

ISE-2404 - DOR I Project

Testing Kits Production for Coronavirus (COVID-19) in U.S.

Suppose in January, 2020, CDC planned to prepare for COVID-19. It was estimated that the infected population would be 1% of entire population of each state who might need to test for COVID-19. The 1% of population can be found in Table 1. Thus, CDC planned to produce all the testing kits and send them to the states. There are three manufacturing centers, located at different places, which are able to fulfill the orders of CDC. Please find the average travel distance from each state to each manufacturing center in Table 1. Since each manufacturing center has limited capability, their maximum production capacities can be found in Table 2. In addition, according to CDC, the production cost for each testing kit is \$1, and the shipping cost of each kit is \$0.001 per mile.

Table 1. 1% Population and three manufacturing center of test kits and their average distances(mile) to each state.

	Population	1% of Population	Center 1	Center 2	Center 3
Alabama	4,779,736	47798	2302	228	1251
Alaska	710,231	7103	2933	5221	5780
Arizona	6,392,017	63921	530	2016	2904
Arkansas	2,915,918	29160	1903	630	1546
California	37,253,956	372540	0	2529	3372
Colorado	5,029,196	50292	979	1602	2393
Connecticut	3,574,097	35741	3263	971	110
Delaware	897,934	8980	3059	705	366
District of Columbia	601,723	6018	2954	618	462
Florida	18,801,310	188014	2644	292	1221
Georgia	9,687,653	96877	2529	0	1070
Hawaii	1,360,301	13604	2795	5137	6096
Idaho	1,567,582	15676	614	2276	2980
Illinois	12,830,632	128307	2109	658	1263
Indiana	6,483,802	64839	2329	526	1046
Iowa	3,046,355	30464	1846	948	1538
Kansas	2,853,118	28532	1491	1093	1884
Kentucky	4,339,367	43394	2382	361	1023
Louisiana	4,533,372	45334	1963	602	1629
Maine	1,328,361	13284	3535	1334	285
Maryland	5,773,552	57736	2985	644	432
Massachusetts	6,547,629	65477	3372	1070	0
Michigan	9,883,640	98837	2419	846	1008
Minnesota	5,303,925	53040	1886	1205	1608

ISE-2404 - DOR I
Project

Mississippi	2,967,297	29673	2111	421	1423
Missouri	5,988,927	59890	1888	730	1492
Montana	989,415	9895	1005	2046	2650
Nebraska	1,826,341	18264	1413	1277	1971
Nevada	2,700,551	27006	267	2374	3169
New Hampshire	1,316,470	13165	3366	1117	94
New Jersey	8,791,894	87919	3119	800	276
New Mexico	2,059,179	20592	977	1555	2450
New York	19,378,102	193782	3070	887	314
North Carolina	9,535,483	95355	2805	352	720
North Dakota	672,591	6726	1520	1557	2047
Ohio	11,536,504	115366	2563	544	810
Oklahoma	3,751,351	37514	1547	986	1868
Oregon	3,831,074	38311	479	2670	3398
Pennsylvania	12,702,379	127024	2907	689	466
Rhode Island	1,052,567	10526	3341	1028	44
South Carolina	4,625,364	46254	2692	198	876
South Dakota	814,180	8142	1453	1401	1994
Tennessee	6,346,105	63462	2305	301	1139
Texas	25,145,561	251456	1470	1104	2087
Utah	2,763,885	27639	585	1998	2795
Vermont	625,741	6258	3291	1095	175
Virginia	8,001,024	80011	2848	479	598
Washington	6,724,540	67246	687	2759	3434
West Virginia	1,852,994	18530	2697	456	701
Wisconsin	5,686,986	56870	2149	917	1274
Wyoming	563,626	5637	979	1764	2460

Table 2. Capacity of three manufacturing center of test kits.

	Center 1	Center 2	Center 3
Capacity	1,500,000	1,200,000	1,350,000

Your team has been hired as an operations research consultant to assist CDC in determining the optimal production plan of testing kits to minimize the total costs.

- a) Formulate this problem as a linear program and write down its dual.

ISE-2404 - DOR I
Project

- b) Solve the model using Excel and clearly state your recommendation to the CDC.

- c) Use the sensitivity report from part (b) to determine how much the **unit shipping cost** (current is \$0.001) from Kansas to the manufacturing center 2 can increase (assuming no change in the costs for the other states) before the current optimal solution would no longer be optimal.
- d) Use the sensitivity report from part (b) to determine how much the **unit shipping cost** (current is \$0.001) from Pennsylvania to the manufacturing center 3 can increase (assuming no change in the costs for the other states) before the current optimal solution would no longer be optimal.

- e) In March, CDC realized that Washington State is in severe situation and would like to order **additional** 500,000 testing kits for it. Use the sensitivity report from part (b) to determine whether the current optimal dual solution is still optimal if we increase the number of testing kits of Washington State by 500,000. If your answer is Yes, please state the new optimal cost. Otherwise, please explain.
- f) A foreign company, expert in producing testing kits, offers \$300,000 for 1 million testing kits. Since it is a special time, the company agrees to deliver all the test kits to any of manufacturing centers. Use the shadow price from the report obtained in part (b) to determine whether it would be worthwhile to purchase from company. Please explain your choice.

ISE-2404 - DOR I Project

TELEVISION

Coronavirus: CDC's faulty testing kits may have been produced in a contaminated lab, claims report

© March 2, 2020 Add Comment 3 Min Read



At the beginning of March, CDC realized that the testing kits may have been contaminated. So it planned to redo the production plan (sorry, but this happens a lot in practice). However, the situation of each state had been changed dramatically. Instead of using 1% of population, CDC decided to re-estimate the required testing kits for each state. Please see the updated required testing kits in Table 3. In addition, due to emergency situations, the production cost and unit shipping cost of each test kit are increased, i.e., the production cost for each testing kit is now \$1.5, and the shipping cost of each kit is now \$0.002 per mile.

Table 3 Updated Required Estimated Testing Kits.

	Estimated Testing Kits
Alabama	9000
Alaska	1500
Arizona	15000
Arkansas	13500
California	442500
Colorado	115500
Connecticut	16500
Delaware	6000
District of Columbia	15000
Florida	76500
Georgia	63000
Hawaii	3000
Idaho	1500

ISE-2404 - DOR I
Project

Illinois	69000
Indiana	19500
Iowa	25500
Kansas	9000
Kentucky	21000
Louisiana	54000
Maine	4500
Maryland	28500
Massachusetts	184500
Michigan	37500
Minnesota	21000
Mississippi	9000
Missouri	6000
Montana	7500
Nebraska	21000
Nevada	30000
New Hampshire	9000
New Jersey	75000
New Mexico	15000
New York	631500
North Carolina	28500
North Dakota	1500
Ohio	24000
Oklahoma	4500
Oregon	48000
Pennsylvania	61500
Rhode Island	21000
South Carolina	19500
South Dakota	13500
Tennessee	39000
Texas	70500
Utah	13500
Vermont	3000
Virginia	45000
Washington	852000

ISE-2404 - DOR I
Project

West Virginia	1500
Wisconsin	28500
Wyoming	1500

- g) Please redo Parts (b)-(f) with the updated data and re-answer their corresponding questions.
- h) Also, please remark which datasets (i.e., Table 1 vs Table 3) make more sense. You might want to check the (<https://covidtracking.com/data/>) to see the current infected population of each state and number of testing cases.