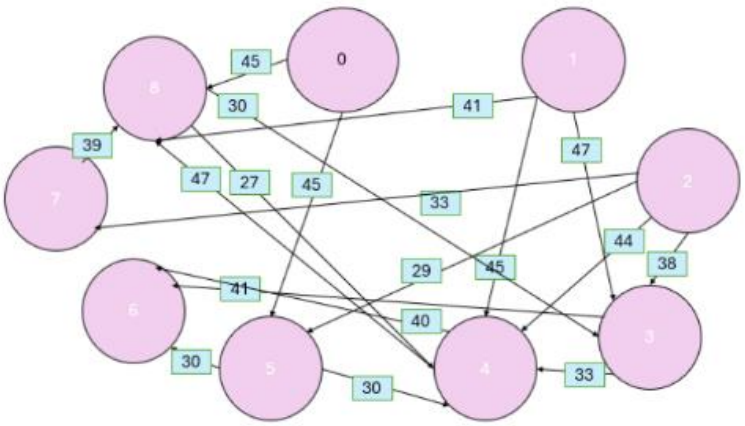
Module 06 – Transshipment Problem

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

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

$Node\ 0 = -x_{05} - x_{08} \geq -204$
$Node\ 1 = -x_{13} - x_{14} \geq -327$
$Node\ 2 = -x_{23} - x_{25} - x_{27} \geq -367$
$Node\ 3 = +x_{13} + x_{23} + x_{83} - x_{36} \geq 250$
$Node\ 4 = +x_{05} - x_{58} - x_{48} - x_{34} \geq 89$
$Node\ 5 = -x_{05} + x_{25} - x_{54} - x_{56} \geq 107$
$Node\ 6 = +x_{36} + x_{56} + x_{76} \geq 250$
$Node\ 7 = +x_{27} \geq 160$
$Node\ 8 = +x_{08} \geq 144$

Model Optimized for Minimal Transportation Cost

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

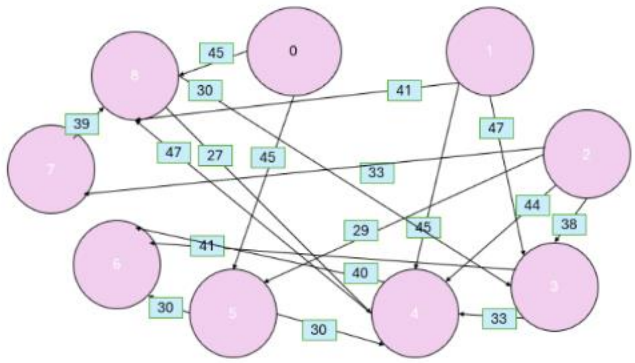
- *A screenshot of your optimized final model (formatted nicely, of course)*
- *A text explanation of what your model is recommending*
- *Update your graph from the EDA section to bold/color the links being used (and show how much is going through that link)*

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 flow principle for this problem is 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 might not work because the solutions won't be possible or efficient. In my problem, each of the nine nodes have either a supply, demand, or act as an intermediary. This means that all the inflow sums and outflow sums must match to make sure proper distribution of the flows of goods.

2)In my model, if the numbers are changed and the total supply increases more than the total demand, it will change the balance. This extra supply can lead to problems, like unused units or higher transportation costs. The model could stop working if there aren't enough paths to send the extra supply to where it's needed. That makes it hard or even impossible to match everything up and use the resources the right way.

3) When I ran the model again with extra supply, a few things could happen. The solver might not be able to find a working solution if there's no way to send out all the extra units. The model might just leave the extra supply at the starting point without moving it anywhere, which isn't the best solution. Also, costs could go up if the model uses weird or complicated routes to deal with the extra supply when there isn't enough demand.

4) To make the model work again, some changes must be made. One way is to increase the demand at one or more of the ending points so they can take the extra 115 units. Another option is to add a fake demand node that can take in the leftover supply to keep things balanced. We might also need to adjust the routes and costs to make sure all the supply is used, and the model still works properly.

5) To make these changes and see what happens, the first thing is to pick a starting point and add 115 more units of supply. Then, raise the demand at one or more ending points by the same amount so everything stays balanced. After that, run the model again to see if it works. If it still doesn't work, try giving the extra supply to a different starting point. Finally, look at how the costs and flow paths changed to see how these updates affected how well the system works overall.