Workforce Planning

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2002, Fall 2010

The Sanitation Department has a problem with overtime spending. OMB claims the Department over spends its OT budget by millions. The Department claims it has to run the OT because OMB hasn’t authorized it to hire enough workers to do all the jobs that must be done. When there is more work to do than workers available, the Department runs overtime by calling workers in on their day off. That is, workers are scheduled to work five of the six days of the Monday to Saturday workweek. Some get Monday off, some Tuesday, etc.

Because of a variety of reasons, there are months in which there are not enough workers available to do all the work. To get enough workers in on a day when there is more work than workers, workers are called in on their scheduled day off rather than just having their day extended as is done in other organizations or industries. Work on the scheduled day off, the sixth work day of the week, is paid at the overtime rate.

On the other hand there are months in which the Department has extra or surplus workers. Those surplus workers are put to work, but the work they do does not reduce the workload of future months. As such in some months there is OT and others surplus.

To solve the problem the Department set out to build a workforce planning model. It consisted of two parts. The first part was an analysis of all the jobs for which the Department was responsible, namely refuse collection, waste disposal, and street cleaning. Since the amount of refuse to collect and the amount of litter to pick up varies seasonally and from month to month, the total number of worker-days needed to do all the work varies as well. As such the Department conducted a thorough study of exactly how many worker-days of effort were needed for the average day of each month.

The second part was an analysis of workforce availability. The percentage of the workforce that shows up for work varies seasonally and from month to month as well. Summer months are vacation months and other times of the year are marked by more sick or injury days. High attrition, mainly due to retirements, is more likely to occur at certain times of the year as well.

The number of worker-days of work required and worker-days available for each month given an initial headcount on January 1 are listed in Table 1. This is the baseline of work that needs to be done under the current agreement with OMB and the baseline of worker-days available for the current workforce assuming no additional workers are hired. It includes all absences for vacation, sick leave, etc. as well as attrition. The salaries of the current workers are already built into the budget and therefore can be considered for this analysis a fixed cost.

When the Department hires new workers, it puts them through a one-month training period during which they are paid their full salary but are not available for any fieldwork. Assume they are hired on the first day of one month and begin field service the first day of the next month. The training facility can train up to 400 new recruits at one time.

New workers earn $3360 per month. For modeling purposes, the average cost for a worker when they work their sixth day is $350 per day. Also, new hires are available for 17 days of straight time work each month after training.

Table 1

Month Monthly Requirement Monthly Available

January 89,050 96,200

February 86,580 92,950

March 87,360 95,160

April 90,740 90,220

May 91,260 89,570

June 92,040 87,230

July 97,890 86,450

August 95,680 85,540

September 95,160 88,920

October 92,950 88,010

November 92,430 86,840

December 91,130 88,660

The Department wants to find a hiring strategy that minimizes cost yet still meet all work requirements. Model one year of work to answer the following questions:

1. How much overtime is incurred if no one is hired?
2. What reduction in cost is achieved by hiring optimally?
3. How many workers would have to be hired (and when) if OMB said they were limiting the Department to $3 million in overtime?
4. In March of the year being modeled, the Mayor said he wanted to do more street cleaning and ordered OMB to budget for 100 more worker-days of street cleaning work be done each day for the rest of the year starting in July. Determine what would happen to the hiring strategy by adding this additional requirement while keeping the $3 million OT limit.

Modeling Tip:

Overtime is incurred when Requirement is greater than Availability. Surplus is incurred when Availability is greater then Requirement. Total Overtime is the sum of all monthly overtime figures. But since Surplus does not cancel Overtime, you cannot calculate Total Overtime by summing the monthly differences. You want to sum only the monthly differences when Requirement is greater than Availability. Remember: “If Statements” are not allowed in Linear Programming models. In this model set up a variable for each month, say DIFF(June) equal to Requirement(June) minus Availability(June). Add another DECISION variable, say OT, with the constraint that OT(June) is greater than or equal to DIFF(June). Then add another constraint that OT(June) must be greater than or equal to zero. If DIFF(June) is negative indicating a Surplus for June, then OT(June) will have to be zero. Then sum the OTs to get Total Overtime for the year.

For example, assume we have 4 months with the following requirements and availability of workers:

1 2 3 4

Avail 78000 85800 91000 85800

Require 104000 88400 88400 80600

Diff 26000 2600 -2600 -5200

(Diff = Require – Avail)

Months 1 and 2 are in deficit and months 3 and 4 are in surplus. As such OT is needed in 1 and 2 but not 3 and 4. To get total OT, the positives must be summed without the negatives. Create (in addition to decision variables for hiring) another row of Decision variables below Diff and call it OT, like this:

Diff 26000 2600 -2600 -5200

OT 0 0 0 0

Since OT is a Decision variable, just put a number (zero is a good start) in the OT cells. The computer (Solver) will figure out which are the right numbers for those cells. In this case it is obvious what the right numbers are:

Diff 26000 2600 -2600 -5200

OT 26000 2600 0 0

To make this happen, create in Solver two constraints for each cell in OT. The first is that OT must be greater than or equal to Diff. The second is that OT must be greater than or equal to zero. If Diff is positive, Solver will make OT equal to Diff to satisfy both constraints. If Diff is negative, Solver will make OT equal to zero to satisfy both constraints. In both cases Solver will pick the smallest number that will satisfy both constraints. Total OT then is the sum of the OT row. That times the per day pay for OT gets put into the objective function.