BUSINESS CASE STUDY-STAFF PLANNING

1. **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.:

Sets:

The indexes for the given problem are,

- State, $s \in State$
- Month, $m \in Month$

Parameters:

- $Demand_{s,m}$ - Demand of Insurance Applications
- $FTE_{s,m}$ - Applications processed by FTE
- $Outsource_{s,m}$ - Applications outsourced.
- $FTE\_Monthly\_Salary_{s,m}$ - Monthly Salary of FTE
- $UnitOutSourceCost_{s,m}$ - Unit Cost for outsourcing 1 application
- $Staff\_Availability_{s,m}$ - Average availability of FTE
- $Staff\_Availability\_LB_{s,m}$ - Minimum availability of FTE
- $Staff\_Availability\_UB_{s,m}$ - Maximum availability of FTE
- MaxAppFTE - Number of insurance applications that can be processed by an FTE in a month when working with 100 percent availability.

Decision variables:

- Total number of applications processed by FTE for each state and month combination

  $FTE_{s,m}$ where $s \in State, m \in Month$

- Total number of applications outsourced for each state and month combination

  $Outsource_{s,m}$ where $s \in State, m \in Month$

Objective Function:

- To minimize the total cost of insurance approval process by distributing the right number of applications between FTE and outsourced.

$\min(\sum_{s,m} FTE_{s,m} * FTE\_Monthly\_Salary_{s,m} + \sum_{s,m} Outsource_{s,m} * UnitOutSourceCost_{s,m})$

where $s \in State$ and $m \in Month$

Constraints:

- **Demand Constraint**: - Demand of Insurance for each state and month combination

  $\sum_{s,m}$FTE$_{s,m}$*Staff_Availability$_{s,m}$*MaxAppFTE=Demand $\forall s \in State, m \in Month$

- **Staff Availability**: - Staff Availability for best and worst case scenarios.

  Staff_Availability$_{s,m}$=Staff_Availability_LB$_{s,m}$ $\forall s \in State, m \in Month$

  Staff_Availability$_{s,m}$<Staff_Availability_UB$_{s,m}$ $\forall s \in State, m \in Month$

- **Outsourcing Regulations**: - Regulatory Regulations on States A & B for outsourcing applications.

  Outsource$_{s,m}$<(0.3*Demand$_{s,m}$) where $s \in A$, $m \in Month$

  Outsource$_{s,m}$<(0.4*Demand$_{s,m}$) where $s \in B$, $m \in Month$

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

Ans.:

- Output_Optimised DataFrame

	State	Month	Demand	No of FTE	No of Outsource	No of FTE Processed Applications	Percent FTE Applications	Percent Outsourced Applications	Estimated Cost	Cost per Application	Estimated Cost in mn $
0	A	Jan	5240	161.7	0	5239	3.09	0.00	808641.975309	154.32	0.8
1	A	Feb	4878	160.5	0	4877	3.29	0.00	802302.631579	164.47	0.8
2	A	Mar	5942	198.1	0	5942	3.33	0.00	990333.333333	166.67	1.0
3	A	Apr	2297	71.8	0	2297	3.12	0.00	358906.250000	156.25	0.4
4	A	May	1992	63.8	0	1991	3.21	0.00	319230.769231	160.26	0.3
5	A	Jun	2275	77.9	0	2275	3.42	0.00	389554.794521	171.23	0.4
6	A	Jul	5334	137.3	1600	3734	2.57	30.00	974397.058824	182.68	1.0
7	A	Aug	3371	110.9	0	3371	3.29	0.00	554440.789474	164.47	0.6
8	A	Sep	3759	116.0	0	3759	3.09	0.00	580092.592593	154.32	0.6
9	A	Oct	3529	120.9	0	3529	3.42	0.00	604280.821918	171.23	0.6
10	A	Nov	4284	110.3	1285	2998	2.57	30.00	782586.764706	182.68	0.8

- Output_Worst DataFrame

	State	Month	Demand	No of FTE	No of Outsource	No of FTE Processed Applications	Percent FTE Applications	Percent Outsourced Applications	Estimated Cost	Cost per Application	Estimated Cost in mn $
0	A	Jan	5240	187.1	0	5239	3.57	0.00	9.357143e+05	178.57	0.9
1	A	Feb	4878	131.3	1463	3415	2.69	29.99	9.200708e+05	188.62	0.9
2	A	Mar	5942	212.2	0	5942	3.57	0.00	1.061071e+06	178.57	1.1
3	A	Apr	2297	76.6	0	2297	3.33	0.00	3.828333e+05	166.67	0.4
4	A	May	1992	71.1	0	1991	3.57	0.00	3.557143e+05	178.57	0.4
5	A	Jun	2275	61.3	682	1593	2.69	29.98	4.291062e+05	188.62	0.4
6	A	Jul	5334	155.6	1600	3733	2.92	30.00	1.065917e+06	199.83	1.1
7	A	Aug	3371	90.8	1011	2360	2.69	29.99	6.358262e+05	188.62	0.6
8	A	Sep	3759	134.2	0	3758	3.57	0.00	6.712500e+05	178.57	0.7
9	A	Oct	3529	95.0	1058	2470	2.69	29.98	6.656323e+05	188.62	0.7
10	A	Nov	4284	125.0	1285	2998	2.92	30.00	8.560917e+05	199.83	0.9

- Output_Best Dataframe

	State	Month	Demand	No of FTE	No of Outsource	No of FTE Processed Applications	Percent FTE Applications	Percent Outsourced Applications	Estimated Cost	Cost per Application	Estimated Cost in mn $
0	A	Jan	5240	145.6	0	5240	2.78	0.00	727777.777778	138.89	0.7
1	A	Feb	4878	143.5	0	4877	2.94	0.00	717352.941176	147.06	0.7
2	A	Mar	5942	185.7	0	5942	3.12	0.00	928437.500000	156.25	0.9
3	A	Apr	2297	67.6	0	2297	2.94	0.00	337794.117647	147.06	0.3
4	A	May	1992	58.6	0	1991	2.94	0.00	292941.176471	147.06	0.3
5	A	Jun	2275	71.1	0	2275	3.12	0.00	355468.750000	156.25	0.4
6	A	Jul	5334	177.8	0	5334	3.33	0.00	889000.000000	166.67	0.9
7	A	Aug	3371	99.1	0	3370	2.94	0.00	495735.294118	147.06	0.5
8	A	Sep	3759	104.4	0	3759	2.78	0.00	522083.333333	138.89	0.5
9	A	Oct	3529	110.3	0	3529	3.12	0.00	551406.250000	156.25	0.6
10	A	Nov	4284	142.8	0	4284	3.33	0.00	714000.000000	166.67	0.7

Note: - For Complete Data frames refer the Jupyter Notebook

3.1. What is the optimal number of staff members for the worst and best cases?

Ans.: The optimal number of staff members is: -

- Worst Case: - 76.7
- Best Case: - 92.9

3.2. What are the percentages of outsourcing for the worst and best cases?

Ans.: The percentages of outsourcing is: -

- Worst Case: - 35.1%
- Best Case: - 4.1%

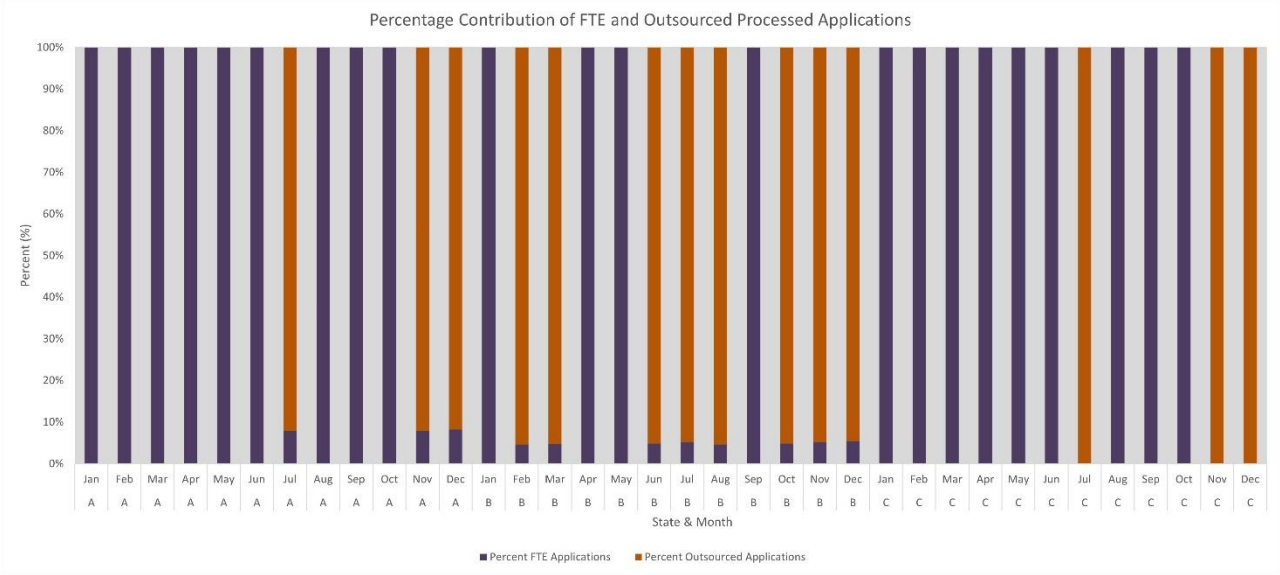
3.3. What is the average cost per application for the worst and best cases.

Ans.: The average cost per application is: -

- Worst Case: - 173
- Best Case: - 145.88

4.1 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%)?

Ans.:



4.2. Create a graph to show how the cost per application increases with respect to any change in the parameters in your analysis?

Ans.: