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R – Solver for Solving Drugs Medication Production Problem Designed for Health Patients Administrations

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Abstract **Original Research Article**

The idea of R – Solver for Linear Programming was efficiently and practically used in this project. An attribute of Linear Programming is to assign raw materials to striving variables in a medical industry for the purpose of maximizing company's profit. The analysis was executed using R- Program and the result showed the individual units of different sizes of materials that should be produced independently in three different processes (for example) to make a certain profit. This numerical result was compared using Quality Management (QM) software for Windows which showed the iterations to the solution. Each process required the use of certain chemical catalyst with limited supply. Thus, from the analysis, it was discovered that likely producing Type A drug medication will or not only contribute objectively to the profit. So, more of Type B drug medication would be needed to be produced and sold to maximize the company's profit and at same time satisfying the patients' needs.

Keywords: Drug production**,** Health Patients Administrations, Linear programming model, R- Software.

I. INTRODUCTION

R-solver is an optimization tool that can be used to solve complex linear programming problems, including those related to medication production. Linear programming is a mathematical method for determining the best outcome in each mathematical model for a specific set of requirements represented by linear relationships. The "R" was introduced by Ihaka & Gentleman in 1996 [5].

In the context of medication production, linear programming can be used to optimize production schedules, inventory levels, and resource allocation [4] to ensure the efficient and cost-effective production of medications. This can help pharmaceutical companies maximize their production capacity, minimize costs, and meet regulatory requirements.

R-solver is a widespread software tool that is used by researchers, analysts, and organizations to solve linear programming problems efficiently and accurately. It allows users to input their problem constraints and objectives, and then calculates the optimal solution based on these inputs.

Overall, utilizing R-solver for linear programming in medication production can help pharmaceutical companies improve their production processes, reduce waste, and improve overall efficiency in producing medications.

In the context of medication production, the problem that can be effectively solved using R-solver and linear programming [10] techniques is the optimization of production processes to minimize costs and maximize efficiency. This involves determining the optimal allocation of resources, such as raw materials, manpower, and production time, to meet the demand for medications while minimizing production costs.

This study specifically solved the problem such as determining the optimal production schedule to meet demand while minimizing costs, allocating resources efficiently to maximize production output and ensuring compliance with regulatory requirements for medication production.

By using R-solver and linear programming techniques, pharmaceutical companies can address these challenges and optimize their medication production processes to improve overall efficiency, reduce costs, and increase profitability.

II. LITERATURE REVIEW

Some researchers (see [1] – [8,10 &11]) investigated the Linear Programming Problems in various ways but none has investigated applying this R - Solver in production of drug medications and administrations in a medical industry. Nwagha *et al*. (2023) [9] studied iron supplementation and blood donation in Nigeria. They looked at the effect of hemoglobin, red cell indices and iron stores. Accordingly, there was a significant percentage recovery of Hemoglobin, red cell indices and iron stores parameters after 6 weeks.

Case Study: The JUHEL Nigeria Pharmaceutical Production Company - Background to the Company

For over 30 years, JUHEL pharmaceutical company (owner - Dr. Ifeanyi Okoye – CEO founded in 1989) has existed in improving the lives of millions of people by ensuring access quality medicines through their consistence, expertise and leadership within the medical industry in the Western part of the Africa. The company has over 150 ranges of pharmaceutical products in their portfolio covering multiple therapeutic areas and formulations including tablets, syrups and infusions.

The JUHEL Nigeria Pharmaceutical Company has branches in Awka, Anambra State and in Emene, Enugu State. The Oral Medicine Manufacturing Plant operates in Emene, Enugu state whereas the Parenteral Medicine Manufacturing Plant in Awka, Anambra State.

Table 1: Showing the JUHEL Nigeria Pharmaceutical Company Services including petroleum, pharmaceutical, water and CSR (Corporate Social Responsibility). Their products include Oral, Parenteral and Drinks

S/N	Oral	Some of the Parenteral (products /strength/unit qty/carton)	Drinks
1	Cold & Cough Medicines (TYPE A & TYPE B)*	Darrows Solution (Half strength)/500ml/20	Ivy Table Water
2	Analgesics	Dextrose Water/5%w/v/1000ml/10	Ivy Table Water
3	Antacids & Antiflatulents	Dextrose Saline/0.9%/1000ml/10	Ivy Table Water
4	Antibiotics	Normal Saline/1000ml/10	Ivy Table Water
5	Anti-diabetics	Peritoneal Dialysis/1000ml/10	Ivy Table Water
6	Anti-helminthics	Dextrose Water/10% w/v/500ml/20	Ivy Table Water
7	Antihistamines	Dextrose Saline/0.9%/500ml/20	Ivy Table Water
8	Antimalarias	Dextrose Saline/4.3%/500ml/20	Ivy Table Water
9	Anti-spasmodic	Normal Saline/500ml/20	Ivy Table Water
10	Cardiovascular & Anxiolytics	Ringes Lactate Solution/500ml/20	Ivy Table Water
11	Vitamins	Darrows Solution (Full strength)/500ml/20	Ivy Table Water
12	Steriods	10% Mannitol Solition/500ml/20	Ivy Table Water

Source: The JUHEL Nigeria Pharmaceutical Company, 2024.

Meanwhile, there are twelve (12) Oral - Cold & Cough Medicines which are summarized in the Table 2 following produced by the JUHEL Nigeria Pharmaceutical Company.

Table 2: Oral - Cold & Cough Medicines

S/N	Cold & Cough Medicines (TYPES)	Medications	Unit QTY	Carton QTY
1	Flu-J tablets	Paracetamol 500mg, Chlorpheniramine maleate 2mg, Ascorbic acid 25mg	500's	42
2	Flu-J tablets in strips	Paracetamol 500mg, Chlorpheniramine maleate 2mg, Ascorbic acid 25mg	50×4's	36
3	Flu-J tablets in Blisters	Paracetamol 500mg, Chlorpheniramine maleate 2mg, Ascorbic acid 25mg	50×4's	50
4	Blister Flu-J Non-Drowsy	Paracetamol 500mg, CetrizineHydrochloride 2.5mg	10	400
5	Blister Flu-J Non-Drowsy	Paracetamol 500mg, CetrizineHydrochloride 2.5mg	10×10's	80
6	Flu-J Syrup	Paracetamol 120mg, Chlorpheniramine maleate 2mg, Ascorbic acid 25mg	100 ml	100
7	Julyn Expectorant	Diphenhydramine + Ammon Chloride + Sod Citrate + Menthol	100ml	100

S/N	Cold & Cough Medicines (TYPES)	Medications	Unit QTY	Carton QTY
8	Julyn Expectorant	Diphenhydramine + Ammon Chloride + Sod Citrate + Menthol	2litres	6
9	Julyn for children	Diphenhydramine + Sod Citrate	100ml	100
10	Julyn for children	Diphenhydramine + Sod Citrate	2litres	6
11	Julyn + Codeine	Julyn + Codeine	100ml	100
12	Juferon	Blood Tonic	200	24

***Source**: The JUHEL Nigeria Pharmaceutical Company, 2024. 1 millilitre = 0.001 litre.*

III. MODEL FORMULATION

Assumptions: Suppose each process requires to produce Type A drug medication (Blister Flu-J Non-Drowsy- example: Paracetamol 500mg) and Type B drug medication (Juferon - Blood Tonic) in certain X chemical catalyst.

The supposing production data were listed in the Table 3 below (for example).

Table 3: TYPE A (Drug Medication 1) – X usage/unit, TYPE B (Drug Medication 2) - X usage/unit, Availability X (gm) involved in three processes

	TYPE A (Drug Medication 1) - X usage/unit	TYPE B (Drug Medication 2) - X usage/unit	Availability X (gm)
Process 1	30	20	2700
Process 2	5	10	850
Process 3	1	1	95
Profit/Unit	700	800	#74000

Max Z = $700x_1 + 800x_2$

Subject to $30x_1 + 20x_2 \leq 2700$

$5x_1 + 10x_2 \leq 850$

$x_1 + x_2 \leq 95$

$x_1, x_2 \geq 0$

Where x_1 is the number of units to be produced and sold of drug medication 1 and x_2 is the number of units to be produced and sold of drug medication 2.

IV. RESEARCH METHODOLOGY

A given Linear Programming Problem is solved using R – Solver.

```
# Linear Programming in R
# Install the lpSolve package
install.packages("lpSolve")
# Load the lpSolve package
library(lpSolve)
# Define the objective function coefficients
obj <- c(700, 800)
# Define the inequality constraints matrix
mat <- matrix(c(30, 20,
          5, 10,
          1, 1), byrow = TRUE, nrow = 3)
# Define the inequality constraints direction
dir <- c("<=", "<=", "<=")
# Define the inequality constraints right-hand side
rhs <- c(2700, 850, 95)
# Solve the linear programming problem
lp <- lp("max", obj, mat, dir, rhs)
# Print the results
print(lp$solution)
print(lp$objval)
```

Result of the Code

```
> # Define the objective function coefficients
> obj <- c(700, 800)
>
> # Define the inequality constraints matrix
> mat <- matrix(c(30, 20,
+           5, 10,
+           1, 1), byrow = TRUE, nrow = 3)
>
> # Define the inequality constraints direction
> dir <- c("<=", "<=", "<=")
>
> # Define the inequality constraints right-hand side
> rhs <- c(2700, 850, 95)
>
> # Solve the linear programming problem
> lp <- lp("max", obj, mat, dir, rhs)
>
> # Print the results
> print(lp$solution)
[1]  20 75
> print(lp$objval)
[1] 74000
```

Therefore, $x_1 = 20$ and $x_2 = 75$.

Table 4: QM for Windows Showing the Iterations to the Solution

Cj	Basic Variables	Quantity	700 X1	800 X2	0 slack 1	0 slack 2	0 slack 3
0	slack 1	2,700	30	20	1	0	0
0	slack 2	850	5	10	0	1	0
0	slack 3	95	1	1	0	0	1
	zj	0	0	0	0	0	0
	cj-zj		700	800	0	0	0
Iteration 2							
0	slack 1	1,000	20	0	1	-2	0
800	X2	85	0.5	1	0	0.1	0
0	slack 3	10	0.5	0	0	-0.1	1
	zj	68,000	400	800	0	80	0
	cj-zj		300	0	0	-80	0
Iteration 3							
0	slack 1	600	0	0	1	2	-40
800	X2	75	0	1	0	0.2	-1
700	X1	20	1	0	0	-0.2	2
	zj	74,000	700	800	0	20	600
	cj-zj		0	0	0	-20	-600

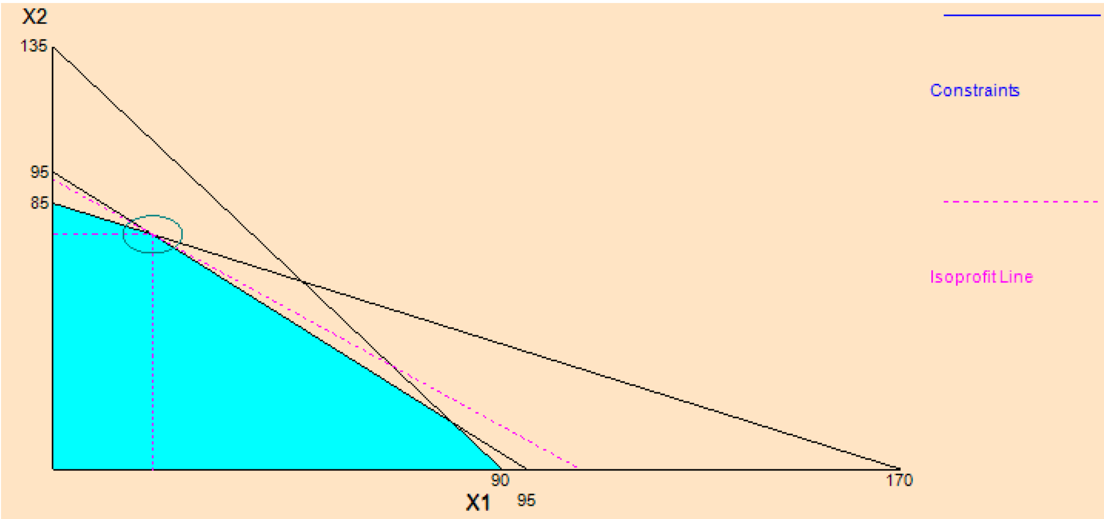

Figure 1: A Graphical Representation of the LP Problem from Table 4

V. DISCUSSION OF RESULT

For every 75 units of Type B drug medication (Juferon - Blood Tonic) the company should produce 20 units of Type A drug medication (Blister Flu-J Non-Drowsy- for example: Paracetamol 500mg). This also encouraged production of iron supplements (Nwagha *et al*., 2023) [9].

VI. CONCLUSION

R-solver has been applied to solve linear programming problems efficiently and accurately. This solver:

1. Determined the optimal production schedule to meet demand while minimizing costs.
2. Allocated resources efficiently to maximize production output.
3. Ensured compliance with regulatory requirements for medication production. For further research, there is need to execute the numerical solution up to twelve (12) variables using the R-Code.

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