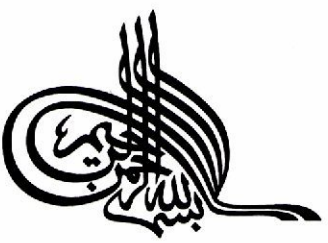

**IN THE NAME OF ALLAH,**
**THE GRACIOUS, THE MERCIFUL**

# Quantitative Analysis for Hospital and Health Administration

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This book is dedicated to

my loving mother, wife,

brothers, sisters and children:

AbdulRahman, Abdulilah, Nouf and Hyfa

## Acknowledgment

I would like to take the opportunity of releasing the second edition of this book to express my deep appreciation and thanks to my colleagues and students who provided me with their feedback on the first edition (1999). It was this feedback that caused the second edition to come out. I'm also grateful for the Department of Public Administration in King Saud University for the support to complete this book. Finally, I would like to thank the team at King Saud University Press for their patience, kindness and effort they made to publish the first and the second editions. I hope that readers will find this edition useful and helpful.

Badran Al-Omar
Riyadh
July 2005

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**PART TWO: NET WORK ANALYSIS**

# INTRODUCTION

Due to the rapid changes and cost increase in health services, shortage of certain health professionals (e.g. allied health specialists), and limited resources decision-making in hospital and health management has become more difficult and complicated. Hospital and health administrators should play a good leadership in responding to the health needs of the community within which the hospital operates. In many cases, decision-makers are faced with many alternatives and they must be able to select the correct choice that maximizes benefits and/or minimizes the costs. Therefore, today's hospital and health administrators need to learn the quantitative techniques available to rationalize their decision-making process. Quantitative analysis in health management is the utilization of the scientific management methods to study the consequences of decisions in complicated cases in the health field. It was developed to help the hospital and/or health administrator to derive effective solutions to health managerial problems and is an integral part of the field of Operations Research (OR).

In addition, OR techniques are also important for better operations within the health care organization by hospital and health administrators in a wide range of issues dealt with by hospital directors/managers, head nurses, head of laboratories, pharmacists, maintenance managers, cleaning staff, laundry managers, etc. Such techniques can help health managers at strategic administrative and operational level of management. Some examples of purposes served by OR techniques may encompass:

- Provide support for strategic and operational planning
- Improve the effectiveness and efficiency of hospital operations
- Improve the allocation of scarce resources
- Better evaluation of health programs and services
- Provide support for negotiations with outside groups (e.g. other health care providers or health insurance companies)
- Better evaluation of the outcomes of health services on the community served.

The above significant managerial issues can be performed with high efficiency if health and managerial information as well as quantitative techniques (such as OR techniques) are utilized correctly in the process of decision-making.

### Development of Operations Research

Operations Research (OR) started during World War II, in 1935, when the British military formed an interdisciplinary team of scientists to review the strategic and tactical problems facing its land and air defense. The goal of this team was to find the best use of the limited resources available to the military. The results of their work caused the UK to better utilize its scarce military resources, which was a deciding factor in the war's outcome.

This impressive performance encouraged the Americans to start similar military management activities. Because of the success achieved during the war, American industrial managers also started to seek the help of OR techniques.

Though the British started this field, the Americans further developed the techniques. For example, in 1947, the American George Dantzig created the first widely accepted technique of OR called 'the simplex method'. Since then, more OR techniques have been developed.

**What is OR?**

According to Burley and O'Sullivan (1986), OR has been defined by many organizations and scientists. In 1962, the British Operational Research Society defined it as:

> The application of the science to complex problems arising in the direction and management of large systems of men, machines, materials and money in industry, business, government and defense. The distinctive approach is to develop a scientific model of the system, incorporating measurements of factors such as chance and risk, with which to predict and compare the outcomes of alternative decisions, strategies or controls. The purpose is to help management determine its policy and actions scientifically.

In contrast, Wilkes (1987) stated that the OR definition according to the American Operations Research Society is "concerned with scientifically deciding how to best design and operate man-machine systems, usually under conditions requiring the allocation of scarce resources."

A definition that takes a wider view of OR is that of Sir Kendall, cited in Burley and O'Sullivan (1986). He wrote, "Operational research is a branch of philosophy; an attitude of mind towards the relationship between man and the environment; a body of methods for the solution of problems which arise in that environment."

It is clear in the above definition that OR is a set of methods for problem solving as well as a way of thinking about the surrounding world. In defining OR we must remember that Cook and Russell (1981) stated that OR "is an interdisciplinary field comprising elements of mathematics, economics, computer science, and engineering." They also added that OR is "the discipline devoted to studying and developing procedures to help in the process of making decisions."

From the above definitions we can also state that OR is concerned with the utilization of the scientific managerial techniques in order to enable hospital and health administrators to make good decisions.

**The OR modeling approach**

OR requires the hospital and health administrator, when faced with a managerial problem, to model the problem. This can be done by finding the essential features or relevant aspects of the situation and arranging them into a conceptual model that can be analyzed and solved. Therefore, the following steps must be followed in an OR study:

1) The administrator must examine and define the problem
2) Then he/she must extract the relevant or essential aspects from this problem
3) Next, a model that represents the problem needs to be constructed
4) Finally, the model needs to be evaluated:
   a. If there is no need for further refinement, the solution can be implemented.
   b. However, if there is a need for further refinement; the problem and/or the model needs to be re-examined.

## Types of Models in Management Science

As mentioned before, to have a good representation of the problem, the model must contain essential or key data of the problem. There are three types of models:

**Iconic model**
A real representation of the phenomenon under study, i.e. the model looks like the real object it represents. For example, an architect's scale model of a building to represent the actual hospital.

**Analog model**
This type of model replaces one characteristic or feature for another. One example is of graphs or histograms which because they represent numerical data pictorially, they are considered as analog models. Also a ruler is an analog model because it replaces real distances in the form of numerical values (for example, an inch can represent a mile).

**Mathematical or symbolic model**
Models of this type try to represent the phenomenon by mathematical figures (such as equations and symbols). Thus, a mathematical or symbolic model can be defined as "a formal structure that creates a framework with which a problem can be analyzed" (Cook and Russell, 1981). Among the mathematical models to be covered by this book are the Linear Programming techniques and Network Analysis.

## Main Topics Covered by the Book

This book covers several OR techniques that have been applied to managerial problems in hospitals and other health care organizations. This book takes the managerial viewpoint and is designed for use of undergraduates, graduates, specialist and/or practitioners in the health care administration. The techniques are:

**1. Linear programming (graphical and simplex method)**

Linear Programming (LP) is a handy technique for solving managerial problems that involve optimizing the objective of any health organization in light of the limited resources (constraints) available to the health organizations' managers. Such constraints are expressed in terms of linear inequalities and/or equations.

LP has been utilized in hospitals and other health organizations to solve problems about the best allocation of scarce resources, problems of scheduling of health staff and pharmaceutical production and consumption.

The benefits to be gained by applying the LP in the administration of health care organizations include:

1) Reduce the cost of health services
2) Maximize the volume of health service in light of limited resources
3) Determine the way through which the health organization achieves the highest benefits
4) Render the health services with the most efficient utilization of employees

**2. Resource assignment technique**

This technique is used to determine the best possible way to optimize work effectiveness by assigning jobs to staff members or machines, with the consideration of the variances exist between objects.

Resource assignment technique has been utilized in hospitals and other health organizations when there are limitations on the volume of available resources to be used; and when there are limitations in the distribution of available resources.

The benefits to be gained by applying this technique in the administration of health care organizations include:

1) Reduce the time (cost) spent in performing health services
2) Delegate health staff to tasks or machines

**3. Transportation technique**

This technique is an expansion of the basic resource assignment technique. In this technique any number of resources can be distributed to any number of destinations. It also allows the health administrators to distribute (allocate) part of one resource to more than one destination.

The technique has been used in hospitals and other health organizations when there is a need for re-allocation of the available sources from some sources to some destinations.

The benefits to be gained by applying this technique in the administration of health care organizations may include:

1) Reduce the time (cost) spent in transporting medicines from the various MOH's

warehouses to its pharmacies.

2) Re-allocate the medical tools from warehouses to hospitals with minimum cost.
3) Re-allocate some medical staff from specific areas to specific areas.

**4. Network analysis**

The main two network-oriented approaches to planning and controlling are the Project Evaluation and Review Technique (PERT) and the Critical Path Method (CPM). Both start with identifying a sequence of activities such as the treatment procedures for a given patient by several departments in a given hospital. They also identify the time estimates for each activity as well as the relationship among such activities. Next a network diagram is constructed to represent the relationships between the various activities.

In PERT three time estimates are identified for each activity, while just one time estimate is used in CPM approach. The goal of both is to identify the critical path that determines the health project (or the course of treatment) completion time. They allow the decision-maker to consider the reduction of the completion time of the project with its associated costs.

These techniques are normally used in the administration of health care organizations when considering programs such as:

1) Starting a new clinic or pharmacy,
2) Immunization program,
3) Opening a new ICU in a hospital, and
4) Performing a medical research project.