IE 202 INTRODUCTION TO MODELING AND OPTIMIZATION
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STAGE-2 REPORT

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First of all, we have solved the problem in both CPLEX and Xpress and found the same solutions. The solution tables that I put in this pdf are from the CPLEX solutions.

Part A

The optimal objective function value of part A is \$ 576,359 which shows the total cost of expanding the operations in a new country. We have 10 candidate districts for opening the stores and after the optimization process we determine that some of them will have stores and the others will not. It is shown below.

C (size 10)	T (size 4)			
	1	2	3	4
1	0	1	0	0
2	0	0	0	0
3	0	1	0	0
4	1	0	0	1
5	0	1	0	1
6	0	1	0	0
7	0	0	0	1
8	1	0	0	1
9	0	1	0	0
10	0	0	0	1

Figure 1: whether there will be a store type T in district C

From the figure we can see that in district 1, there will be only 2M store. There will be no store in district 2. In district 3 there will be a 2M store etc.

In total, we are going to open 12 stores in this country to cover all demands and 2 of these stores will be Jet, 5 of them will be 2M, zero 3M and 5 of them will be 5M.

Part A con't

We have a chance to increase the capacity of the store up to 10 percent of its current capacity in return of a cost. So, to operate in this country with minimum cost, we increased some of the stores' capacity according to the optimization result. It is seen below.

C (size 10)	T (size 4)			
	1	2	3	4
1	0	1	0	0
2	0	0	0	0
3	0	1	0	0
4	1	0	0	1
5	0	1	0	1
6	0	1	0	0
7	0	0	0	1
8	0	0	0	0
9	0	1	0	0
10	0	0	0	1

Figure 2: whether the store's capacity will be increased or not

From figure 2 we can conclude that we are going to increase the capacities of 10 stores. Only the capacity of the 5M store in the 8th district and the Jet store in the 8th district will not be increased.

We can also try to find the total cost manually to see it clearly. W are going to open two Jet stores which costs $16000 , five 2M stores which costs $80000 and five 5M stores costs $470000. In total the opening cost is $ 566000 .

We have also capacity increasing cost which is $300 + $(5 \times 400) + $(4 \times 600) = 4700.

So, the sum of opening and increasing the capacity of the stores is;
$566000 + $4700 = $570,700 .

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From there we can understand that $576,359 - $570,700 = 5679 is the amount of money which is spent for the covering the demand of one district from another which is I think not a big deal.

Part B

The optimal objective function found as 136. So, it means that the maximum distance a truck has to travel in a single journey is 136 km.

We decided to open 4 warehouses and their distribution is decided by program which is in the below.

D (size 10)	Value
1	1
2	1
3	0
4	0
5	0
6	0
7	0
8	1
9	0
10	1

Figure 3: Distribution of warehouses

So, we are going to build warehouses in districts 1, 2, 8 and 10.

Part B con't

Now, let's check which district is served by which warehouse.

D (size 10)	D (size 10)									
	1	2	3	4	5	6	7	8	9	10
1	1	0	0	0	1	0	0	0	1	0
2	0	0	0	1	0	0	1	0	0	0
3	0	0	0	0	0	0	0	0	0	0
4	0	0	0	0	0	0	0	0	0	0
5	0	0	0	0	0	0	0	0	0	0
6	0	0	0	0	0	0	0	0	0	0
7	0	0	0	0	0	0	0	0	0	0
8	0	0	0	0	0	0	0	1	0	0
9	0	0	0	0	0	0	0	0	0	0
10	0	0	1	0	0	1	0	0	0	1

Figure 4: Which district served by which warehouse

From Figure 4, it is seen that;
district 1 is served by warehouse in district 1,
district 2 is not served as there is not any store in there,
district 3 is served by warehouse in districts 10
district 4 is served by warehouse in district 2
district 5 is served by warehouses in districts 1
district 6 is served by warehouses in districts 10
district 7 is served by warehouses in districts 2
district 8 is served by warehouses in districts 8
district 9 is served by warehouses in districts 1
district 10 is served by warehouses in districts 10

Part C

The new optimal objective function value becomes $577,203 which is $844 more than the part A, which is expected because we have more constraints in here.

Let's check in which districts we will build which kind of stores.

C (size 10)	T (size 4)			
	1	2	3	4
1	0	1	0	0
2	0	0	0	0
3	0	1	0	0
4	1	0	0	1
5	0	1	0	1
6	0	1	0	0
7	0	0	0	1
8	1	0	0	1
9	0	0	0	0
10	0	1	0	1

Figure 5: whether there will be a store type T in district C

In total, we are going to build 12 stores like partA. The only difference is the place of one 2M store; so, in partA we had a 2M in district 9, but now instead of district 9, we have it in district 10.

Also, the same amount and types of stores' capacities are increased. Because it is same, I did not put its table in here.

It's seen that the cost of building and increasing the capacity of the stores is same.
So, 844 dollars increase in the cost happens because of the new restriction on the stores.