CHAPTER 1. INTRODUCTION

A. Operations Research : Art and Science

1. What is operations research?

   OR is a scientific approach to decision making that involves the activities/ operations of organizational systems.

   OR is sometimes called Management Science.

2. What are the outstanding characteristics of OR?

   a. OR's approach – scientific method : research

      OR's field of application – operations extensively applied in business, industry, military, civil government, hospitals.

   b. OR has a broad- organizational point of view.

      - It attempts to resolve the conflicts of interest among the components of the organization in a way that is best for the organization as a whole.

   c. OR's goal- to identify the best possible course of action.

3. The Art of Modelling

   An OR study consists in building a model of the physical situation. Since the real world is complicated, we only concentrate on the dominant variable that greatly influence the real world set up.

   The ' *assumed real world* ' is abstracted from the real situation by concentrating on the dominant variables that control the behavior of the real system.

DEFINITION:

A MODEL is an idealized/ simplified representation of the real world system in its relevant aspect.

Why do we prefer a substitute for the ' real thing' rather than the ' thing itself'?

Often, the motivation is economic – to save time, money, effort or some other valuable commodities. Sometimes the real world system of the real environment is so complicated that a representative model is needed just to understand it or to communicate with others about it.

TYPES OF OR MODELS

1. **Mathematical or symbolic** – all relevant variables are quantifiable.
2. **Simulation or heuristic** – 'imitates' the behavior of the system over a period of time.

CHAPTER II. LINEAR PROGRAMMING: FORMULATIONS AND SOLUTIONS

A. ***Concepts of linear programming***

NOTE: Linear programming is probably the best known and most widely – used branch of operations research.

DEFINITION:

Linear programming is planning of activities to obtain an optimal result.

It is a mathematical program in which the objective function is linear in the unknowns and the constraints consist of linear inequalities and linear equalities.

LINEAR: all mathematical functions are required to be linear (of degree 1)

PROGRAMMING: does not refer to computer programming but essentially a synonym for planning

B. Recommended Procedure for Linear Programming

1. Linear Programming Formulations

A general LP is given by

Max (Min) $d + c_1x_1 + c_2x_2 + c_3x_3 + \ldots + c_nx_n$

Such that

$ax1 + a_{i2}x_2 + \ldots + a_{in}x_n = b_i$, i=1,2,3,..., p

$a_ix_1 + a_{i2}x_2 + \ldots + a_{in}x_n \leq b_i$, i= p+1, ..., t

$a_ix_1 + a_{i2}x_2 + \ldots + a_{in}x_n \geq b_i$, i=t+1, ... ,n

$x_i \geq 0$, for all I where d_i , C_i's, a_ij's, b_is, are constants

Five Areas for which LP is now widely used;

a. BLENDING

In blending, several raw ingredients are mixed into a final product that must fulfill certain specifications. The objective is to determine the blend of ingredients that does not exceed available supply, meets all technical specifications, and minimizes costs.

b. DETERMINING PRODUCT MIX

In this problem, determine the kinds and quantities of products to be manufactured in order to maximize profit. The final product must take into consideration the limited resources, expected demand for each product.

c. PHYSICAL DISTRIBUTION AND ASSIGNMENT

This is the shipment of goods from supply points to warehouses or centers of customer demand. The problem is to determine the shipping pattern that minimizes shipping costs, meets all demand and does not exceed available supply. In assignment problems, the objective is to assign facilities or people to specified jobs in order to maximize performance or minimize costs or time.

d. PRODUCTION SCHEDULING AND INVENTORY PLANNING

Many firms produce products that are subject to fluctuations in demand. The problem is to determine a production schedule that meets anticipated demand and yet maintains reasonable inventory levels and minimizes the overall costs of production and carrying inventory.

GUIDE QUESTIONS:

1. How many decisions are to be made?
   ⇨ # of decision variables.
2. What is the objective function in terms of the decision variables?
3. On constraints and restrictions:
   What conditions must be satisfied? Watch out or budget constraints, limited supply of resources, minimum levels to be satisfied, upper bounds which must not be exceeded, etc.
4. Be conscious of units of measure involved at each stage of the formulation.
5. One last warning: What assumptions made the LP formulation valid?

EXAMPLE:

A farmer owns 400 hectares of land where he plans to raise two crops: rice and market vegetables. The problem is his limited supply of labor: only 6000 man-hours per week are available.

A hectare of rice uses up (to) 10 man-hours per week while a hectare of vegetables uses up to 40-man hours. However, rice nets PHP 150.00 per hectare while vegetable net PHP 200.00 per hectare. The farmer is free to decide how much hectare to devok to either crop, subject only to the labor and land, but a previous contract requires the farmer to plant at least half of the 400 hectares with rice.

Under these conditions, what options are available to the farmer? Which option is optimal in thr sense of maximizing total profits from the farm?

LINEAR PROGRAMMING ASSUMPTIONS

1. *CERTAINTY ASSUMPTION*

   Assume that the prices and production coefficients remain fixed throughout the optimization period.

   The farmers production is not subject to any chance fluctuations due to weather, human errors, price changes.
2. *NON NEGATIVITY ASSUMPTION*

   $X_I \geq 0$

3. *CONTINUITY ASSUMPTION*

We assume that the values of the variables can take any non-integer values. But if x_i's represent tractors, eggs. Fractional values will be meaningless. In this case, integer programming will be more applicable to solve it.

4. ***LINEARITY ASSUMPTION***

This may be divided into two:

a. Proportionality

If a hectare of rice uses 10 man hours, 2 hectares uses 20 man hours. In general, x_i hectares will use $10x_i$ man hours of labor, no more no less.

b. Additivity

The total profits from x_i hectares of rice and x_2 hectares of vegetables may be added