Module 06 – Transshipment 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 visual graph of your data like what we saw for the sample problem*
    - https://excalidraw.com
    - https://mermaid.live
    - https://dreampuf.github.io/GraphvizOnline
    - Powerpoint

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.
Hint: This one differs a bit from the sample problem in terms of Balance-of-Flow

MIN= $\mathbf{45x_{05} + 45x_{08} + 47x_{13} + 45x_{14} + 38x_{23} + 29x_{25} + 33x_{27} + 41x_{36} + 30x_{54} + 30x_{56}}$

Node 0= $\mathbf{-x_{05} - x_{08} \geq -204}$
Node 1= $\mathbf{-x_{13} - x_{14} \geq -327}$
Node 2= $\mathbf{-x_{23} - x_{25} - x_{27} \geq -367}$
Node 3= $\mathbf{+x_{13} + x_{23} + x_{83} - x_{36} \geq 250}$
Node 4= $\mathbf{x_{05} - x_{58} - x_{84} - x_{34} \geq 89}$
Node 5= $\mathbf{+x_{05} + x_{25} - x_{54} - x_{56} \geq 107}$
Node 6= $\mathbf{+x_{36} + x_{56} + x_{76} \geq 250}$
Node 7= $\mathbf{+x_{27} \geq 160}$
Node 8= $\mathbf{+x_{08} \geq 144}$

Model Optimized for Minimal Transportation Cost

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*
- *Update your graph from the EDA section to bold/color the links being used (and show how much is going through that link)*

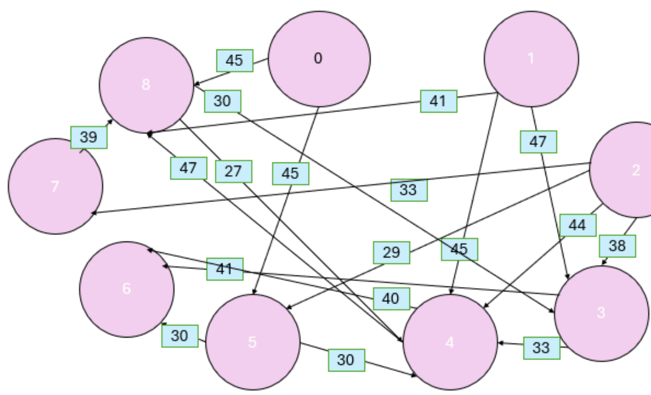
Model with Stipulation

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

Follow these steps to complete this section:

1. *Describe the necessity of the Balance-of-Flow for this problem type*

2. *What happens when you change your model to make Total Supply > Total Demand (i.e. add 115 units to one of the sources)*
3. *What happens when you rerun your model?*
4. *What do you need to change to make your model work again?*
5. *Make the changes and report on your findings.*
    a. *PS there is a small chance that the source you added 115 to may make your model infeasible. If so, add the 115 units to a different source.*



						Total Transportation Cost:	$ 40,202.00

Ship	From		To		Unit Cost
60	0	Buttercream Beach	5	Peanut Butter Parlor	$ 45.00
144	0	Buttercream Beach	8	Vanilla Chai Vortex	$ 45.00
238	1	Butterscotch Bluffs	3	Gingerbread Glades	$ 47.00
89	1	Butterscotch Bluffs	4	Honeysuckle Hollow	$ 45.00
0	1	Butterscotch Bluffs	8	Vanilla Chai Vortex	$ 41.00
12	2	Caramel Cascades	3	Gingerbread Glades	$ 38.00
0	2	Caramel Cascades	4	Honeysuckle Hollow	$ 44.00
195	2	Caramel Cascades	5	Peanut Butter Parlor	$ 29.00
160	2	Caramel Cascades	7	Tartberry Thicket	$ 33.00
0	3	Gingerbread Glades	4	Honeysuckle Hollow	$ 33.00
0	3	Gingerbread Glades	6	Swedish Fish Shores	$ 41.00
0	4	Honeysuckle Hollo	6	Swedish Fish Shores	$ 40.00
0	4	Honeysuckle Hollo	8	Vanilla Chai Vortex	$ 47.00
0	5	Peanut Butter Parlo	4	Honeysuckle Hollow	$ 30.00
148	5	Peanut Butter Parlo	6	Swedish Fish Shores	$ 30.00
0	7	Tartberry Thicket	8	Vanilla Chai Vortex	$ 39.00
0	8	Vanilla Chai Vortex	3	Gingerbread Glades	$ 30.00
0	8	Vanilla Chai Vortex	4	Honeysuckle Hollow	$ 27.00

Nodes		Inflow	Outflow	Net Flow	Supply/Demand
0	Buttercream Beach	0	204	-204	-204
1	Butterscotch Bluffs	0	327	-327	-327
2	Caramel Cascades	0	367	-367	-367
3	Gingerbread Glades	250	0	250	250
4	Honeysuckle Hollov	89	0	89	89
5	Peanut Butter Parlo	255	148	107	107
6	Swedish Fish Shores	148	0	148	250
7	Tartberry Thicket	160	0	160	160
8	Vanilla Chai Vortex	144	0	144	144

1)The balance of the flow principle tells us that the total supply is equal to the total demand in the transportation or network of the problem. If the balance is not maintained in the model, it may become infeasible do to the leading unoptimized solution and the inability to allocate the properly. In my problem each of the nine nodes have either a supply, demand, or act as an intermediary. Meaning that all the inflow sums and outflow sums must match to ensure proper distribution of the flows of goods.

2)In my model if the numbers are to be altered by increasing the total supply beyond the total demand (adding 115 units to a source) it will create an imbalance in the chart. This surplus supply may lead to the inefficiencies where some of the said units remain unused and or increased transportation cost. Also the model might become a infeasible chart if there is no available paths to demand points in which are absorbed creating an extra supply. Therefore, making it impossible to allocate the resources correctly.

3)Upon rerunning the model with this excess supply, several outcomes could occur. The solver might fail to find a feasible solution if there is no way to distribute the additional units. Alternatively, the model may allow the surplus supply to remain at the source without being transported, which would result in a suboptimal solution. Additionally, transportation costs could rise if the model is forced to create inefficient routes to accommodate the new supply without corresponding demand.

4)To restore feasibility to the model, adjustments must be made. One way to do this is by increasing demand at one or more sink nodes to absorb the additional 115 units. Another option is to introduce a dummy demand node that can take in the surplus supply to maintain balance. Additionally, transportation paths and costs may need to be revised to ensure that all supply is properly allocated while keeping the model feasible.

5)To implement these changes and analyze their effects, the first step is to select a source node and increase its supply by 115 units. Next, the demand at one or more nodes should be increased by an equivalent amount to maintain balance. After making these adjustments, the model should be rerun to check for feasibility. If the model remains infeasible, the extra supply should be reallocated to a different source. Finally, the new transportation costs and flow distribution should be analyzed to understand the impact of these changes on the overall efficiency of the system.