then the total labor hours used for tables is $5x$ and the total labor hours for chairs is $4y$. The total use of labor can then be expressed as a linear function: $5x + 4y$. If the production line were to produce more tables and chairs, then the labor hours used would increase *proportionally* and *additively*.

LP models also assume that each parameter is known for sure (certainty) and that decision variables can take fractional as well as integer values (divisibility). When the constraints or the objective function cannot be expressed as linear equations, then other mathematical programming techniques can be used, such as nonlinear programming, integer programming, optimization heuristics, neural networks, or decision trees.

This chapter focuses on the understanding of fundamentals of mathematical programming in general and linear programming in particular. It demonstrates the importance of LP as a business analytics tool and discusses the potential use of LP to improve organizational performance. The model is explained graphically, and its solution is demonstrated graphically and via Microsoft Excel Solver.

LP Formulation

The formulation of the LP models is demonstrated with two examples. The first example is from a manufacturing environment, and the second example relates to a political marketing firm. Both examples can be represented graphically; the first example is a maximization problem, while the second example is a minimization problem. These examples are simple, but they will lay the foundation for the more complicated LP models discussed in the next chapters.

Example 1: Rolls Bakery Production Runs

Rolls Bakery produces two different types of products: dinner roll cases (DRC) and sandwich roll cases (SRC). The bakery has a total of 150 machine hours available among its baking lines during a typical production week. Each of the two products is produced in lots of 1,000 cases at a time. Each product has a different wholesale price, processing time, cost of raw materials, and weekly market demand. These values are shown in Table 2-1. The selling price for each product case is \$0.75 for a DRC and \$0.65 for a SRC. Because a production lot consists of 1,000 cases, the price per lot is \$750 and \$650, respectively, as shown in column 2 of Table 2-1. Each production lot of DRC requires 10 hours of processing time and each production lot of SRC requires 15 hours of processing time (column 3). The cost of raw materials is also calculated per lot (column 4), and it is \$250 and \$200, respectively. The labor cost per hour is \$10.

Column 5 can be used to calculate the net profit per each lot. The net profit per each DRC lot can be calculated as follows: The price per one lot of DRC is \$750 (column 2). The cost per lot is calculated by adding the cost of raw materials (\$250) and labor cost (\$10 × 10 hours = \$100). As such, the net profit for a lot of DRCs is: net profit = \$750 – (\$250 – \$100) = \$400. Similarly, the net profit for a production lot of SRCs is: net profit = \$650 – (\$200 – \$150) = \$300. Both of these profits are shown in column 5.

Finally, the contractual agreements with the retailers require that Rolls Bakery produce no fewer than 3,000 cases of DRC and no fewer than 4,000 cases of SRC, as indicated in column 6. Because each production lot can prepare 1,000 cases, the weekly demand can be met by producing three lots of DRCs and four lots of SRCs (column 7). Rolls Bakery wants to determine how many production lots should run every week from each product to maximize the total net profit while meeting the weekly demand and not exceeding the available machine hours.

Table 2-1 Production Requirements for Rolls Bakery

Product	(1) Wholesale Price per Case	(2) Wholesale Price per Lot	(3) Processing Time (in Hours) per Lot	(4) Cost of Raw Materials per Lot	(5) Net Profit per Lot	(6) Demand for Cases	(7) Demand for Production Lots
Dinner roll case (DRC)	\$0.75	\$750	10	\$250	\$400	3,000	3
Sandwich roll case (SRC)	\$0.65	\$650	15	\$200	\$300	4,000	4