IE 222: Operation Research

Case Study of RUKN MULTAGA ALHALWA Factory

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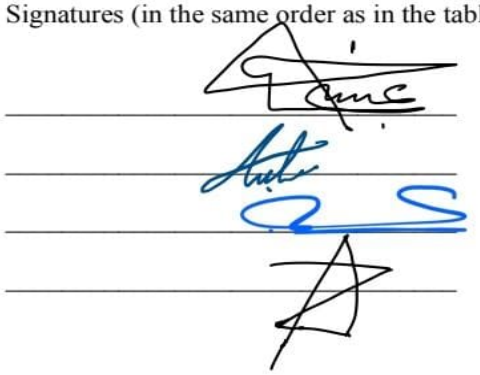

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Abstract: This study aims to use the linear programming model to increase the profits of RUKN MULTAGA ALHALWA factory by optimizing the available raw materials. We collected five products, and it turned out that they have many problems and wasted capabilities. Their total profit per day was 1628 SR. After applying the study and making maximum possible use of the raw materials, the daily profit becomes 4020 SR.

Introduction:

Due to the importance of analysis and operations research in finding optimal solutions with high accuracy and relatively short time.

We visited one of the sweets products factories, which is the RUKN MULTAGA ALHALWA, to implement the study of this project. RUKN MULTAGA ALHALWA Factory is a sweets factory that has affiliated stores with the same name. It produces daily quantities and distributes them in a way to meet the demand for each store. The factory contains 14 workers, each worker works 8 hours per day, which is equivalent to 112 working hours per day (6,720 minutes per day).

Our aim in this study is to increase the profit of the factory by analyzing the data and designing a linear programming model that finds the optimal solution.

Problem Statement:

Many factories face problems in making full use of the available resources, some of them do not know how to increase profit through the available resources, especially in the food processing sector, because of the amount of raw materials in each product and the time of preparation. Some of them may eventually resort to getting rid of these raw materials because they have expired. The problem facing the factory is to determine the optimal quantity for each product according to the available resources to obtain the highest possible profit.

Data:

Table 1: the demand, profit, and preparation time for each product.

Products	Daily demand (Unit)	Preparation time (Min/unit)	Profit (SR/unit)
Regular cake	53	10	2.1
Saffron cake	190	1.5	1.54
kiryatus	9	4.5	0.5
Latte sweet	248	5	0.2
cheesecake	150	2	7.8

Table 2: The amount, number of raw materials in each product. And Availability of raw materials per day .

	Regular cake	Saffron cake	kiryatus	Latte sweet	cheesecake	available
egg (piece)	3	0.5	0	0	0	729
butter (g)	283	0	0	0	5.5	20000
sugar (g)	0	11.12	0	0	15	32000
cream (piece)	0	0	0	2	2	1776
white cream (g)	50	10	0	0	4	14500
Liquid milk (piece)	0	0.2	0.2	0	0	58
Condensed milk (piece)	0	0	0.4	0.5	0	163
yogurt (g)	0	0	0	0	90	46250
Milk Powder (g)	0	0	0	0	40	17500
Lotus biscuit (g)	0	0	40	0	0	600
Gelatin (g)	0	0	0	0	0.5	650
Max Mix (g)	250	47	0	0	0	67000
Caramel powder (g)	0	0	0	45	0	14880
filling (g)	250	0	0	0	0	13250
Croissant (piece)	0	0	7	0	0	108
Salty biscuits (g)	0	0	0	43	0	15000

Modeling:

The aim of this study is to develop a linear programming model designed to increase the daily profits of a sweets factory by increasing the production of the highest profit product, considering the amount of available raw materials.

Sets:

Product: the set of products given that $p \in \{1,..,5\}$.

Raw: the set of raw materials given that $r \in \{1,..,16\}$.

Constants:

- $Demand_p$:The demand of product type p.
- $Profit_p$: The profit of product type p.
- $Ravial_r$:The availability of raw material type r.
- Manhour : The available man hours.
- $Araw_{rp}$: The amount of raw material r in product p.
- $Ntime_p$: The needed time to produce product type p.

Decision variables:

- X_p :The number of units produced of product type p.

Objective function:

$$\text{Max } z = \sum_{p \in Product} Profit_p \quad X_p$$

Constraints:

For all p ∈Product: $X_p \geq Demand_p$. (Demand for each product produced per day).

For all r ∈Raw: $\sum_{p \in Product} Araw_{rp} \; X_p \leq Ravial_r$ (Available of each raw material per day).

$\sum_{p \in Product} Ntime_p \; Xp \leq Manhour$ (Available of manhour per day).

For all p ∈Product: $X_p \in IN$. (Integer constraint).

Lingo Code:

```
Sets:
Product/1..5/: Demand, Profit, Ntime, x;
Raw/1..16/: Ravail;
RP(Raw,Product):Araw;
Endsets

Data:
Demand = @ole();
Profit = @ole();
Ntime = @ole();
Manhour = 6720;
Ravail = @ole();
Araw = @ole();
Enddata

!Objective function;
Max = Z;
Z = @sum(Product(p): Profit(p) * x(p));

!Constraints;

!Demand for each product produced per day;
@for (Product(p): x(p) >= Demand(p));

!Available of each raw material per day;
@for (Raw(r): @sum(Product(p): Araw(r,p)*x(p)) <= Ravail(r));

!Available of  man hour per day;
@sum(Product(p): Ntime(p) * x(p)) <= Manhour;

!integer constraint;
@for (Product(p):@gin(x(p)));
```

Production per day before the model:

Table 3: Production information per day before the model:

Products	Regular cake	Saffron cake	kiryatus	Latte sweet	Cheesecake	Total	Available of raw material	The raw material unused
Units produced	53	190	9	248	150	650	-	-
Profit (SR)	111.3	292.6	4.5	49.6	1170	1628	-	-
egg (piece)	159	95	0	0	0	254	729	475
butter (g)	14999	0	0	0	825	15824	20000	4176
sugar (g)	0	2112.8	0	0	2250	4362.8	32000	27637.2
cream (piece)	0	0	0	496	300	796	1776	980
white cream (g)	2650	1900	0	0	600	5150	14500	9350
Liquid milk (piece)	0	38	1.8	0	0	39.8	58	18.2
Condensed milk (piece)	0	0	3.6	124	0	127.6	163	35.4
yogurt (g)	0	0	0	0	13500	13500	46250	32750
Milk Powder (g)	0	0	0	0	6000	6000	17500	11500
Lotus biscuit (g)	0	0	360	0	0	360	600	240
Gelatin (g)	0	0	0	0	75	75	650	575
Max Mix (g)	13250	8930	0	0	0	22180	67000	44820
Caramel powder (g)	0	0	0	11160	0	11160	14880	3720
Filling (g)	13250	0	0	0	0	13250	13250	0
Croissant (piece)	0	0	63	0	0	63	108	45
Salty biscuits (g)	0	0	0	10664	0	10664	15000	4336

Production per day after the model (the optimal solution):

Table 4: Production information per day after the model:

Products	Regular cake	Saffron cake	kiryatus	Latte sweet	cheesecake	Total	Available of raw material	The raw material unused
Units produced	53	281	9	318	437	1098	-	-
Profit (SR)	111.3	432.74	4.5	63.6	3408.6	4020.74	-	-
egg (piece)	159	140.5	0	0	0	299.5	729	429.5
butter (g)	14999	0	0	0	2403.5	17402.5	20000	2597.5
sugar (g)	0	3124.72	0	0	6555	9679.72	32000	22320.28
cream (piece)	0	0	0	636	874	1510	1776	266
white cream (g)	2650	2810	0	0	1748	7208	14500	7292
Liquid milk (piece)	0	56.2	1.8	0	0	58	58	0
Condensed milk(piece)	0	0	3.6	159	0	162.6	163	0.4
Yogurt (g)	0	0	0	0	39330	39330	46250	6920
Milk Powder (g)	0	0	0	0	17480	17480	17500	20
Lotus biscuit (g)	0	0	360	0	0	360	600	240
Gelatin (g)	0	0	0	0	218.5	218.5	650	431.5
Max Mix (g)	13250	13207	0	0	0	26457	67000	40543
Caramel powder (g)	0	0	0	14310	0	14310	14880	570
filling (g)	13250	0	0	0	0	13250	13250	0
Croissant (piece)	0	0	63	0	0	63	108	45
Salty biscuits (g)	0	0	0	13674	0	13674	15000	1326

The model has increased production by 281 unit of saffron cake, 318 unit of latte sweet, and 437 unit of cheesecake, in order to increase profit while not exceeding the available raw materials. The units produced of regular cake did not change due to the amount of filling available as well as kiryatus because liquid milk have been used for Saffron cake because saffron has more profit.

Comparison between results before and after modeling:

Table 5: Compare results before and after modeling:

	Total units produced	Total unused raw material (g)	Total unused raw material (piece)	Production hours (Per day)	Workers	Total profit (SR)
Before	650	139104.2	1553.6	39.925	5	1628
After	1098	82260.28	740.9	57.6	7 (1.6h over time)	4020.74

As the table shows the profit has increased by 2392.74 SR per day, 873350.1 SR per year.

Total unused raw material reduced by 56843.92 g and 812.7 piece.

Production hours has increased by 17.675 hours per day which means need for two more workers and 1.6 hours over time.

Conclusions and recommendations:

As seen from the results, we advise the factory to consider the results of the study because it gives a higher profit compared to the current situation.

Of course, the demand for products is volatile, and the establishment may encounter difficulties in achieving the results of the study. Therefore, we propose the following solutions:

The first solution: Promote products for which the study has shown benefit by increasing production per day, in order to increase the demand for them, or contract with other selling stores in order to sell these products. Knowing that there will be some remaining quantities of raw materials that will not be used even after applying the results of the study.

The second solution: In the event of the inability to implement the first solution, we advise them to reduce the quantities of unused raw materials to reduce the cost and not to waste it.
