

Staff Planning Case Study Report

Problem Introduction

An insurance company InsurePlus wants help with finding the optimal number of staff that they need for their insurance application approval process for the calendar year 2021. In the industry, the number of staffs is considered as a continuous variable. This is also called a Full-Time Equivalent (FTE) of the staff. For example, if a full-time employee (FTE =1) works for 50 hours a week, 10 hours corresponds to 0.2 FTEs. If the pay for 50 hours a week is \$5000, then 0.2 FTE who may be a part-time employee will be paid \$1000 (5000×0.2). The information provided are as follows.

Problem Statement and Background

- The company operates in three states: A, B and C. The state-wise demand for insurance for the year is shown in the table provided below:

States	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
A	5240	4878	5942	2297	1992	2275	5334	3371	3759	3529	4284	5183
B	4927	2628	2974	2338	4020	3147	4271	2620	4517	4155	3137	4227
C	1162	1967	1898	2261	2030	1642	2489	2496	922	2421	963	1998

The company can either handle an application with the staff that they hire or outsource it to a vendor. Assume that there is no capacity limitation to outsourcing.

- If they hire staff, he/she can handle 40 insurance applications per month when he/she works 100% of the workdays. However, there are days that he/she will be unavailable to process applications due to training, off days, etc.
- A staff member's availability (in percentage) to work on processing the insurance applications for each month is shown in the table given below. As mentioned before, with 100% availability, each member can handle 40 applications.

States	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
A	81%	76%	75%	80%	78%	73%	68%	76%	81%	73%	68%	65%
B	81%	76%	75%	80%	78%	73%	68%	76%	81%	73%	68%	65%
C	81%	76%	75%	80%	78%	73%	68%	76%	81%	73%	68%	65%

- States A and B have a regulatory restriction that the outsourced insurance applications cannot be more than 30% and 40% of the total number of applications for each month, respectively.
- The table given below shows the cost of the staff vs external resources:

State	Annual Salary of Staff	Outsourcing Cost per Application
A	\$60,000	\$180
B	\$55,000	\$150
C	\$53,000	\$160

The objective is to optimise the total cost for the application approval process by distributing the right number of applications between the FTEs and the vendors while meeting the monthly demand for each state at the same time.

Mathematical model for the deterministic optimisation problem

The following are the indexes, parameters, decision variables and objective function for the optimisation problem.

1. Indexes

- a. For this problem we have two indexes i.e.
 - i. States
 - ii. Month

2. Parameters

- a. We can consider the following as the parameters for this model:
 - i. Demand: Number of applications expected for each month.
 - ii. Staff availability: Percentage of staff available for the month.
 - iii. Cost: Application outsource cost @
 - iv. Salary: Salary for the FTE/staff (S)

3. Decision Variables

- a. Number of FTE / staff – $X_{s,m}$
- b. Number of outsourced applications – $Y_{s,m}$

4. Objective Function

- a. Sum for all states (Sum for all months (No: of FTE * FTE salary + No: of outsourced app * unit outsourced cost))

$$\min \sum_{s,m} X * S + Y * C$$

Where

X = Number of FTEs

Y = Number of outsourced applications

S = Salary for the FTE

C = Unit Cost for the outsourced application

s = state

m = month

5. Constraints

- a. There are two main constraints i.e. demand constraint and outsourcing constraint
- b. Demand Constraint: Number of applications that can be processed for a month.
- c. Outsourcing constraint:
 - i. For state "A" only 30% of the applications can be outsourced.
 - ii. For state "B" only 40% of the applications can be outsourced.

MODEL-1

In this model we will optimize using the average staff availability data. All the parameters and decision variables remains the same as given above.

The Following is the Data table with cost, number of FTEs and applications outsourced for each state and months.

S.No.	BankLoc	Month	Demand	FTE	App. Outsourced	App_Proc_FTE	Cost	Percent Outsourced	Avg_CostperApp
0	A	Jan	5240	161.7284	0	5240	808642	0	154.32
1	A	Feb	4878	160.4605	0	4878	802302.6	0	164.47
2	A	Mar	5942	198.0667	0	5942	990333.3	0	166.67
3	A	Apr	2297	71.78125	0	2297	358906.3	0	156.25
4	A	May	1992	63.84615	0	1992	319230.8	0	160.26
5	A	Jun	2275	77.91096	0	2275	389554.8	0	171.23
6	A	Jul	5334	137.2794	1600	3734	974397.1	30	182.68
7	A	Aug	3371	110.8882	0	3371	554440.8	0	164.47
8	A	Sep	3759	116.0185	0	3759	580092.6	0	154.32
9	A	Oct	3529	120.8562	0	3529	604280.8	0	171.23
10	A	Nov	4284	110.2574	1285	2999	782586.8	30	182.68
11	A	Dec	5183	139.5769	1554	3629	977604.6	29.98	188.62
12	B	Jan	4927	152.0679	0	4927	696977.9	0	141.46
13	B	Feb	2628	51.875	1051	1577	395410.4	39.99	150.46
14	B	Mar	2974	59.5	1189	1785	451058.3	39.98	151.67
15	B	Apr	2338	73.0625	0	2338	334869.8	0	143.23
16	B	May	4020	128.8462	0	4020	590544.9	0	146.9
17	B	Jun	3147	64.69178	1258	1889	485204	39.97	154.18
18	B	Jul	4271	94.22794	1708	2563	688078.1	39.99	161.1
19	B	Aug	2620	51.71053	1048	1572	394206.6	40	150.46
20	B	Sep	4517	139.4136	0	4517	638978.9	0	141.46
21	B	Oct	4155	85.37671	1662	2493	640609.9	40	154.18
22	B	Nov	3137	69.22794	1254	1883	505394.7	39.97	161.11
23	B	Dec	4227	97.57692	1690	2537	700727.6	39.98	165.77
24	C	Jan	1162	35.8642	0	1162	158400.2	0	136.32
25	C	Feb	1967	64.70395	0	1967	285775.8	0	145.29
26	C	Mar	1898	63.26667	0	1898	279427.8	0	147.22
27	C	Apr	2261	70.65625	0	2261	312065.1	0	138.02
28	C	May	2030	65.0641	0	2030	287366.5	0	141.56
29	C	Jun	1642	56.23288	0	1642	248361.9	0	151.26
30	C	Jul	2489	0	2489	0	398240	100	160
31	C	Aug	2496	82.10526	0	2496	362631.6	0	145.29
32	C	Sep	922	28.45679	0	922	125684.2	0	136.32
33	C	Oct	2421	82.91096	0	2421	366190.1	0	151.26
34	C	Nov	963	0	963	0	154080	100	160
35	C	Dec	1998	0	1998	0	319680	100	160

Summary:

Total Demand: 113294

Total Outsourced Application: 20749.0

Total FTE: 3086

Avg FTE: 85.72

Estimated Cost: 17962336.43

Worst- and Best-Case Analysis**Model – Lower Bound**

In this model we will optimize using the lower bound of staff availability data. All the parameters and decision variables remains the same as given above.

The Following is the Data table with cost, number of FTEs and applications outsourced for each state and months.

S.No.	Bank Loc	Month	Demand	FTE	App_O utsourc ed	App_Pro c_FTE	Cost	Percent Outsour ced	Avg_Costper App
0	A	Jan	5240	187	0	6063.429	935714.30	0	178.57
1	A	Feb	4878	131	1463	3992.923	920070.80	29.99	188.62
2	A	Mar	5942	212	0	6366.429	1061071.00	0	178.57
3	A	Apr	2297	77	0	2450.133	382833.30	0	166.67
4	A	May	1992	71	0	2219.657	355714.30	0	178.57
5	A	Jun	2275	61	682	1789.062	429106.20	29.98	188.62
6	A	Jul	5334	156	1600	4231.867	1065917.00	30	199.83
7	A	Aug	3371	91	1011	2759.385	635826.20	29.99	188.62
8	A	Sep	3759	134	0	4349.7	671250.00	0	178.57
9	A	Oct	3529	95	1058	2775.123	665632.30	29.98	188.62
10	A	Nov	4284	125	1285	3398.867	856091.70	30	199.83
11	A	Dec	5183	151	1554	3931.417	1035762.00	29.98	199.84
12	B	Jan	4927	106	1970	3421.671	779532.70	39.98	158.22
13	B	Feb	2628	61	1051	1843.877	435646.80	39.99	165.77
14	B	Mar	2974	64	1189	1912.5	470537.50	39.98	158.22
15	B	Apr	2338	47	935	1496.533	354597.20	39.99	151.67
16	B	May	4020	86	1608	2687.657	636021.40	40	158.21
17	B	Jun	3147	73	1258	2121.492	521696.80	39.97	165.78
18	B	Jul	4271	107	1708	2904.733	745661.80	39.99	174.59
19	B	Aug	2620	60	1048	1838.031	434315.40	40	165.77
20	B	Sep	4517	97	1806	3137.014	714664.90	39.98	158.22
21	B	Oct	4155	96	1662	2799.831	688771.20	40	165.77
22	B	Nov	3137	78	1254	2134.067	547700.70	39.97	174.59
23	B	Dec	4227	106	1690	2748.417	737996.50	39.98	174.59
24	C	Jan	1162	42	0	1344.6	183291.70	0	157.74
25	C	Feb	1967	0	1967	0	314720.00	100	160
26	C	Mar	1898	68	0	2033.571	299386.90	0	157.74
27	C	Apr	2261	75	0	2411.733	332869.40	0	147.22
28	C	May	2030	73	0	2262	320208.30	0	157.74
29	C	Jun	1642	0	1642	0	262720.00	100	160

30	C	Jul	2489	0	2489	0	398240.00	100	160
31	C	Aug	2496	0	2496	0	399360.00	100	160
32	C	Sep	922	33	0	1066.886	145434.50	0	157.74
33	C	Oct	2421	0	2421	0	387360.00	100	160
34	C	Nov	963	0	963	0	154080.00	100	160
35	C	Dec	1998	0	1998	0	319680.00	100	160

Summary:

Total Demand: 113294

Worst Case Total Outsourced Application: 39808.0

Worst Case Total FTE: 2761.4

Worst Case Avg FTE: 76.71

Worst Case Estimated Cost: 19599482.5

Model – Upper Bound

In this model we will optimize using the upper bound of staff availability data. All the parameters and decision variables remains the same as given above.

The Following is the Data table with cost, number of FTEs and applications outsourced for each state and months.

S.No.	BankLoc	Month	Demand	FTE	App Outsourced	App_Proc_FTE	Cost	Percent_Outsourced	Avg_CostperApp
0	A	Jan	5240	146	0	4716	727777.8	0	138.89
1	A	Feb	4878	143	0	4361.506	717352.9	0	147.06
2	A	Mar	5942	186	0	5570.625	928437.5	0	156.25
3	A	Apr	2297	68	0	2161.882	337794.1	0	147.06
4	A	May	1992	59	0	1827.953	292941.2	0	147.06
5	A	Jun	2275	71	0	2075.938	355468.8	0	156.25
6	A	Jul	5334	178	0	4836.16	889000	0	166.67
7	A	Aug	3371	99	0	3014.071	495735.3	0	147.06
8	A	Sep	3759	104	0	3383.1	522083.3	0	138.89
9	A	Oct	3529	110	0	3220.213	551406.3	0	156.25
10	A	Nov	4284	143	0	3884.16	714000	0	166.67
11	A	Dec	5183	185	0	4812.786	925535.7	0	178.57
12	B	Jan	4927	137	0	4434.3	627280.1	0	127.31
13	B	Feb	2628	77	0	2349.741	354264.7	0	134.8
14	B	Mar	2974	93	0	2788.125	425963.5	0	143.23
15	B	Apr	2338	69	0	2200.471	315171.6	0	134.8
16	B	May	4020	118	0	3688.941	541911.8	0	134.8
17	B	Jun	3147	98	0	2871.638	450742.2	0	143.23
18	B	Jul	4271	85	1708	2323.787	647769.4	39.99	151.67
19	B	Aug	2620	77	0	2342.588	353186.3	0	134.8
20	B	Sep	4517	125	0	4065.3	575081	0	127.31
21	B	Oct	4155	130	0	3791.438	595117.2	0	143.23
22	B	Nov	3137	63	1254	1707.253	475780.6	39.97	151.67
23	B	Dec	4227	91	1690	2355.786	668782.7	39.98	158.22
24	C	Jan	1162	32	0	1045.8	142560.2	0	122.69

25	C	Feb	1967	58	0	1758.729	255517.2	0	129.9
26	C	Mar	1898	59	0	1779.375	261963.5	0	138.02
27	C	Apr	2261	67	0	2128	293708.3	0	129.9
28	C	May	2030	60	0	1862.824	263701	0	129.9
29	C	Jun	1642	51	0	1498.325	226630.2	0	138.02
30	C	Jul	2489	83	0	2256.693	366436.1	0	147.22
31	C	Aug	2496	73	0	2231.718	324235.3	0	129.9
32	C	Sep	922	26	0	829.8	113115.7	0	122.69
33	C	Oct	2421	76	0	2209.163	334148.4	0	138.02
34	C	Nov	963	32	0	873.12	141775	0	147.22
35	C	Dec	1998	71	0	1855.286	315160.7	0	157.74

Summary:

Total Demand: 113294

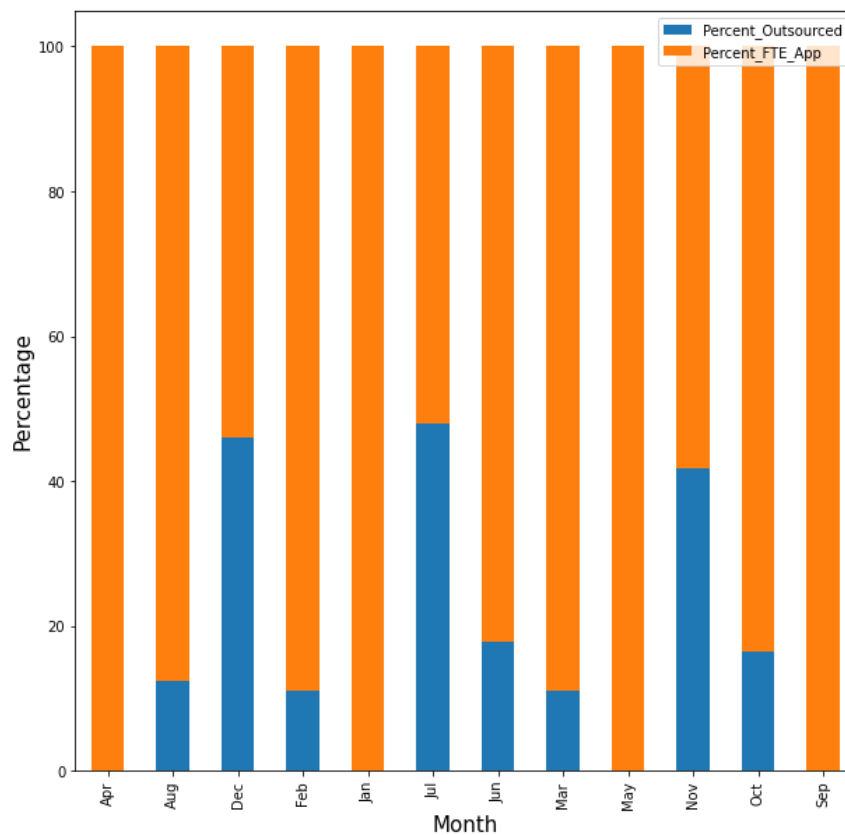
Best Case Total Outsourced Application: 4652.0

Best Case Total FTE: 3343

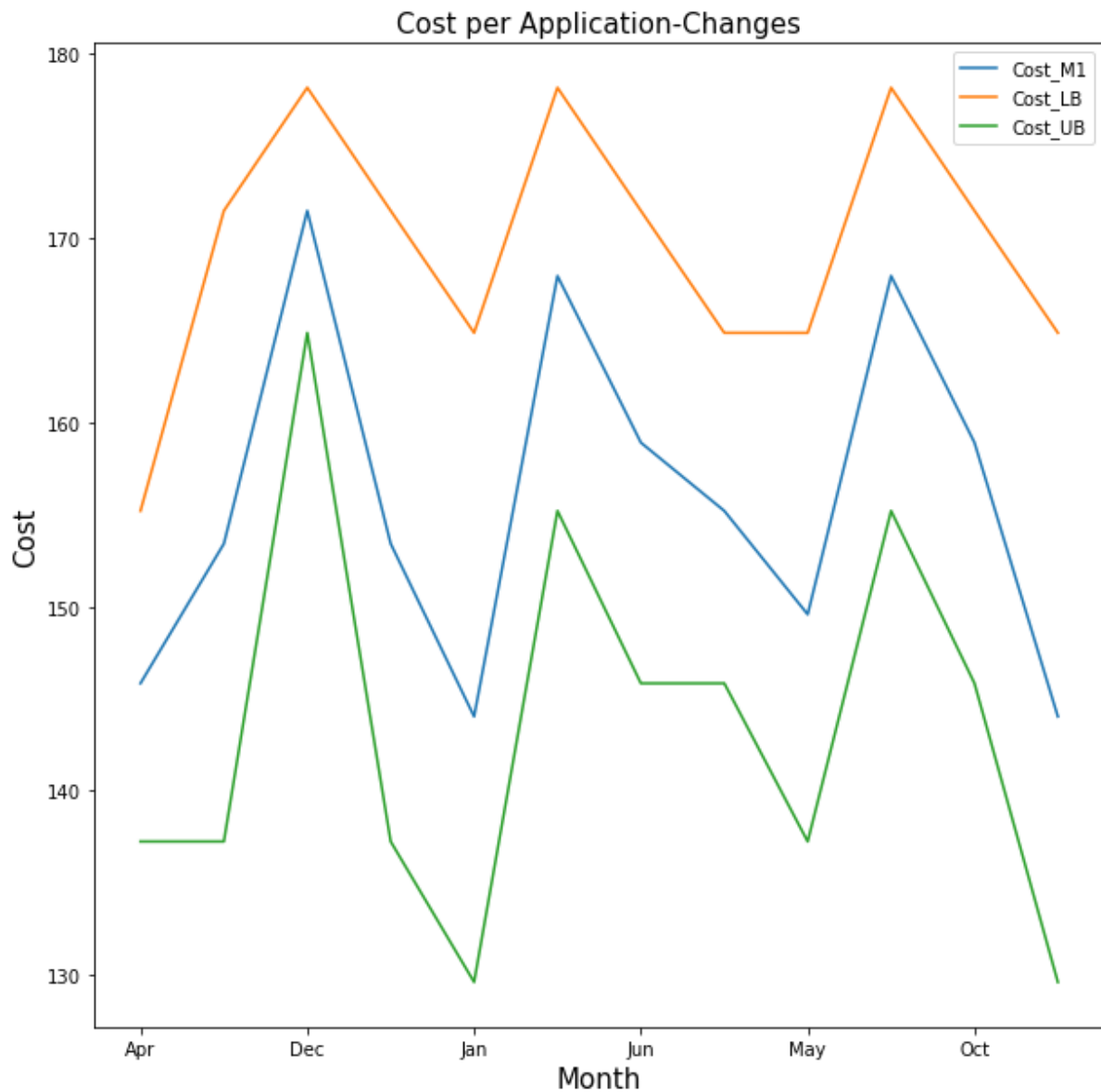
Best Case Avg FTE: 92.87

Best Case Estimated Cost: 16527535.629

**Percentage of Applications Processed by the staff and by the vendor for each month
(Based on Model-1)**



In the Model-1, the months of April, January, May and September there is 100% FTEs and no application is outsourced. The outsourcing is above 40% for the months of December, July and November.

Cost per application increases with respect to any change in the parameters in the analysis

- As per the above graph, the lower bound model where there is low availability of FTEs/staff, the cost increases. This is due to the increased outsourcing of applications.
- When there is higher percentage of staff/FTEs availability the cost decreases, this is evident from the low outsourcing of applications.
- Looking at the average staff availability model i.e. Model-1 (M1), this could be the usual scenario.