Business Analytics II

Luis J. Novoa

CBAE #2

Section 2 Mo-Wed 4:00 – 5:15 & Section 4 Mo-Wed 5:30-6:45

By: Nick Lami and Zach Ritter

I understand that violations to the JMU Honor Code will be reported to the JMU Honor Council and heavily penalized.I pledge that I have neither given nor received assistance from anyone other than Dr. Novoa on this assignment.

Date: April 6th, 2020

Spreadsheet Model

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O
1		January	February	March	April	May	June	July	Total	Contract Cost	Total Contract Cost	Training Cost	Total Training Cost	Overall Cost (per contract)	Total Cost
2	Contract 1(A)	0	0	0	0	6	0	0	6	$1,900	$11,400	$850	$5,100	$16,500	$318,150
3	Contract 2(B)	6	0	0	0	0	0	0	6	$4,600	$27,600		$5,100	$32,700	
4	Contract 3(C)	6	13	0	4	10	0	0	33	$7,300	$240,900		$28,050	$268,950	
5		A1	A2	A3	A4	A5	A6	A7			**$279,900**		**$38,250**		
6									Workers				Totals		Min Req. Workers
7	Contract 1(A)	1							0	Jan(A1)		Jan	12	>=	12
8			1						0	Feb(A2)		Feb	25	>=	25
9				1					0	Mar(A3)		Mar	19	>=	19
10					1				0	Apr(A4)		Apr	17	>=	17
11						1			6	May(A5)		May	20	>=	20
12							1		0	June(A6)		June	14	>=	14
13								1	0	July(A7)		July	10	>=	10
14		B1	B2	B3	B4	B5	B6								
15	Contract 2(B)	1							6	Jan(B1)					
16		1	1						6	Feb(B1,B2)					
17			1	1					0	Mar(B2,B3)					
18				1	1				0	Apr(B3,B4)					
19					1	1			0	May(B4,B5)					
20						1	1		0	June(B5,B6)					
21							1		0	July(B6)					
22		C1	C2	C3	C4	C5									
23	Contract 3©	1							6	Jan(C1)					
24		1	1						19	Feb(C1,C2)					
25		1	1	1					19	Mar(C1,C2,C3)					
26			1	1	1				17	Apr(C2,C3,C4)					
27				1	1	1			14	May(C3,C4,C5)					
28					1	1			14	June(C4,C5)					
29						1			10	July(C5)					

Formula Model

	A	B	C	D	E	F	G	H	I	J
1		January	February	March	April	May	June	July	Total	Contract Cost
2	Contract 1(A)	0	0	0	0	6	0	0	=SUM(B2:H2)	1900
3	Contract 2(B)	6	0	0	0	0	0	0	=SUM(B3:H3)	4600
4	Contract 3(C)	6	13	0	4	10	0	0	=SUM(B4:H4)	7300
5		A1	A2	A3	A4	A5	A6	A7		
6									Workers	
7	Contract 1(A)	1							=SUMPRODUCT(B2:H2,B7:H7)	Jan(A1)
8			1						=SUMPRODUCT(B2:H2,B8:H8)	Feb(A2)
9				1					=SUMPRODUCT(B2:H2,B9:H9)	Mar(A3)
10					1				=SUMPRODUCT(B2:H2,B10:H10)	Apr(A4)
11						1			=SUMPRODUCT(B2:H2,B11:H11)	May(A5)
12							1		=SUMPRODUCT(B2:H2,B12:H12)	June(A6)
13								1	=SUMPRODUCT(B2:H2,B13:H13)	July(A7)
14		B1	B2	B3	B4	B5	B6			
15	Contract 2(B)	1							=SUMPRODUCT(B3:H3,B15:H15)	Jan(B1)
16		1	1						=SUMPRODUCT(B3:H3,B16:H16)	Feb(B1,B2)
17			1	1					=SUMPRODUCT(B3:H3,B17:H17)	Mar(B2,B3)
18				1	1				=SUMPRODUCT(B3:H3,B18:H18)	Apr(B3,B4)
19					1	1			=SUMPRODUCT(B3:H3,B19:H19)	May(B4,B5)
20						1	1		=SUMPRODUCT(B3:H3,B20:H20)	June(B5,B6)
21							1		=SUMPRODUCT(B3:H3,B21:H21)	July(B6)
22		C1	C2	C3	C4	C5				
23	Contract 3©	1							=SUMPRODUCT(B4:H4,B23:H23)	Jan(C1)
24		1	1						=SUMPRODUCT(B4:H4,B24:H24)	Feb(C1,C2)
25		1	1	1					=SUMPRODUCT(B4:H4,B25:H25)	Mar(C1,C2,C3)
26			1	1	1				=SUMPRODUCT(B4:H4,B26:H26)	Apr(C2,C3,C4)
27				1	1	1			=SUMPRODUCT(B4:H4,B27:H27)	May(C3,C4,C5)
28					1	1			=SUMPRODUCT(B4:H4,B28:H28)	June(C4,C5)
29						1			=SUMPRODUCT(B4:H4,B29:H29)	July(C5)
30										

Formula Model Pt 2

K	L	M	N	O
Total Contract Cost	Training Cost	Total Training Cost	Overall Cost (per contract)	Total Cost
=J2*I2	850	=I2*L2	=M2+K2	=N2+N3+N4
=J3*I3		=I3*L2	=M3+K3	
=J4*I4		=I4*L2	=M4+K4	
=K2+K3+K4		**=M2+M3+M4**		
		Totals		Min Req. Workers
	Jan	=I7+I15+I23	>=	12
	Feb	=I8+I16+I24	>=	25
	Mar	=I9+I17+I25	>=	19
	Apr	=I10+I18+I26	>=	17
	May	=I11+I19+I27	>=	20
	June	=I12+I20+I28	>=	14
	July	=I13+I21+I29	>=	10

Answer Report

Solver Options

Max Time Unlimited, Iterations Unlimited, Precision 0.000001, Use Automatic Scaling
Max Subproblems Unlimited, Max Integer Sols Unlimited, Integer Tolerance 1%, Assume NonNegative

Objective Cell (Min)

Cell	Name	Original Value	Final Value
$O$2	Contract 1(A) Total Cost	0	318150

Variable Cells

Cell	Name	Original Value	Final Value	Integer
$B$2	Contract 1(A) January	0	0	Contin
$C$2	Contract 1(A) February	0	0	Contin
$D$2	Contract 1(A) March	0	0	Contin
$E$2	Contract 1(A) April	0	0	Contin
$F$2	Contract 1(A) May	0	6	Contin
$G$2	Contract 1(A) June	0	0	Contin
$H$2	Contract 1(A) July	0	0	Contin
$B$3	Contract 2(B) January	0	6	Contin
$C$3	Contract 2(B) February	0	0	Contin
$D$3	Contract 2(B) March	0	0	Contin
$E$3	Contract 2(B) April	0	0	Contin
$F$3	Contract 2(B) May	0	0	Contin
$G$3	Contract 2(B) June	0	0	Contin
$H$3	Contract 2(B) July	0	0	Contin
$B$4	Contract 3(C) January	0	6	Contin
$C$4	Contract 3(C) February	0	13	Contin
$D$4	Contract 3(C) March	0	0	Contin
$E$4	Contract 3(C) April	0	4	Contin
$F$4	Contract 3(C) May	0	10	Contin
$G$4	Contract 3(C) June	0	0	Contin
$H$4	Contract 3(C) July	0	0	Contin

Constraints

Cell	Name	Cell Value	Formula	Status	Slack
$M$7	Jan Totals	12	$M$7>=$O$7	Binding	0
$M$8	Feb Totals	25	$M$8>=$O$8	Binding	0
$M$9	Mar Totals	19	$M$9>=$O$9	Binding	0
$M$10	Apr Totals	17	$M$10>=$O$10	Binding	0
$M$11	May Totals	20	$M$11>=$O$11	Binding	0
$M$12	June Totals	14	$M$12>=$O$12	Binding	0
$M$13	July Totals	10	$M$13>=$O$13	Binding	0

Sensitivity Report

Microsoft Excel 16.0 Sensitivity Report
Worksheet: [CBAE 2 - Zach Ritter.xlsx]Model
Report Created: 4/4/2020 4:48:06 PM

Variable Cells

Cell	Name	Final Value	Reduced Cost	Objective Coefficient	Allowable Increase	Allowable Decrease
$B$2	Contract 1(A) January	0	50	2750	1E+30	50
$C$2	Contract 1(A) February	0	0	2750	1E+30	0
$D$2	Contract 1(A) March	0	50	2750	1E+30	50
$E$2	Contract 1(A) April	0	50	2750	1E+30	50
$F$2	Contract 1(A) May	6	0	2750	0	50
$G$2	Contract 1(A) June	0	50	2750	1E+30	50
$H$2	Contract 1(A) July	0	50	2750	1E+30	50
$B$3	Contract 2(B) January	6	0	5450	0	0
$C$3	Contract 2(B) February	0	0	5450	1E+30	0
$D$3	Contract 2(B) March	0	50	5450	1E+30	50
$E$3	Contract 2(B) April	0	0	5450	1E+30	0
$F$3	Contract 2(B) May	0	0	5450	1E+30	0
$G$3	Contract 2(B) June	0	50	5450	1E+30	50
$H$3	Contract 2(B) July	0	5450	5450	1E+30	5450
$B$4	Contract 3(C) January	6	0	8150	0	0
$C$4	Contract 3(C) Februar	13	0	8150	0	50
$D$4	Contract 3(C) March	0	0	8150	0	0
$E$4	Contract 3(C) April	4	0	8150	0	50
$F$4	Contract 3(C) May	10	0	8150	50	2700
$G$4	Contract 3(C) June	0	8150	8150	1E+30	8150
$H$4	Contract 3(C) July	0	8150	8150	1E+30	8150

Constraints

Cell	Name	Final Value	Shadow Price	Constraint R.H. Side	Allowable Increase	Allowable Decrease
$M$7	Jan Totals	12	2700	12	6	0
$M$8	Feb Totals	25	2750	25	0	6
$M$9	Mar Totals	19	2700	19	6	6
$M$10	Apr Totals	17	2700	17	6	0
$M$11	May Totals	20	2750	20	1E+30	6
$M$12	June Totals	14	2700	14	0	4
$M$13	July Totals	10	2700	10	4	0

Questions:

1. Formulation of LP

   Minimize cost of X: X= (1900+850)* I (Ai) + (4600+850) *I (Bi) + (7300+850)*I (Ci)
   Constraints:

   A1+B1+C1 >= 12
   A2+B1+B2+C1+C2 >= 25
   A3+B2+B3+C1+C2+C3 >= 19
   A4+B3+B4+C2+C3+C4 >= 17
   A5+B4+B5+C3+C4+C5 >= 20
   A6+B5+B6+C4+C5 >= 14
   A7+B6+C5 >= 10
   Ai, Bi, Ci >= 0

Answer Sheet:

1. The optimal plan is to hire a total of 12, 25, 19, 17, 20, 14, and 10 temporary workers for the months of January through July, respectively, for a total cost of $318,150.
2. The optimal hiring plan will result in costs of $279,900 for contracts and $38,250 for training.
3. The constraint on temporary employee requirements in June is binding because we are trying to minimize the cost and the demand constraint must be binding. It has a shadow price of $2,700 and a right-hand-side range of 14.
4. If the number of temporary workers required in June increases to 15, then the optimal hiring plan changes, and the total cost increases.