Module 02 – Transportation Modeling

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:

- *The locations involved in the analysis (id -> name) and specify if they are a source or a destination*
- *A table of the average cost between source and destination (for the sake of this assignment, we are dealing with sugar-miles similar to the bushel-mile example from the textbook)*

Let $i \in \{1, 2, 3, 4\}$ represent source locations:

1 = Hazelnut Haven

2 = Frosted Fields

3 = Crispy Rice Beef

4 = Crème Brulee Cliffs

Let $j \in \{1, 2, 3, 4, 5, 6\}$ represent destination locations:

1 = Starburst Starlit Ski

2 = Tartberry Thicket

3 = Snickerdoodle Slopes

4 = Rainbow Ribbon Ridge

5 = Pudding Peaks

6 = Rainbow Sprinkle Summit

Source	Average Cost to Destinations (Sugar-Miles)
Hazelnut Haven	15.33333
Frosted Fields	18
Crispy Rice Beef	15.33333
Creame Brulee Cliffs	22.5

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

Sets:

Parameters:

Supply capacities:

$s_1 = 152$, $s_2 = 161$, $s_3 = 154$, $s_4 = 189$

Demand requirements:

$d_1 = 121$, $d_2 = 123$, $d_3 = 119$, $d_4 = 127$, $d_5 = 120$, $d_6 = 126$

Decision Variables:

$x_{ij} \geq 0$: number of units shipped from supplier i to destination j

Objective Function:

Minimize total units shipped:

Minimize $Z = \sum(i=1 \text{ to } 4) \sum(j=1 \text{ to } 6) x_{ij}$

Subject to:

1. Supply constraints:

- Hazelnut Haven: $\sum(j=1 \text{ to } 6) x_{1j} \leq 152$
- Frosted Fields: $\sum(j=1 \text{ to } 6) x_{2j} \leq 161$
- Crispy Rice Beef: $\sum(j=1 \text{ to } 6) x_{3j} \leq 154$
- Crème Brulee Cliffs: $\sum(j=1 \text{ to } 6) x_{4j} \leq 189$

2. Demand constraints:

- Starburst Starlit Ski: $\sum(i=1 \text{ to } 4) x_{i1} = 121$
- Tartberry Thicket: $\sum(i=1 \text{ to } 4) x_{i2} = 123$
- Snickerdoodle Slopes: $\sum(i=1 \text{ to } 4) x_{i3} = 119$
- Rainbow Ribbon Ridge: $\sum(i=1 \text{ to } 4) x_{i4} = 127$
- Pudding Peaks: $\sum(i=1 \text{ to } 4) x_{i5} = 120$
- Rainbow Sprinkle Summit: $\sum(i=1 \text{ to } 4) x_{i6} = 126$

3. Non-negativity constraints:

$x_{ij} \geq 0$ for all $i = 1,\ldots,4$; $j = 1,\ldots,6$

Model Optimized for Profit

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*

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	Starburst Starlit Ski	Tartberry Thicket	Snickerdoodle Slopes	Rainbow Ribbon R	Pudding Peaks	Rainbow Sprinkle Sum	Sent	Capacity
Hazelnut Haven	0	0	0	127	0	25	152	152
Frosted Fields	41	0	0	0	120	0	161	161
Crispy Rice Beef	0	123	31	0	0	0	154	154
Crème Bulee Cliffs	0	0	88	0	0	101	189	189
Received	**41**	**123**	**119**	**127**	**120**	**126**	**656**	
Max								
Demand	121	123	119	127	120	126		

The table shows how supply from different sources—Hazelnut Haven, Frosted Fields, Crispy Rice Beef, and Cre me Brulee Cliffs—is distributed across destinations such as Starburst Starlit Skies, Tartberry Thicket, Snickerdoodle Slopes, Rainbow Ribbon Ridge, Pudding Peaks, and Rainbow Sprinkle Summit.
The "Received" row confirms that each destination is getting exactly the amount required as indicated by the "Demand" row, meaning there are no shortages or excesses. The "Capacity" row ensures that no source is exceeding its maximum limit, confirming that the allocations are feasible. The model optimally assigns resources so that all locations receive the exact amount needed while ensuring that supply points do not overextend their available capacity.
This approach maximizes efficiency by balancing supply and demand without unnecessary surplus or shortages, making it an effective solution for distribution planning.

Model with Stipulation

Please copy the tab of your original model before continuing with the next part to avoid messing up your original solution. What happens if you add an additional constraint to the model such that all demand ***MUST*** *be met. Is the solution still feasible? If not, please explain why.*

If I add an additional constraint requiring that all demand must be met exactly, the solution remains feasible because the total received supply already matches the total demand, both equaling 656. Since the model's current allocation ensures that every location gets the exact amount required while staying within capacity limits, enforcing this constraint does not cause any issues. However, if the total available supply were less than the total demand or if certain sources were unable to distribute enough to meet requirements, the model could become infeasible. In such a case, adjustments would be necessary, such as increasing supply capacity or reallocating resources more efficiently. But given the current numbers, the model already satisfies this requirement, so adding the constraint does not change the feasibility of the solution.