Step 4: Identify the Set of Non-Negativity Constraints

This is a rather formal step but very important nonetheless. Can Rolls Bakery produce a negative number of rolls? The answer is obviously no. However, the model must formally state this. As a result, the LP model is forced to generate non-negativity values by adding the following constraints:

$$x_1 \geq 0 \text{ and } x_2 \geq 0 \tag{2.4}$$

Overall Formulation

After completing these four steps, the LP model for Rolls Bakery results in the following formulation:

$$\text{Max } Z = 400x_1 + 300x_2$$

subject to:

$10x_1 + 15x_2 \leq 150$ (constraint 1)

$x_1 \geq 3$ (constraint 2)

$x_2 \geq 4$ (constraint 3)

$x_1, x_2 \geq 0$ (non-negativity constraints)

Formulating LP models is the first step toward achieving optimal solutions. The second step, solution methodology, is presented later in this chapter. But, first, another model formulation, a minimization model with two decision variables, is discussed.

Example 2: Political Advertisement Agency

Political Communications (PoliCom) is a marketing firm that specializes in political campaigns during elections. In the current election, the company is working for a gubernatorial candidate. The campaign has a goal to reach one million voters every week until election day. It is estimated that each advertisement has a nonmarginal impact. That is, the impact in the voting results is the same whether an advertisement reaches one voter five times or reaches five voters only once. Based on the data from past races, TV spots are considered

more effective than radio campaigns. For example, on an average, each TV advertisement can reach 25,000 viewers and a radio advertisement can reach 12,500 listeners. The cost per each TV spot is $1,200 and the cost for each radio spot is $400. In addition to voter impact, TV campaigns also generate greater voter turnout and donations. As a result, the campaign has decided to purchase a minimum of 30 TV spots and no more than 60 radio spots every week. The goal is to identify how many TV and radio spots must be purchased every week so the campaign can minimize the overall advertisement cost.

Formulation Steps

The suggested LP formulation steps will be followed in this example as well.

Step 1: Define Decision Variables

The description of the PoliCom example states, "The goal is to identify how many TV and radio spots must be purchased every week." As such, the decision variables can be defined as:

x_1 = number of TV spots to be purchased during a week

x_2 = number of radio spots to be purchased during a week

Step 2: Formulate the Objective Function

The goal of PoliCom is to *minimize* the cost. In this example, the *contribution coefficients* are respectively 1,200 and 400. As such, the objective function can be stated as:

$$\text{Min } Z = 1200x_1 + 400x_2$$

where Z represents the total weekly costs if the campaign decides to purchase x_1 TV spots and x_2 radio spots every week.

Step 3: Identify the Set of Constraints

The number of voters reached by each TV ad is 25,000. If the campaign runs x_1 spots, then it is expected to reach $25{,}000x_1$ voters.