**Exercises**

**in**

**Linear programming Formulation**

Formulate the following problem statements as LP problems

**Exercise 1 (Marketing Research)**

MSI conducts marketing research to learn about consumer characteristics, attitudes, and preferences. Marketing research services include designing the study, conducting surveys, analyzing data collected, and providing recommendations for the client. In the research design phase, targets or quotas may be established for the number and types of respondents to be surveyed. MSI’s objective is to conduct the survey so as to meet the client’s needs at a minimum cost.

A client firm requested MSI’s assistance in ascertaining consumer reaction to a recently marketed household product. During meetings with the client, MSI agreed to conduct door-to-door personal interviews to obtain responses from households with children and households without children. In addition, MSI agreed to conduct both day and evening interviews.

The client’s contract called for MSI to conduct 1000 interviews under the following quota guidelines:

1. Interview at least 400 households with children.
2. Interview at least 400 households without children.
3. The total number of households interviewed during the evening must be at least as great as the number of households interviewed during the day.
4. At least 40% of the interviews for households with children must be conducted during the evening.
5. At least 60% of the interviews for households without children must be conducted during the evening.

Because the interviews for households with children take additional interviewer time and because evening interviewers are paid more than daytime interviewers, the cost varies with the type of interview. Based on previous research studies, estimates of the interview costs are as follows:

|  |  |  |
| --- | --- | --- |
|  | **Interview Cost** | |
| **Household** | **Day** | **Evening** |
| Children | $20 | $25 |
| No children | $18 | $20 |

**Solution**

**Exercise 2 (Blending Problem)**

Ferdinand Feed Company receives four raw grains from which it blends its dry pet food. The pet food advertises that each ½ Kg packet meets the minimum daily requirements for vitamin C (6 units), protein (5 units) and iron (5 units). The cost of each raw grain as well as the vitamin C, protein, and iron units per pound of each grain are summarized below. Ferdinand is interested in producing the ½-Kg mixture at minimum cost while meeting the minimum daily requirements

**Vitamin C Protein Iron**

**Grain Units/Kg Units/Kg Units/Kg Cost/Kg**

1 9 12 0 75

2 16 10 14 90

3 8 10 15 80

4 10 8 7 70

**Solution**

**Exercise 3 (Product Mix)**

Floataway Tours has $420,000 that can be used to purchase new rental boats for hire during the summer. The boats can be purchased from two different manufacturers. Floataway Tours would like to purchase at least 50 boats and would like to purchase the same number from Sleekboat as from Racer to maintain goodwill. At the same time, Floataway Tours wishes to have a total seating capacity of at least 200. The company wants to maximize its daily profit.

**Boat Builder Cost Maximum Seating Expected Daily Profit**

Speedhawk Sleekboat $6000 3 $ 70

Silverbird Sleekboat $7000 5 $ 80

Catman Racer $5000 2 $ 50

Classy Racer $9000 6 $110

**Solution**

**SOLUTIONS**

**Exercise 1 (Marketing Research)**

**The Decision Variables**

DC = the number of daytime interviews of households with children

EC = the number of evening interviews of households with children

DNC = the number of daytime interviews of households without children

ENC = the number of evening interviews of households without children

**The Objective Function**

Min 20DC + 25EC + 18DNC + 20ENC

**The Constraints**

DC + EC + DNC + ENC = 1000 Total Interviews

DC + EC ≥ 400 Households with children

DNC + ENC ≥ 400 Households without children

-DC + EC - DNC + ENC ≥ 0 At least as many evening interviews as day interviews

-0.4DC + 0.6EC ≥ 0 At least 40% of homes-w-children interviews during the evening

-0.6DNC + 0.4ENC ≥ 0 At least 60% of homes-w/o-children interviews during the evening

DC, EC, DNC, ENC ≥ 0 (Non-Negativity Constraints)

**Exercise 2 (Blending Problem)**

**Decision Variables**

xj = the Kg of grain j (j = 1,2,3,4) used in the ½-Kg mixture

**Objective Function**

Min .75x1 + .90x2 + .80x3 + .70x4

**Constraints:**

x1 + x2 + x3 + x4 = 0.5 (Total weight of the mix is 0.5 Kg)

9x1 + 16x2 + 8x3 + 10x4 ≥ 6 (Total amount of Vitamin C in the mix is at least 6 units)

12x1 + 10x2 + 10x3 + 8x4 ≥ 5 (Total amount of protein in the mix is at least 5 units)

14x2 + 15x3 + 7x4 ≥ 5 (Total amount of iron in the mix is at least 5 units)

xj ≥ 0 for all j (Non Negativity of Variables)

**Exercise 3 (Product Mix)**

**Decision Variables**

*x*1 = number of Speedhawks ordered

*x*2 = number of Silverbirds ordered

*x*3 = number of Catmans ordered

*x*4 = number of Classys ordered

**Objective Function**

Max 70*x*1 + 80*x*2 + 50*x*3 + 110*x*4

**Constraints**

6000*x*1 + 7000*x*2 + 5000*x*3 + 9000*x*4 < 420,000 Spend no more than $420,000:

*x*1 + *x*2 + *x*3 + *x*4 > 50 Purchase at least 50 boats:

*x*1 + *x*2 = *x*3 + *x*4 or *x*1 + *x*2 - *x*3 - *x*4 = 0 Equal number of Sleekboat & Racer boats

3*x*1 + 5*x*2 + 2*x*3 + 6*x*4 > 200 Capacity at least 200:

*xi* > 0, for *i* = 1, 2, 3, 4 Non-negativity of variables: