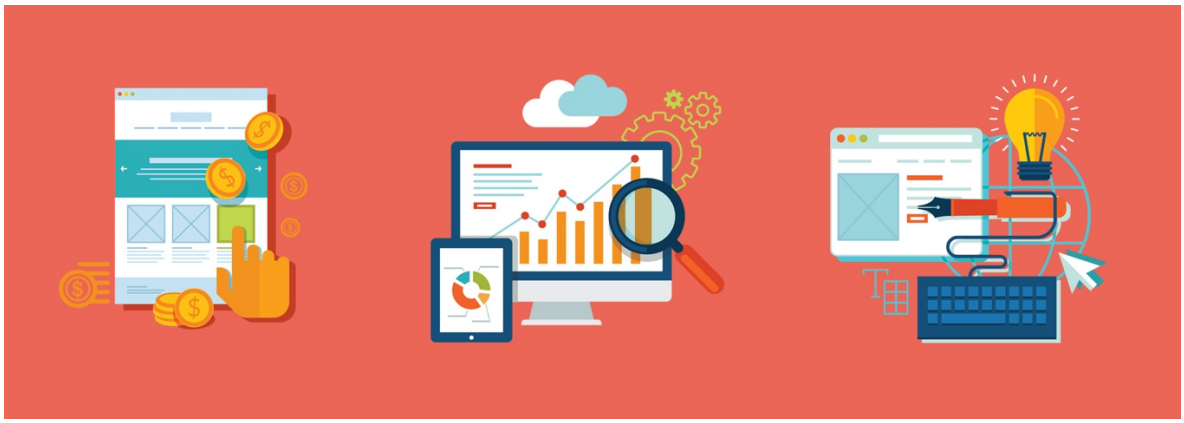
greatlearning

Submitted to

GREAT LAKES
INSTITUTE OF MANAGEMENT
Global Mindset - Indian Roots



OPTIMIZATION TECHNIQUE

ASSIGNMENT

Submitted by

MOHAMED YUSUF S

Assignment: 1

A manufacturing firm produces three products A, B & C, using the same limited resources, which is raw material, labor and processing time on the packaging machine. Product A requires 2 kgs. raw material, 3 labor hours and 4 machine hours. Similarly, Product B requires 5 kgs. raw material, 5 labor hours, 5 machine hours and Product C requires 4 kgs. raw material, 6 labor hours and 2 machine hours. The availability of raw material is capped at 90 kgs., labor hours at 130 hours and packaging machine hours at 150 kgs. The profits of product A, B & C are ` 25, ` 50 and ` 30 respectively. Answer the following questions,

1. What is the optimal output of products A, B & C to maximize the profits?
2. What is the capacity utilization of labor hours?
3. At what profit will the Product C be viable for manufacturing?
4. Over what range of the constraints will the shadow price remain the same for the packaging machine?
5. If the 1 kgs of raw material is short, what will be the new output for Product A, B & C?

Problem:

1. We have a constraint on availability of Raw material, Labor hours and Packaging machine hours. Let's find the optimal production quantity for Product A, B and C with the above constraints.

Manufacturing Problem					
Products	A	B	C		
Profit	25	50	30		
Desired Optimal Output	30	6	0	Obj Profit	1050

Products	A	B	C			Availability	Utilization %
Raw Material (In Kgs)	2	5	4	90	<=	90	100
Labour (In Hours)	3	5	6	120	<=	130	92
Machine (In Hours)	4	5	2	150	<=	150	100

Solution 1:

The objective of the problem is to find the best combination of products to manufacture from the given constraint and to maximize the total profit. Function to maximize the Profit is called objective function. We can formulate with the help of Excel Solver function. First, we need to set the objective cell which is the SumProduct function PROFIT. Then we need choose Max option and finally we need the all constraints such as availability of Raw material, Labor Hours and machine hours. The Simplex method suggest us to manufacture 30 units of Product A and 6 units of Product B. It also recommends no to make Product C since the profit is low relatively.

Solution 2:

Based on the above simplex method, Labor hours had been utilized to 92% of the total capacity available i.e. 120 labor hours can be utilized out of 130 labor hours.

Products	A	B	C			Availability	Utilization %
Raw Material (In Kgs)	2	5	4	90	<=	90	100
Labour (In Hours)	3	5	6	120	<=	130	92
Machine (In Hours)	4	5	2	150	<=	150	100

Solution 3:

Based on the sensitivity report of the above simplex method, if the profit (objective coefficient) of Product C increases from 30 to 36 then there is a viability of manufacturing it. Hence 3 units of Product C can be made with maximum utilization of all resources with an increase in total profit.

Variable Cells

Cell	Name	Final Value	Reduced Cost	Objective Coefficient	Allowable Increase	Allowable Decrease
C4	Desired Optimal Output A	30	0	25	5	5
D4	Desired Optimal Output B	6	0	50	12.5	4.166666667
E4	Desired Optimal Output C	0	-5	30	5	1E+30

Manufacturing Problem					
Products	A	B	C		
Profit	25	50	36		
Desired Optimal Output	33	2	3	Obj Profit	1053

Products	A	B	C			Availability	Utilization %
Raw Material (In Kgs)	2	5	4	90	<=	90	100
Labour (In Hours)	3	5	6	130	<=	130	100
Machine (In Hours)	4	5	2	150	<=	150	100

Solution 4: Shadow price for Machine will be Rs.2.5 per hour ie. if the machine hpurs increases or decrease by 1 hour then there will be Rs.2.5 increase or decrease in the desired profit.

Cell	Name	Final Value	Shadow Price	Constraint R.H. Side	Allowable Increase	Allowable Decrease
F10	Machine (In Hours) PROFIT	150	2.5	150	20	60
F8	Raw Material (In Kgs) PROFIT	90	7.5	90	20	15
F9	Labour (In Hours) PROFIT	120	0	130	1E+30	10

Manufacturing Problem					
Products	A	B	C		
Profit	25	50	30		
Desired Optimal Output	30	6	0	Obj Profit	1047.50

Products	A	B	C			Availability	Utilization %
Raw Material (In Kgs)	2	5	4	90	<=	90	100
Labour (In Hours)	3	5	6	120	<=	130	92
Machine (In Hours)	4	5	2	149	<=	149	100

Solution 5:

If 1 kg of Raw material is short on the total availability then the desired optimal output would be 31,6 and 0 for Product A, B and C respectively. Also, there will be decrease in profit of Rs.7.50 on Total profit.

Manufacturing Problem					
Products	A	B	C		
Profit	25	50	30		
Desired Optimal Output	31	6	0	Obj Profit	1042.50

Products	A	B	C			Availability	Utilization %
Raw Material (In Kgs)	2	5	4	89	<=	89	100
Labour (In Hours)	3	5	6	120	<=	130	92
Machine (In Hours)	4	5	2	150	<=	150	100

Conclusion: It's the decision of the management to choose whether to have the higher profits by neglecting the production of Product C referred in solution 1 or to manufacture Product C by increasing the profit per unit. Excel Solver function helps us to find the best and optimal solution in this particular problem using Simplex linear method.

Problem 2 :

An electronics company is engaged in the manufacture of two components C_1 & C_2 used in telecom tower sets. Each unit of C_1 cost the company ` 6 in wages and ` 7 in materials, while each unit of C_2 costs the company ` 26 in wages and ` 17 in materials. The company sells both the products on two-period credit terms but the company's labor & material expenses must be paid in cash. The selling price of C_1 is ` 40 per unit and of $C_2$ is ` 90. Because of the strong monopoly of the company for these components it is assumed that the company can sell at the prevailing prices as many units as it produces. The company's production capacity is limited by two considerations. First at the beginning of the period 1, the company has an initial balance of ` 18,000/-. Second the company has an available 2500 hours of machine time and 1800 hours of assembly time. The production of each C_1 requires 4 hours of machine time and 2 hours of assembly time, whereas the production of each unit of C_2 requires 3 hours of machine time and 4 hours of assembly time.

Formulate & solve the above problem as a LP problem.

Solution 1:

From the above problem we could understand that the overheads have to be met with available cash balance in hand since the company's cash flow is based on the receipt from the revenue from credit sales. For the term one we have a cash balance of Rs.18000 which needs to be distributed to Wages and Procurement of Raw materials. We also have other constrains on Machine hours and Assembly running hours.

The objective of the above problem is to find the higher sales from the given constraint so we shall use the Simplex Linear method to get the optimal result. We need to use the SumProduct Function on the Sales price and Desired Sales Units on the Objective Cell. Later using the Excel Solver, we need to choose the Objective cell and add the constraints such as Wage cost, Raw material cost, Machine hours and Assembly running hours. Once we compute the result using Simplex Linear Method we shall get the below results when the Cash balance budget to Wages and Raw material cost is shared on 50:50 Ratio respectively

ELECTRONICS COMPANY				
Components	C1	C2		
Sales Price	40	90		
Desired Sale Units	386	257	Obj Sales	38571

Solution Matrix					Availability	Ratio	Utilization %
Wage Cost	6	26	9000	<=	9000	50	100
Raw Material Cost	7	17	7071	<=	9000	50	79
Machine Hours	4	3	2314	<=	2500		93
Assembly Hours	2	4	1800	<=	1800		100

Solution 2:

Alternatively, when the cash balance is utilized in the ratio of 58:42 for Wage cost and Raw material cost respectively then we shall have the following results

ELECTRONICS COMPANY				
Components	C1	C2		
Sales Price	40	90		
Desired Sale Units	180	360	Obj Sales	39600

Solution Matrix					Availability	Ratio	Utilization %
Wage Cost	6	26	10440	<=	10440	58	100
Raw Material Cost	7	17	7380	<=	7560	42	98
Machine Hours	4	3	1800	<=	2500	5	72
Assembly Hours	2	4	1800	<=	1800		100

We could see the utilization of Raw Material has increased by 19% and also the overall sale has increased. Let's also see the shadow price on sensitivity report below

Variable Cells						
Cell	Name	Final Value	Reduced Cost	Objective Coefficient	Allowable Increase	Allowable Decrease
C5	Desired Sale Units C1	180	0	40	5	19.23076923
D5	Desired Sale Units C2	360	0	90	83.33333333	10

Constraints						
Cell	Name	Final Value	Shadow Price	Constraint R.H. Side	Allowable Increase	Allowable Decrease
E10	Machine Hours SALES	1800	0	2500	1E+30	700
E11	Assembly Hours SALES	1800	17.85714286	1800	63	193.8461538
E8	Wage Cost SALES	10440	0.714285714	10440	840	1960
E9	Raw Material Cost SALES	7380	0	7560	1E+30	180

Conclusion:

We could see the shadow price of Assembly hours as Rs.17.86 which means that 1 unit of change in Assembly hours availability will increase or decrease the Total Sales. We have already attained the maximum capacity for Assembly hours. From the above 2 solutions we feel that solution 2 is best since our aim of higher sales with limited constraint is achieved more optimally.