt	2 yard rayon 1.5 yards lining	\$270	\$120
Faux leather pants	3 yard leatherette	\$350	\$178
Faux leather shirt	1.5 yard leatherette	\$200	\$160
blouse	1.5 yard rayon	\$120	\$90
Cotton wrap sweater	1.5 yard cotton fabric	\$130	\$60
Cotton shorts	0.5 yard cotton fabric	\$75	\$40

The facility has ordered 9,000 yards of cashmere at \$60 per yard, 45,000 yards of wool at \$9 per yard, 28,000 yards of lining at \$1.5 per yard, 18,000 yards of silk at \$13 per yard, 30,000 yards of rayon at \$2.25 per yard, 20,000 yards of leatherette at \$12 per yard, and 30,000 yards of cotton fabric at \$2.50 per yard for next month's production. Any leftover material can be sent back to the supplier for a full refund. However, scraps won't be accepted.

The production of the silk shirt and cotton wrap up sweater leaves leftover scraps of material. So even though the silk shirt only requires 1.5 yards of silk, due to its layout 2 yards of silk is needed. But due to the smart layout design they can cut the fabric so that the silk cami can be produced with the remaining 0.5 yards of silk. Thus, whenever a silk shirt is produced a silk cami is also produced. Similarly the cotton wrap sweater layout requires 2 yards of cotton fabric and a cotton short is produced with the scrap 0.5

yards. While the production of a silk shirt always results with the production of a silk cami it is also possible to produce the silk cami without producing a silk shirt. The same is true for the cotton wrap sweater and cotton shorts (production of cotton wrap sweater results with production of cotton shorts, but cotton shorts can be produced on their own too).

Elizabeth's team has also spent significant time on demand forecasting. The demand for faux leather products seems to be temporary, and based on their forecasting models they expect a maximum demand of 5000 pairs of faux leather pants and 6000 faux leather shirts. Cashmere sweater demand seems to be limited to a maximum of 4000, and the silk shirt and cami have a maximum demand of 12000 and 15000, respectively. Note that these are the maximum demand they expect to see, they are not required to meet all this demand. The forecasting models also resulted with a maximum demand of 7000 and 5000 for the wool pants and jacket, respectively. Elizabeth aims to meet at least 60% of the demand for wool pants and jackets. They expect to have a minimum demand of 2800 rayon skirts, which they also plan to meet.

a) One of the main agenda items for the meeting with Eddy is the faux leather products. Eddy has calculated that \$500,000 of the design and other costs are attributable to faux leather shirts. He argues that the net contribution of these items should at least cover these fixed costs. Net contribution of a product is found by subtracting the variable costs(material, labor and equipment) from the price of an item. This corresponds to \$22 for a faux leather shirt. Eddie argues that given this number and the demand forecasts it is not worthwhile to produce faux leather shirts and that they should be taken out from the product line up. What do you think of his argument? Explain?

b) Formulate and solve linear programming model(s) to maximize profit. (Note you may be able to simplify your models by solving multiple smaller LP's). Clearly define your variables, objective function and constraints. **Include a LEGIBLE screen shot of your Excel/AMPL models and sensitivity reports.**

c) The faux leather supplier has informed Elizabeth that the leatherette cannot be sent back, so there will be no refund for extra material. This means that 20,000 yards of leatherette at \$12 per yard will have to be paid no matter what, it is a sunk cost. Does this change the production plan? Make sure to look at the sensitivity report, and only resolve if necessary. Explain your reasoning.

d) Provide an intuitive explanation to the difference in your answers (if any) due to this change in refund policy

e) Assume, original problem (i.e. refund is still possible for leatherette). The sewing department has reported that due to the thickness of the fabric, it requires more sewing hours for each wool jacket, increasing the labor and equipment cost of each wool jacket by \$40. How does your production plan change and profit change (if any). Only resolve if necessary. Explain your reasoning.

f) Assume, original problem (i.e. refund is still possible for leatherette, no change to wool jacket costs). Elizabeth thinks that there is room for some price adjustments, without impacting demand. She proposes increasing the price of a jacket to \$350? What will be the optimal production plan and profit (do not resolve, explain your answer)

g) Assume, original problem (i.e. refund is still possible for leatherette, no change to wool jacket costs/price). The supplier has informed that due to a cancellation 10000 additional yards of lining are available.

- If the cost is the same should Elizabeth purchase more lining? What will be resulting profit? Will the production plan change? (do not resolve, if you cannot say the resulting profit without resolving state that, explain your answer)

-if she has to pay \$ 3.50 per yard of extra lining, should she still purchase the extra lining? What will be the resulting profit? Will the production plan change? (do not resolve, explain your answer)

h) Elizabeth has made a new deal which will allow her to sell all items in unlimited quantity for a 40% discount (i.e. prices are decreased by 40%) at the end of the season (i.e. the upper bounds from the model are valid only for the original price). What should be the new plan? Your model(s) should only include products that are still “profitable” at sale. Make sure to include your model and solution. Please state your solution. **Include a LEGIBLE screen shot of your Excel/AMPL models and the sensitivity reports.**

-For the products that are still profitable at 40% discount, if your model suggests not producing any, at what price points would you decide to produce them?

i) There is a new bold jacket design that requires 2 yards of wool, 1 yard of leatherette and 2 yards of lining, that requires \$180 for labor and equipment costs. What is the minimum price it should sell for, for it to be a viable product?

After providing answers to a-i, in part j, below, you are asked to prepare an executive summary report. Make sure you present your answers to above questions separately, before answering part j.

j) Please write an **executive report** about the results (recommended production plan, expected profits, etc.) based on initial problem data.

Your report should summarize your recommendations and address possible expansions based on the previous questions and any additional analysis you perform. Note that this is an **executive report** you are providing to assist in this year’s planning, as well as, for future year’s planning, assuming similar costs/prices.