A Review On Linear Programming Analysis Of The Outsourcing Problem Using MATLAB

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Abstract: This study examines the case where market demand exceeds the company's capacity to manufacture. Manufacturing companies often function in situations where internal production resources constrain their throughput. Such situations are characterized as the problem of finite capacity scheduling. Management policy is to meet all demand in order to prevent competitor from entering the field. Now, if management needs to decide what quantities of each product to manufacture and what quantities to buy from external contractors. In this study we have described two methodologies based on LP analysis to solve production outsourcing problem using latest version of MATLAB. We choose the best methodology which gives us maximum profits.

Index Terms: constrain, Linear Programming, markup price, MATLAB, outsourcing, revenue, throughput.

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1. INTRODUCTION

Management aims to maximize its throughput from manufacturing and from outsourcing products. The throughput from manufacturing one unit of product is defined as the difference between market price and the cost of raw materials. In Coman, A and Ronen [1] et al considered a production facility consisting of four resources A, B, C and D, manufacturing three different products P, Q and R. The facility operates five days a week for an eight hour shift per day. Capacity thus totals 2400 working minutes per week. Figure 1 depicts the flow layout throughput on the production floor. Each of the three products incorporates two of four raw materials 1, 2, 3 and 4. The cost of each raw material unit is $20, thus the total value of raw materials in each final product is $40. The products are sold on the market at $130 for unit of P, $150 for unit of Q and $190 for unit of R. The market demand is 100 units of each one of the three products. The company's operating expenses of $12000 include labor, energy, financing etc. The contractors supply products P for $66, product Q for $68 and product R for $98. These prices include the cost of raw materials. The management policy is to meet all demand in order to prevent competitors from entering the arena. Hence, as an analyst we have analyzed the problem using the LP analysis with the help of MATLAB.
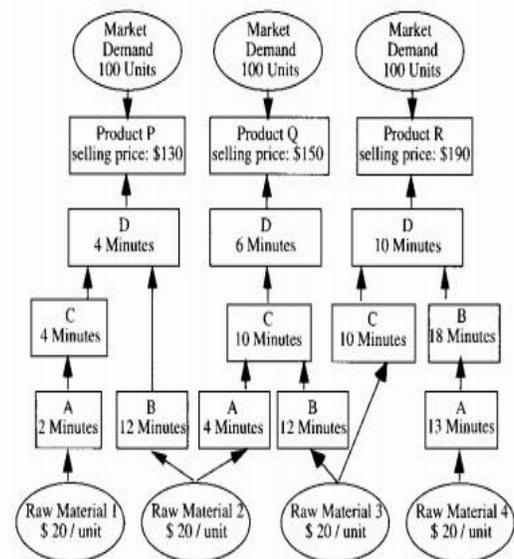
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Figure 1.   Resource time per product in minutes.

2. FIRST METHODOLOGY TO OUTSOURCING PROBLEM

From the figure 1 we see that the profit per unit of product is its unit revenue less the raw material cost per unit. Hence, throughput per unit for product P is $90, for product Q is $110 and for product R is $150. The problem is to maximize the profit, $Z = 90P+110Q+150R$ subject to the following constraints:

$2P+4Q+12R \leq 2400$
$12P+12Q+18R \leq 2400$
$4P+10Q+10R \leq 2400$
$4P+6Q+10R \leq 2400$
$P \leq 100$
$Q \leq 100$
$R \leq 100$, where P, Q, R $\geq$ 0.

After formulating the LP model, we solved with the help of the MATLAB commands as discussed in Flt Lt Dinesh Kumar Gupta [2] as follows :

```
1 -    f=[-90 -110 -150]
2 -    A=[2 4 13;12 12 18;4 10 10;4 6 10;1 0 0;0 1 0;0 0 1;-1 0 0;0 -1 0;0 0 -1]
3 -    b=[2400;2400;2400;2400;100;100;100;0;0;0]
4 -    simlp(f,A,b)
5 -    -f*ans
```

```
f =

    -90    -110    -150


A =

     2      4     13
    12     12     18
     4     10     10
     4      6     10
     1      0      0
     0      1      0
     0      0      1
    -1      0      0
     0     -1      0
     0      0     -1


b =

         2400
         2400
         2400
         2400
          100
          100
          100
            0
            0
            0


ans =

            0
     100.0000
      66.6667


ans =

        21000
```

The above results indicate that we can manufacture P = 0 units, Q = 100 units at $110 throughput per manufactured product and R = 67 units at $150 throughput per manufactured unit. Total revenue will be $ 21000. This means we can outsource 100 units of P at $64 throughput

per contracted unit and 33 units of R at $92 throughput per contracted unit.
Total facility throughput = 100*110 + 67*150 + 100*64 + 33*92 = $30486
Operating expenses = $12000
Net Profit = $18486

3. SECOND METHODOLOGY TO OUTSOURCING PROBLEM

In this method we take contractor markup which is the difference between contractor price per unit and raw material cost per unit. We see that contractor markup price for product P is $26, for product Q is $28 and for product R is $58. Now, we formulate a LP model with value of Z = 26P+28Q+58R subject to constraints same as discussed in first methodology and solving it by using MATLAB as follows:

```
1 -    f=[-26 -28 -58]
2 -    A=[2 4 13;12 12 18;4 10 10;4 6 10;1 0 0;0 1 0;0 0 1;-1 0 0;0 -1 0;0 0 -1]
3 -    b=[2400;2400;2400;2400;100;100;100;0;0;0]
4 -    simlp(f,A,b)
5 -    -f*ans
```

```
f =

    -26    -28    -58


A =

     2      4     13
    12     12     18
     4     10     10
     4      6     10
     1      0      0
     0      1      0
     0      0      1
    -1      0      0
     0     -1      0
     0      0     -1


b =

         2400
         2400
         2400
         2400
          100
          100
          100
            0
            0
            0
```

```
ans =

            0
      50.0000
     100.0000


ans =

     7200
```

The results indicate that we should manufacture P = 0 units, Q = 50 units at $110 throughput per manufactured unit and R = 100 units at $150 throughput per manufactured unit. We can outsource P = 100 units at $64 throughput/contracted unit and Q = 50 units at $82 throughput/contracted unit.
Total facility throughput = 50*110+100*150+100*64+50*82
= $31000
Operating Expenses = $12000
Net Profit = $19000

4. CONCLUSION
The $19000 throughput obtained from second methodology is $514 higher than the throughput obtained from first methodology to this outsourcing problem. The summary of the two methodologies is given in tabular form as shown in table 1. Hence, we conclude that the second methodology is most recommended for present production system. This model was demonstrated to be analytically robust and at the same time simpler to implement using MATLAB. This study will be highly beneficial to practicing engineers to

enable them to decide economically what quantities of each product to manufacture and what quantities to buy from external contractors. Needless to say that as the market place tightens and companies are fighting for every dollar of revenue, they need to adopt such innovative analytical methods using MATLAB that will give them a competitive edge of their closest rivals.

	FIRST METHODOLOGY	SECOND METHODOLOGY
P Manufactured Quantity	0	0
Q	100	50
R	67	100
P Outsourced Quantity	100	100
Q	0	50
R	33	0
Net profit	$18486	$19000

Table1 Summary of the two methodologies.

REFERENCES
[1] Coman, A and Ronen, B.(2000). Production outsourcing: a linear programming model for the Theory-Of-Constraints. International Journal of Production Resources, vol. 38, no. 7, 1631-1639.

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