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An Attempt to Improve the Quality of Life of Terracotta Artists with the Help of Linear Programming Problem

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Abstract:
This paper basically shows a direction to improve the standard of living of Terracotta artist i.e. how to increase their daily income. Here the work of rural Terracotta artist is highlighted. The tasks they perform are divided into three categories, namely: Architectural ornaments and facings, Structural units and pottery, Material for Sculpture. They are again divided into two categories as medium and small artefacts. Very large or very small artworks are not accounted here as they are exceptional works. Information about how much time it takes to do each job and how much profit it makes is collected from them. With all those data, the linear programming problem is formulated and solved with the help of graphical method of LPP. Our objective here is to maximize their profits.

Key words: Linear programming problem, objective function, Terracotta, artist.

Introduction: The linear programming problem (LPP) is a problem concerned with finding the optimal value of a linear function. The optimal value can be either the maximum value or the minimum value. Here, the linear function is considered as an objective function.

In 1939, the Soviet mathematician and economist Leonid Kantorovich presented a linear programming equivalent problem to the general linear programming problem; he also gave a method for solving it [1]. During world war-II he devised a way of planning expenditure and revenue to reduce the cost of the army and increase the losses inflicted on the enemy.

Terracotta: Terracotta is the art of pottery. It is a Latin word. 'Terra' means soil and 'cotta' means to burn. The product made of burnt clay is known as Terracotta. Its use can be traced back to the beginning of human civilization. This art prevalent in the Sumerian and Maya civilizations. Many terracotta artefacts of the Maurya Empire, Gupta Empire have been found in India's West Bengal and Bangladesh [2]. Panchmura, Bishnupur in Bankura district of West Bengal is famous for its Terracotta industry.

First clay is prepared by mixing straw and burn with sticky soil. After that various items are made and allowed to dry in the sun. After drying in the sun, various designs are carved on the finished articles and burnt in fire. This is how terracotta is made. Terracotta is mainly made for household use. Apart from this, Terracotta is also made for the decoration of various establishments or any artistic display.




General linear programming problem [3]**:** The mathematical structure of the general linear programming problem is as follows:

$$Optimize\ Z = c_1x_1 + c_2x_2 + c_3x_3 + \cdots + c_nx_n.$$

Subject to the constraints:

$$a_{11}x_1 + a_{12}x_2 + a_{13}x_3 + \cdots + a_{1n}x_n (\leq\ =\ \geq) b_1,$$
$$a_{21}x_1 + a_{22}x_2 + a_{23}x_3 + \cdots + a_{2n}x_n (\leq\ =\ \geq) b_2,$$
$$\cdots\cdots\cdots\cdots\cdots\cdots\cdots\cdots\cdots\cdots\cdots\cdots$$
$$\cdots\cdots\cdots\cdots\cdots\cdots\cdots\cdots\cdots\cdots\cdots\cdots$$
$$a_{m1}x_1 + a_{m2}x_2 + a_{m3}x_3 + \cdots + a_{mn}x_n (\leq\ =\ \geq) b_n.$$

$a_{ij}(i = 1,2,3, \dots, m\,; j = 1,2, \dots, n)$Are activity parameters?

$b_i(i = 1,2,3, \dots, m)$ Are requirement parameters?

$$x_j \geq 0, j = 1,2, \dots, n$$

Formulation of an LPP [4]**:**

1. Determine the decision variables and conditions which are associated with the problem.
2. Ascertain the objective of the decision maker whether he wants to minimize or to maximize i.e. Determine the objective function.
3. Describe the constraints; write the constraints in terms of the decision variables.
4. State the non-negativity constraints.

Limitations [5]**:**

i) All relations in LPP are assumed to be linear. Although not all relations in real life can be expressed linearly.

ii) When the number of variables and constraints increases, the problem becomes more complex and difficult to solve.

iii) Linear programming often gives fractional answers which do not correspond to real life.

iv) Specifying an objective function in mathematical form is not an easy task.

Problem: Teracotta artists of Panchmura use Architectural ornaments and facings, Structural units and pottery, Material for sculpture to produce medium and small (too big and too small products are not accounted for) artistic work. Following table represents the time required for each part, the time available for artist and the profit on each work.

Types of Terracotta	Time required for making Terracotta (minutes/unit)		Maximum time available per day for a artist (minutes)
	Medium (20 inches)	Small (16inches)	
Architectural ornaments and facings	75	40	300
Structural units and pottery	30	36	180
Material for sculpture	80	30	240
Profit per unit	Rs. 800	Rs. 600	

We have to find the number of medium and small products make per day to maximize the profit.

Solution: Let the artist produce $x_1$unit of each medium product per day and x_2 unit of each small product.

Profit on each medium product is Rs. 800 and profit on each small product is Rs. 600.
Thus the problem is to find x_1 and $x_2$which will maximize the objective function.
Objective is to maximize the profit.

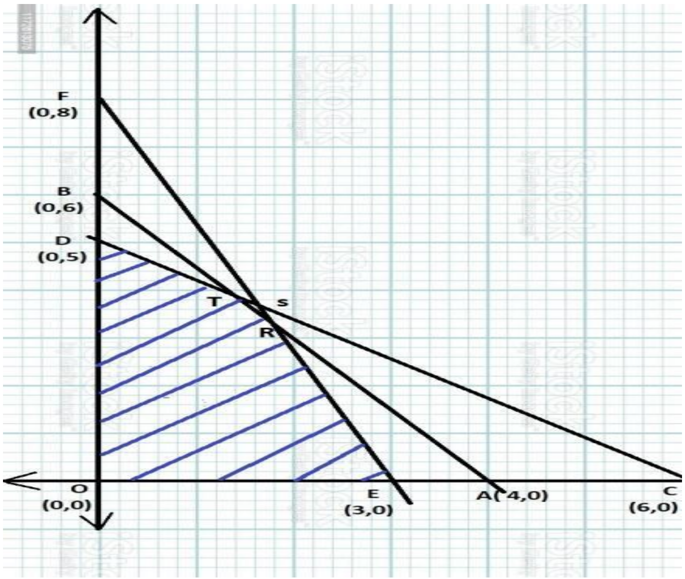
i.e.$Max\ Z = 800x_1 + 600x_2$

Subject to the constraints

$$75x_1 + 40x_2 \leq 300$$
$$30x_1 + 36x_2 \leq 180$$
$$80x_1 + 30x_2 \leq 240$$
$$x_1, x_2 \geq 0.$$

We draw the straight lines with the help of the constraints taken as equations.

$$\frac{x_1}{4} + \frac{x_2}{6} = 1 \ldots \quad (i)$$
$$\frac{x_1}{6} + \frac{x_2}{5} = 1 \ldots\ldots (ii)$$
$$\frac{x_1}{3} + \frac{x_2}{8} = 1 \ldots\ldots (iii)$$



Solving (i) & (iii) we get $x_1 = \frac{12}{7},\ x_2 = \frac{24}{7}$.
Solving (i) & (ii) we get $x_1 = \frac{3}{2},\ x_2 = \frac{15}{4}$.
Solving (ii) & (iii) we get $x_1 = \frac{18}{11},\ x_2 = \frac{40}{11}$.

The corner points of the feasible region are
$(0,0),\quad E(3,0),\quad R\left(\frac{12}{7},\frac{24}{7}\right),\ T\left(\frac{3}{2},\frac{15}{4}\right),\quad D(0,5)$.
Now, $Z_{(0,0)} = 0,\ Z_{(3,0)} = 2400,\ Z_{\left(\frac{12}{7},\frac{24}{7}\right)} = 3428.57,$
$Z_{\left(\frac{3}{2},\frac{15}{4}\right)} = 3450,\quad Z_{(0,5)} = 3000.$

Thus the optimal solution of the L.P.P is
$x_1 = \frac{3}{2},\ x_2 = \frac{15}{4}\ \ and\ Max\ Z = 3450$.

Conclusion: Terracotta is a rural industry that is almost extinct today. So some special ideas or special technologies are needed to sustain this industry. In this paper an attempt has been made to give an idea of how their daily income can be increased.

Although it is not possible to express their problems in a completely linear way, still attempts have been made to solve the problems by expressing them through linear programming.

From this paper, many students and researchers can create an idea about the works and lives of Terracotta artists and get inspiration to research on them.

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