Prescriptive Analytics Assignment 2

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October 2019

1 Introduction

The aim of this assignment is to help improve the efficiency of The Moloka Confectionary in the North West (MNS) using linear programming, and analysis.

2 Questions

2.1 a

The controller is basing his report on the overall variable costs, rather than the cost per unit. If we take the cost per unit into consideration, we can see how many of each item would need to be produced in order to cover the fixed costs.

Since there are constraints placed on the amount of each product that can be produced, it would be better to compare the break even number of units to the maximum constraint on how many can be produced. The difference between the two can then be used to find the maximum profit that can be made from each product. This can be seen in table 2.

Since the maximum constraint placed on the crunch nuts is below the maximum threshold needed to cover the fixed costs, it does make sense that the product should be discontinued, otherwise at best they can only lose a total of R10.35 for this product line.
The maximum constraint placed on the cluster nuts is above the maximum threshold needed in order to make a profit. It could make sense to keep the product, as it has the potential to make a total profit of R64.8 for this product line. The capital used to pay for the fixed costs of producing the cluster nuts could instead be used to produce more whole nuts which do not have a constraint on their production.

$(609/3.17) * 1.93 = R370.78$

The profit the company could make by rather stopping production of cluster

nuts, and investing that profit into whole nuts is R 305.98. And so based on these financials, I would agree with the controller.

Variable cost per unit	Whole	Cluster	Crunch	Roasted
Direct Material	1.28	1.12	0.96	1.6
Direct Labour	1.05	0.80	0.64	0.65
Manufacturing Overhead	0.32	0.28	0.24	0.45
Selling & Administration	0.52	0.36	0.41	0.6
Total variable costs	3.17	2.56	2.25	3.3

Table 1: Break down of variable costs

	Whole	Cluster	Crunch	Roasted
Sales revenue per unit	5.1	3.6	3.4	4.625
Variable cost per unit	3.17	2.56	2.25	3.3
Profit per unit	1.93	1.04	1.15	1.325
Total fixed costs	1266	609	182	243
No.units needed to cover fixed costs	656	452	159	146
Max constraint on unit production	Inf	500	150	200
Difference between above 2 lines	Inf	48	-9	54
Maximum profit	Inf	64.8	-10.35	90.18

Table 2: Break even point

The fixed cost linear programming simulation can be found in the attached excel spreadsheet. From this simulation it can be seen that if it was possible to stop producing a product, it would be best to stop producing the crunch and roasted nuts product lines. This is different to what was seen above, as the financials do not take into consideration the nut, chocolate and machine constraints. And so unless the chocolate and nut inventory, as well as the machine time, is increased, it will be optimal to stop production of the crunch and roasted nuts product lines.

Taking the the financials and the constraints into consideration, I would agree with the controller on the crunch nuts being discontinued, but not the cluster nuts.

2.2 b

The rest of the simulations assumes that all of the products will continue their production, and so fixed costs cannot be removed for any product.

$x1 < -Wholenuts$
$x2 < -Clusternuts$
$x3 < -Crunchnuts$

$x4 < -Roastednuts$

Since the fixed costs are constant, we are going to maximize the profit we can get from the per unit profits.

maximize: $1.93x1 + 1.04x2 + 1.15x3 + 1.325x4$

s.t.

Whole nuts must stay above 1000 units
$x1 >= 1000$

Cluster nuts must stay above 400 units
$x2 >= 400$

Cluster nuts must stay below 500 units
$x2 <= 500$

Crunch nuts must stay below 150 units
$x3 <= 150$

Roasted nuts must stay below 200 units
$x4 <= 200$

Constraint on the nuts
$0.6x1 + 0.4x2 + 0.2x3 + x4 <= 1100$

Constraint on the chocolate
$0.4x1 + 0.6x2 + 0.8x3 <= 800$

Non-negative constraint
$x1, x2, x3, x4 >= 0$

2.3 c

Please find attached the excel sheet.

2.4 d

The optimal number of each product can be found in the table below.

Whole nut	Cluster nut	Crunch nut	Roasted nut
1029	400	150	200

Table 3: Optimal unit production solution

With these values the profit would be:

$$Profit = 1.93x1 + 1.04x2 + 1.15x3 + 1.325x4 - fixedcosts = R853$$

2.5 e

Variable Cells

Cell	Name	Final Value	Reduced Cost	Objective Coefficient	Allowable Increase	Allowable Decrease
B7	Whole nuts	1029	0	1.93	0.37	0.305
C7	Cluster nuts	400	0	1.04	0.1952	1E+30
D7	Crunch nuts	150	0	1.15	1E+30	0.185
E7	Roasted nuts	200	0	1.325	1E+30	0.553

Constraints

Cell	Name	Final Value	Shadow Price	Constraint R.H. Side	Allowable Increase	Allowable Decrease
G10	Maximize	1029	0	1000	29	1E+30
G11	Maximize	400	-0.1952	400	45.3125	400
G12	Maximize	400	0	500	1E+30	100
G13	Maximize	150	0.185	150	47.33333333	150
G14	Maximize	200	0.553	200	72.5	177.5
G15	Maximize	1007.4	0	1100	1E+30	92.6
G16	Maximize	771.6	0	800	1E+30	28.4
G17	Maximize	1779	0	3600	1E+30	1821
G18	Maximize	3158	0	3600	1E+30	442
G19	Maximize	1339	0	3600	1E+30	2261
G20	Maximize	3600	0.772	3600	177.5	72.5

Figure 1: Sensitivity report

2.6 f

No, the solution is not degenerate, as all the variables are not zero, and so there are not any redundant constraints.

2.7 g

Yes, the algorithm arrived on a solution, since this is a linear problem it does not run the risk of landing up in a local optima.

2.8 h

I would recommend that they reduce the production of the cluster nuts, as it's minimum production constraint has the largest allowable decrease, whilst still

keeping in the optimal solution. Also according to it's unit profit coefficient, it brings in the least profit per unit.

It also is set at the lowest constraint, with a shadow price of -R0.1952, and so any increase would result in a lower profit.

2.9 i

I would recommend they increase the production of roasted nuts. The roasted nuts have the largest allowable increase (72.5) of the minimum restrictions on the production of the nuts.

The shadow price for increasing the constraint on the roasted nuts is 0.553, which is the largest shadow price from the constraints placed on the production of the nuts.

2.10 j

The resource that is preventing MNS from making more money, is having more time on the packaging machine. The company should be willing to pay R0.772 per minute on the machine, and should aim to increase it by 177.5 minutes.

2.10.1 k

Nothing, buying more chocolate would not help, as not all of the current chocolate is being used, and so buying more would be redundant.

2.11 l

No it would not change, the allowable decrease of the coefficient (which is unit profit) is R0.305.