Chapter - 8

MANAGEMENT AS AN INPUT, AND ITS INFLUENCE ON OUTPUT

- Introduction
- Tools Analysis
- Formulating of Linear Programmeing Model
- Data Analysis
- Decision Variable
- Constraints, Objective Functions
- Non-negative Constraints
- Inference
8.1 INTRODUCTION

The role of scientific management is vital for success of any enterprise. Much importance and care were not given for implementing management principles in organising tiny industrial units. Khadi and Village Industrial units are managed by skilled artisan or by the experienced khadi worker, who may not be aware of the latest development in management techniques. Application of tools of management such as Fund flow, Cash flow, Ratio analysis, Operating cycle, Operation Research Techniques etc. will facilitate the manager to assess his performance and run the business with more profit. It is the need of the hour to apply such modern techniques on Khadi and Village Industries to make it more profitable. In this chapter an attempt is made to apply the Operation Research Techniques (Linear programme) on Khadi and Village Industries to make it more profitable.

8.1.1 Operation Research Techniques

Operation Research Techniques or programming techniques are the model building technique used in management decision making. These techniques provide
solutions in terms of the value of the variable involved. Operations research is a comparatively new science.

Operation research involves the application of scientific tools for finding optimum solutions to problems involving the operations of systems. It provides a quantitative basis for managerial decision-making. Operation research is based on interdisciplinary team approach involving the use of mathematics, physics, economics and engineering. Operation Research technique are sophisticated techniques and they are very helpful in tackling complex problems of business and industry.

8.1.2. Steps involved in formulation of Operation Research Model
1. The problem is formulated in quantitative terms. All variables (controllable factors) and coefficients (Non-controllable factors) which are pertinent to the problem are defined in mathematical terms.
2. A mathematical model is constructed expressing inter-relationship between different variables.
3. An optimum solution is obtained on the basis of various equations of the model.
4. The model and the solution obtained therefrom are tested, for validity in the light of actual observations. The model is modified, if necessary.
5. The model is implemented by putting the solution to work.
8.2 Tools Analysis

There are numerous number of Operation Research techniques available. Among the available Operation Research techniques, Linear Programming techniques have been used to analyse the management as an input and its influence on output. (Let us briefly discuss the about the linear programming techniques)

8.2.1 Linear Programming

The word 'Linear' means that the relationships handled are represented by straight lines or involve linear function. The word 'programming' implies use of mathematical procedure to find the best solution. Thus linear programming may be defined as a mathematical technique involving the maximisation or minimisation of a linear function (called objective function) of variables subject to a constraint of linear inequalities (called linear restraints).

Further, linear programming is a mathematical technique for deciding the optimum use or allocation of limited resources. So as to minimize costs or to maximise profits. The basic purpose of using linear programming is to achieve to best possible allocation of scarce resources. For example, a production manager must allocate the limited man hours or machine hours among different products so as to maximise profits. Similarly, a transport firm must allocate the capacity time of its vehicles so as to execute the delivery orders in time.
8.2.2 Requirements of Linear Programming

Linear programming can be applied to only those problems which satisfy the following conditions:

i) **Objective Function**

There must be clearly defined objective which can be stated quantitatively. In business problems, the objective is usually the maximisation of profits or the minimisation of costs.

ii) **Constraints**

All restrictions relating to resources etc, should be fully spelt out. They must be capable of mathematical expression.

Hi) **Linearity**

The various relationships to be expressed in the form of equations must be linear. Linear means proportional relationship between two or more variables. Under linear relationship, every increment in one variable results in proportionate change in another variable. Such a relationship is generally found between inputs and outputs.

iv) **Non-negativity**

The value of variables must be positive and not negative. This suits the production decisions as negative values of physical quantities are never possible.
v)  **Finiteness**

The number of inputs, outputs and activities need to be finite or otherwise an optimal solution is not possible to compute.

Thus, linear programming is applicable to problems of quantitative and linear nature where maximisation or minimisation objective is to be achieved under given constraints.$^1$

### 8.2.3 Formulation of the Problem

This study deals with the formulation of the problem, into an appropriate mathematical model. For this, it is necessary to study comprehensively the components of the problem, namely, a) the decision maker, b) the objective, c) the alternative courses of action and d) the environment.

After identifying the components of the problem the relationship that exists among the components of the problem should be analysed. Also there must be complete agreement on the above points between persons initiating the Operation Research and the persons performing the study.

The major objectives of any industry or institutions are, a) to manufacture good quality products and b) to earn maximum profit.$^2$
The aim of this study is to formulate a linear programming model and suggest ways to maximise the profit of Khadi and Village Industries institutions.

The data relating to the various inputs (raw material, labour and capital) by these institutions of Khadi and Village Industries.

8.2.4 Methods of Linear Programming

A linear programming problem can be solved either by the graphical method or by the simplex method. The graphical method involves the use of graphs. It is relatively simpler but can be applied effectively, when only two decision variables are involved. The simplex method is useful in more complicated problems. But it requires comparatively advance mathematics. The computation procedure is so wearisome that it is necessary to use computers to handle the volume of calculations involved in actual business problems. In simplex method, the computational routine is an interactive process, i.e, it is repeated again and again. Successive solutions are developed until the optimum solution is found. It always begins at the point of no production, technically known as the zero solution. The simplex method is based on the property that every successive solution is an improvement over the earlier solution.

In this study, a linear programming model is developed and an optimal solution is obtained using LINDO package for
maximising the profit of the Khaai and Village Industries institutions.

8.2.5 Methodology

1) Describing the problem in its context
2) Collecting preliminary information
3) Defining the problem explicitly
4) Setting up objective of the study
5) Formulating the Operation Research problems
6) Constructing the model representing the system under study
7) Testing and updating the model
8) Deriving a solution
9) Controlling the solution
10) Putting the solution to work (implementing the solution)

8.3 Data available on the problem

The Khadi and Village Industries institutions have two types of inputs, called raw material, and labour. The details are given in the following table 8.1.
Table No.8.1

Formulation of raw materials, labour in Khadi and Village Industries Institutions

Khadi production in Meters
Village industries production in Kgs.
(Rs. in lakhs)

<table>
<thead>
<tr>
<th>S. No.</th>
<th>Particulars</th>
<th>GKVIPCT</th>
<th>MNSS</th>
<th>GSS</th>
<th>KSS</th>
<th>TNSS</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Khadi Village Industries</td>
<td>Khadi Village Industries</td>
<td>Khadi Village Industries</td>
<td>Khadi Village Industries</td>
<td>Khadi Village Industries</td>
<td>Khadi Village Industries</td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>Raw material cost</td>
<td>284.20</td>
<td>423.29</td>
<td>114.91</td>
<td>76.60</td>
<td>20.16</td>
<td>80.63</td>
</tr>
<tr>
<td>2</td>
<td>Labour cost</td>
<td>256.60</td>
<td>376.24</td>
<td>100.72</td>
<td>53.16</td>
<td>17.82</td>
<td>21.40</td>
</tr>
<tr>
<td>3</td>
<td>Profit</td>
<td>6.46</td>
<td>15.07</td>
<td>5.27</td>
<td>4.31</td>
<td>(-) 1.26</td>
<td>(-) 0.32</td>
</tr>
<tr>
<td>4</td>
<td>Production (in unit)</td>
<td>627111</td>
<td>1410957</td>
<td>255556</td>
<td>8830000</td>
<td>44800</td>
<td>431500</td>
</tr>
</tbody>
</table>

Source: The statement of Final Accounts of the above Institution
8.4 Inadequacy of Data

Industry wise and product wise data on raw material cost and labour cost are not available.

8.5 Data Analysis

8.5.0 Formulating an LP Model

Formulating a linear programme to model a situation involves three basic steps:

1. Specify the decision variable (input)
2. Specify the constraints
3. Specify the objective function

8.5.1 Decision variables

Since we desire to determine the number of the institution under the study like, GKVIPCT, MNSS, GSS, KSS and TNSS.

Let $X_1$ be the number of units of khadi products in GKVIPCT. Where 1 unit = 6,27,111 meters

Let $X_2$ be the number of units of village industries products in GKVIPCT. Where 1 unit = 14,10,957 Kgs.

Let $X_3$ be the number of units of khadi products in MNSS. Where 1 unit = 2,55,356 meters.

Let $X_4$ be the number of units of village industries products in MNSS. Where 1 unit = 38,30,000 Kgs.
Let $X_s$ be the number of units of khadi products in GSS. Where 1 unit = 44.800 meters.

Let $X_v$ be the number of units of village industries products in GSS. Where 1 unit = 40.31,500 Kgs.

Let $X_k$ be the number of units of khadi products in KSS. Where 1 unit = 2.51,113 meters.

Let $X_v$ be the number of units of village industries products in KSS. Where 1 unit = 2.43,400Kgs.

Let $X_l$ be the number of units of khadi industries produced in TNSS. Where 1 unit = 2.33,756 meters.

Let $X_v$ be the number of units of village industries produced in TNSS. Where 1 unit = 2.47,833Kgs.

8.5.2 Constraints

Here the Khadi and Village Industry problems imposes restrictions on the usage of inputs (raw materials and labour) in the number of various institutions. The usage of inputs restriction may be expressed as follows, the inputs required for manufacturing of the institutions, is less than or equal to maximum inputs availability. This leads to the restrictions:

*Raw Materials Cost Constraints*

Raw material cost of GKV, IPCT, MNSS, GSS, KSS and TNSS is 282.20 lakhs and 423.29 lakhs 114.91 lakhs and 76.60 lakhs 20.16 lakhs and 80.63 lakhs 113.01 lakhs and 60.85 lakhs 132.19 lakhs and 74.35 lakhs.
282.20 \( X_1 + 423.29 \ X_2 + 114.91 \ X_3 + 76.60 \ X_4 + 20.16 \ X_5 \geq 80.63 \)
\( X_6 + 113.01 \ X_7 + 60.85 \ X_8 + 132.19 \ X_9 + 74.35 \ X_{10} \geq 1376.19 \)

**Labour Cost Constraints**

Labour cost of GKVIPCT, MNSS, GSS, KSS and TNSS is 250.83 lakhs and 376.25 lakhs, 139.72 lakhs and 93.15 lakhs, 17.88 lakhs and 21.85 lakhs, 329.89 lakhs and 253.05 lakhs, and 124.63 lakhs respectively.

250.83 \( X_1 + 376.25 \ X_2 + 139.72 \ X_3 + 93.15 \ X_4 \geq 197.88 \ X_5 \geq 21.85 \)
\( X_6 + 329.89 \ X_7 + 28.29 \ X_8 + 253.05 \ X_9 + 124.63 \ X_{10} \geq 1735.54 \)

**8.5.3 Objective Functions**

Since each institution gives the profit of 6.46 and 15.07 lakhs, the total profit producing \( X_1 \) and \( X_2 \) products of GKVIPCT is Rs.6.46 \( X_1 \) + 15.07 \( X_2 \) lakhs.

Similarly, the total profit on product \( X_3 \) and \( X_4 \) in the MNSSSS is 5.27 \( X_3 \) + 4.31 \( X_4 \).

The total profit on product \( X_5 \) and \( X_6 \) of GSS is Rs.(-)1.26 \( X_5 \) + (-) 0.32 \( X_6 \) Lakhs.

The total profit on product \( X_7 \) and \( X_8 \) of KSS is Rs.10.50 \( X_7 \) + 7.01 \( X_8 \) lakhs.

The total profit on product \( X_9 \) and \( X_{10} \) of TNSS is Rs.4.09 \( X_9 \) + 2.62 \( X_{10} \) lakhs.
Let $Z$ represent the total net profit. Then the objective function may be written mathematically as,

$$\text{Maximum profit } 6.41X_1 + 15.07X_2 + 5.27X_3 + 4.31X_4 +$$

$$(-) 1.26X_5 + (-) 0.32X_6 + 10.50X_7 + 7.01X_8 + 4.09X_9 + 2.62X_{10}$$

$$= \text{Rs.} 53.75 \text{ Lakhs. } \text{Max } Z = \text{Rs.} 53.75 \text{ Lakhs}$$

**Subject to the Constrain**

**Raw Material**

$$282.20X_1 + 423.29X_2 + 114.91X_3 + 76.60X_4 + 20.16X_5 + 80.63X_6 + 113.01X_7 + 60.85X_8 + 132.19X_9 + 74.35X_{10} \geq 1378.19$$

**Labour**

$$250.83X_1 + 376.25X_2 + 139.72X_3 + 93.15X_4 + 17.88X_5 + 21.85X_6 + 329.89X_7 + 28.29X_8 + 253.05X_9 + 124.63X_{10} \geq 1735.54$$

**Non-Negativity Constraints**

Since the institute can not produce negative number of items which are meaningless, we must have $X_1, X_2, X_3, X_4, X_5, X_6, X_7, X_8, X_9, X_{10} \geq 0$

Hence the manufacturers allocation problem can be put in the following mathematical form and the model was solved by using LINDO package and the following solution were obtained.
Model - I

Table 8.2

Find Real Numbers of Linear Programming

<table>
<thead>
<tr>
<th>Demand</th>
<th>Solution</th>
<th>Present production</th>
<th>Demand in production</th>
</tr>
</thead>
<tbody>
<tr>
<td>$X_{a} \geq 0$</td>
<td>$\exists$</td>
<td>627.11</td>
<td>0</td>
</tr>
<tr>
<td>$X_{b} \geq 0$</td>
<td>$\exists$</td>
<td>141.957</td>
<td>0</td>
</tr>
<tr>
<td>$X_{c} \geq 0$</td>
<td>$\exists$</td>
<td>255.356</td>
<td>0</td>
</tr>
<tr>
<td>$X_{d} \geq 0$</td>
<td>$\exists$</td>
<td>363.200</td>
<td>0</td>
</tr>
<tr>
<td>$X_{e} \geq 0$</td>
<td>$\exists$</td>
<td>445.000</td>
<td>0</td>
</tr>
<tr>
<td>$X_{f} \geq 0$</td>
<td>$\exists$</td>
<td>403.500</td>
<td>0</td>
</tr>
<tr>
<td>$X_{g} \geq 0$</td>
<td>$\exists$</td>
<td>251.113</td>
<td>0</td>
</tr>
<tr>
<td>$X_{h} \geq 0$</td>
<td>$\exists$</td>
<td>13.528</td>
<td>243400</td>
</tr>
<tr>
<td>$X_{i} \geq 0$</td>
<td>$\exists$</td>
<td>293.756</td>
<td>0</td>
</tr>
<tr>
<td>$X_{j} \geq 0$</td>
<td>$\exists$</td>
<td>247.833</td>
<td>0</td>
</tr>
</tbody>
</table>

$X_{a} \geq 0$ Produce in 13.528 X 243400 Kgs. = 3292715 Kgs. of Village Industries products. The total profit in this model for all five institutions will be Rs. 74,833 Lakhs.
The following assumptions are made, since, the items must be produced (market demand).

**TABLE - 8.3**

<table>
<thead>
<tr>
<th>Demand</th>
<th>Solution</th>
<th>Present production</th>
<th>Demand in production</th>
</tr>
</thead>
<tbody>
<tr>
<td>$X_1 \geq 1$</td>
<td></td>
<td>627111</td>
<td>627111</td>
</tr>
<tr>
<td>$X_2 \geq 1$</td>
<td></td>
<td>1410957</td>
<td>1410957</td>
</tr>
<tr>
<td>$X_3 \geq 1$</td>
<td></td>
<td>255356</td>
<td>255356</td>
</tr>
<tr>
<td>$X_4 \geq 1$</td>
<td></td>
<td>3830000</td>
<td>3830000</td>
</tr>
<tr>
<td>$X_5 \geq 0$</td>
<td></td>
<td>44800</td>
<td>0</td>
</tr>
<tr>
<td>$X_6 \geq 0$</td>
<td></td>
<td>4031500</td>
<td>0</td>
</tr>
<tr>
<td>$X_7 \geq 1$</td>
<td></td>
<td>251113</td>
<td>251113</td>
</tr>
<tr>
<td>$X_8 \geq 1$</td>
<td>1.31</td>
<td>243400</td>
<td>318854</td>
</tr>
<tr>
<td>$X_9 \geq 1$</td>
<td></td>
<td>293756</td>
<td>293756</td>
</tr>
<tr>
<td>$X_{10} \geq 1$</td>
<td></td>
<td>247833</td>
<td>247833</td>
</tr>
</tbody>
</table>

$X_t \geq 1$ produce $31$ times $x$ $2.43,400$ kgs $= 3,18,854$ Kg of Village Industries Products. The total profit in this model for all five institutions will be Rs.57,481 lakhs.
Model - III

If the maximum availability of labour cost is assumed Rs.2000 lakhs, the following solutions were obtained for the assumption.

Table - 8.4
Find the Assumption Number of Linear Programming
Khadi cloth in metres
Village Industries products in Kgs.

<table>
<thead>
<tr>
<th>Demand</th>
<th>Solution</th>
<th>Present production</th>
<th>Demand in production</th>
</tr>
</thead>
<tbody>
<tr>
<td>$X_1 \geq 1$</td>
<td>1</td>
<td>$62711^+$</td>
<td>62711</td>
</tr>
<tr>
<td>$X_2 \geq 1$</td>
<td>1</td>
<td>$14^+095$</td>
<td>141095</td>
</tr>
<tr>
<td>$X_3 \geq 1$</td>
<td>1</td>
<td>255356</td>
<td>255356</td>
</tr>
<tr>
<td>$X_4 \geq 1$</td>
<td>1</td>
<td>3830000</td>
<td>3830000</td>
</tr>
<tr>
<td>$X_5 \geq 0$</td>
<td>0</td>
<td>44800</td>
<td>0</td>
</tr>
<tr>
<td>$X_6 \geq 0$</td>
<td>0</td>
<td>4031500</td>
<td>0</td>
</tr>
<tr>
<td>$X_7 \geq 1$</td>
<td>1</td>
<td>251113</td>
<td>251113</td>
</tr>
<tr>
<td>$X_8 \geq 1$</td>
<td>2.656</td>
<td>243400</td>
<td>646470</td>
</tr>
<tr>
<td>$X_9 \geq 1$</td>
<td>1</td>
<td>293756</td>
<td>293756</td>
</tr>
<tr>
<td>$X_{10} \geq 1$</td>
<td>1</td>
<td>247833</td>
<td>247833</td>
</tr>
</tbody>
</table>

$X_8 \geq 1$ produce in $2.656 \times 243400$ Kgs. = 646470 Kgs.

Maximum profit (for all the five institutions) = Rs.66,921 lakhs
Model - IV

If change the maximum of raw materials and labour cost are Rs.1500 Lakhs and Rs.2000 Lakhs respectively. The following solutions were obtained for the same assumption (≥ 1).

Table - 8.5

Find the assumption number of Linear Programming

<table>
<thead>
<tr>
<th>Demand</th>
<th>Solution</th>
<th>Present production</th>
<th>Demand in production</th>
</tr>
</thead>
<tbody>
<tr>
<td>X, ≥ 1</td>
<td>1</td>
<td>627111</td>
<td>127111</td>
</tr>
<tr>
<td>X, ≥ 1</td>
<td>1</td>
<td>1410957</td>
<td>1410957</td>
</tr>
<tr>
<td>X, ≥ 1</td>
<td>1</td>
<td>255356</td>
<td>255356</td>
</tr>
<tr>
<td>X, ≥ 1</td>
<td>1</td>
<td>3830000</td>
<td>3830000</td>
</tr>
<tr>
<td>X, ≥ 0</td>
<td>0</td>
<td>44800</td>
<td>0</td>
</tr>
<tr>
<td>X, ≥ 0</td>
<td>0</td>
<td>4031500</td>
<td>0</td>
</tr>
<tr>
<td>X, ≥ 1</td>
<td>3.371</td>
<td>251113</td>
<td>251113</td>
</tr>
<tr>
<td>X, ≥ 1</td>
<td>1</td>
<td>293756</td>
<td>293756</td>
</tr>
<tr>
<td>X, ≥ 1</td>
<td>1</td>
<td>247833</td>
<td>247833</td>
</tr>
</tbody>
</table>

X, ≥ 1 produce in 3.371 X 243400 Kgs. = 820501 Kgs. of Village Industries products. Maximum Profit (Z) = 71.931 lakhs (All the five institutions)
8.6 Inference

As per model No.1, except Karur Sarvodaya Sangh other institutions are not economically viable. Even in Karur Sarvodaya Sangh, it is advised to give up Khadi work and concentrate more on V.I. production. The reasons for the rejection of other institutions as per the model No.1 are some of the following.

Profit maximisation is not the major objective in Khadi and Village Industries Sector. The above model may be alright with regard to corporate sector, where the major objective is maximisation of profit by reducing the cost of input. They can cut cost of raw materials by adding low quality of raw materials, or adding synthetic materials or other chemicals which is not close substitute for natural products which are normally costlier than the synthetic products. Further Khadi and Village Industries Sector mainly uses Agro-based raw materials which are perishable in nature and can not be stored for longer time. Some materials are to be purchased at the time of harvest and have to be stored, hence the carrying cost will escalate the cost of raw materials.

For example, butter is a natural product which is costlier than its close substitute margarine. Cardamom is costlier than the synthetic essence. Corporate sector go for substitute to
reduce the cost, but Khadi and Village Industries, can not refuse agro-based, natural products, just to reduce the cost.

In the case of labour, the Khadi and Village Industries institution can not introduce machines to replace labour. The main objective is to provide employment, whereas corporate sector, can easily introduce machines to cut the cost of labour. The above two inputs namely raw materials and labour constitute nearly 75% on value of production. Hence, as per Operation Research Techniques the above units are not to be viable. But two units (MNSS and KSS) are said to be viable even after the application of Operation Research Techniques, since they produce value added materials such as silk sarees etc.

Based on the above analysis, the following suggestions are made to make the Khadi and Village Industries viable without reducing employment.

1. Produce more value added materials.
2. Apply simple tools and machinery to increase the productivity without reducing employment.
3. Conduct market research, survey etc. to find out the behaviour of the consumer, and accordingly change the production pattern.
4. Slowly withdraw the Government support and try to make Khadi and Village Industries a self-reliant one.
5. Pay more attention on marketing the Khadi and Village Industries products under one common brand name, with the support of media for advertisement.

Model - II

In the model second, $X_i$ to $X_n > 1$ is applied and the result is favorable except $X_5$ $X_6$, relates to Gandhi Seva Sangam, Chatrapatti. As stated in the preceding chapter, the performance of this institution was not remarkable due to some administrative reasons. Other institutions are showing satisfactory result and the enhanced profit is 57.48 Lakhs.

Model - III

In the previous two models, factors such as cost of raw materials, labour, are not changed. In the present model, labour cost is changed and assumed to be 2000 lakhs. Karur Sarvodaya Sangh will produce 2.656 times of VI products, as it earns more profit. Other institutions can maintain the present level of production. The total profit in this model for all the five institutions will be Rs.66.921 lakhs.

Model - IV

In the model IV, both cost of raw materials and labour are increased to 1500, and 2000 lakhs respectively. The result
reveals that Karur Sarvodaya Sangh, will produce 3.371 time more of VI products and the total profit will be Rs.71.931 Lakhs.

In the present scenario of globalization, privatization, and stiff competition from corporate sector, the Khadi and Village Industries Sector may not be in a position to increase market network immediately. Further it cannot invest more on raw materials and labour as there is financial crisis. Hence it is suggested that the model No.II may be applied to Khadi and Village Industries Sector enabling them to earn profit of Rs.57.481 Lakhs without any additional investment.
End notes

