OPTIMISATION CASE STUDY - STAFF PLANNING

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Q1. The company wants to know the optimised staffing recommendations for the business case described. Write the mathematical model for the deterministic optimisation problem. Define and explain your decision variables, objective function and the constraint.

Ans:

Decision Variable: Is the quantity that the decision-maker controls in order to optimize the objective function.

In our particular case study, the decision variables are the number of insurance application that needs to be processed by the FTE's (Full time employees) and Outsources staff, and this is calculated by state, by month.

x[s,m] -> FTE (Number of applications processed for each state for each month)

y[s,m] -> Number of outsourced application for each state for each month

Objective Function: It is the entity that we are looking to optimize (either maximize or minimize)

In our particular case study, the objective function is to minimize the cost of processing insurance applications

Minimise $(\sum 1\_i \sum 1\_j \; [\![X(s,m)*]\!] \; FTESalary(s, m) + \sum 1\_i \sum 1\_j \; [\![Y(s, m)*]\!] \; UnitCost(s, m))$

(for all s in States for all m in Months)

Constraints: They are the restrictions or limitations on the decision variables. They usually limit the value of the decision variable.

In our particular case study, we have the following constraints:

<u>Demand constraints: Demand of insurance for each state for each month</u>

For each state-month: x[s,m]* Service rate* StaffAvPer[s,m] + y[s,m] == demand

<u>Staff Availability Limits/ Best- and worst-case scenario</u>

StaffAvPer[s,m] > lb[s,m] for s in States and for m in Months (average availability > Lower Bound)

StaffAvPer[s,m] < ub[s,m] for s in States and for m in Months (average availability < Upper Bound)

<u>Vendor Outsource Limits for State A and B</u>

$$y[A,m] < (outrestA[A,m]*outsourcevendor1[A,m]) \text{ for } S = A \text{ and for } m \text{ in Months}$$

$$y[B,m] < (outrestB[B.m]*outsourcevendor2[B,m]) \text{ for } S = B \text{ and for } m \text{ in Months}$$

Q2. Code the problem in Python using any optimisation package of your choice.

Expected output:

Create a data frame containing the number of outsourced applications and the number of FTEs for each state-month combination. You can choose to have extra columns like staff availability, demand etc. in your data frame apart from the ones mentioned earlier.

Ans:

	StateMonth	FTE	Outsourced	StaffAvailability	Demand	FTE_App_Served	App_Outsourced
0	(A, Jan)	161.73	0.0	0.81	5240	5240.0	0.0
1	(A, Feb)	160.46	0.0	0.76	4878	4878.0	0.0
2	(A, Mar)	198.07	0.0	0.75	5942	5942.0	0.0
3	(A, Apr)	71.78	0.0	0.80	2297	2297.0	0.0
4	(A, May)	63.85	0.0	0.78	1992	1992.0	0.0
5	(A, Jun)	77.91	0.0	0.73	2275	2275.0	0.0
6	(A, Jul)	137.28	1600.0	0.68	5334	3734.0	1600.0
7	(A, Aug)	110.89	0.0	0.76	3371	3371.0	0.0
8	(A, Sep)	116.02	0.0	0.81	3759	3759.0	0.0
9	(A, Oct)	120.86	0.0	0.73	3529	3529.0	0.0
10	(A, Nov)	110.26	1285.0	0.68	4284	2999.0	1285.0
11	(A, Dec)	139.58	1554.0	0.65	5183	3629.0	1554.0
12	(B, Jan)	152.07	0.0	0.81	4927	4927.0	0.0
13	(B, Feb)	51.88	1051.0	0.76	2628	1577.0	1051.0
14	(B, Mar)	59.50	1189.0	0.75	2974	1785.0	1189.0
15	(B, Apr)	73.06	0.0	0.80	2338	2338.0	0.0
16	(B, May)	128.85	0.0	0.78	4020	4020.0	0.0
17	(B, Jun)	64.69	1258.0	0.73	3147	1889.0	1258.0
18	(B, Jul)	94.23	1708.0	0.68	4271	2563.0	1708.0
19	(B, Aug)	51.71	1048.0	0.76	2620	1572.0	1048.0
20	(B, Sep)	139.41	0.0	0.81	4517	4517.0	0.0
21	(B, Oct)	85.38	1662.0	0.73	4155	2493.0	1662.0
22	(B, Nov)	69.23	1254.0	0.68	3137	1883.0	1254.0
23	(B, Dec)	97.58	1690.0	0.65	4227	2537.0	1690.0
24	(C, Jan)	35.86	0.0	0.81	1162	1162.0	0.0
25	(C, Feb)	64.70	0.0	0.76	1967	1967.0	0.0
26	(C, Mar)	63.27	0.0	0.75	1898	1898.0	0.0
27	(C, Apr)	70.66	0.0	0.80	2261	2261.0	0.0
28	(C, May)	65.06	0.0	0.78	2030	2030.0	0.0
29	(C, Jun)	56.23	0.0	0.73	1642	1642.0	0.0
30	(C, Jul)	0.00	2489.0	0.68	2489	0.0	2489.0
31	(C, Aug)	82.11	0.0	0.76	2496	2496.0	0.0
32	(C, Sep)	28.46	0.0	0.81	922	922.0	0.0
33	(C, Oct)	82.91	0.0	0.73	2421	2421.0	0.0
34	(C, Nov)	0.00	963.0	0.68	963	0.0	963.0
35	(C, Dec)	0.00	1998.0	0.65	1998	0.0	1998.0

The dataframe containing the number of outsourced applications (**App_Outsourced**) and the number of FTEs (**FTE_App_Served**) for each state-month combination is attached on left.

Q3. The company wants the solution for a scenario, where no more than 10% of the applications for every month in each state is handled by the external resources for quality assurance reasons.

Ans:

	StateMonth	FTE	Outsourced	StaffAvail	Demand	FTE_App_Served	App_Outsourced
0	(A, Jan)	161.73	0.0	0.81	5240	5240.0	0.0
1	(A, Feb)	160.46	0.0	0.76	4878	4878.0	0.0
2	(A, Mar)	198.07	0.0	0.75	5942	5942.0	0.0
3	(A, Apr)	71.78	0.0	0.80	2297	2297.0	0.0
4	(A, May)	63.85	0.0	0.78	1992	1992.0	0.0
5	(A, Jun)	77.91	0.0	0.73	2275	2275.0	0.0
6	(A, Jul)	176.51	533.0	0.68	5334	4801.0	533.0
7	(A, Aug)	110.89	0.0	0.76	3371	3371.0	0.0
8	(A, Sep)	116.02	0.0	0.81	3759	3759.0	0.0
9	(A, Oct)	120.86	0.0	0.73	3529	3529.0	0.0
10	(A, Nov)	141.76	428.0	0.68	4284	3856.0	428.0
11	(A, Dec)	179.42	518.0	0.65	5183	4665.0	518.0
12	(B, Jan)	152.07	0.0	0.81	4927	4927.0	0.0
13	(B, Feb)	77.83	262.0	0.76	2628	2366.0	262.0
14	(B, Mar)	89.23	297.0	0.75	2974	2677.0	297.0
15	(B, Apr)	73.06	0.0	0.80	2338	2338.0	0.0
16	(B, May)	128.85	0.0	0.78	4020	4020.0	0.0
17	(B, Jun)	97.02	314.0	0.73	3147	2833.0	314.0
18	(B, Jul)	141.32	427.0	0.68	4271	3844.0	427.0
19	(B, Aug)	77.57	262.0	0.76	2620	2358.0	262.0
20	(B, Sep)	139.41	0.0	0.81	4517	4517.0	0.0
21	(B, Oct)	128.08	415.0	0.73	4155	3740.0	415.0
22	(B, Nov)	103.82	313.0	0.68	3137	2824.0	313.0
23	(B, Dec)	146.35	422.0	0.65	4227	3805.0	422.0
24	(C, Jan)	35.86	0.0	0.81	1162	1162.0	0.0
25	(C, Feb)	64.70	0.0	0.76	1967	1967.0	0.0
26	(C, Mar)	63.27	0.0	0.75	1898	1898.0	0.0
27	(C, Apr)	70.66	0.0	0.80	2261	2261.0	0.0
28	(C, May)	65.06	0.0	0.78	2030	2030.0	0.0
29	(C, Jun)	56.23	0.0	0.73	1642	1642.0	0.0
30	(C, Jul)	82.39	248.0	0.68	2489	2241.0	248.0
31	(C, Aug)	82.11	0.0	0.76	2496	2496.0	0.0
32	(C, Sep)	28.46	0.0	0.81	922	922.0	0.0
33	(C, Oct)	82.91	0.0	0.73	2421	2421.0	0.0
34	(C, Nov)	31.88	96.0	0.68	963	867.0	96.0
35	(C, Dec)	69.19	199.0	0.65	1998	1799.0	199.0

The data frame containing the number of outsourced applications, where no more than 10% of the applications for every month in each state is handled by the external resources is attached on left.

Q 3.2 For the scenario given above - What is the additional average cost per application of keeping the 10% limit on outsourcing? (Note: Compare with the cost in question 2)

Ans:

The additional average cost per application of keeping the 10% limit on outsourcing

```
Cost per Application with distribution to FTE and Outsourced limit of 30 % (State A) and 40 % (State B) -  158.55

Cost per Application with distribution to FTE and Outsourced limit of 10 % to all States -  159.77

Additional Cost per application is -  1.22
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Additional Cost per application is $1.22

Q 3.3 If the company increases the outsourcing costs by 20% for quality assurance, what would you recommend the optimal outsourcing percentage should be?

Ans:

Average optimal percentage of outsourcing of application can be found by the below formula:

outsource / demand *100

```
1  data_n = data.copy()
2  data_n['outsourced']=outsourced_df['outsourced']
3
4  data_n['outsourced %'] = (data_n['outsourced']/data_n['Demand']) * 100
```

```
1  data_n[["State","Month","Demand","outsourced","outsourced %"]]
```

	State	Month	Demand	outsourced	outsourced %
0	A	Jan	5240	0.0	0.0
1	A	Feb	4878	0.0	0.0
2	A	Mar	5942	0.0	0.0
3	A	Apr	2297	0.0	0.0
4	A	May	1992	0.0	0.0
5	A	Jun	2275	0.0	0.0
6	A	Jul	5334	0.0	0.0
7	A	Aug	3371	0.0	0.0
8	A	Sep	3759	0.0	0.0
9	A	Oct	3529	0.0	0.0
10	A	Nov	4284	0.0	0.0
11	A	Dec	5183	0.0	0.0
12	B	Jan	4927	0.0	0.0
13	B	Feb	2628	0.0	0.0
14	B	Mar	2974	0.0	0.0
15	B	Apr	2338	0.0	0.0
16	B	May	4020	0.0	0.0
17	B	Jun	3147	0.0	0.0
18	B	Jul	4271	0.0	0.0
19	B	Aug	2620	0.0	0.0
20	B	Sep	4517	0.0	0.0
21	B	Oct	4155	0.0	0.0
22	B	Nov	3137	0.0	0.0
23	B	Dec	4227	0.0	0.0
24	C	Jan	1162	0.0	0.0
25	C	Feb	1967	0.0	0.0
26	C	Mar	1898	0.0	0.0
27	C	Apr	2261	0.0	0.0
28	C	May	2030	0.0	0.0
29	C	Jun	1642	0.0	0.0
30	C	Jul	2489	0.0	0.0
31	C	Aug	2496	0.0	0.0
32	C	Sep	922	0.0	0.0
33	C	Oct	2421	0.0	0.0
34	C	Nov	963	0.0	0.0
35	C	Dec	1998	0.0	0.0

```
1 # Average optimal percentage of outsourcing
2
3 data_n['outsourced %'].mean()
```
0.0

Average optimal percentage of outsourcing of application is Zero.

Q4. The company also wants to know the staffing recommendations for the worst-case and best-case scenarios. As mentioned earlier, there are days that an employee will be unavailable to process applications due to training, off days, etc. This will affect employee availability.

- What is the optimal number of staff members for the worst cases?

	StateMonth	FTE	Outsourced	StaffAvail	Demand	FTE_App_Served	App_Outsourced
0	(A, Jan)	187.14	0.0	0.70	5240	5240.0	0.0
1	(A, Feb)	131.35	1463.0	0.65	4878	3415.0	1463.0
2	(A, Mar)	212.21	0.0	0.70	5942	5942.0	0.0
3	(A, Apr)	76.57	0.0	0.75	2297	2297.0	0.0
4	(A, May)	71.14	0.0	0.70	1992	1992.0	0.0
5	(A, Jun)	61.27	682.0	0.65	2275	1593.0	682.0
6	(A, Jul)	155.58	1600.0	0.60	5334	3734.0	1600.0
7	(A, Aug)	90.77	1011.0	0.65	3371	2360.0	1011.0
8	(A, Sep)	134.25	0.0	0.70	3759	3759.0	0.0
9	(A, Oct)	95.04	1058.0	0.65	3529	2471.0	1058.0
10	(A, Nov)	124.96	1285.0	0.60	4284	2999.0	1285.0
11	(A, Dec)	151.21	1554.0	0.60	5183	3629.0	1554.0
12	(B, Jan)	105.61	1970.0	0.70	4927	2957.0	1970.0
13	(B, Feb)	60.65	1051.0	0.65	2628	1577.0	1051.0
14	(B, Mar)	63.75	1189.0	0.70	2974	1785.0	1189.0
15	(B, Apr)	46.77	935.0	0.75	2338	1403.0	935.0
16	(B, May)	86.14	1608.0	0.70	4020	2412.0	1608.0
17	(B, Jun)	72.65	1258.0	0.65	3147	1889.0	1258.0
18	(B, Jul)	106.79	1708.0	0.60	4271	2563.0	1708.0
19	(B, Aug)	60.46	1048.0	0.65	2620	1572.0	1048.0
20	(B, Sep)	96.82	1806.0	0.70	4517	2711.0	1806.0
21	(B, Oct)	95.88	1662.0	0.65	4155	2493.0	1662.0
22	(B, Nov)	78.46	1254.0	0.60	3137	1883.0	1254.0
23	(B, Dec)	105.71	1690.0	0.60	4227	2537.0	1690.0
24	(C, Jan)	41.50	0.0	0.70	1162	1162.0	0.0
25	(C, Feb)	0.00	1967.0	0.65	1967	0.0	1967.0
26	(C, Mar)	67.79	0.0	0.70	1898	1898.0	0.0
27	(C, Apr)	75.37	0.0	0.75	2261	2261.0	0.0
28	(C, May)	72.50	0.0	0.70	2030	2030.0	0.0
29	(C, Jun)	0.00	1642.0	0.65	1642	0.0	1642.0
30	(C, Jul)	0.00	2489.0	0.60	2489	0.0	2489.0
31	(C, Aug)	0.00	2496.0	0.65	2496	0.0	2496.0
32	(C, Sep)	32.93	0.0	0.70	922	922.0	0.0
33	(C, Oct)	0.00	2421.0	0.65	2421	0.0	2421.0
34	(C, Nov)	0.00	963.0	0.60	963	0.0	963.0
35	(C, Dec)	0.00	1998.0	0.60	1998	0.0	1998.0

- What is the optimal number of staff members for the best cases?

	StateMonth	FTE	Outsourced	StaffAvail	Demand	FTE_App_Served	App_Outsourced
0	(A, Jan)	145.56	0.0	0.90	5240	5240.0	0.0
1	(A, Feb)	143.47	0.0	0.85	4878	4878.0	0.0
2	(A, Mar)	185.69	0.0	0.80	5942	5942.0	0.0
3	(A, Apr)	67.56	0.0	0.85	2297	2297.0	0.0
4	(A, May)	58.59	0.0	0.85	1992	1992.0	0.0
5	(A, Jun)	71.09	0.0	0.80	2275	2275.0	0.0
6	(A, Jul)	177.80	0.0	0.75	5334	5334.0	0.0
7	(A, Aug)	99.15	0.0	0.85	3371	3371.0	0.0
8	(A, Sep)	104.42	0.0	0.90	3759	3759.0	0.0
9	(A, Oct)	110.28	0.0	0.80	3529	3529.0	0.0
10	(A, Nov)	142.80	0.0	0.75	4284	4284.0	0.0
11	(A, Dec)	185.11	0.0	0.70	5183	5183.0	0.0
12	(B, Jan)	136.86	0.0	0.90	4927	4927.0	0.0
13	(B, Feb)	77.29	0.0	0.85	2628	2628.0	0.0
14	(B, Mar)	92.94	0.0	0.80	2974	2974.0	0.0
15	(B, Apr)	68.76	0.0	0.85	2338	2338.0	0.0
16	(B, May)	118.24	0.0	0.85	4020	4020.0	0.0
17	(B, Jun)	98.34	0.0	0.80	3147	3147.0	0.0
18	(B, Jul)	85.43	1708.0	0.75	4271	2563.0	1708.0
19	(B, Aug)	77.06	0.0	0.85	2620	2620.0	0.0
20	(B, Sep)	125.47	0.0	0.90	4517	4517.0	0.0
21	(B, Oct)	129.84	0.0	0.80	4155	4155.0	0.0
22	(B, Nov)	62.77	1254.0	0.75	3137	1883.0	1254.0
23	(B, Dec)	90.61	1690.0	0.70	4227	2537.0	1690.0
24	(C, Jan)	32.28	0.0	0.90	1162	1162.0	0.0
25	(C, Feb)	57.85	0.0	0.85	1967	1967.0	0.0
26	(C, Mar)	59.31	0.0	0.80	1898	1898.0	0.0
27	(C, Apr)	66.50	0.0	0.85	2261	2261.0	0.0
28	(C, May)	59.71	0.0	0.85	2030	2030.0	0.0
29	(C, Jun)	51.31	0.0	0.80	1642	1642.0	0.0
30	(C, Jul)	82.97	0.0	0.75	2489	2489.0	0.0
31	(C, Aug)	73.41	0.0	0.85	2496	2496.0	0.0
32	(C, Sep)	25.61	0.0	0.90	922	922.0	0.0
33	(C, Oct)	75.66	0.0	0.80	2421	2421.0	0.0
34	(C, Nov)	32.10	0.0	0.75	963	963.0	0.0
35	(C, Dec)	71.36	0.0	0.70	1998	1998.0	0.0

- What are the percentages of outsourcing for the worst cases?

	State	Month	Demand	outsourced_WC	outsourced_WC %
0	A	Jan	5240	0.0	0.000000
1	A	Feb	4878	1463.0	29.991800
2	A	Mar	5942	0.0	0.000000
3	A	Apr	2297	0.0	0.000000
4	A	May	1992	0.0	0.000000
5	A	Jun	2275	682.0	29.978022
6	A	Jul	5334	1600.0	29.996250
7	A	Aug	3371	1011.0	29.991101
8	A	Sep	3759	0.0	0.000000
9	A	Oct	3529	1058.0	29.980164
10	A	Nov	4284	1285.0	29.995331
11	A	Dec	5183	1554.0	29.982636
12	B	Jan	4927	1970.0	39.983763
13	B	Feb	2628	1051.0	39.992390
14	B	Mar	2974	1189.0	39.979825
15	B	Apr	2338	935.0	39.991446
16	B	May	4020	1608.0	40.000000
17	B	Jun	3147	1258.0	39.974579
18	B	Jul	4271	1708.0	39.990635
19	B	Aug	2620	1048.0	40.000000
20	B	Sep	4517	1806.0	39.982289
21	B	Oct	4155	1662.0	40.000000
22	B	Nov	3137	1254.0	39.974498
23	B	Dec	4227	1690.0	39.981074
24	C	Jan	1162	0.0	0.000000
25	C	Feb	1967	1967.0	100.000000
26	C	Mar	1898	0.0	0.000000
27	C	Apr	2261	0.0	0.000000
28	C	May	2030	0.0	0.000000
29	C	Jun	1642	1642.0	100.000000
30	C	Jul	2489	2489.0	100.000000
31	C	Aug	2496	2496.0	100.000000
32	C	Sep	922	0.0	0.000000
33	C	Oct	2421	2421.0	100.000000
34	C	Nov	963	963.0	100.000000
35	C	Dec	1998	1998.0	100.000000

- What are the percentages of outsourcing for the best cases?

	State	Month	Demand	outsourced_BC	outsourced_BC %
0	A	Jan	5240	0.0	0.0
1	A	Feb	4878	0.0	0.0
2	A	Mar	5942	0.0	0.0
3	A	Apr	2297	0.0	0.0
4	A	May	1992	0.0	0.0
5	A	Jun	2275	0.0	0.0
6	A	Jul	5334	0.0	0.0
7	A	Aug	3371	0.0	0.0
8	A	Sep	3759	0.0	0.0
9	A	Oct	3529	0.0	0.0
10	A	Nov	4284	0.0	0.0
11	A	Dec	5183	0.0	0.0
12	B	Jan	4927	0.0	0.0
13	B	Feb	2628	0.0	0.0
14	B	Mar	2974	0.0	0.0
15	B	Apr	2338	0.0	0.0
16	B	May	4020	0.0	0.0
17	B	Jun	3147	0.0	0.0
18	B	Jul	4271	1708.0	40.0
19	B	Aug	2620	0.0	0.0
20	B	Sep	4517	0.0	0.0
21	B	Oct	4155	0.0	0.0
22	B	Nov	3137	1254.0	40.0
23	B	Dec	4227	1690.0	40.0
24	C	Jan	1162	0.0	0.0
25	C	Feb	1967	0.0	0.0
26	C	Mar	1898	0.0	0.0
27	C	Apr	2261	0.0	0.0
28	C	May	2030	0.0	0.0
29	C	Jun	1642	0.0	0.0
30	C	Jul	2489	0.0	0.0
31	C	Aug	2496	0.0	0.0
32	C	Sep	922	0.0	0.0
33	C	Oct	2421	0.0	0.0
34	C	Nov	963	0.0	0.0
35	C	Dec	1998	0.0	0.0

- What is the average cost per application for the worst cases?

```
1  # write your code here
2
3  # Average cost = totalcost / sum of all demands
4
5  round((model4.totalCost())/sum(data['Demand']),2)
6
```
173.0

The average cost per application for the worst cases is $173

- What is the average cost per application for the best cases?

```
1  # write your code here
2
3  # Average cost = totalcost / sum of all demands
4
5  round((model5.totalCost())/sum(data['Demand']),2)
```
145.88

The average cost per application for the worst cases is $145.88

Q5. Create the following visualisations using your preferred method (i.e. Python, PowerPoint, Excel, etc.) and add it to your report.
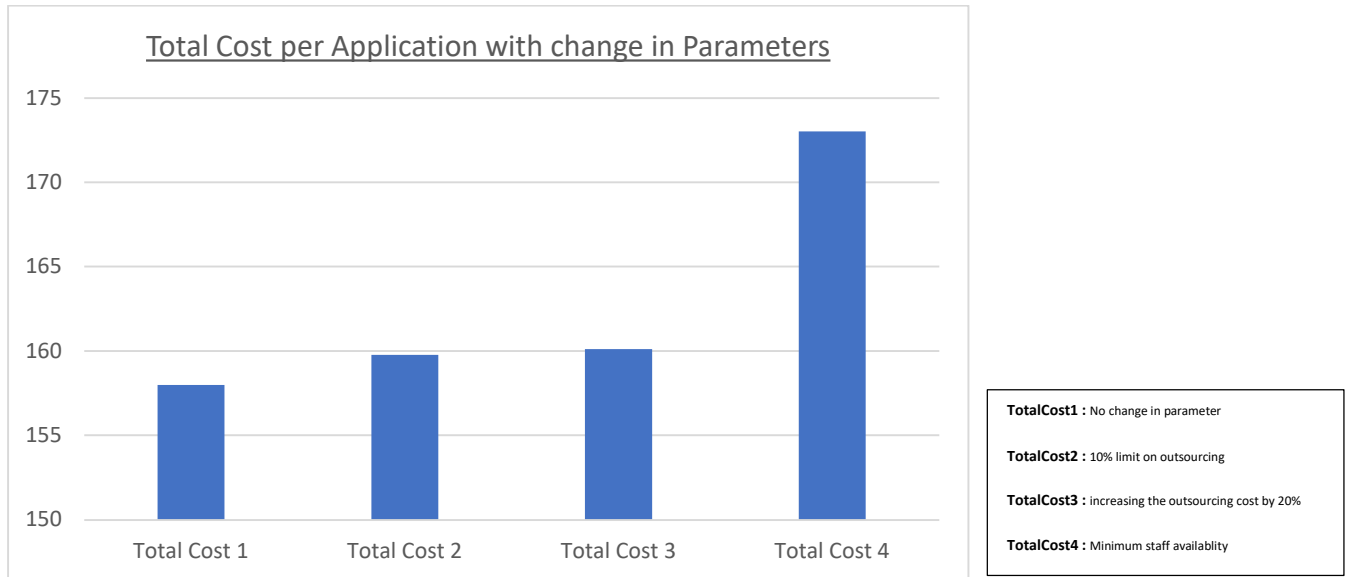
Q 5.1: Use the solution of Q2 to create a stacked column chart that shows the percentage of applications processed by the staff and by the vendor for each month (%staff processed applications + %vendor processed applications should add up to 100%).

Ans5.1:
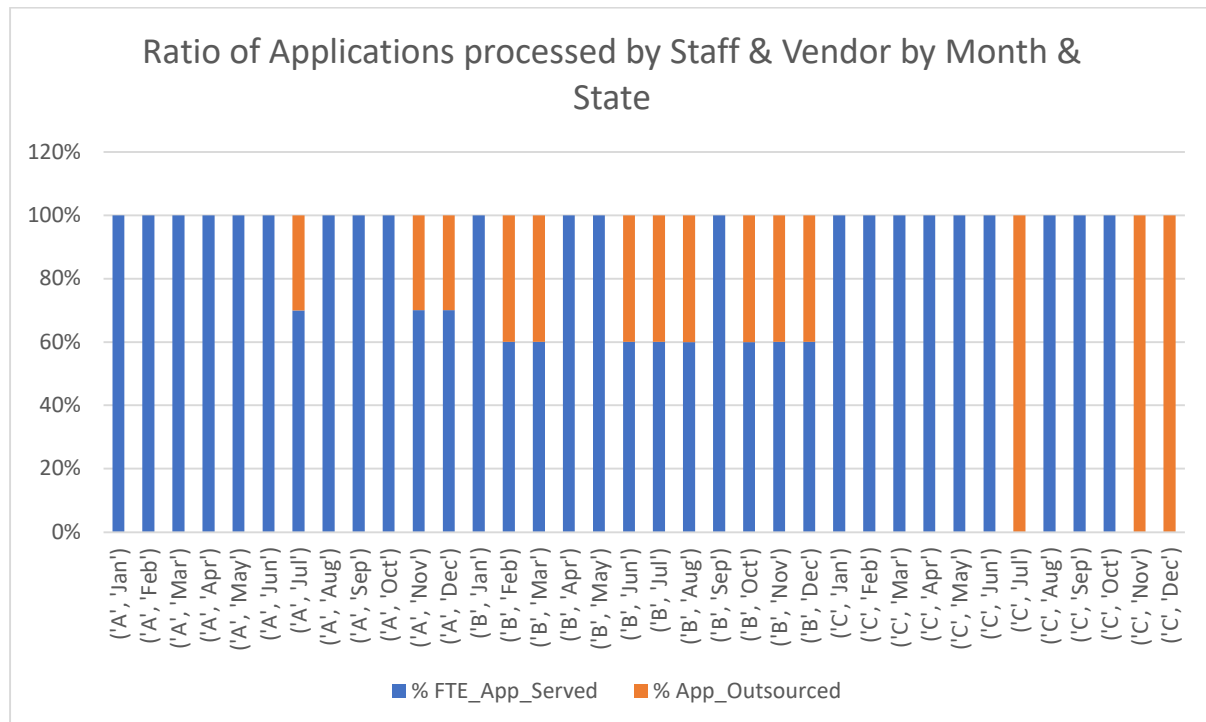
Q 5.2: Create a graph to show how the cost per application increases with respect to any change in the parameters in your analysis. (Hint: Use the cost per application that you calculate in Questions 2, 3 and 4, i.e., the actual scenario, 10% outsourcing limit, best case and worst case.)

Ans:

Total Cost per Application with change in Parameters

TotalCost1 : No change in parameter

TotalCost2 : 10% limit on outsourcing

TotalCost3 : increasing the outsourcing cost by 20%

TotalCost4 : Minimum staff availablity

Q6. The company comes across an additional proposed outsourced vendor as 'VENDOR 2'.

6.1: Calculate the optimal staffing at a 10% limit on outsourcing while maintaining the vendor ratio (60%:40%) for the number of applications that can be outsourced for every month in each state.

Ans:

	StateMonth	FTE	Outsourced	StaffAvail	Demand	FTE_App_Served	App_Outsourced
0	(A, Jan)	161.73	0.0	0.81	5240	5240.0	0.0
1	(A, Feb)	160.46	0.0	0.76	4878	4878.0	0.0
2	(A, Mar)	178.40	236.0	0.75	5942	5352.0	590.0
3	(A, Apr)	71.78	0.0	0.80	2297	2297.0	0.0
4	(A, May)	63.85	0.0	0.78	1992	1992.0	0.0
5	(A, Jun)	70.21	90.0	0.73	2275	2050.0	225.0
6	(A, Jul)	176.62	212.0	0.68	5334	4804.0	530.0
7	(A, Aug)	110.89	0.0	0.76	3371	3371.0	0.0
8	(A, Sep)	116.02	0.0	0.81	3759	3759.0	0.0
9	(A, Oct)	108.87	140.0	0.73	3529	3179.0	350.0
10	(A, Nov)	141.88	170.0	0.68	4284	3859.0	425.0
11	(A, Dec)	179.54	206.0	0.65	5183	4668.0	515.0
12	(B, Jan)	152.07	0.0	0.81	4927	4927.0	0.0
13	(B, Feb)	77.89	104.0	0.76	2628	2368.0	260.0
14	(B, Mar)	89.30	118.0	0.75	2974	2679.0	295.0
15	(B, Apr)	73.06	0.0	0.80	2338	2338.0	0.0
16	(B, May)	128.85	0.0	0.78	4020	4020.0	0.0
17	(B, Jun)	97.16	124.0	0.73	3147	2837.0	310.0
18	(B, Jul)	141.40	170.0	0.68	4271	3846.0	425.0
19	(B, Aug)	77.63	104.0	0.76	2620	2360.0	260.0
20	(B, Sep)	139.41	0.0	0.81	4517	4517.0	0.0
21	(B, Oct)	128.08	166.0	0.73	4155	3740.0	415.0
22	(B, Nov)	103.93	124.0	0.68	3137	2827.0	310.0
23	(B, Dec)	146.42	168.0	0.65	4227	3807.0	420.0
24	(C, Jan)	35.86	0.0	0.81	1162	1162.0	0.0
25	(C, Feb)	64.70	0.0	0.76	1967	1967.0	0.0
26	(C, Mar)	63.27	0.0	0.75	1898	1898.0	0.0
27	(C, Apr)	70.66	0.0	0.80	2261	2261.0	0.0
28	(C, May)	65.06	0.0	0.78	2030	2030.0	0.0
29	(C, Jun)	56.23	0.0	0.73	1642	1642.0	0.0
30	(C, Jul)	82.50	98.0	0.68	2489	2244.0	245.0
31	(C, Aug)	82.11	0.0	0.76	2496	2496.0	0.0
32	(C, Sep)	28.46	0.0	0.81	922	922.0	0.0
33	(C, Oct)	82.91	0.0	0.73	2421	2421.0	0.0
34	(C, Nov)	31.91	38.0	0.68	963	868.0	95.0
35	(C, Dec)	69.35	78.0	0.65	1998	1803.0	195.0

6.2: Calculate the optimal Allocation of the applications after relaxing the ratio criterion (60%: 40%) mentioned above.

Ans:

	StateMonth	FTE	Outsourced	StaffAvail	Demand	FTE_App_Served	App_Outsourced
0	(A, Jan)	161.73	0.0	0.81	5240	5240.0	0.0
1	(A, Feb)	0.00	0.0	0.76	4878	0.0	0.0
2	(A, Mar)	0.00	0.0	0.75	5942	0.0	590.0
3	(A, Apr)	0.00	0.0	0.80	2297	0.0	0.0
4	(A, May)	0.00	0.0	0.78	1992	0.0	0.0
5	(A, Jun)	0.00	0.0	0.73	2275	0.0	225.0
6	(A, Jul)	0.00	0.0	0.68	5334	0.0	530.0
7	(A, Aug)	0.00	0.0	0.76	3371	0.0	0.0
8	(A, Sep)	116.02	0.0	0.81	3759	3759.0	0.0
9	(A, Oct)	0.00	0.0	0.73	3529	0.0	350.0
10	(A, Nov)	0.00	0.0	0.68	4284	0.0	425.0
11	(A, Dec)	0.00	0.0	0.65	5183	0.0	515.0
12	(B, Jan)	152.07	0.0	0.81	4927	4927.0	0.0
13	(B, Feb)	0.00	2628.0	0.76	2628	0.0	260.0
14	(B, Mar)	0.00	2974.0	0.75	2974	0.0	295.0
15	(B, Apr)	73.06	0.0	0.80	2338	2338.0	0.0
16	(B, May)	128.85	0.0	0.78	4020	4020.0	0.0
17	(B, Jun)	0.00	3147.0	0.73	3147	0.0	310.0
18	(B, Jul)	0.00	4271.0	0.68	4271	0.0	425.0
19	(B, Aug)	0.00	2620.0	0.76	2620	0.0	260.0
20	(B, Sep)	139.41	0.0	0.81	4517	4517.0	0.0
21	(B, Oct)	0.00	4155.0	0.73	4155	0.0	415.0
22	(B, Nov)	0.00	3137.0	0.68	3137	0.0	310.0
23	(B, Dec)	0.00	4227.0	0.65	4227	0.0	420.0
24	(C, Jan)	35.86	0.0	0.81	1162	1162.0	0.0
25	(C, Feb)	64.70	0.0	0.76	1967	1967.0	0.0
26	(C, Mar)	63.27	0.0	0.75	1898	1898.0	0.0
27	(C, Apr)	70.66	0.0	0.80	2261	2261.0	0.0
28	(C, May)	65.06	0.0	0.78	2030	2030.0	0.0
29	(C, Jun)	56.23	0.0	0.73	1642	1642.0	0.0
30	(C, Jul)	0.00	0.0	0.68	2489	0.0	245.0
31	(C, Aug)	82.11	0.0	0.76	2496	2496.0	0.0
32	(C, Sep)	28.46	0.0	0.81	922	922.0	0.0
33	(C, Oct)	82.91	0.0	0.73	2421	2421.0	0.0
34	(C, Nov)	0.00	0.0	0.68	963	0.0	95.0
35	(C, Dec)	0.00	0.0	0.65	1998	0.0	195.0