

Module 08 – Scheduling Problem

Exploratory Data Analysis

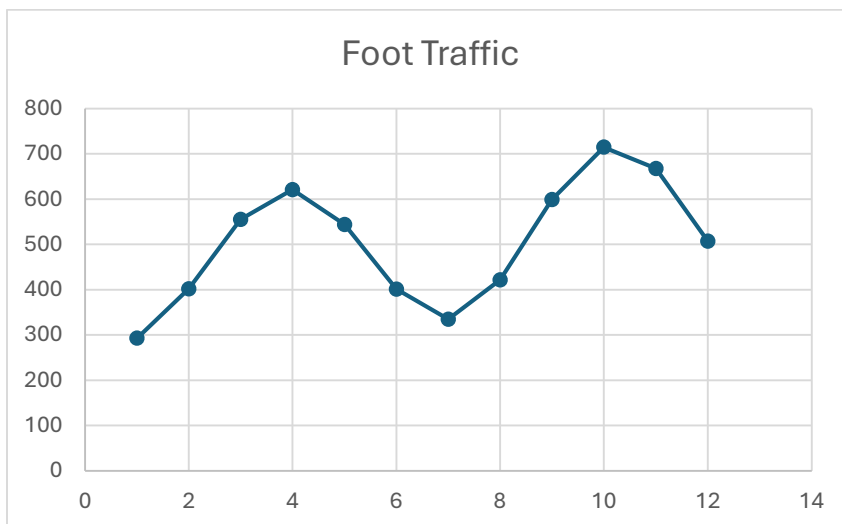
In this section, you should perform some data analysis on the data provided to you. Please format your findings in a visually pleasing way and please be sure to include these cuts:

- *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.*

Agency	Beginning Month of Service	Duration of Service	Montly Salary
The Gooley Guild	2	3	11117
Caramel Caper	5	2	11246
Suckerpunch Sweets	7	3	12039
The Candy Cauldron	12	2	9922
Sweet Whirlwind	9	3	10082

Shift	Month Off	Yearly Wage (\$)
The Gooley Guild	1, 4-12	11117
Caramel Caper	1-4, 7-12	11246
Suckerpunch Sweets	1-6, 10-12	12039
The Candy Cauldron	2-11	9922
Sweet Whirlwind	1-8	10082

Average Full Time Salary: \$8901 but you have to multiply by 12 because it's one month so it is \$106,812.



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.

Objective: Minimize Total Wage Expense (Rounded)

Minimize:

Minimize:

$$111,165X_1 + 112,462X_2 + 120,390X_3 + 99,222X_4 + 100,816X_5 + 135,366X_6 + 106,813X_7$$

Decision Variables

Let:

- X_1 : Number of workers assigned to The Gooney Guild
- X_2 : Number of workers assigned to Caramel Caper
- X_3 : Number of workers assigned to Suckerpunch Sweets
- X_4 : Number of workers assigned to The Candy Cauldron
- X_5 : Number of workers assigned to Sweet Whirlwind
- X_6 : Number of Full-Time workers
- X_7 : Number of workers assigned to Shift 7 (or alternate rotation)

Constraints: Workers Required by Month

Month 1:

$$X_1 + X_2 + X_3 + X_4 + X_5 + X_6 + X_7 \geq 293$$

Month 2:

$$X_1 + X_2 + X_3 + X_4 + X_5 + X_6 + X_7 \geq 402$$

Month 3:

$$X_1 + X_2 + X_3 + X_4 + X_5 + X_6 + X_7 \geq 555$$

Month 4:

$$X_1 + X_2 + X_3 + X_4 + X_5 + X_6 + X_7 \geq 621$$

Month 5:

$$X_1 + X_2 + X_3 + X_4 + X_5 + X_6 + X_7 \geq 544$$

Month 6:

$$X_1 + X_2 + X_3 + X_4 + X_5 + X_6 + X_7 \geq 401$$

Month 7:

$$X_1 + X_2 + X_3 + X_4 + X_5 + X_6 + X_7 \geq 335$$

Month 8:

$$X_1 + X_2 + X_3 + X_4 + X_5 + X_6 + X_7 \geq 422$$

Month 9:

$$X_1 + X_2 + X_3 + X_4 + X_5 + X_6 + X_7 \geq 599$$

Month 10:

$$X_1 + X_2 + X_3 + X_4 + X_5 + X_6 + X_7 \geq 715$$

Month 11:

$$X_1 + X_2 + X_3 + X_4 + X_5 + X_6 + X_7 \geq 668$$

Month 12:

$$X_1 + X_2 + X_3 + X_4 + X_5 + X_6 + X_7 \geq 507$$

Nonnegativity and Integer Requirements

$X_i \geq 0$ and integer for all $i \in \{1, 2, \dots, 7\}$

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

Shift	Month On = 1, Month Off = 0												Workers Schedule	Wages per Worker	Duration	Monthly
	1	2	3	4	5	6	7	8	9	10	11	12				
The Gooley Guild	0	1	1	1	0	0	0	0	0	0	0	0	199	\$ 33,351	3	\$ 11,117
Caramel Caper	0	0	0	0	1	1	0	0	0	0	0	0	122	\$ 22,492	2	\$ 11,246
Suckerpunch Sweets	0	0	0	0	0	0	1	1	1	0	0	0	0	\$ 36,117	3	\$ 12,039
The Candy Cauldron	1	0	0	0	0	0	0	0	0	0	0	1	85	\$ 19,844	2	\$ 9,922
Sweet Whirlwind	0	0	0	0	0	0	0	0	1	1	1	0	293	\$ 30,246	3	\$ 10,082
Full Time	1	1	1	1	1	1	1	1	1	1	1	1	422	\$ 106,812		
Available	507	621	621	621	544	544	422	422	715	715	715	507				
Required	293	402	555	621	544	401	335	422	599	715	668	507	Total ->	\$ 65,004,355		

Based on the constraints and cost minimization goal, the model recommends maintaining a relatively consistent workforce size between 500 to 600 workers per month throughout the year. Staffing levels increase gradually as demand rises toward the end of the year, with the highest workforce requirements during the holiday season (October to December). This approach ensures the business meets all monthly labor demands efficiently while minimizing total wage expenses.

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 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.

Shift	Month On = 1, Month Off = 0												Workers Schedule	Wages per Worker	Duration	Monthly
	1	2	3	4	5	6	7	8	9	10	11	12				
The Gooley Guild	0	1	1	1	0	0	0	0	0	0	0	0	185	\$ 33,351	3	\$ 11,117
Caramel Caper	0	0	0	0	0	1	1	0	0	0	0	0	108	\$ 22,492	2	\$ 11,246
Suckerpunch Sweets	0	0	0	0	0	0	0	1	1	1	0	0	0	\$ 36,117	3	\$ 12,039
The Candy Cauldron	1	0	0	0	0	0	0	0	0	0	0	1	71	\$ 19,844	2	\$ 9,922
Sweet Whirlwind	0	0	0	0	0	0	0	0	1	1	1	0	279	\$ 30,246	3	\$ 10,082
Full Time	1	1	1	1	1	1	1	1	1	1	1	1	436	\$ 106,812		\$ 106,812
Available	507	621	621	621	544	544	436	436	715	715	715	507				
Required	293	402	555	621	544	401	335	422	599	715	668	507	Total ->	\$ 65,016,661		

To align with leadership's directive to reduce the full-time workforce due to long-term associated costs, a new constraint was added to the model, limiting full-time workers to 80% of the original recommendation—reducing the count from 544 to

436. Interestingly, this adjustment resulted in a slightly higher total wage expense, increasing from \$65,004,355 to \$65,016,661. This small increase is due to the model compensating for the reduction in full-time employees by hiring more temporary workers, particularly in shifts like The Gooney Guild and Sweet Whirlwind, which have higher monthly costs. The updated model still meets all labor requirements, but the shift from full-time to temporary labor demonstrates that cutting full-time roles doesn't necessarily reduce overall expenses when more expensive temporary labor is used to fill the gap.

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.*

To explore this, my model was adjusted to determine what the average monthly salary per full-time worker would need to be in order to meet all labor demands while keeping the total annual cost the same as the original model. Based on the original total wage expense of \$65,004,355 and assuming approximately 680 full-time workers, the company would need to pay each full-time employee about \$7,974 per month. This adjustment would allow the business to eliminate temporary labor entirely while maintaining the same overall staffing costs. However, this salary is significantly higher than the original monthly full-time wage of \$6,225, which may or may not be feasible depending on operational constraints.

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.*

Considering the clear trends and seasonality of the business, with labor demand peaking in the final quarter of the year due to holiday-related increases; leadership should adopt a hybrid staffing strategy. The model shows that maintaining a core full-time workforce of around 500–550 workers provides year-round stability, while selectively using temporary labor in high-demand months (September to December) ensures flexibility without unnecessary overhead. Rather than eliminating temporary or full-time workers entirely, the company can optimize costs by balancing both types strategically. Additionally, cross-training full-time staff to handle multiple roles during the off-season and using short-term contracts or seasonal incentives may offer a cost-effective way to handle spikes without long-term commitments. Overall, a blended, responsive workforce model that aligns with seasonal fluctuations would minimize waste and ensure operational efficiency year-round.