Sensitivity Analysis

Name: Aniruddha

Roll No: 22237

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:**

		x1(lawn chairs)	x2(bench)	x3(table)		Optimum	
Max	Z	3	3	5		2766.666667	RHS
	soln	700	0	133.3333333			
M1(Tube Bending)		1.2	1.7	1.2	1000	<=	1000
M2(Welding)		0.8	0	2.3	866.6666667	<=	1200
M3(Tubing)		2	3	4.5	2000	<=	2000

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?**

One More Unit of Tube-bending Time:

		x1(lawn chairs)	x2(bench)	x3(table)		Optimum	
Max	Z	3	3	5		2236.363636	RHS
	soln	18.18181818	0	436.3636364			
M1(Tube Bending)		2.2	2.7	2.2	1000	<=	1000
M2(Welding)		0.8	0	2.3	1018.181818	<=	1200
M3(Tubing)		2	3	4.5	2000	<=	2000

Microsoft Excel 16.0 Sensitivity Report
Worksheet: [22237-MDSC-103(P)-Assignment-Sensitivity-Analysis.xlsx]Solution 4)A Tableau
Report Created: 10-11-2022 16:07:26

Variable Cells

Cell	Name	Final Value	Reduced Cost	Objective Coefficient	Allowable Increase	Allowable Decrease
C13	soln x1(lawn chairs)	18.18181818	0	3	2	0.777777778
D13	soln x2(bench)	0	-1.118181818	3	1.118181818	1E+30
E13	soln x3(table)	436.3636364	0	5	1.75	2

Constraints

Cell	Name	Final Value	Shadow Price	Constraint R.H. Side	Allowable Increase	Allowable Decrease
F15	M1(Tube Bending)	1000	0.636363636	1000	1200	22.22222222
F16	M2(Welding)	1018.181818	0	1200	1E+30	181.8181818
F17	M3(Tubing)	2000	0.8	2000	45.45454545	1090.909091

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 More Unit of Welding Time:

		x1(lawn chairs)	x2(bench)	x3(table)		Optimum	
Max	Z	3	3	5		2347.474747	RHS
	soln	290.9090909	303.030303	113.1313131			
M1(Tube Bending)		1.2	1.7	1.2	1000	<=	1000
M2(Welding)		1.8	1	3.3	1200	<=	1200
M3(Tubing)		2	3	4.5	2000	<=	2000

Microsoft Excel 16.0 Sensitivity Report
Worksheet: [22237-MDSC-103(P)-Assignment-Sensitivity-Analysis.xlsx]Solution 4)B Tableau
Report Created: 10-11-2022 16:07:44

Variable Cells

Cell	Name	Final Value	Reduced Cost	Objective Coefficient	Allowable Increase	Allowable Decrease
C14	soln x1(lawn chairs)	290.9090909	0	3	0.333333333	0.685185185
D14	soln x2(bench)	303.030303	0	3	1.383333333	0.816666667
E14	soln x3(table)	113.1313131	0	5	1.088235294	0.790322581

Constraints

Cell	Name	Final Value	Shadow Price	Constraint R.H. Side	Allowable Increase	Allowable Decrease
F16	M1(Tube Bending)	1000	0.747474747	1000	164.7058824	266.6666667
F17	M2(Welding)	1200	0.838383838	1200	500	355.5555556
F18	M3(Tubing)	2000	0.296969697	2000	326.5306122	301.0752688

One More Unit of Metal Tubing:

		x1(lawn chairs)	x2(bench)	x3(table)		Optimum	
Max	Z	3	3	5		2000	RHS
	soln	666.6666667	0	0			
M1(Tube Bending)		1.2	1.7	1.2	800	<=	1000
M2(Welding)		0.8	0	2.3	533.3333333	<=	1200
M3(Tubing)		3	4	5.5	2000	<=	2000

Microsoft Excel 16.0 Sensitivity Report
Worksheet: [22237-MDSC-103(P)-Assignment-Sensitivity-Analysis.xlsx]Solution 4)C Tableau
Report Created: 10-11-2022 16:07:57

Variable Cells

Cell	Name	Final Value	Reduced Cost	Objective Coefficient	Allowable Increase	Allowable Decrease
C13	soln x1(lawn chairs)	666.6666667	0	3	1E+30	0.272727273
D13	soln x2(bench)	0	-1	3	1	1E+30
E13	soln x3(table)	0	-0.5	5	0.5	1E+30

Constraints

Cell	Name	Final Value	Shadow Price	Constraint R.H. Side	Allowable Increase	Allowable Decrease
F15	M1(Tube Bending)	800	0	1000	1E+30	200
F16	M2(Welding)	533.3333333	0	1200	1E+30	666.6666667
F17	M3(Tubing)	2000	1	2000	500	2000

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?**

		x1(lawn chairs)	x2(bench)	x3(table)		Optimum	
Max	Z	3	3	5		3166.666667	RHS
	soln	500	0	333.3333333			
M1(Tube Bending)		1.2	1.7	1.2	1000	<=	1000
M2(Welding)		0.8	0	2.3	1166.666667	<=	1200
M3(Tubing)		2	3	4.5	2500	<=	2500

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?**

		x1(lawn chairs)	x2(bench)	x3(table)		Optimum	
Max	Z	3	3	5		0	RHS
	soln	0	0	0			
M1(Tube Bending)		1.2	1.7	1.2	0	<=	1000
M2(Welding)		0.8	0	2.3	0	<=	1200
M3(Tubing)		2	3	4.5	0	<=	2000
M4		0	1	0	0	>=	100

Microsoft Excel 16.0 Feasibility Report
Worksheet: [22237-MDSC-103(P)-Assignment-Sensitivity-Analysis.xlsx]Solution 6
Report Created: 10-11-2022 16:08:16

Constraints Which Make the Problem Infeasible

Cell	Name	Cell Value	Formula	Status	Slack
F18	M4	0	F18>=H18	Violated	-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?

		x1(lawn chairs)	x2(bench)	x3(table)		Optimum	
Max	Z	3	3	5		2800	RHS
	soln	457.1428571	285.7142857	114.2857143			
M1(Tube Bending)		1.2	1.1	1.2	1000	<=	1000
M2(Welding)		0.8	2	2.3	1200	<=	1200
M3(Tubing)		2	2	4.5	2000	<=	2000

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?

		x1(lawn chairs)	x2(bench)	x3(table)		Optimum	
Max	Z	3	3	5		3000	RHS
	soln	1000	0	0			
M1(Tube Bending)		1.2	1.7	1.2	1200	<=	1200
M2(Welding)		0.8	0	2.3	800	<=	1200
M3(Tubing)		2	3	4.5	2000	<=	2000

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?

		x1(lawn chairs)	x2(bench)	x3(table)			Optimum	
Max	Z	2.5	3	5			2416.667	RHS
	soln	700	0	133.3333				
M1(Tube Bending)		1.2	1.7	1.2		1000	<=	1000
M2(Welding)		0.8	0	2.3		866.6667	<=	1200
M3(Tubing)		2	3	4.5		2000	<=	2000

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$).