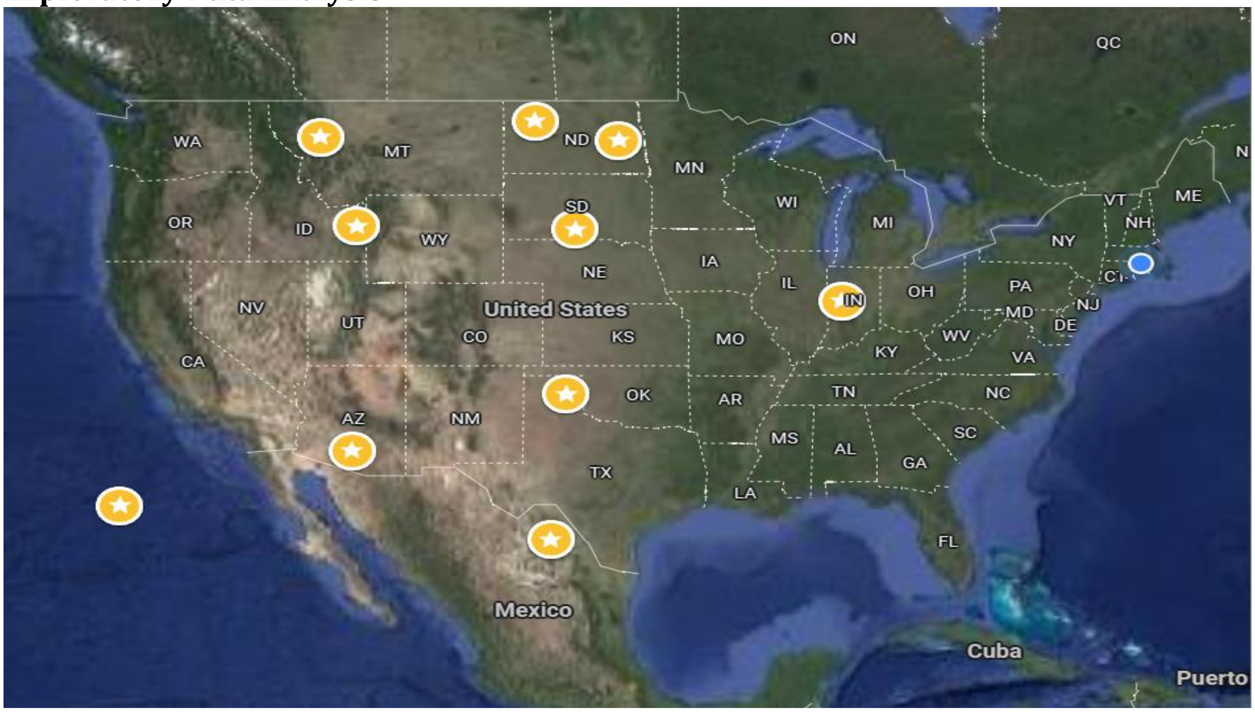
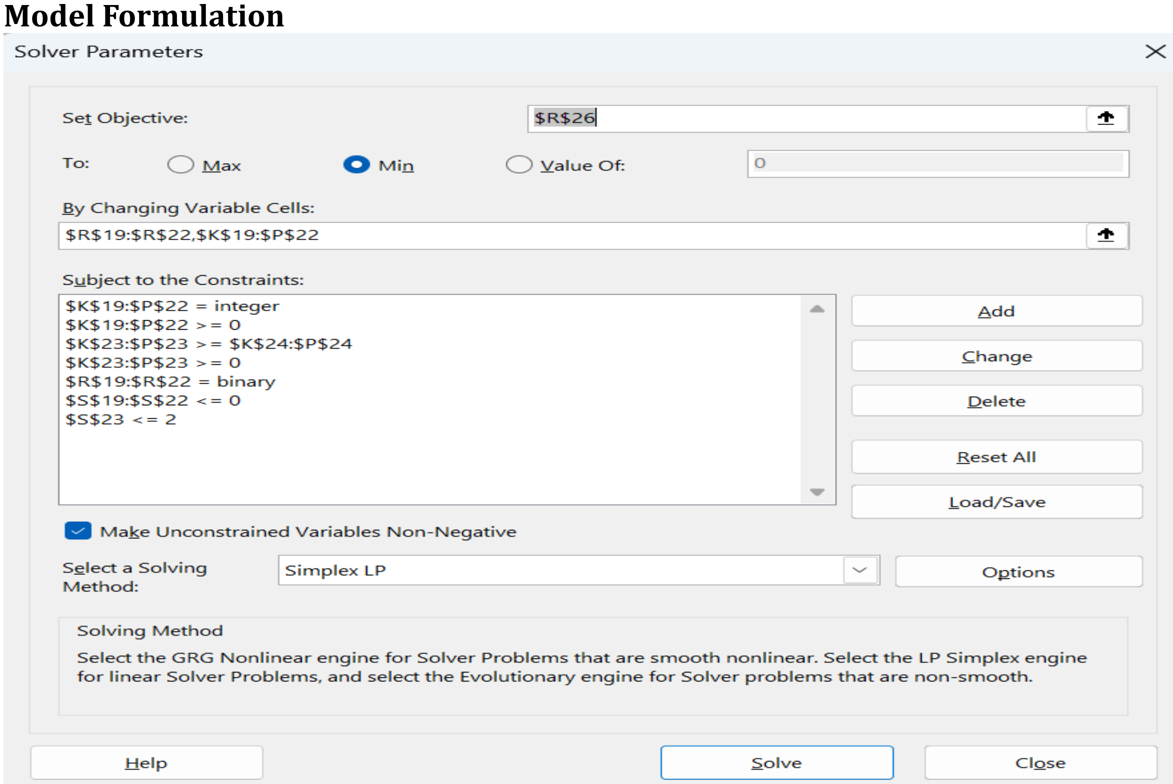
Module 09 – Fixed Charge Problem

Exploratory Data Analysis



Model Formulation



MIN: $\$1{,}960X_1 - \$2{,}900X_2 - \$2{,}569X_3 - \$1{,}824X_4$

Distribution Centers Subject to:

$13.73X_1 + 11.34X_2 + 26.17X_3 + 11.03X_4 \geq 907$ } Soda Pop Springs
$11.64X_1 + 13.43X_2 + 28.26X_3 + 8.94X_4 \geq 784$ } Marzipan Metropolis
$3.44X_1 + 28.51X_2 + 43.34X_3 + 6.14X_4 \geq 689$ } Starburst Starlit Skies
$11.19X_1 + 13.88X_2 + 28.71X_3 + 8.49X_4 \geq 830$ } Peppermint Peninsula
$19.73X_1 + 5.34X_2 + 20.17X_3 + 17.03X_4 \geq 930$ } Pudding Peaks
$7.52X_1 + 32.59X_2 + 47.42X_3 + 10.22X_4 \geq 718$ } Mallow Melt Mountains
$Y_i \leq 2$ } Max Distribution Centers

$X_1 - 0Y_1 \leq 0$ } linking constraint 1
$X_2 - 930Y_2 \leq 0$ } linking constraint 2
$X_3 - 0Y_3 \leq 0$ } linking constraint 3
$X_4 - 3928Y_4 \leq 0$ } linking constraint 4

All Y_i must be binary
$X_i \geq 0$, $i = 1, 2, 3, 4$

Model Optimized for Min Costs to Supply DCs

WH v DC >	1	2	3	4	5	6
1	13.73	11.64	3.44	11.19	19.73	7.52
2	11.34	13.43	28.51	13.88	5.34	32.59
3	26.17	28.26	43.34	28.71	20.17	47.42
4	11.03	8.94	6.14	8.49	17.03	10.22

										Set Up Costs	
WH v DC >	1	2	3	4	5	6	WH Sum Sent	Binary Variables	Linking Constraints	Actual	Possible
1	0	0	0E+00	0	0	0	0	0	0E+00	$ -	$ 1,960
2	0	0	0	0	930	0	930	1	-3928	$ 2,900	$ 2,900
3	0	0	0	0	0	0	0	0	0	$ -	$ 2,569
4	907	784	689	830	0	718	3928	1	-930	$ 1,824	$ 1,824
Used	907	784	689	830	930	718	4858		2		
Available	907	784	689	830	930	718	4858	Total Demand			
							Total Cost	$ 45,318.49			

The following model recommends that to minimize total costs in transporting goods between the 6 Distribution Centers and 4 Warehouses, certain steps must be taken. Following the data graph listed above, they must "Use" all the "Available" demand that they have. In doing so, they will optimize total costs by gaining the most efficiency out of the routes run. Between the 12 possible combinations the business can make out (6 x 2 = 12), "Used" demand can be filled with 907, 784, 689, 830, 930, & 718 sent to each Distribution Center, respectively. As a result, this sums up the total demand between all locations, equaling 4,858. By following this model, the business can prevent unnecessary spending on the "Set-up Costs" tied to operating a transportation-based business.

Model with Stipulation

Please perform 2 out of the 3 scenarios below with a short text description on what changed:

1. *Instead of only being able to open 2 warehouses, what happens to our objective function when we can only open 1 warehouse?*
   <u>When limiting the maximum number of warehouses, the model will employ from 2 to 1, the Total Cost will increase by $8,000. Additionally, the workload will all be shipped from the Warehouses to the Distribution Center 4, making the binary variable there equal to 1. Also, the Actual Set-Up Costs will all be allocated to $1,824.</u>

2. *Right now, we have $1 per unit shipped over the distance between the warehouse and the DC. What happens to our objective function when we increase this to $30? Does your DC assignment change at all?*
   <u>When increasing the Cost per Unit Distance from $1 to $30, the Total Cost increases significantly. Originally, being around $45,000, it jumps to $1.2M in response to the cost of transportation jumping up by a factor of 30. Although the Total Cost increases with the new unit transportation, the function remains the same, where DCs 2 and 4 are used and 1 and 3 are not.</u>