

Module 08 – Scheduling Problem

Exploratory Data Analysis

In this section, you should perform some data analysis on the data provided to you. Please format your findings in a visually pleasing way and please be sure to include these cuts:

- Make a table (similar to the textbook example) showing the temporary agency data
- Run summary statistics on the sample of Full-Time employee salaries. Record the Mean to use in our model
- Make a line graph showing foot traffic over the next 12 months. Call out any seasonality or trend you may see.

Model Formulation

Write the formulation of the model into here prior to implementing it in your Excel model. Be explicit with the definition of the decision variables, objective function, and constraints.

Solver Parameters

Set Objective:

To: ☐ Max ☒ Min ☐ Value Of:

By Changing Variable Cells:

Subject to the Constraints:

☒ Make Unconstrained Variables Non-Negative

Select a Solving Method:

Solving Method
Select the GRG Nonlinear engine for Solver Problems that are smooth nonlinear. Select the LP Simplex engine for linear Solver Problems, and select the Evolutionary engine for Solver problems that are non-smooth.

MIN: $23,862X_1 + 22,503X_2 + 19,875X_3 + 16,292X_4 + 21,303X_5 + 72,372X_6$

Workers required each day:

$0X_1 + 0X_2 + 0X_3 + 0X_4 + 1X_5 + 1X_6 \geq 220$ } January
 $0X_1 + 0X_2 + 0X_3 + 0X_4 + 1X_5 + 1X_6 \geq 301$ } February
 $0X_1 + 0X_2 + 0X_3 + 0X_4 + 1X_5 + 1X_6 \geq 416$ } March
 $0X_1 + 0X_2 + 1X_3 + 0X_4 + 0X_5 + 1X_6 \geq 466$ } April
 $0X_1 + 0X_2 + 1X_3 + 0X_4 + 0X_5 + 1X_6 \geq 408$ } May
 $1X_1 + 0X_2 + 1X_3 + 0X_4 + 0X_5 + 1X_6 \geq 301$ } June

$$\begin{aligned}
 1X_1 + 0X_2 + 0X_3 + 0X_4 + 0X_5 + 1X_6 &\geq 251 \text{ } \} \text{ July} \\
 1X_1 + 0X_2 + 0X_3 + 1X_4 + 0X_5 + 1X_6 &\geq 316 \text{ } \} \text{ August} \\
 0X_1 + 0X_2 + 0X_3 + 1X_4 + 0X_5 + 1X_6 &\geq 449 \text{ } \} \text{ September} \\
 0X_1 + 1X_2 + 0X_3 + 0X_4 + 0X_5 + 1X_6 &\geq 536 \text{ } \} \text{ October} \\
 0X_1 + 1X_2 + 0X_3 + 0X_4 + 0X_5 + 1X_6 &\geq 501 \text{ } \} \text{ November} \\
 0X_1 + 1X_2 + 0X_3 + 0X_4 + 0X_5 + 1X_6 &\geq 380 \text{ } \} \text{ December}
 \end{aligned}$$

X_1 = the number of workers assigned to shift 1
 X_2 = the number of workers assigned to shift 2
 X_3 = the number of workers assigned to shift 3
 X_4 = the number of workers assigned to shift 4
 X_5 = the number of workers assigned to shift 5
 X_6 = the number of workers assigned to shift 6
 X_7 = the number of workers assigned to shift 7

Model Optimized for Min Costs to Cover Store Foot Traffic

Implement your formulation into Excel and be sure to make it neat. This section should include:

- A screenshot of your optimized final model (formatted nicely, of course)
- A text explanation of what your model is recommending

| Agency | Days On = 1, Days Off = 0 | | | | | | | | | | | | Workers | Wages per Worker |
|------------------------|---------------------------|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|----------|------------------|
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | Schedule | |
| WigglePop Wonders | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | \$ 23,862 |
| The Jellybean Treasury | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 1 | 120 | \$ 22,503 |
| PopRocks & PixieDust | 0 | 0 | 0 | 1 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 50 | \$ 19,875 |
| Gumdrops & Giggles | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 0 | 0 | 0 | 33 | \$ 16,292 |
| Cocoa Quirk | 1 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | \$ 21,303 |
| Full Time | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 416 | \$ 72,372 |
| Available | 416 | 416 | 416 | 466 | 466 | 466 | 416 | 449 | 449 | 536 | 536 | 536 | | |
| Required | 220 | 301 | 416 | 466 | 408 | 301 | 251 | 316 | 449 | 536 | 501 | 380 | Total -> | \$ 34,338,478 |

My model is recommending that to minimize total costs in scheduling workers, certain steps must be taken. Following the data graph listed above, they must balance both full and part-time workers along with their average salary. They must make available between 12 months 416, 416, 416, 466, 466, 466, 416, 449, 449, 536, 536, & 536 workers, respectively. By doing so, the Net Flow between the agencies will fulfill the required workers' need to work each month.

Model with Stipulation

Please copy the tab of your original model before continuing with the next part to avoid messing up your original solution.

Please do both of the following:

1. Unfortunately, leadership wishes to have a reduction in the workforce. While the monthly salary for full-time employees is cheaper than temporary workers, there are other costs associated with full-time employees that they wish to cut. Add a constraint to your model that takes your first model's recommended number of full-time employees and constrains it to be only 80% of it. Add a text explanation of the change in the optimal value, as well as any other changes noticed between the models.

By altering the number of full-time workers hired by 20%, there are a series of outcomes. As seen in the model, the workers' schedule drops from 416 to 332.8. Additionally, the Available number of workers between the 12 months drops to 332.8, 332.8, 332.8, 382.8, 382.8, 382.8, 332.8, 365.8, 365.8, 452.8, 452.8, & 452.8. As a result of these factors, the minimized function for Total Cost drops more than \$6,000, meaning the business will achieve savings of \$6,000 annually if the cutting of hours is put into effect.

2. *Alternatively, leadership would like to see what the average monthly salary for an employee would need to be to cut out all temporary workers, as they believe that will help negate excess spending. Convert your model (or do the math out yourself) to figure out what monthly salary you would need to pay your full-time employees to only have full-time workers at the same optimal cost as the original model.*
The cost is \$30,106,732 Annually & \$2,508,894 Monthly for the Full-time workers.
3. *Considering trends and seasonality of this business, what would you recommend leadership to do? Feel free to play with the model and recommend something else.*
I would recommend employing 80% of the workforce as full-time employees and 20% of the workforce as part-time workers. I believe that model would result in the most cost savings and be economically feasible in the short and long term.