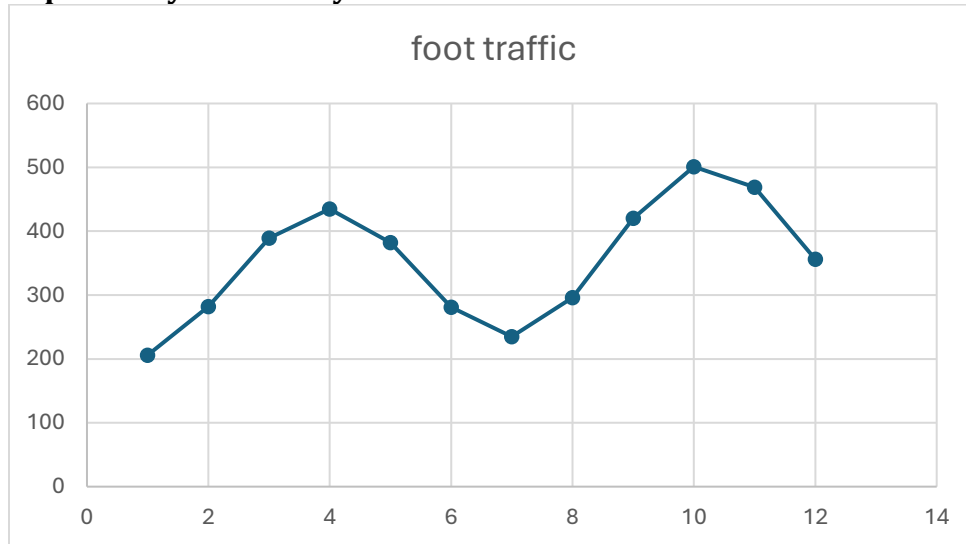# Module 08 – Scheduling Problem

Exploratory Data Analysis

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.

MIN: $25{,}053X_1+20{,}622X_2+28{,}419X_3+13{,}682X_4+13{,}156X_5+75{,}828X_6$

X_1= the number of workers assigned to Candy Cloud Co.

X_2= the number of workers assigned to Crackleberry Confections

X_3= the number of workers assigned to The Gooey Guild

X_4= the number of workers assigned to Whisker Licks

X_5= the number of workers assigned to The Jellybean Treasury

X_6= the number of workers assigned to Full-time

1. $1X_1+ 0X_2+0X_3+0X_4+0X_5+1X_6 >= 206$
2. $1X_1+1X_2+0X_3+0X_4+0X_5+1X_6>=282$
3. $0X_1+1X_2+0X_3+0X_4+0X_5+1X_6>=389$
4. $0X_1+1X_2+0X_3+0X_4+0X_5+1X_6>=435$
5. $0X_1+0X_2+1X_3+0X_4+0X_5+1X_6>=382$
6. $0X_1+0X_2+1X_3+0X_4+0X_5+1X_6>=281$
7. $0X_1+0X_2+1X_3+0X_4+0X_5+1X_6>235$
8. $0X_1+0X_2+0X_3+1X_4+0X_5+1X_6>=296$
9. $0X_1+0X_2+0X_3+1X_4+0X_5+1X_6>=420$
10. $0X_`1+0X_2+0X_3+0X_4+1X_5+1X_6>=501$
11. $0X_1+0X_2+0X_3+0X_4+1X_5+1X_6>=469$
12. $1X_1+0X_2+0X_3+0X_4+0X_5+1X_6>=356$

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	January	February	March	April	May	June	July	August	September	October	November	December	Workers Schedule	Wages per workers
Candy Cloud Co.	1	1	0	0	0	0	0	0	0	0	0	1	0	$ 25,053.00
Crackleberry Confections	0	1	1	1	0	0	0	0	0	0	0	0	53	$ 20,622.00
The Gooey Guild	0	0	0	0	1	1	1	0	0	0	0	0	0	$ 28,419.00
Whisker Licks	0	0	0	0	0	0	0	1	1	0	0	0	38	$ 13,682.00
The Jellybean Treasury	0	0	0	0	0	0	0	0	0	1	1	0	119	$ 13,156.00
full time	1	1	1	1	1	1	1	1	1	1	1	1	382	$ 75,828.05
Available	382	435	435	435	382	382	382	420	420	501	501	382		
Required	206	282	389	435	382	281	235	296	420	501	469	356	Total	$ 32,144,761.86

In order, to minimize costs those are the amount of workers that should be scheduled.

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	January	February	March	April	May	June	July	August	September	October	November	December	Workers Schedule	Wages per workers	% decrease
Candy Cloud Co.	1	1	0	0	0	0	0	0	0	0	0	1	8	25053	6.4
Crackleberry Confections	0	1	1	1	0	0	0	0	0	0	0	0	87	20622	69.6
The Gooey Guild	0	0	0	0	1	1	1	0	0	0	0	0	34	28419	27.2
Whisker Licks	0	0	0	0	0	0	0	1	1	0	0	0	72	13682	57.6
The Jellybean Treasury	0	0	0	0	0	0	0	0	0	1	1	0	153	13156	122.4
full time	1	1	1	1	1	1	1	1	1	1	1	1	348	75828.052	348
Available	356	443	435	435	382	382	382	420	420	501	501	356			
Required	206	282	389	435	382	281	235	296	420	501	469	356	Total	$ 32,346,918.10	

The cost would increase for the company..

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.*

Shift	January	February	March	April	May	June	July	August	September	October	November	December	Workers Schedule	Wages per workers	%
Candy Cloud Co.	0	0	0	0	0	0	0	0	0	0	0	0	0	25053	
Crackleberry Confections	0	0	0	0	0	0	0	0	0	0	0	0	0	20622	
The Gooey Guild	0	0	0	0	0	0	0	0	0	0	0	0	0	28419	
Whisker Licks	0	0	0	0	0	0	0	0	0	0	0	0	0	13682	
The Jellybean Treasury	0	0	0	0	0	0	0	0	0	0	0	0	0	13156	
full time	1	1	1	1	1	1	1	1	1	1	1	1	501	75828.052	
Available	501	501	501	501	501	501	501	501	501	501	501	501			
Required	206	282	389	435	382	281	235	296	420	501	469	356	Total	$ 37,989,854.05	

This is what the model would look like if we cut off all the temporary workers and only had full-time workers, workers scheduled would be 501, an approximate total cost of 37 M

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.*

Shift	January	February	March	April	May	June	July	August	September	October	November	December	Workers Schedule	Wages per workers	% d
Candy Cloud Co.	0	0	0	0	0	0	0	0	0	0	0	0	0	25053	
Crackleberry Confections	0	1	1	1	0	0	0	0	0	0	0	0	87	20622	
The Gooey Guild	0	0	0	0	0	0	0	0	0	0	0	0	0	28419	
Whisker Licks	0	0	0	0	0	0	0	1	1	0	0	0	72	13682	
The Jellybean Treasury	0	0	0	0	0	0	0	0	0	1	1	0	153	13156	
full time	1	1	1	1	1	1	1	1	1	1	1	1	348	75828.052	
Available	348	435	435	435	348	348	348	420	420	501	501	348			
Required	206	282	389	435	382	281	235	296	420	501	469	356	Total	$ 31,180,248.10	

6319.004333 $ 5,186.34

Considering the trends and seasonality, the highest numbers of workers needed are seen in the months of April, September, October, and November. Which should be considered for the months that most workers should be hired and utilized. I attempted to remove all the usage of temporary workers and leave the full-time workers. However, my model came down to all 0's for available and decision variables and having an unfeasible solution. Also, only having full-time workers would not meet the requirements of workers and leave the company short-staffed. In the image above what I did, I input days for workers to work in the months where we need workers to come in to work, but we see ourselves short on workers in May and December without the utilization of some agencies. However, I believe inputting these agencies into the model will increase costs, specifically, Candy Cloud Co and Gooey Guild. I will try one more time to see the increase in total cost this does for the company, even though we are trying to minimize cost and input that function into our solver.

2nd attempt...
Moreover, seeing that we were only short on those months May and December and we did not need those agencies to work for 3 months consequently. Reducing the months worked from 3 to 1 has reduced $1,000,000 in cost.

Very first Original Model (light orange are the ones adjusted in the next)

Shift	January	February	March	April	May	June	July	August	September	October	November	December	Workers Schedule	Wages per workers
Candy Cloud Co.	1	1	0	0	0	0	0	0	0	0	0	1	0	$ 25,053.00
Crackleberry Confections	0	1	1	1	0	0	0	0	0	0	0	0	53	$ 20,622.00
The Gooey Guild	0	0	0	0	1	1	1	0	0	0	0	0	0	$ 28,419.00
Whisker Licks	0	0	0	0	0	0	0	1	1	0	0	0	38	$ 13,682.00
The Jellybean Treasury	0	0	0	0	0	0	0	0	0	1	1	0	119	$ 13,156.00
full time	1	1	1	1	1	1	1	1	1	1	1	1	382	$ 75,828.05
Available	382	435	435	435	382	382	382	420	420	501	501	382		
Required	206	282	389	435	382	281	235	296	420	501	469	356	Total	$ 32,144,761.86

Agency	Initial Work Date	# of Months worked	Months Off
Candy Cloud Co.	12	3	
Crackleberry Confections	2	3	
The Gooey Guild	5	3	
Whisker Licks	8	2	
The Jellybean Treasury	10	2	
full time	1	12	

Second Model

Shift	January	February	March	April	May	June	July	August	September	October	November	December	Workers Schedule	Wages per workers	% decrease
Candy Cloud Co.	0	0	0	0	0	0	0	0	0	0	0	1	75	8351	60
Crackleberry Confections	0	1	1	1	0	0	0	0	0	0	0	0	154	20622	123.2
The Gooey Guild	0	0	0	1	0	0	0	0	0	0	0	0	101	9473	80.8
Whisker Licks	0	0	0	0	0	0	1	1	0	0	0	0	139	13682	111.2
The Jellybean Treasury	0	0	0	0	0	0	0	0	1	1	0	0	220	13156	176
full time	1	1	1	1	1	1	1	1	1	1	1	1	281	75828.052	348
Available	281	435	435	435	382	281	281	420	420	501	501	356			
Required	206	282	389	435	382	281	235	296	420	501	469	356	Total	$ 30,862,686.61	

Agency	Initial Work Date	# of Months worked	Months Off	nthly salary amo
Candy Cloud Co.	12	1	11	$ 8,351.00
Crackleberry Confed	2	3	9	$ 6,874.00
The Gooey Guild	5	1	11	$ 9,473.00
Whisker Licks	8	2	10	$ 6,841.00
The Jellybean Treas	10	2	10	$ 6,578.00
full time	1	12	0	$ 6,319.00

We see the reduction of cost once we reduce the months those companies will be working with us, we should not be hiring them in months where they are not needed as much, it will generate more cost by us having them there, I highly recommend working with the lower cost agencies and potentially negotiating with them, possibly pay them the same we were paying candy cloud co and groovey guild, but for more months if that makes sense. We see our cost go down to 30M from what it was originally in #1.