

CASE STUDY - Decision making in low uncertainty scenarios.

This client is dedicated to preparing meals for children (1 to 7 years old) in private schools. His business currently operates in a commercial kitchen rented by the hour. The demand for the service has increased and they will need to rent a fully dedicated kitchen. The variables to consider are the number of lunches, which is equivalent to the number of students, and the cost of renting a full-time kitchen, the income is a fixed monthly parameter and it is equivalent to \$100 x month x child, other data to consider is that the financial statements of the last two years have projected an average net profit, before tax, of 30%.

There is a possibility that starting the new school year in August the service will demand 5 new schools, each school with a maximum number of students. The contract with each school is safe, what is not sure is that all parents subscribe to the foodservice for their children, it is estimated, a priori, that half of the students hire the service, this at best. In the worst case, new students are not being considered.

There is also the possibility in the 15 current schools (S1 to S15) that in the first two months (August, September) 100% of the students who came from the previous school year did not contract the service, except for two schools (S10 and S14) that guaranteed the same number of students. As a conservative measure, a probability of dropouts is then estimated for each school as can be seen in the table below.

MODEL: measure of risk (uncertainty variables) and objective function or reward

Historic Data - Average last 6 months

Current number of students per month	200
Monthly Fixed Fee per Student (US\$)	100.00
Monthly Gross Income (US\$)	20,000.00
Monthly Net Income (30%)	6,000.00

Therefore, the **uncertainty variables** are the **number of students per school and the cost of kitchen rent** that is in a variable range depending on when the lease contract closes. If the lease closes in June, as an incentive the kitchen owner has offered a rental cost of \$3,500 per month, fixed for one year, but if our client decides to rent in September, the cost of the rent can increase up to 10%.

It is then necessary to make a decision, which we propose is based on data analysis using a simulation method to estimate the Net Income in September, considering a better and worse scenario which gives us a range of values to generate a uniform distribution of the possible number of students, this is then our measure of risk, and the **objective function or reward is the Net Income**, which is determined by 30% of the Gross Income minus the cost of the kitchen rent.

Uncertainty variables: **Lease** June Incentive September +5% to 10%
3,500.00 **3,850.00**

Number of Students per School

	Best Case	Worst Case	Mean
# STUDENTS NEXT SCHOOL YEAR	360	155	258
Monthly Gross Income (US\$)	36,000.00	15,500.00	
Cost & Expenses (70%) + Lease	28,700.00	14,700.00	
REWARD (Monthly Net Income)	\$ 7,300.00	\$ 800.00	

Objective Function = Net income = # students x fee x 0.3 - lease

In the **best case**, it is estimated that the number of students is the same as the one that closed in June, that is, that no child is withdrawn from the meal program, plus the expected value (EV) of the new children of the five new schools.

In the **worst case**, the number of children is only the expected value applying the renovation probabilities in the current schools (S1 to S15), then, it is considered that no new children will require the meal service.

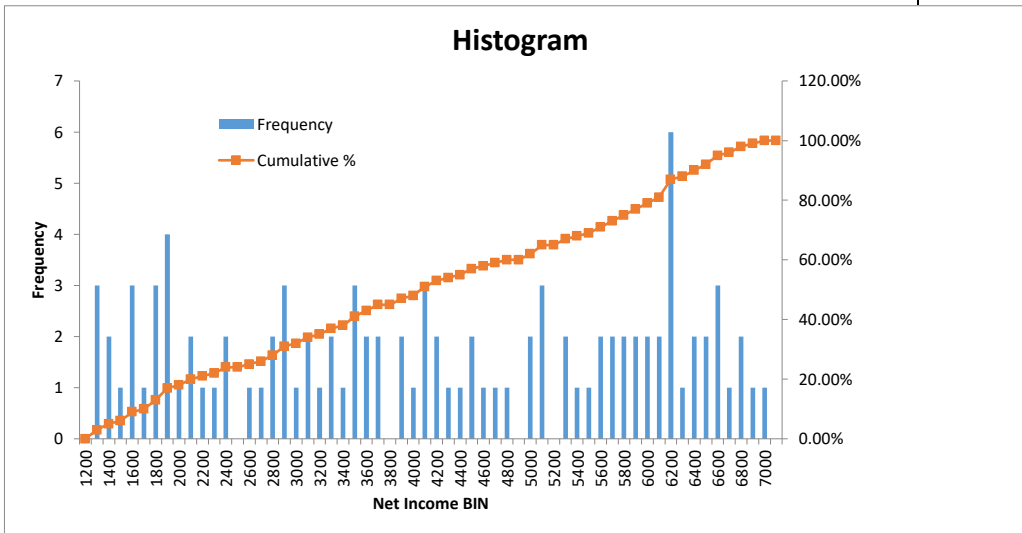
Schools	Renewal	# Students / School	Expected Value
S1	0.7	14	9
S2	0.8	20	16
S3	0.8	15	12
S4	0.5	10	5
S5	0.3	8	2
S6	0.65	5	3
S7	0.9	10	9
S8	0.85	9	7
S9	0.8	10	8
S10	1	22	22
S11	0.9	35	31
S12	0.7	10	7
S13	0.95	14	13
S14	1	7	7
S15	0.45	11	4
TOTAL		200.00	155.00

Sim Run	# students	Lease (US\$)	Monthly Net Income
1	158	3,504.70	1,227.88
2	274	3,703.51	4,522.52
3	299	3,746.48	5,234.44
4	237	3,639.97	3,469.50
5	357	3,845.68	6,878.49
6	175	3,534.88	1,727.93
7	347	3,828.44	6,592.80
8	359	3,849.05	6,934.25
9	216	3,604.25	2,877.59
10	331	3,799.77	6,117.53
11	283	3,718.21	4,766.08
12	160	3,508.01	1,282.76
13	183	3,547.85	1,942.99
14	179	3,541.26	1,833.78
15	345	3,825.03	6,536.16
16	271	3,698.53	4,439.86
17	347	3,828.54	6,594.39
18	353	3,837.48	6,742.55
19	352	3,837.18	6,737.59
20	309	3,763.08	5,509.69
21	255	3,671.53	3,992.56
22	172	3,529.20	1,633.94
23	159	3,507.51	1,274.44
24	180	3,542.36	1,852.01
25	232	3,632.27	3,341.88
26	268	3,692.96	4,347.64
27	333	3,803.27	6,175.59
28	342	3,819.40	6,442.87
29	320	3,782.45	5,830.61
30	258	3,676.30	4,071.51
31	225	3,618.71	3,117.26
32	228	3,625.37	3,227.54
33	220	3,611.31	2,994.59
34	177	3,537.82	1,776.78
35	169	3,524.04	1,548.44
36	294	3,736.85	5,074.96
37	245	3,653.00	3,685.45
38	307	3,758.90	5,440.30
39	271	3,698.88	4,445.70
40	342	3,818.82	6,433.32
41	317	3,775.89	5,721.92
42	313	3,769.33	5,613.24
43	257	3,673.94	4,032.39
44	210	3,593.54	2,700.05
45	298	3,744.87	5,207.89
46	333	3,804.29	6,192.59
47	231	3,629.21	3,291.26
48	178	3,539.76	1,808.82
49	326	3,792.59	5,998.59
50	204	3,584.41	2,548.71
51	256	3,672.16	4,003.00
52	215	3,601.91	2,838.83
53	337	3,810.37	6,293.30
54	294	3,736.58	5,070.54

NEW SCHOOLS	# Tot Students	Sign-up Probability	Expected Value (NEW Students)
S16	80	0.5	40
S17	60	0.5	30
S18	60	0.5	30
S19	50	0.5	25
S20	70	0.5	35
TOTAL	320	2.5	160

Once the simulation for 100 runs has been made by generating random values of the number of students, the Net Income is calculated with the objective function and the average and standard deviation are analyzed. (See simulation on the right table)

The decision is taken after generating a histogram to see the Net Income value that is generated most frequently, resulting in \$6,200 which is higher than the current Net Income of \$6000.



The final decision is then to rent the kitchen in June to secure the offer of \$ 3,500 x month, fixed for a whole year.

Net Income BIN	Frequency	Cumulative %	Frequency
1200	0	0.00%	6
1300	3	3.00%	4
1400	2	5.00%	3
1500	1	6.00%	3
1600	3	9.00%	3
1700	1	10.00%	3
1800	3	13.00%	3
1900	4	17.00%	3
2000	1	18.00%	3
2100	2	20.00%	3
2200	1	21.00%	2
2300	1	22.00%	2
2400	2	24.00%	2
2500	0	24.00%	2
2600	1	25.00%	2
2700	1	26.00%	2
2800	2	28.00%	2
2900	3	31.00%	2
3000	1	32.00%	2
3100	2	34.00%	2
3200	1	35.00%	2
3300	2	37.00%	2
3400	1	38.00%	2
3500	3	41.00%	2
3600	2	43.00%	2
3700	2	45.00%	2
3800	0	45.00%	2
3900	2	47.00%	2

55	239	3,644.25	3,540.48
56	339	3,814.15	6,355.96
57	328	3,795.09	6,040.01
58	329	3,797.37	6,077.88
59	289	3,729.44	4,952.12
60	195	3,568.74	2,289.04
61	338	3,812.57	6,329.77
62	311	3,766.35	5,563.86
63	163	3,512.85	1,362.94
64	321	3,783.64	5,850.25
65	251	3,663.70	3,862.81
66	302	3,751.53	5,318.17
67	221	3,613.34	3,028.23
68	330	3,798.83	6,101.96
69	251	3,664.16	3,870.43
70	316	3,774.04	5,691.30
71	265	3,688.03	4,265.86
72	188	3,556.17	2,080.88
73	198	3,573.57	2,369.23
74	169	3,524.36	1,553.75
75	291	3,732.58	5,004.16
76	209	3,592.48	2,682.53
77	176	3,535.12	1,732.00
78	323	3,787.11	5,907.78
79	170	3,525.49	1,572.34
80	214	3,600.37	2,813.34
81	279	3,711.67	4,657.75
82	288	3,726.66	4,906.10
83	237	3,639.83	3,467.20
84	235	3,636.77	3,416.40
85	260	3,679.01	4,116.47
86	331	3,800.92	6,136.65
87	197	3,570.95	2,325.68
88	350	3,833.57	6,677.76
89	162	3,512.54	1,357.81
90	211	3,595.17	2,727.14
91	186	3,553.48	2,036.28
92	179	3,540.35	1,818.73
93	318	3,778.10	5,758.56
94	239	3,643.41	3,526.50
95	164	3,516.20	1,418.52
96	333	3,803.63	6,181.61
97	192	3,562.82	2,190.98
98	260	3,679.22	4,120.01
99	242	3,648.07	3,603.68
100	221	3,612.35	3,011.76
Mean	259	3,677.82	4,096.70
Stddev	62	106.61	1,766.63
MIN	158	3,504.70	1,227.88
MAX	359	3,849.05	6,934.25

4000	1	48.00%	2
4100	3	51.00%	2
4200	2	53.00%	2
4300	1	54.00%	2
4400	1	55.00%	1
4500	2	57.00%	1
4600	1	58.00%	1
4700	1	59.00%	1
4800	1	60.00%	1
4900	0	60.00%	1
5000	2	62.00%	1
5100	3	65.00%	1
5200	0	65.00%	1
5300	2	67.00%	1
5400	1	68.00%	1
5500	1	69.00%	1
5600	2	71.00%	1
5700	2	73.00%	1
5800	2	75.00%	1
5900	2	77.00%	1
6000	2	79.00%	1
6100	2	81.00%	1
6200	6	87.00%	1
6300	1	88.00%	1
6400	2	90.00%	1
6500	2	92.00%	1
6600	3	95.00%	0
6700	1	96.00%	0
6800	2	98.00%	0
6900	1	99.00%	0
7000	1	100.00%	0
More	0	100.00%	0
