Module 2 - The LP Model Assignment by Christian U. Osadebe

Solution to Problem 1: Back Savers Backpack Production

a. Decision Variables

Let:

- X_1 = number of Collegiate backpacks produced per week
- X_2 = number of Mini backpacks produced per week

b. Objective Function

Maximize weekly profit:

Each Collegiate generates a unit profit of $32, and Mini generates a unit profit of $24.

- Maximize $Z = 32X_1+24X_2$

c. Constraints

1. **Nylon Availability**

- Collegiate uses 3 sq ft
- Mini uses 2 sq ft
- Total available: 5,000 sq ft (received each week)

- $3X_1 + 2X_2 \leq 5000$

2. **Labor Time**

- Collegiate: 45 minutes
- Mini: 40 minutes
- Total labor: 35 laborers × 40 hours/week = 1,400 hours = 84,000 minutes

- $45X_1 + 40X_2 \leq 84,000$

3. **Sales Forecast Limits**
   - $X_1 \leq 1,000$
   - $X_2 \leq 1,200$
4. **Non-Negativity**
   - $X_1 \geq 0, X_2 \geq 0$

d. Full Mathematical Formulation

Maximize $Z = 32X_1 + 24X_2$

ST: $3X_1 + 2X_2 \leq 5000$ (Nylon)

$45X_1 + 40X_2 \leq 84,000$ (Labor)

$X_1 \leq 1000$ (Collegiate demand)

$X_2 \leq 1200$ (Mini demand)

$X_1, X_2 \geq 0$

Solution to Problem 2: Weigelt Corporation Production Allocation

Table 1. Product data

Sizes	Profit per Unit ($)	Storage Space (sq ft/day)	Sales Forecasts (units/day)
Large	420	20	900
Medium	360	15	1,200
Small	300	12	750

Table 2. Plant data

Plants	Storage Capacity (sq ft/day)	Excess Production Capacity (units/day)
1	13,000	750
2	12,000	900
3	5,000	450

a. Decision Variables

Let:

- j = L, M, S (Large, Medium, Small)
- i = 1, 2, 3 (plant 1, 2, and 3)
- X_{ij} = number of units of each size
  - At Plant 1: X_{1L}, X_{1M}, X_{1S}
  - At Plant 2: X_{2L}, X_{2M}, X_{2S}
  - At Plant 3: X_{3L}, X_{3M}, X_{3S}

b. Objective Function

Maximize total profit:

- Maximize $Z = 420(X_{1L} + X_{2L} + X_{3L}) + 360(X_{1M} + X_{2M} + X_{3M}) + 300(X_{1S} + X_{2S} + X_{3S})$

c. Constraints

1. **Production Capacity**
   - $X_{1L} + X_{1M} + X_{1S} \leq 750$
   - $X_{2L} + X_{2M} + X_{2S} \leq 900$
   - $X_{3L} + X_{3M} + X_{3S} \leq 450$

2. **Storage Space**
   - $20X_{1L} + 15X_{1M} + 12X_{1S} \leq 13000$
   - $20X_{2L} + 15X_{2M} + 12X_{2S} \leq 12000$
   - $20X_{3L} + 15X_{3M} + 12X_{3S} \leq 5000$
3. **Sales Forecasts**
   - $X_{1L} + X_{2L} + X_{3L} \leq 900$
   - $X_{1M} + X_{2M} + X_{3M} \leq 1200$
   - $X_{1S} + X_{2S} + X_{3S} \leq 750$
4. **Equal Utilization of Capacity**

   Let p = percentage of excess capacity used at each plant

   i.e.: $p = (X_{1L} + X_{1M} + X_{1S})/ 750 = (X_{2L} + X_{2M} + X_{2S})/ 900 = (X_{3L} + X_{3M} + X_{3S})/450$

   Therefore:

   $X_{1L} + X_{1M} + X_{1S)} = 750p$

   $X_{2L} + X_{2M} + X_{2S} = 900p$

   $X_{3L} + X_{3M} + X_{3S} = 450p$
5. **Non-Negativity**

   $X_{ij} \geq 0$