

## Operations Research Chapter 5

Par, Inc., is a small manufacturer of golf equipment and supplies whose management has decided to move into the market for medium- and high-priced golf bags. Par's distributor is enthusiastic about the new product line and has agreed to buy all the golf bags Par produces over the next three months.

After a thorough investigation of the steps involved in manufacturing a golf bag, management determined that each golf bag produced will require the following operations:

1. Cutting and dyeing the material
2. Sewing
3. Finishing (inserting umbrella holder, club separators, etc.)
4. Inspection and packaging

The linear program for this problem is

$$\begin{aligned}
 &\text{Max} && 10x_1 + 9x_2 \\
 &\text{s.t.} && \\
 &&& \frac{7}{10}x_1 + 1x_2 \leq 630 && \text{Cutting and dyeing time} \\
 &&& \frac{1}{2}x_1 + \frac{5}{6}x_2 \leq 600 && \text{Sewing time} \\
 &&& 1x_1 + \frac{2}{3}x_2 \leq 708 && \text{Finishing time} \\
 &&& \frac{1}{10}x_1 + \frac{1}{4}x_2 \leq 135 && \text{Inspection and packaging time} \\
 &&& x_1, x_2 \geq 0
 \end{aligned}$$

where

- $x_1$  : number of standard bags produced
- $x_2$  : number of deluxe bags produced

The final simplex tableau is

		$x_1$	$x_2$	$s_1$	$s_2$	$s_3$	$s_4$	
<i>Basis</i>	$c_B$	10	9	0	0	0	0	
$x_2$	9	0	1	$\frac{30}{16}$	0	$-\frac{21}{16}$	0	<b>252</b>
$s_2$	0	0	0	$-\frac{15}{16}$	1	$\frac{5}{32}$	0	<b>120</b>
$x_1$	10	1	0	$-\frac{20}{16}$	0	$\frac{30}{16}$	0	<b>540</b>
$s_4$	0	0	0	$-\frac{11}{32}$	0	$\frac{9}{64}$	1	<b>18</b>
$z_j$		10	9	$\frac{70}{16}$	0	$\frac{111}{16}$	0	<b>7668</b>
$c_j - z_j$		0	0	$-\frac{70}{16}$	0	$-\frac{111}{16}$	0	

- a. Calculate the range of optimality for the profit contribution of the standard bag.
- b. Calculate the range of optimality for the profit contribution of the deluxe bag.
- c. If the profit contribution per deluxe bag drops to \$7 per unit, how will the optimal solution be affected?
- d. What unit profit contribution would be necessary for the deluxe bag before Par, Inc., would consider changing its current production plan?
- e. If the profit contribution of the deluxe bags can be increased to \$15 per unit, what is the optimal production plan? State what you think will happen before you compute the new optimal solution.
- f. Calculate the range of feasibility for b1 (cutting and dyeing capacity).
- g. Calculate the range of feasibility for b2 (sewing capacity).

- h. Calculate the range of feasibility for  $b_3$  (finishing capacity).
- i. Calculate the range of feasibility for  $b_4$  (inspection and packaging capacity).
- j. Which of these four departments would you be interested in scheduling for overtime? Explain.
- k. Calculate the final simplex tableau for the Par, Inc., problem (Problem 6) after increasing  $b_1$  from 630 to  $682\frac{4}{11}$ .
- l. Would the current basis be optimal if  $b_1$  were increased further? If not, what would be the new optimal basis?
- m. How much would profit increase if an additional 30 hours became available in the cutting and dyeing department (i.e., if  $b_1$  were increased from 630 to 660)?
- n. How much would profit decrease if 40 hours were removed from the sewing department?
- o. How much would profit decrease if, because of an employee accident, only 570 hours instead of 630 were available in the cutting and dyeing department?
- p. Suppose because of some new machinery Par, Inc., was able to make a small reduction in the amount of time it took to do the cutting and dyeing (constraint 1) for a standard bag. What effect would this reduction have on the objective function?
- q. Management believes that by buying a new sewing machine, the sewing time for standard bags can be reduced from  $\frac{1}{2}$  to  $\frac{1}{3}$  hour. Do you think this machine would be a good investment? Why?
- m. Write the dual problem.