Second Edition

QUANTITATIVE METHODS IN HEALTH CARE MANAGEMENT

TECHNIQUES AND APPLICATIONS

Yasar A. Ozcan

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JOSSEY-BASS
A Wiley Imprint
www.josseybass.com

Published by Jossey-Bass
A Wiley Imprint
989 Market Street, San Francisco, CA 94103–1741—www.josseybass.com

Library of Congress Cataloging-in-Publication Data

Ozcan, Yasar A.
Quantitative methods in health care management : techniques and applications / Yasar A. Ozcan.—2nd ed.
p. ; cm.
Includes bibliographical references and index.
ISBN-13: 978-0-470-43462-8
ISBN-10: 0-470-43462-7
1. Health services administration—Statistical methods. 2. Health services administration—Decision making. 3 Health services administration—Methodology. I. Title.
[DNLM: 1. Health Services Administration. 2. Statistics as Topic. 3. Decision Making, Organizational. 4. Decision Support Techniques. 5. Models, Theoretical. WA 950 O99q 2009]
RA394.O98 2009
362.1072′7—dc22

2009001457

Printed in the United States of America
FIRST EDITION

PB Printing 10 9 8 7 6 5 4 3 2 1

CONTENTS

TABLES, FIGURES, & EXHIBITS

TABLES

FIGURES

EXHIBITS

To my wife, Gulperi, and my daughters, Gunes and Nilufer

FOREWORD

I would like to congratulate Professor Yasar Ozcan on producing this excellent, comprehensive textbook, *Quantitative Methods in Health Care Management.* The field has needed such a textbook for a very long time, and Professor Ozcan is eminently qualified in bringing it to us.

The last textbook in this area was written over twenty years ago. To all of us in health services research and management, we know that health care delivery today bears little resemblance to that era. So too, the use, types, and depth of quantitative methods and techniques have progressed greatly in this time period. Professor Ozcan brings us not only the latest and best methods and techniques, but also illustrates their uses through current cases and examples.

And what I like best about this textbook is that it has been written by one of the leading and most knowledgeable health care management professors in the world. Professor Ozcan has been at the forefront in developing and applying many of the methods in the book, and as founding editor of the journal *Health Care Management Science,* he draws on the latest knowledge available from other areas.

For those of us who teach quantitative methods in health care management courses, this book will make our task far easier. More importantly, it will provide our students with a comprehensive text that they can draw on in their health care management careers. In addition, this text is a welcome, comprehensive, and up-to-date addition to the work of current managers and to all those who say, "There must be a better way to deliver health care."

Indeed there is, and the application of the methods and ideas in this book will provide many, many answers.

William P. Pierskalla, Ph.D.
Distinguished Professor and Dean Emeritus,
The Anderson School, UCLA,
and Ronald Rosenfeld Professor Emeritus,
The Wharton School, University of Pennsylvania

ACKNOWLEDGMENTS

Writing this book could not have been achieved without the help and encouragement of many individuals. I take this opportunity to thank them; if I miss anyone, it is through authorial oversight only, as all the help received was deeply appreciated. First of all, I thank my colleague Ramesh K. Shukla, who provided valuable insights and material for the productivity chapter. Many thanks go to my graduate students from the MSHA Class of 2007 and MSHA Class of 2006 who received the first draft of the manuscript and pointed out many corrections. Similarly, graduate students from the MSHA Class of 2005 lent their real-life experiences with quantitative techniques and associated materials and data, which are used in the examples and exercises throughout the text. In that vein, more specifically, I thank Adrian Amedia, Joani Brough, Mark Cotter, Sandy Chung, Suzanne Coyner, Alan Dow, and Paulomi Sanyal for their resourcefulness.

I would like to acknowledge Dorothy Silvers for her diligent editing of the manuscript from cover to cover. I extend my sincere thanks as well to Jossey-Bass/Wiley staff members Andrew Pasternack and Seth Schwartz, for their cooperativeness and help in the production of this manuscript.

No book can be written on time without the support and encouragement of loved ones. I am indebted to my wife, Gulperi Ozcan, who became my sounding board for every example in this book. Moreover, she extended her support throughout the development of the manuscript even as I deprived her of my time in favor of my desktop. I thank her for the sustained support she has given me throughout my academic career and our personal life.

Yasar A. Ozcan, Ph.D.
May 15, 2008
Richmond, Virginia

THE AUTHOR

Yasar A. Ozcan, Ph.D. is a professor in the Department of Health Administration, Virginia Commonwealth University (VCU), where he has served as a faculty member for over thirty years. Dr. Ozcan teaches quantitative health care management courses in graduate professional programs in health administration, and methodology courses at the doctoral level. He has served twice as president of the Health Applications Section in the Institute of Operations Research and Management Science. Professor Ozcan is the founding Editor in Chief of a highly regarded journal, *Health Care Management Science,* and coeditor of the *Journal of Central Asian Health Services Research.*

Dr. Ozcan has been principal and co-principal investigator on various federal and state grants and contracts. He has also provided management consultancy services to health care facilities and managed care organizations.

Dr. Ozcan's scholarly work is in the areas of systems productivity, technical efficiency, financial efficiency, and effectiveness. Specifically, he has applied data envelopment analysis to measure efficiency across the range of health care facilities and practices, including hospitals, nursing homes, health maintenance organizations, mental health care organizations, physician practices, and other facilities. He has presented numerous papers in professional meetings and published extensively in these areas.

Dr. Ozcan has long been active in distance education, having taught quantitative techniques, the content of this book, both in the traditional and on-line graduate programs at VCU since 1988.

INTRODUCTION

This book is written to meet the need for a quantitative methods curriculum in health administration or health care management programs. It is designed so that it can be used for one-semester courses in graduate programs as well as for advanced undergraduate programs in health administration. Practical and contemporary examples from the field make it a useful reference book for health care managers, as well.

The quantitative techniques offered in this book are those more amenable to the health care management environment and those most frequently used. The second edition employs the use of Excel. Although the simpler examples are demonstrated in the text, their Excel solutions are also provided. As techniques increase in sophistication, as for example in queuing models, Excel template solutions are preferred to lengthy formulas and look-up tables. The second edition also incorporates *learning objectives* at the beginning of each chapter and *key terms* at the end of each chapter to facilitate the appropriate pedagogy for learning. Because the intent of the book is to make students into able users of quantitative methods for decision making, the interpretation of the results from hand-calculated or Excel solutions to guide for informed decision making is the foremost goal. Thus, students who have had basic algebra and introductory statistics courses should be able to follow the contents of this book.

The book has fifteen chapters including the introductory chapter. The presentation of quantitative techniques starts with forecasting, which provides the data for many of the other techniques discussed, as well as for planning in health care facilities. The chapter on decision making provides the decision techniques not only for single attribute decision theory, but also for the multi-attribute methods often used in health care management decisions, especially in evaluating new contracts or in requests for proposals.

Chapters Four and Five provide techniques for facility location and layout. The techniques discussed for layout also can be used to improve flows in facilities. Hence, in Chapter Six, reengineering is introduced as the means to identify bottlenecks in operational processes and to correct them. Chapters Seven and Eight cover staffing and resource scheduling management in health care facilities; surgical suite resource management is highlighted. These two chapters can be assigned and covered together in one session. Chapter Nine, on productivity, not only presents the traditional productivity concepts and their measurements in both inpatient and outpatient settings, but also discusses more contemporary methods of productivity measurements as conducted through data envelopment analysis.

Chapter Ten explains linear programming and its use in resource allocation. Furthermore, integer programming, an extension of linear programming, is discussed and illustrated for staff scheduling. Supply chain management in health care has become popular in recent decades, and the first part of Chapter Eleven discusses that; the second part of the chapter is devoted to traditional techniques for inventory management. Quality control, essential above all in health care, is discussed in Chapter Twelve. Types of control charts and their developments are illustrated. Several approaches to quality control, including total quality management, continuous quality improvement, and six-sigma, are discussed. The tools for quality improvement are presented.

Project management is the subject of Chapter Thirteen, where program evaluation and review technique/critical path method (PERT/CPM) techniques are discussed in detail, with examples of project compression. The last two chapters cover queuing and simulation techniques with emphasis on capacity decisions using those tools. Simple queuing methods are shown with detailed examples. More sophisticated ones are illustrated by Excel solutions.

The sequence of chapters has a certain logic. For example, in Chapter Four, the location of a new facility is identified; and in Chapter Five, layout of that facility can be explored. On the other hand, Chapter Five can be also used in an independent layout analysis for existing facilities to improve flow and productivity. Similarly, Chapters Six, Seven, Eight and Nine are built to feed the knowledge onward. Chapters Fourteen and Fifteen address capacity issues using different techniques. Regardless of this sequence, however, the chapters can be selected in any order and presented to students based on the professor's preferences.

Developing exercises for the techniques explained in each chapter has been a consuming task. Any errors and oversights in that process are solely mine. I will appreciate reader comments to improve or correct the exercises, as well as suggestions for incorporating additional material in future editions.

There are on-line resources to accompany this book. On-line resources (password protected) are available to professors who adopt the book and to the students. Professors' resources include PowerPoint lectures, solutions to exercises, prototype course syllabus, Excel templates, and additional exercises with solutions. Student resources include solutions to selected exercises, Excel templates, a subset of additional exercises with solutions, and other study guide materials. These resources can be accessed via www.josseybass.com/go/ozcan2e.

CHAPTER

1

INTRODUCTION TO QUANTITATIVE DECISION-MAKING METHODS IN HEALTH CARE MANAGEMENT

LEARNING OBJECTIVES:

- Recognize the quantitative techniques for decisions about delivering health care of high quality.
- Describe the historical background and the development of decision techniques.
- Describe the health care manager's role and responsibilities in decision making.
- Review the scope of health services and follow recent trends in health care.
- Describe health services management and distinct characteristics of health services.

In today's highly complicated, technological, and competitive health care arena, the public's outcry is for administrators, physicians, and other health care professionals to provide high quality care at a lower cost. Health care managers must therefore find ways to get excellent results from more limited resources. The goal of this book is to introduce aspiring health care managers to operations research models that allow decision makers to sort out complex issues and to make the best possible use of available resources. Such models are used, for example, to forecast patient demand, and to guide capital acquisition and capacity decisions, facility planning, personnel and patient scheduling, supply chain, and quality control. They use mathematical and statistical techniques: multivariate statistical analysis, decision analysis, linear programming, project evaluation and review technique (PERT), queuing analysis, and simulation, to name a few.

This book presents all these techniques from the perspective of health care organizations' delivery of care, rather than their traditional manufacturing applications. This chapter covers a brief historical background and the development of decision techniques and explains the importance of health care managers using these techniques. Finally, the scope, distinctive characteristics, and current trends of health services are emphasized. After reading this chapter, you should have a fair understanding of how important quantitative techniques are for decisions about delivering health care of high quality.

HISTORICAL BACKGROUND AND THE DEVELOPMENT OF DECISION TECHNIQUES

Beginning in the 1880s, the scientific management era brought about widespread changes in the management of the factories that had been created at an explosive rate during the Industrial Revolution. The movement was spearheaded by an efficiency engineer and inventor, Frederick Winslow Taylor, who is regarded as the father of modern scientific management. Taylor proposed a "science of management" based on observation, measurement, analysis, and improvement of work methods, along with economic incentives. He also believed that management's tasks are to plan, carefully select and train workers, find the best way to perform each job, achieve cooperation between management and workers, and separate management activities from work activities. Taylor's work was based on his idea that conflicts between labor and management occur because management has no idea how long jobs actually take. He therefore focused on time studies that evaluated work methods in great detail to identify the best way to do each job. Taylor's classic 1911 book, *The Principles of Scientific Management,* explained these guiding principles: (1) development of science for each element of work; (2) scientific selection and training of workers; (3) cooperation between management and employees; and (4) responsibility shared equally between workers and management (Taylor, 1911). Other early contributors to scientific methods of management were Frank and Gillian Gilbreth, who worked on standardization, and Henry Gantt, who emphasized the psychological effects that work conditions have on employees—he developed a time-based display chart to schedule work. Quantitative inventory management was developed by F. W. Harris in 1915. In the 1930s, W. Shewhart and associates developed