INSTITUTO SUPERIOR DE AGRONOMIA

Applied Operations Research

**Goal programming – Exercises**

1) The Dewright Company problem includes all three possible types of goals: a lower, one-sided goal (long-term profit); a two-sided goal (employment level); and an upper, one-sided goal (capital investment). Letting the decision variables *x*1, *x*2, *x*3 be the production rates of products 1, 2, and 3, respectively, we see that these goals can be stated as

profit goal is a lower one-sided goal: 12 x1 + 9 x2 + 15 x3 ≥ 125

employment goal is a two-sided goal: 5 x1 + 3 x2 + 4 x3 = 40

investment goal is an upper one-sided goal: 5x 1 + 7 x2 + 8 x3 ≤ 55

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| **Factor** | **Unit contribution** | | | **Goal Unit** | | | **Penalty Weight** |
| **Product** | | |
| **1** | **2** | **3** |
| Long-term profit | 12 | 9 | 15 | ≥ | 125 | (millions of dollars) | 5 |
| Employment level | 5 | 3 | 4 | = | 40 | (hundreds of employees) | 2(+), 4(-) |
| Capital investment | 5 | 7 | 8 | ≤ | 55 | (millions of dollars) | 3 |

Given the penalty weights incurred by missing these goals shown in the rightmost column of the table, find the production rates of the 3 products that minimize the sum of weighted penalties.

2) Reconsider the original version of the Dewright Co. problem presented in exercise 1 and summarized in the table below. After further reflection about the solution obtained by the simplex method, management now is asking some what-if questions.

a)Management wonders what would happen if the penalty weights in the rightmost column of the table were to be changed to 7, 4, 1, and 3, respectively. Would you expect the optimal solution to change? Why?

b) Management is wondering what would happen if the total profit goal were to be increased to at least $140 million (without any change in the original penalty weights). Solve the revised model with this change.

c) Solve the revised model if both changes are made.

**Multi-objective Linear Programming – Exercise**

1) Blackstone Mining Company operates 2 coal mines Wythe and Giles producing 3 types of coal: high, medium and low level. The manager is anticipating a demand increase for coal in the coming year. Projections indicate a 48 ton increase in the demand for high-grade coal, a 28-ton increase in the demand for medium-coal and a 100-ton increase in the demand for low-grade coal. To handle these demand increases extra shifts of workers to the mines must be scheduled. The amount of coal that can be produced in a month’s time at each mine by a shift of workers is summarizes in the table below:

|  |  |  |
| --- | --- | --- |
| Coal production by type of coal | Wythe Mine | Giles Mine |
| High | 12 | 4 |
| Medium | 4 | 4 |
| Low | 10 | 20 |

Each extra shift has an extra cost of 40000/month at Wythe and 32000/month at Giles. One extra shift can be scheduled per month at each mine. The extraction methods lead to the production of toxic water. Running an extra shift leads to the production of 800 and 1250 gallons of toxic water at Wythe and Giles, respectively. Despite safety guidelines are followed, 0.2 and 0.45 life-threatening accidents are expected to occur at Wythe and Giles, respectively

1.1) Define the managers’ problem

1.2) Identify the decision variables

1.3) Write the objective function(s)

1.4) Define the constraints

1.5) Formulate the problem in Excel for solver application considering the multi-objective linear programming weighted normalized method