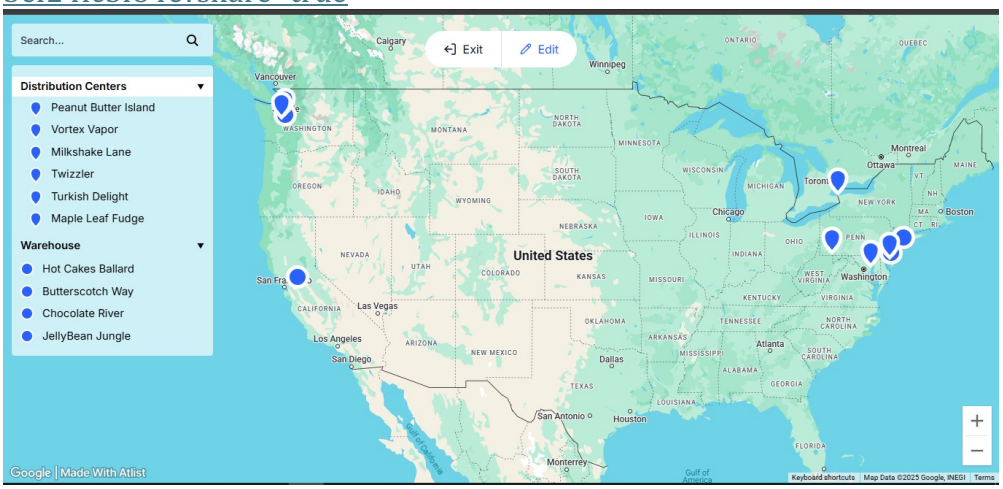
Module 09 – Fixed Charge Problem Solved

Exploratory Data Analysis

- *A visual graph of the data on a map*
- Link to the map: https://my.atlist.com/map/085b0a0f-956a-4f2a-9508-3ef24fc5f84e?share=true



The around icons are the warehouses, and the location icon is for the DCs.

Model Formulation

1. ***Decision Variables***

   In this model "Warehouse and DCs consignments = $N$11:$S$14,$M$22:$P$22 are Decision Variables

2. ***Objective Function***

   Objective Function, Total Cost =SUMPRODUCT(N5:S8,N11:S14)+SUMPRODUCT(M19:P19,M22:P22)

3. ***Constraints***

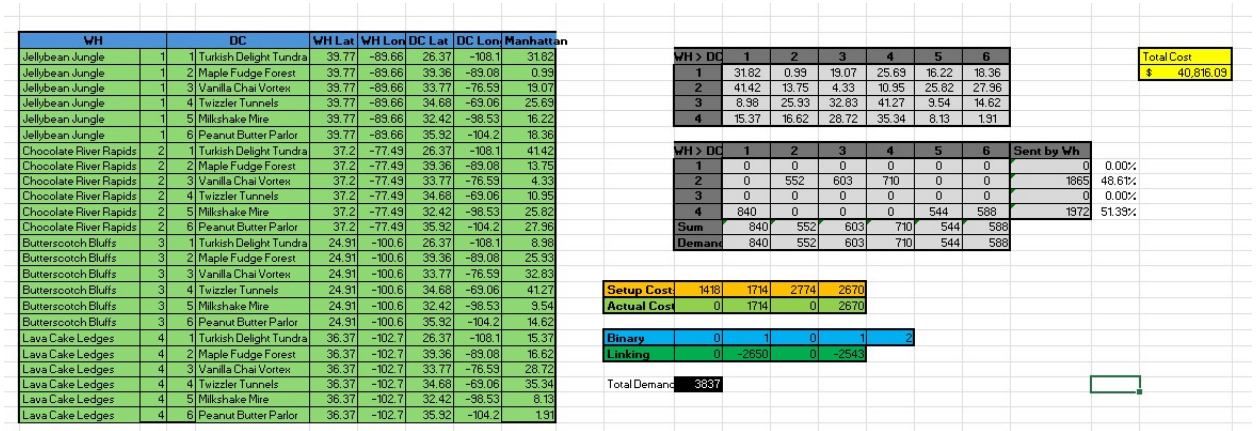
   In the model the following Constraints are given:

```
$M$22:$P$22 = binary
$M$23:$P$23 <= 0
$N$11:$S$14 = integer
$N$11:$S$14 >= 0
$N$15:$S$15 = $N$16:$S$16
$Q$22 <= 2
```

1. ***Warehouse used or not should be binary***
2. ***The linkings should be less than or equal zero***
3. ***The consignments to the WH DCs should be integers***
4. ***The consignments to the WH DCs should be greater than or equal zero***
5. ***Sum and demand of the DCs should be equal***
6. ***Max warehouse to be used 2***

Model Optimized for Min Costs to Cover Store Foot Traffic

- *A screenshot of the optimized final model :*



WH		DC		WH Lat	WH Lon	DC Lat	DC Lon	Manhattan
Jellybean Jungle	1	1	Turkish Delight Tundra	39.77	-89.66	26.37	-108.1	31.82
Jellybean Jungle	1	2	Maple Fudge Forest	39.77	-89.66	39.36	-89.08	0.99
Jellybean Jungle	1	3	Vanilla Chai Vortex	39.77	-89.66	33.77	-76.59	19.07
Jellybean Jungle	1	4	Twizzler Tunnels	39.77	-89.66	34.68	-69.06	25.69
Jellybean Jungle	1	5	Milkshake Mire	39.77	-89.66	32.42	-98.53	16.22
Jellybean Jungle	1	6	Peanut Butter Parlor	39.77	-89.66	35.92	-104.2	18.36
Chocolate River Rapids	2	1	Turkish Delight Tundra	37.2	-77.49	26.37	-108.1	41.42
Chocolate River Rapids	2	2	Maple Fudge Forest	37.2	-77.49	39.36	-89.08	13.75
Chocolate River Rapids	2	3	Vanilla Chai Vortex	37.2	-77.49	33.77	-76.59	4.33
Chocolate River Rapids	2	4	Twizzler Tunnels	37.2	-77.49	34.68	-69.06	10.95
Chocolate River Rapids	2	5	Milkshake Mire	37.2	-77.49	32.42	-98.53	25.82
Chocolate River Rapids	2	6	Peanut Butter Parlor	37.2	-77.49	35.92	-104.2	27.36
Butterscotch Bluffs	3	1	Turkish Delight Tundra	24.91	-100.6	26.37	-108.1	8.98
Butterscotch Bluffs	3	2	Maple Fudge Forest	24.91	-100.6	39.36	-89.08	25.93
Butterscotch Bluffs	3	3	Vanilla Chai Vortex	24.91	-100.6	33.77	-76.59	32.83
Butterscotch Bluffs	3	4	Twizzler Tunnels	24.91	-100.6	34.68	-69.06	41.27
Butterscotch Bluffs	3	5	Milkshake Mire	24.91	-100.6	32.42	-98.53	9.54
Butterscotch Bluffs	3	6	Peanut Butter Parlor	24.91	-100.6	35.92	-104.2	14.62
Lava Cake Ledges	4	1	Turkish Delight Tundra	36.37	-102.7	26.37	-108.1	15.37
Lava Cake Ledges	4	2	Maple Fudge Forest	36.37	-102.7	39.36	-89.08	16.62
Lava Cake Ledges	4	3	Vanilla Chai Vortex	36.37	-102.7	33.77	-76.59	28.72
Lava Cake Ledges	4	4	Twizzler Tunnels	36.37	-102.7	34.68	-69.06	35.34
Lava Cake Ledges	4	5	Milkshake Mire	36.37	-102.7	32.42	-98.53	8.13
Lava Cake Ledges	4	6	Peanut Butter Parlor	36.37	-102.7	35.92	-104.2	1.91

WH > DC	1	2	3	4	5	6
1	31.82	0.99	19.07	25.69	16.22	18.36
2	41.42	13.75	4.33	10.95	25.82	27.36
3	8.98	25.93	32.83	41.27	9.54	14.62
4	15.37	16.62	28.72	35.34	8.13	1.91

Total Cost	
$	40,816.09

WH > DC	1	2	3	4	5	6	Sent by Wh	
1	0	0	0	0	0	0	0	0.00%
2	0	552	603	710	0	0	1865	48.61%
3	0	0	0	0	0	0	0	0.00%
4	840	0	0	0	544	588	1972	51.39%
Sum	840	552	603	710	544	588		
Demand	840	552	603	710	544	588		

Setup Cost	1418	1714	2774	2670	
Actual Cost	0	1714	0	2670	
Binary	0	1	0	1	2
Linking	0	-2650	0	-2543	
Total Demand	3837				

- *Explanation of the model and recommendation:*

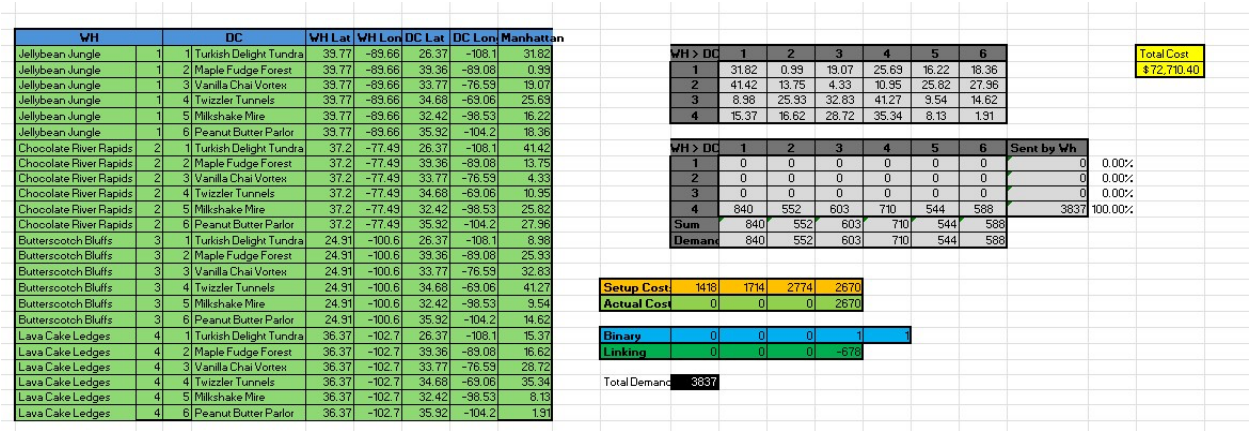
  The model has six Distribution centers and 4 Warehouses with their latitudes and longitudes are given. From which there Manhattan distances were calculated.

  Products were distributed from the warehouses to the DCs according to their demands but to minimize cost, the strategic model considered 2 warehouses to be used and an objective function, which was optimized through Excel Solver.

  The Model is recommending to use warehouse 2 and 4 their uses percentages are 48.6%, 51.33% with minimum cost **$ 40,816.09 .**

Model with Stipulation

1. *Instead of only being able to open 2 warehouses, if only one warehouse to be used then the model suggests to use warehouse 4, and the total cost arises to* $ 72,710.40.



WH		DC		WH Lat	WH Lon	DC Lat	DC Lon	Manhattan
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Jellybean Jungle	1	2	Maple Fudge Forest	39.77	-89.66	39.36	-89.08	0.99
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Jellybean Jungle	1	6	Peanut Butter Parlor	39.77	-89.66	35.92	-104.2	18.36
Chocolate River Rapids	2	1	Turkish Delight Tundra	37.2	-77.49	26.37	-108.1	41.42
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Chocolate River Rapids	2	4	Twizzler Tunnels	37.2	-77.49	34.68	-69.06	10.95
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WH > DC	1	2	3	4	5	6
1	31.82	0.99	19.07	25.69	16.22	18.36
2	41.42	13.75	4.33	10.95	25.82	27.96
3	8.98	25.93	32.83	41.27	9.54	14.62
4	15.37	16.62	28.72	35.34	8.13	1.91

Total Cost: $72,710.40

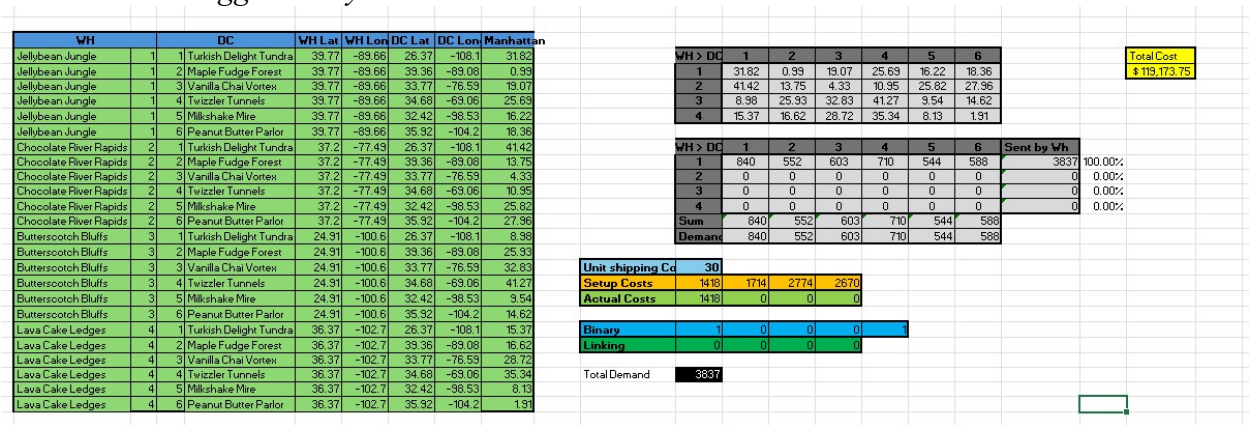
WH > DC	1	2	3	4	5	6	Sent by Wh	
1	0	0	0	0	0	0	0	0.00%
2	0	0	0	0	0	0	0	0.00%
3	0	0	0	0	0	0	0	0.00%
4	840	552	603	710	544	588	3837	100.00%
Sum	840	552	603	710	544	588		
Demand	840	552	603	710	544	588		

Setup Cost	1418	1714	2774	2670
Actual Cost	0	0	0	2670

Binary	0	0	0	1	1
Linking	0	0	0	-678	

Total Demand: 3837

2. *If the shipping cost rises to $ 30 then the objective function's total cost is $ 119,173.75, and the model suggests only to use warehouse one.*



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Jellybean Jungle	1	6	Peanut Butter Parlor	39.77	-89.66	35.92	-104.2	18.36
Chocolate River Rapids	2	1	Turkish Delight Tundra	37.2	-77.49	26.37	-108.1	41.42
Chocolate River Rapids	2	2	Maple Fudge Forest	37.2	-77.49	39.36	-89.08	13.75
Chocolate River Rapids	2	3	Vanilla Chai Vortex	37.2	-77.49	33.77	-76.59	4.33
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Butterscotch Bluffs	3	1	Turkish Delight Tundra	24.91	-100.6	26.37	-108.1	8.98
Butterscotch Bluffs	3	2	Maple Fudge Forest	24.91	-100.6	39.36	-89.08	25.93
Butterscotch Bluffs	3	3	Vanilla Chai Vortex	24.91	-100.6	33.77	-76.59	32.83
Butterscotch Bluffs	3	4	Twizzler Tunnels	24.91	-100.6	34.68	-69.06	41.27
Butterscotch Bluffs	3	5	Milkshake Mire	24.91	-100.6	32.42	-98.53	9.54
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WH > DC	1	2	3	4	5	6
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2	41.42	13.75	4.33	10.95	25.82	27.96
3	8.98	25.93	32.83	41.27	9.54	14.62
4	15.37	16.62	28.72	35.34	8.13	1.91

Total Cost: $119,173.75

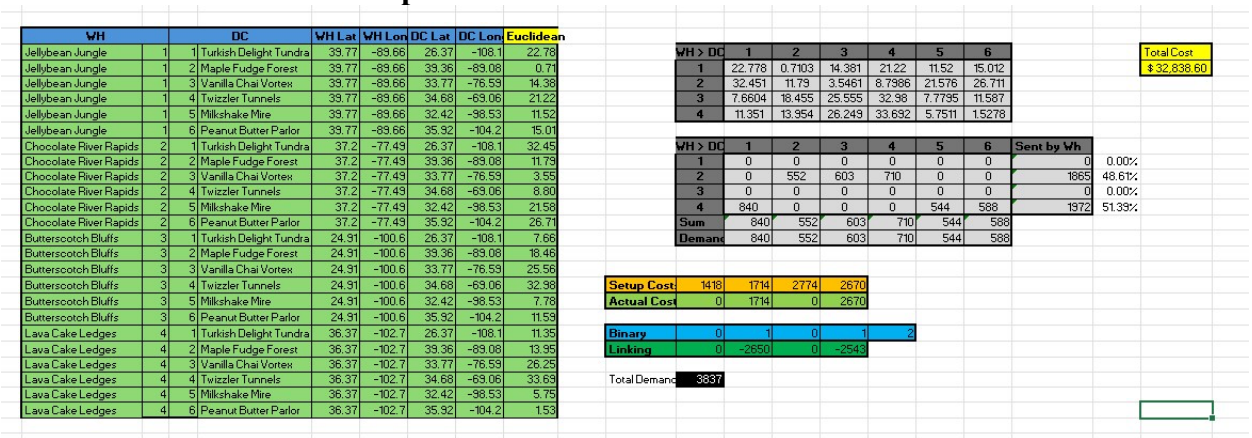
WH > DC	1	2	3	4	5	6	Sent by Wh	
1	840	552	603	710	544	588	3837	100.00%
2	0	0	0	0	0	0	0	0.00%
3	0	0	0	0	0	0	0	0.00%
4	0	0	0	0	0	0	0	0.00%
Sum	840	552	603	710	544	588		
Demand	840	552	603	710	544	588		

Unit shipping Co	30			
Setup Costs	1418	1714	2774	2670
Actual Costs	1418	0	0	0

Binary	1	0	0	0	1
Linking	0	0	0	0	

Total Demand: 3837

3. *If Euclidean distance is used the total cost is reduced to* $ 32,838.60 from $ 40,816.09 **saving thousands. So it can be said Euclidean distance is better than Manhattan distance for this specific model.**



WH		DC		WH Lat	WH Lon	DC Lat	DC Lon	Euclidean
Jellybean Jungle	1	1	Turkish Delight Tundra	39.77	-89.66	26.37	-108.1	22.78
Jellybean Jungle	1	2	Maple Fudge Forest	39.77	-89.66	39.36	-89.08	0.71
Jellybean Jungle	1	3	Vanilla Chai Vortex	39.77	-89.66	33.77	-76.59	14.38
Jellybean Jungle	1	4	Twizzler Tunnels	39.77	-89.66	34.68	-69.06	21.22
Jellybean Jungle	1	5	Milkshake Mire	39.77	-89.66	32.42	-98.53	11.52
Jellybean Jungle	1	6	Peanut Butter Parlor	39.77	-89.66	35.92	-104.2	15.01
Chocolate River Rapids	2	1	Turkish Delight Tundra	37.2	-77.49	26.37	-108.1	32.45
Chocolate River Rapids	2	2	Maple Fudge Forest	37.2	-77.49	39.36	-89.08	11.79
Chocolate River Rapids	2	3	Vanilla Chai Vortex	37.2	-77.49	33.77	-76.59	3.55
Chocolate River Rapids	2	4	Twizzler Tunnels	37.2	-77.49	34.68	-69.06	8.80
Chocolate River Rapids	2	5	Milkshake Mire	37.2	-77.49	32.42	-98.53	21.58
Chocolate River Rapids	2	6	Peanut Butter Parlor	37.2	-77.49	35.92	-104.2	26.71
Butterscotch Bluffs	3	1	Turkish Delight Tundra	24.91	-100.6	26.37	-108.1	7.66
Butterscotch Bluffs	3	2	Maple Fudge Forest	24.91	-100.6	39.36	-89.08	18.48
Butterscotch Bluffs	3	3	Vanilla Chai Vortex	24.91	-100.6	33.77	-76.59	25.56
Butterscotch Bluffs	3	4	Twizzler Tunnels	24.91	-100.6	34.68	-69.06	32.98
Butterscotch Bluffs	3	5	Milkshake Mire	24.91	-100.6	32.42	-98.53	7.78
Butterscotch Bluffs	3	6	Peanut Butter Parlor	24.91	-100.6	35.92	-104.2	11.59
Lava Cake Ledges	4	1	Turkish Delight Tundra	36.37	-102.7	26.37	-108.1	11.35
Lava Cake Ledges	4	2	Maple Fudge Forest	36.37	-102.7	39.36	-89.08	13.95
Lava Cake Ledges	4	3	Vanilla Chai Vortex	36.37	-102.7	33.77	-76.59	26.25
Lava Cake Ledges	4	4	Twizzler Tunnels	36.37	-102.7	34.68	-69.06	33.69
Lava Cake Ledges	4	5	Milkshake Mire	36.37	-102.7	32.42	-98.53	5.75
Lava Cake Ledges	4	6	Peanut Butter Parlor	36.37	-102.7	35.92	-104.2	1.53

WH > DC	1	2	3	4	5	6
1	22.778	0.7103	14.381	21.22	11.52	15.012
2	32.451	11.79	3.5461	8.7986	21.576	26.711
3	7.6604	18.455	25.555	32.98	7.7795	11.587
4	11.351	13.954	26.249	33.632	5.7511	1.5278

Total Cost: $32,838.60

WH > DC	1	2	3	4	5	6	Sent by Wh	
1	0	0	0	0	0	0	0	0.00%
2	0	552	603	710	0	0	1865	48.61%
3	0	0	0	0	0	0	0	0.00%
4	840	0	0	0	544	588	1972	51.39%
Sum	840	552	603	710	544	588		
Demand	840	552	603	710	544	588		

Setup Cost	1418	1714	2774	2670
Actual Cost	0	1714	0	2670

Binary	0	1	0	1	2
Linking	0	-2650	0	-2543	

Total Demand: 3837