Tutorial #7: Decision Aid Methodology
31st May, 2011

Question: Airport Gate Assignment

Bet Airways flies several flights to- and from- one of its hub airports of Bombay daily. Bombay airport has 25 gates in all to be shared among different airlines. However Bet being a premium service carrier ensures that all its flights get slots in the gates so that the passengers can reach the airport terminal directly by walking through the aerobridge. Even though they hold the option of ferrying passengers by buses to the airport terminal, they do not want to explicitly plan for this eventuality.

Every flight that enters Bombay departs as a different flight number. For example, a flight from Bangalore with flight number BY401 arrives at Bombay at 19:15 hours and departs as flight number BY712 to Chennai at 20:20 hours. Two different flight numbers arriving and departing the airport with the **same** aircraft is called a turn. Sometimes an incoming flight might arrive on one day but only depart the next day. It is still considered to be the part of the same turn, but the length of the stay at the airport tarmac or gate will decide if a turn is a **long turn**.

Meanwhile at the corporate office of Bet, there is a heated discussion on the escalated costs for airport operations. Airport Authority of India, which is the managing body of all airports in India, has raised the different airport fees by as much as 50% in the last 2-3 years. Airline companies have to pay for runway slots, tarmac positions, gate slots as well as aerobridges. CFO and the Vice President (Sales) differ on their view about taming the escalating costs at the airports. While CFO wants to review Bet's policy of allocating a gate slot and aerobridge to every incoming flight, VP (Sales) feels that it is a major differentiator in this business and any policy changes would require a lot of efforts, rebranding and, most of all, hurt the company's image which recently advertised about every Bet flight being provided with an aerobridge. A majority of Bet's customers are Business flyers, but CFO insists that gate slot costs have risen by over 100% in just one year and Bombay airport has again hiked the rentals.

After an intervention by the CEO, it is agreed that Duty Manager at Bombay airport would be asked to improve the gate utilization and see the impact for the next few weeks. It is in this situation that the duty manager hires you as a consultant to optimize the operational costs at the Bombay airport.

These are challenges for you:

- One of your first tasks is to find out the optimal number of gates that would satisfy a gating position or a tarmac position for every flight. Cost of using a gate at any time of the day is Rs. 5000. For example, if there are 25 gates and Bet is able to gate all its flights in 20 gates, the gate utilization cost is Rs. 5000 x 20 = Rs. 10000. Duty manager wants to ensure that every flight actually finds a gate. However if a turn cannot be slotted to the gate, duty manager wants you to penalize such a turn by giving a notional cost of Rs. 10000. What is the optimal number of gates?

- Let us assume that there must be a gap of 15 mins between every departing turn and next arriving turn. What is the optimal number of gates required then?

- Assume that some gates have specific equipment restrictions. It means that those gates cannot handle equipments that are specified. How does your optimal solution change?

- Analyze the solution. It seems that the need to provide gates to overnight turns is one of the constraining reasons requiring more gates than necessary. This can be offset by towing any long turn that has duration of more than 2 hours into two short turns. Assume that the aircraft can return to the remote bay after 20 mins of arriving and can again return to the departing gate 20 mins before departing. Assume that the cost of towing is Rs. 2000. How does the optimal solution change?

Question: Sensitivity Analysis

You have 5 food items to choose from. Being a highly health conscious individual you want minimize the calorie intake, while satisfying the necessary vitamin requirements for healthy life. The data is as given below:

Food Item	**1**	**2**	**3**	**4**	**5**
Calories	40	26	30	47	35
Vitamin A	11	9	9	17	12
Vitamin B	8	15	18	12	19
Vitamin C	12	7	8	8	16

Vitamin	Minimum Requirement
Vitamin A	800
Vitamin B	800
Vitamin C	600

Use MATHPROG to answer the following:

a. Determine the combination of food items that must be consumed in order to minimize the calorie intake while meeting the vitamin intake requirements. Note: The complete data and model files have been provided to you to answer this question.

b. Find all the dual variable and reduced cost values.

c. If the calorie content of each unit of food item 1 is reduced from 40 to 20, would this affect your optimal diet? Explain why or why not.

d. How would the optimal solution change if the Vitamin C content of food item 3 is increased from 8 to 12 units? Explain the result.