Sensitivity Analysis

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MDSC -103

Question B)

Outdoors, Inc has, as one of its product lines, lawn furniture. They currently have three items in that line: a lawn chair, a standard bench, and a table. These products are produced in a two-step manufacturing process involving the tube-bending department and the welding department. The time required by each item in each department is as follows:

	Product			Present Capacity
	Lawn Chair	Bench	Table	
Tube Bending(hrs)	1.2	1.7	1.2	1000 hrs.
Welding(hrs)	0.8	0	2.3	1200 hrs
Tubing(lbs.)	2	3	4.5	2000 lbs

The contribution that Outdoors, Inc. receives from the manufacture and sale of one unit of each product is $3 for a lawn chair, $3 for a bench and $5 for a table. The company is trying to plan its production mix for the current selling season. It feels that it can sell any number it produces, but unfortunately production is further limited by available material, because of a prolonged strike. The company has on hand 2000 lbs. of tubing. The three products require the following amounts of this tubing: 2 lbs. per chair, 3 lbs. per bench, and 4.5 lbs. per table.

Question and Answers:

1. Formulate LP model for this problem?

Let's take number of Lawn Chairs = x1,

Number of Benches = x2,

Number of Tables = x3.

Objective function,

Maximize Z = 3x1 + 3x2 + 5x3

Subject to: 1.2x1 + 1.7x2 + 1.2x3 <= 1000 (M1)

0.8x1 + 0x2 + 2.3x3 <= 1200(M2)

2x1 + 3x2 + 4.5x3 <= 2000(M3)

X1, x2, x3 >= 0

2. Solve the problem by SOLVER:

	A	B	C	D	E	F	G	H	I	J	K	L
1			x1(lawn chairs)	x2(bench)	x3(table)			Optimum				
2	Max	Z	3	3	5			2766.66667	RHS			
3		soln	700	0	133.3333							
4												
5	M1(Tube Bending)		1.2	1.7	1.2		1000	<=	1000			
6	M2(Welding)		0.8	0	2.3		866.6667	<=	1200			
7	M3(Tubing)		2	3	4.5		2000	<=	2000			
8												
9												
10												
11												
12												
13												

The Maximum Profit it can make is 2766.667 $ by selling 700 Lawn Chairs ,0 Benches, 133 Tables under given constraints.

Solution: Z = 2766.667, x1 = 700, x2 = 0, x3 = 133.3333

3. **What is the optimal production mix? What contribution can the firm anticipate by producing this mix?**

As from the solution above the optimal production mix is 700 Lawn Chairs, 0 Benches 133 Tables and Profit that can be made is 2766.667. The firm need not produce or spend money or materials for manufacturing the Benches since the optimum profit is made by not selling any benches.

4. **What is the value of one unit more of tube-bending time? Of welding time? Of metal tubing?**

	A	B	C	D	E	F	G	H	I
1			x1(lawn chairs)	x2(bench)	x3(table)			Optimum	
2	Max	Z	3	3	5			2236.364	RHS
3		soln	18.18181818	0	436.3636				
4									
5	M1(Tube Bending)		2.2	2.7	2.2		1000	<=	1000
6	M2(Welding)		0.8	0	2.3		1018.182	<=	1200
7	M3(Tubing)		2	3	4.5		2000	<=	2000
8									

The Z = 2236.364, x1 = 18.18, x2 = 0, x3 = 436.36. If there is increase in one more unit of Tube Bedding time the profit gained is 2236.364 $ By selling 18 chairs and 0 benches and 436 tables.

One Unit Of Welding Time:

	A	B	C	D	E	F	G	H	I
1			x1(lawn chairs)	x2(bench)	x3(table)			Optimum	
2	Max	Z	3	3	5			2347.475	RHS
3		soln	290.9090909	303.0303	113.1313				
4									
5	M1(Tube Bending)		1.2	1.7	1.2		1000	<=	1000
6	M2(Welding)		1.8	1	3.3		1200	<=	1200
7	M3(Tubing)		2	3	4.5		2000	<=	2000
8									

One More Unit Of Metal Tubing:

	A	B	C	D	E	F	G	H	I
1			x1(lawn chairs)	x2(bench)	x3(table)			Optimum	
2	Max	Z	3	3	5			2000	RHS
3		soln	666.6666667	0	0				
4									
5	M1(Tube Bending)		1.2	1.7	1.2		800	<=	1000
6	M2(Welding)		0.8	0	2.3		533.3333	<=	1200
7	M3(Tubing)		3	4	5.5		2000	<=	2000
8									
9									
10									

Z=2000, x1 = 666.6667, x2 = 0, x3 =0. If there is increase in one more unit of Metal Tubing time the profit gained is 2000$ By selling 666 chairs and 0 benches and 0 tables

5. **A local distributor has offered to sell Outdoors, Inc some additional metal tubing for $ 0.60/lb. Should Outdoors buy it? If yes, how much would the firm's contribution increase if they bought 500 lbs. and used it in an optimal fashion?**

	A	B	C	D	E	F	G	H	I
1			x1(lawn chairs)	x2(bench)	x3(table)			Optimum	
2	Max	Z	3	3	5			3166.667	RHS
3		soln	500	0	333.3333				
4									
5	M1(Tube Bending)		1.2	1.7	1.2		1000	<=	1000
6	M2(Welding)		0.8	0	2.3		1166.667	<=	1200
7	M3(Tubing)		2	3	4.5		2500	<=	2500
8									
9									

As we can see from the above tableau, If Outdoors Buy 500 lbs more of Metal Tubing of 1 lb for $0.60. So, for Metal Tubing we have 500 lbs extra resources, we can have profit of 3166.667$ and 500 chairs and 0 Benches and 333 Tables can be sold. So, the cost for 500 lbs. of metal tubing is 300 $. Profit made = 3166.667$ - 300$ = 2866.667$. Before we were making 2766.667$ without these 500 lbs. of metal tubing. Now we are making 100$ more than the earlier time. So, it's advisable

6. **If Outdoors, Inc. feels that it must produce at least 100 benches to round out its product line, what effect will that have on its contribution?**

	A	B	C	D	E	F	G	H	I
1			x1(lawn chairs)	x2(bench)	x3(table)			Optimum	
2	Max	Z	3	3	5			0	RHS
3		soln	0	0	0				
4									
5	M1(Tube Bending)		1.2	1.7	1.2		0	<=	1000
6	M2(Welding)		0.8	0	2.3		0	<=	1200
7	M3(Tubing)		2	3	4.5		0	<=	2000
8	M4		0	1	0		0	>=	100

7. **The R&D department has been redesigning the bench to make it more profitable. The new design will require 1.1 hours of tube-bending time, 2.0 hours of welding time, and 2.0 lbs. of metal tubing. If it can sell one unit of this bench with a unit contributing of $3, what effect will it have on overall contribution?**

	A	B	C	D	E	F	G	H	I
1			x1(lawn chairs)	x2(bench)	x3(table)			Optimum	
2	Max	Z	3	3	5			2800	RHS
3		soln	457.1428571	285.71429	114.2857				
4									
5	M1(Tube Bending)		1.2	1.1	1.2		1000	<=	100
6	M2(Welding)		0.8	2	2.3		1200	<=	120
7	M3(Tubing)		2	2	4.5		2000	<=	200
8									

So, If the R&D decides the given changes for manufacturing benches, the optimum value is 2800$. The objective function remains the same, since the product price was decided for 3$. Here, 457 lawn chairs, 285 benches and 114 tables are getting manufactured and the profit increased is 33.33$. So, it's advisable

9.

Outdoors, Inc. has a chance to sell some of its capacity in tube bending at cost + $1.50 per hour. If it sells 200 hours at that price, how will this affect contribution?

	A	B	C	D	E	F	G	H	I
1			x1(lawn chairs)	x2(bench)	x3(table)			Optimum	
2	Max	Z	3	3	5			0	RHS
3		soln	0	0	0				
4									
5	M1(Tube Bending)		1.2	1.7	1.2		0	<=	1000
6	M2(Welding)		0.8	0	2.3		0	<=	1200
7	M3(Tubing)		2	3	4.5		0	<=	2000
8	M4		0	1	0		0	>=	100

10. If the contribution on chairs were to decrease to $2.50, what would be the optimal production mix and what contribution would this production plan give?

	A	B	C	D	E	F	G	H	I
1			x1(lawn chairs)	x2(bench)	x3(table)			Optimum	
2	Max	Z	2.5	3	5			2416.667	RHS
3		soln	700	0	133.3333				
4									
5	M1(Tube Bending)		1.2	1.7	1.2		1000	<=	1000
6	M2(Welding)		0.8	0	2.3		866.6667	<=	1200
7	M3(Tubing)		2	3	4.5		2000	<=	2000
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10									
11									

In this we can see that the profit obtained is 2416.667 $ and products manufactured are 700 lawn chairs, 0 benches and 133 tables. So, this is not a good contribution from the lawn chairs. Since the profit got decreased from 2766.667$ to 2416.667 i.e. (-350$).