INTRODUCTION TO THE USE OF OPERATIONS RESEARCH TECHNIQUES IN MANAGEMENT DECISION MAKING

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ABSTRACT

This paper presents operational research (OR) science methods as veritable tools for management decision making in industries, military, government, etc. Operational research methods employ mathematical modeling or network diagram to assist management to arrive at decisions. The applications of operational research techniques are widespread, and have been responsible for increase in efficiency and productivity of business firms of different categories. The steps of operational research and its techniques are captured. Places of application of operations research in waste management are also presented.

KEYWORDS: Operations research, technique, mathematical modeling, network diagram.

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1. Introduction

Operational Research (OR) has been defined by various writers, each trying to explain the meaning of the subject matter. Operational Research is the use of mathematics (through modeling) to assist management arrive at decisions. Operational Research is a scientific approach to operational decision making[1]. What OR does is to present management with alternative solution to problems and to allow judgment to take place, employing sound mathematical and scientific ground rather than on the basis of experience and intuition.

Operational research science is the application of a scientific approach to solving management problems in order to help managers make better decisions[2]. The applications of operational research techniques are widespread, and have been responsible for increase in efficiency and productivity of business firms of different categories. We can also call operational research as operations research, management science, quantitative methods, qualitative analysis, and decision sciences.

Application of operational research include using it to solve problems in different organizations such as government, military, business and industry, health care and environment and in waste management.

1.1 The Nature of Operations Research

Operations Research is a problem solving technique based on the scientific method. It is more than just a collection of techniques. It involves a philosophy of approaching a problem in a logical manner like any other science. It is this philosophy of logical and consistent problem solving approach that is called the nature or process of operations research.

Operations research, or Operational research in British usage, is a discipline that deals with the application of advanced analytical methods to help make better decisions: It is often considered to be a sub-field of mathematics. The term management science and decision science are sometimes used as synonyms[3]. Employing techniques from other mathematical sciences, such as mathematical modeling, statistical analysis, and mathematical optimization, operations research arrives at optimal or near-optimal solutions to complex decision making problems. Operations research is often concerned with determining the maximum (of profit, performance, or yield) or minimum (of loss, risk, or cost) of real world objectives. Originally in military efforts before World War II, its techniques have grown to concern problems in a variety of industries. Operations research can also be said to be the application of scientific methods and techniques to decision-making problems. A decision making problem occurs where there are two

or more alternative courses of action, each of which leads to a different and sometimes unknown end result.

Operations research is also used to maximize the utility of limited resources. The objective is to select the best alternative, that is, the one leading to the best result. It could be a maximization case or minimization case.

1.2 Overview

Operational Research (OR) encompasses a wide range of problem-solving techniques and methods targeted at improved decision making and efficiency, such as simulation, mathematical optimization, queuing theory and other stochastic process models, Markov decision processes, econometric methods, data envelopment analysis, neural networks, expert systems, decision analysis, and the analytic hierarchy process. Almost all of these techniques involve the construction of mathematical models that attempt to describe the system. Due to the computational and statistical nature of most of these fields, OR also has strong ties to computer science and analytics.

2. Methodology

The success of operations research depends on the following six simply stated rules: (1) formulate the problem, (2) construct a model of the system, (3) select a solution technique, (4) obtain a solution to the problem, (5) establish controls over the system, and (6) implement the solution[4].

Initially, the first statement of the problem is usually vague and inaccurate. It may be a cataloging of observable effects. It is necessary to identify the decision maker, the alternatives, goals and constraints, and the parameters of the system. A statement of the problem properly contains four basic elements that, if correctly identified and articulated, greatly eases the model formulation. These elements can be combined in the following general form "Given (the system description), the problem is to optimize (the objective function), by choice of the (decision variable), subject to a set of (constraints and restrictions)".

In modeling the system, one usually relies on mathematics, although graphical and analog statement must be modified, and the sequence of problem-model-technique-solution-problem may have to be repeated several times. The controls one established by performing the sensitivity analysis on the parameters. This also indicates the areas in which the data collecting effort should be made.

Implementation is perhaps the least interest to the theorists, but in reality, it is the most important step. If direct action is not taken to implement the solution, the whole effort may end as a dust-collecting report on the shelf.

3. Steps Involved in Operations Research

Operations Research encompasses a logical, systematic approach to problem solving as shown in Figure 1.

The steps involved in operations research are:

1. Observation
2. Definition of problem
3. Model construction
4. Model Solution Testing the model and solution, and
5. Implementation of solution results and feedback.

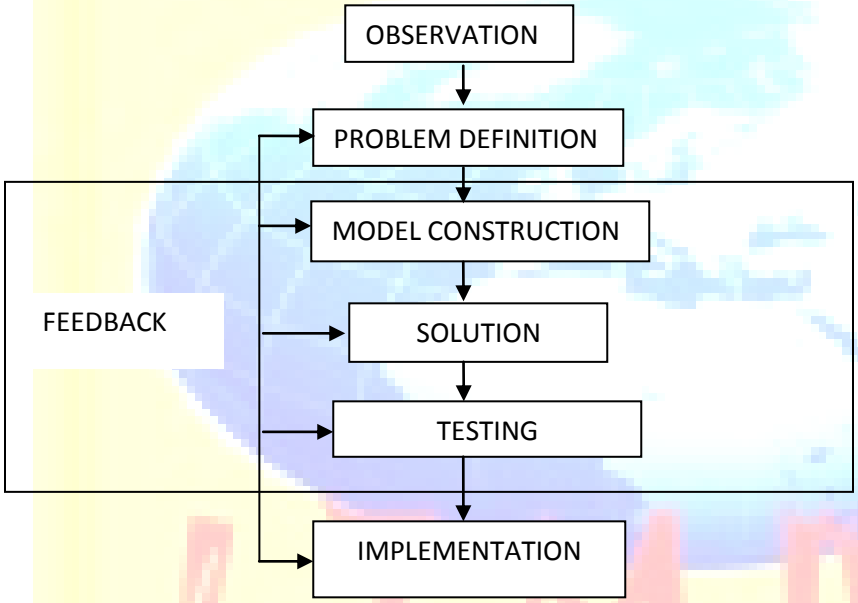

Fig. 1: Operations research processes

Observation: This involves the process of identification of the problem that exists in the system or organization.

Problem definition: This comes after problem identification. Problem definition includes a statement of the limits of the problem and its degree of occurrence as well as definition of the objectives of the organization.

Model construction: A set of mathematical relationships or equations is used to represent the existing problem. The models or relationships usually consist of decision variables, an objective function, and model constraints. The decision variables are mathematical symbols that represent levels of activity by the firm or industry. The objective function is a mathematical relationship that describes the objective of the firm in terms of the decision variables. It may be a

minimization or maximization function. The model constraints are also functions of the decision variables. These constraints represent the restrictions placed on the firm by the operating environment.

[5] and [6] gave conditions under which a problem will exist.

The conditions are:

- A decision maker who has objectives and goals to satisfy;
- Alternative solutions to the problem;
- Some doubt as to what the best alternative is; and
- Relevance of the problem solved to an environment.

Model Solution: After model construction, it is solved using appropriate operation research technique. The effectiveness of each technique is dependent on the nature of the problem. The valve of the decision variables is the major output from the solution.

Testing the Model and Solution: The model and solution can be tested by comparing the model solution with past data and comparing the actual system performance with that indicated by the models. The worth of the model is then indicated by the deviation indicated by this comparison. A positive deviation at reasonable cost will indicate that the model is good.

Implementation of Results: This is the last step. The information obtained is combined with the manager's own expertise and experience in making the ultimate decision. It is necessary to note that if the results are not implemented, then the resources utilized during the problem identification to the solution stage are wasted. Implementation involves training people who will execute the solution, planning for smooth transition from the old to the new system and checking the performance periodically until the new system is well established.

4. Techniques of Operations Research

The various techniques of operations research are illustrated in Figure 2.

As classified by [7], the Operations research techniques are summarized under the following major headings:

- Mathematical Linear Programming
- Probabilities techniques
- Inventory techniques
- Network techniques
- Others

Linear Mathematical Programming Techniques

They comprise of predetermined set of mathematical steps used to solve a problem. Here it is assumed that all parameters in the models are known with certainty. Hence, the solution results are assumed to be known with certainty. The techniques which assume certainty in their solutions are referred to as deterministic. The mathematical programming problem is linear if all the functional relationships in the model are linear.

Probabilistic Techniques

Here, the values of the parameters are not known with certainty. It is assumed that the parameters vary according to a certain probability distributions.

Inventory Techniques

Inventory analysis is very popular in operations research because all types of organizations have inventory. Inventory techniques are used to determine how much to order at one time and when to order this quantity in order to minimize total cost.

Network Techniques

These can either be probabilistic or deterministic. Here, the models are presented as diagram rather than strictly mathematical relationships. Network techniques are applied in project analysis. Projects as the construction of a building, the development of a drug, the installation of a computer system, or the construction of a drainage system can be developed as networks. These networks are used to illustrate the way in which the parts of the project are organized and to determine the time duration of the projects.

The network techniques used for project analysis are Critical Path Method (CPM) and Project Evaluation and Review Technique (PERT). These two techniques are basically identical except that PERT is a probabilistic technique while CPM is a deterministic technique.

Other Linear & Non-linear Techniques

- **Dynamic Programming Models:** They take into account the effects of decisions today on future time periods. Dynamic models are useful for processes that extend over a number of periods or events. It is a problem solution approach in which a problem is broken down into smaller sub-problems called stages, and then the stages are solved sequentially.

- **Break-even analysis or Profit Analysis:** Through this analysis, the number of units of a product to produce which will equate total revenue with total cost is determined. The point where this occurs (that is where profit is zero) is called the break-even point. It gives the manager a point of reference in determining how many units will be needed in order to make profit.

- **Calculus:** This could also be used to solve inventory problems. The use of calculus involves finding the partial derivatives of the objective function with respect to each of the decision variables and equating each equation to zero.
- **Non-linear Problems** are solved using calculus or classical optimization. Many problems encountered in practice can only be formulated by non-linear programming. Non-linear programming has the same general form as linear programming except that the objective function and/or the constraints are non-linear in form.

5. Application places in waste management

Mathematical programming is widely applied in waste management in the following areas:

i. Optimization of the efficiency of single treatment units and the operating conditions.
ii. Choice of treatment plants and the optimum sequence of operation.
iii. Choice of crew size for the operation of collection vehicles and assignment of collection vehicles to sanitation zones.
iv. Scheduling of routes for individual waste collection trucks.
v. Location of treatment facilities, transfer stations, and disposal sites.
vi. Choice of alternatives for least waste management cost and minimum environmental degradation.
vii. Least cost waste collection (Agunwamba et al, 2000).

6. Discussion and Conclusion

The effectiveness and efficiency of any management depends on that quality of decision taken on their different activities. Managers are often challenged by the alternative to choose from many for optimal solution. Operations research (OR) techniques are tools used by managers for optimal decision making. Mostly, OR tools use mathematical modeling while others use network diagrams. Also, some are deterministic while others are probabilistic in nature.

In conclusion, operations research, being a scientific method should be adopted by management of different organizations (banks, firms, industries, etc) in decision making to enable them arrive at desired optimal solution. The OR method/tool to be used at any point in time depends on problem to be tackled. The one that best suits the problem should be employed.

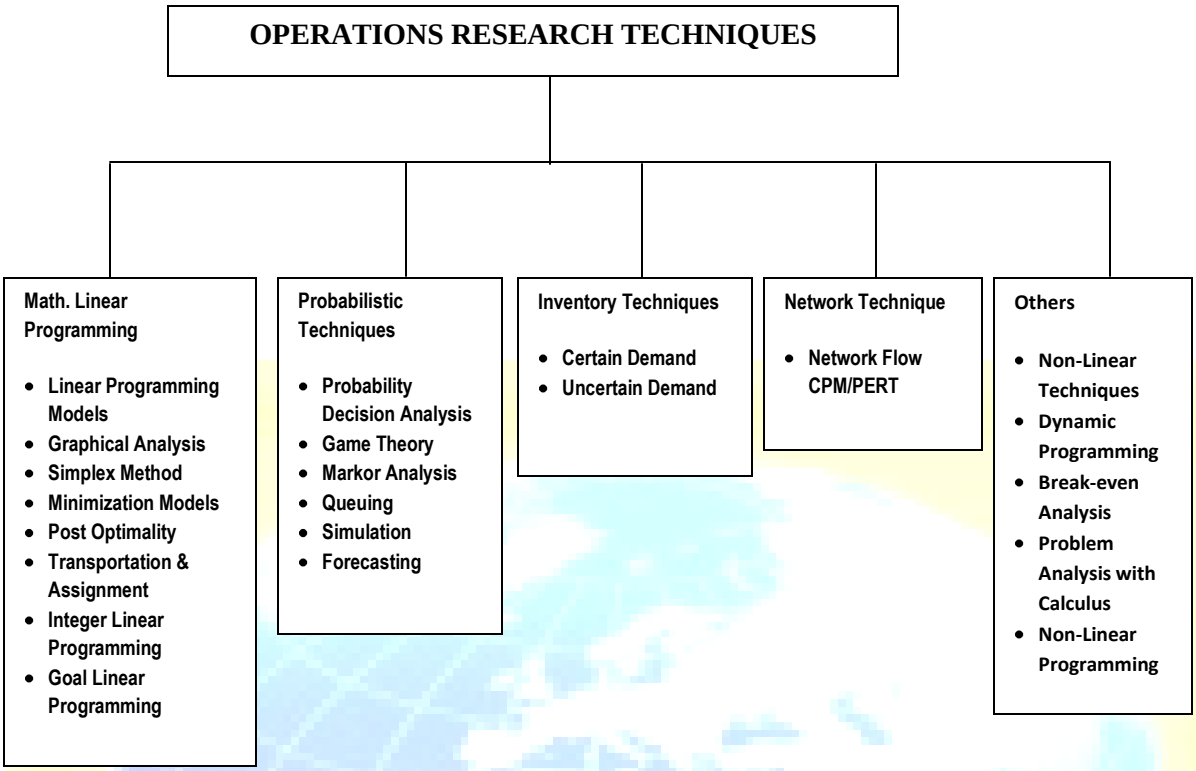

Fig 2: Operation Research Techniques [7]

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