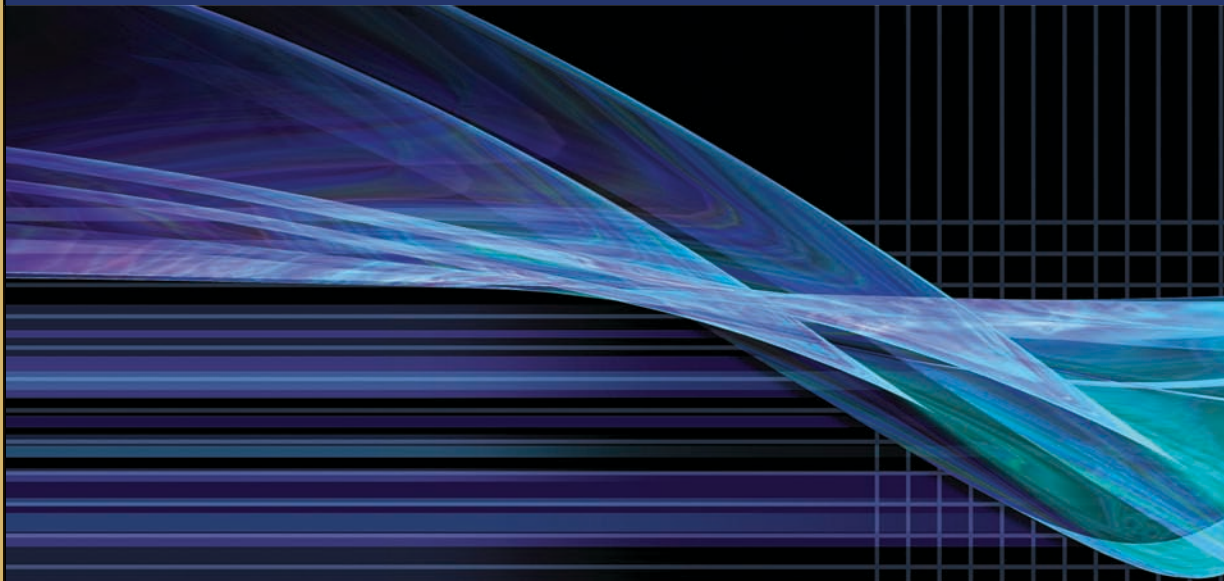


Second Edition

# QUANTITATIVE METHODS IN HEALTH CARE MANAGEMENT

**TECHNIQUES AND APPLICATIONS**



**Yasar A. Ozcan**



# QUANTITATIVE METHODS IN HEALTH CARE MANAGEMENT



# QUANTITATIVE METHODS IN HEALTH CARE MANAGEMENT

Techniques  
and Applications

*Second Edition*

**YASAR A. OZCAN**

 **JOSSEY-BASS**  
A Wiley Imprint  
[www.josseybass.com](http://www.josseybass.com)

Copyright © 2009 by John Wiley & Sons, Inc. All rights reserved.

Published by Jossey-Bass

A Wiley Imprint

989 Market Street, San Francisco, CA 94103-1741—www.josseybass.com

No part of this publication may be reproduced, stored in a retrieval system, or transmitted in any form or by any means, electronic, mechanical, photocopying, recording, scanning, or otherwise, except as permitted under Section 107 or 108 of the 1976 United States Copyright Act, without either the prior written permission of the publisher, or authorization through payment of the appropriate per-copy fee to the Copyright Clearance Center, Inc., 222 Rosewood Drive, Danvers, MA 01923, 978-750-8400, fax 978-646-8600, or on the Web at [www.copyright.com](http://www.copyright.com). Requests to the publisher for permission should be addressed to the Permissions Department, John Wiley & Sons, Inc., 111 River Street, Hoboken, NJ 07030, 201-748-6011, fax 201-748-6008, or online at [www.wiley.com/go/permissions](http://www.wiley.com/go/permissions).

Readers should be aware that Internet Web sites offered as citations and/or sources for further information may have changed or disappeared between the time this was written and when it is read.

**Limit of Liability/Disclaimer of Warranty:** While the publisher and author have used their best efforts in preparing this book, they make no representations or warranties with respect to the accuracy or completeness of the contents of this book and specifically disclaim any implied warranties of merchantability or fitness for a particular purpose. No warranty may be created or extended by sales representatives or written sales materials. The advice and strategies contained herein may not be suitable for your situation. You should consult with a professional where appropriate. Neither the publisher nor author shall be liable for any loss of profit or any other commercial damages, including but not limited to special, incidental, consequential, or other damages.

Jossey-Bass books and products are available through most bookstores. To contact Jossey-Bass directly call our Customer Care Department within the U.S. at 800-956-7739, outside the U.S. at 317-572-3986, or fax 317-572-4002.

Jossey-Bass also publishes its books in a variety of electronic formats. Some content that appears in print may not be available in electronic books.

### *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

<b>Tables, Figures, &amp; Exhibits</b>	<b>ix</b>
<b>Foreword</b>	<b>xix</b>
<b>Acknowledgments</b>	<b>xxi</b>
<b>The Author</b>	<b>xxiii</b>
<b>Introduction</b>	<b>xxv</b>
<b>1 INTRODUCTION TO QUANTITATIVE DECISION-MAKING METHODS IN HEALTH CARE MANAGEMENT</b>	<b>1</b>
Historical Background and the Development of Decision Techniques	2
The Health Care Manager and Decision Making	3
Information Technology (IT) and Health Care Management	3
The Scope of Health Care Services, and Recent Trends	4
Health Care Services Management	6
Distinctive Characteristics of Health Care Services	6
Summary	9
Key Terms	9
<b>2 FORECASTING</b>	<b>11</b>
Steps in the Forecasting Process	12
Forecasting Approaches	13
Summary	44
Key Terms	44
Exercises	45
<b>3 DECISION MAKING IN HEALTH CARE FACILITIES</b>	<b>51</b>
The Decision Process	52
The Decision Tree Approach	66

Decision Analysis with Nonmonetary Values and Multiple Attributes	68
Summary	73
Key Terms	73
Exercises	73
<b>4 FACILITY LOCATION</b>	<b>81</b>
Location Methods	83
Summary	99
Key Terms	99
Exercises	99
<b>5 FACILITY LAYOUT</b>	<b>103</b>
Product Layout	104
Process Layout	105
Summary	116
Key Terms	116
Exercises	116
<b>6 REENGINEERING</b>	<b>121</b>
Work Design in Health Care Organizations	123
Summary	155
Key Terms	155
Exercises	155
<b>7 STAFFING</b>	<b>161</b>
Workload Management Overview	162
Summary	182
Key Terms	182
Exercises	182
<b>8 SCHEDULING</b>	<b>187</b>
Staff Scheduling	187
Summary	202
Key Terms	202
Exercises	203



<b>9</b>	<b>PRODUCTIVITY</b>	<b>205</b>
	Trends in Health Care Productivity: Consequences of PPS	206
	Summary	231
	Key Terms	231
	Exercises	232
<b>10</b>	<b>RESOURCE ALLOCATION</b>	<b>237</b>
	Linear Programming	237
	Summary	258
	Key Terms	258
	Exercises	258
<b>11</b>	<b>SUPPLY CHAIN AND INVENTORY MANAGEMENT</b>	<b>263</b>
	Health Care Supply Chain	263
	Summary	285
	Key Terms	285
	Exercises	285
<b>12</b>	<b>QUALITY CONTROL</b>	<b>289</b>
	Quality in Health Care	289
	Quality Measurement and Control Techniques	296
	Summary	318
	Key Terms	320
	Exercises	320
<b>13</b>	<b>PROJECT MANAGEMENT</b>	<b>327</b>
	The Characteristics of Projects	328
	Summary	353
	Key Terms	354
	Exercises	354
<b>14</b>	<b>QUEUING MODELS AND CAPACITY PLANNING</b>	<b>365</b>
	Capacity Analysis and Costs	382
	Summary	384
	Key Terms	386
	Exercises	386

<b>15</b>	<b>SIMULATION</b>	<b>395</b>
	Simulation Process	395
	Performance Measures and Managerial Decisions	406
	Summary	408
	Key Terms	408
	Exercises	408
<b>APPENDIXES</b>		
	<b>Appendix A Standard Normal Distribution <math>P(0 &lt; z &lt; x)</math></b>	<b>411</b>
	<b>Appendix B Standard Normal Distribution <math>P(-3.5 &lt; z &lt; 3.5)</math></b>	<b>413</b>
	<b>Appendix C Cumulative Poisson Probabilities</b>	<b>416</b>
	<b>Appendix D t Distribution</b>	<b>423</b>
	<b>References</b>	<b>425</b>
	<b>Index</b>	<b>429</b>

# TABLES, FIGURES, & EXHIBITS

## TABLES

1.1.	Total Expenditures on Health as % GDP for 30 OECD Countries	4
1.2.	Distribution of Health Providers and Health Workers in Health Services in 2006, and Expected Growth	5
1.3.	Health Services by Occupation in 2006, and Projected Growth	7
2.1.	Heal-Me Hospital Average Daily Patient Days	35
2.2.	Quarterly Indexes for Heal-Me Hospital	37
2.3.	Monthly Indexes for Heal-Me Hospital	37
2.4.	Daily Indexes for Heal-Me Hospital	38
2.5.	Monthly and Daily Adjusted Forecasts for Heal-Me Hospital	40
2.6.	Error Calculations	41
3.1.	Payoff Table	55
3.2.	Demand for Additional MRIs	56
3.3.	Maximin Solution	57
3.4.	Maximax Solution	57
3.5.	Sensitivity Analysis Using Hurwitz Optimism Parameters	59
3.6.	Opportunity Losses (Regrets)	59
3.7.	Laplace Strategy	60
3.8.	Payoff Table for EMV	63
3.9.	Expected Opportunity Loss	63
3.10.	Best Outcomes Under Certainty	65
3.11.	Total Cost of Alternatives Under Various Demand Conditions	65
3.12.	Regret Table Using Costs	66
3.13.	Summary of Supplier Proposals	71
4.1.	Factors to be Considered in Establishing a Satellite Clinic	87
4.2.	Relative Scores on Factors for a Satellite Clinic	89
4.3.	Relative Factor Scores and Weights	89
4.4.	Composite Scores	90

4.5.	Satellite Clinic Factor Rankings and Minimum Acceptable Levels	91
4.6.	Satellite Clinic Factor Minimum Acceptable Levels	93
4.7.	Satellite Clinic Factor Importance Rankings	93
4.8.	Selected Richmond Metropolitan Area Hospitals	95
4.9.	Selected Richmond Metropolitan Area Hospitals and Their Interaction with the Blood Bank	96
5.1.	Distance and Flows Among Three Hospital Departments	112
5.2.	Possible Assignment Configurations of Departments to Three Locations	113
5.3.	Ranking Departments According to Highest Flow	113
5.4.	Total Cost of a Layout	114
6.1.	Typical Allowance Percentages for Varying Health Care Delivery Working Conditions	131
6.2.	Observed Times and Performance Ratings for Nursing Unit Activities	133
6.3.	Observed and Normal Time Calculations for Nursing Unit Activities	134
6.4.	Abridged Patient Care Tasks in a Nursing Unit	136
6.5.	Work Sampling Data Collection Form for Nursing Unit	137
6.6.	Random Numbers	141
6.7.	Development of the Schedule for a Work Sampling Study	143
6.8.	Final Work Sampling Schedule	144
6.9.	Partial Work Distribution Chart for Nursing Unit	144
7.1.	Examples of Work Standards	164
7.2.	Daily Census, Required Labor Hours, and Acuity Level Statistics for a Medical or Surgical Floor	168
7.3.	Average Census, Required Labor Hours, and Acuity Level Statistics for a Medical or Surgical Floor	169
7.4.	Weighted Average Utilization for a Laboratory Based on Workload Fluctuations by Shift	172
7.5.	Workload Standards for Microscopic Procedures in Laboratory	173
7.6.	Calculation of Staffing Requirements for Microscopic Procedures	174
7.7.	The Effect of Shift Alternatives on Staffing—The Coverage Factor	177
10.1.	Nurse Scheduling with Integer Programming	257
11.1.	A-B-C Classification Analysis	275
12.1.	Factors for Determining Control Limits for Mean and Range Charts (for Three-Sigma or 99.7 Percent–Confidence Level)	307

13.1.	Activity Precedence Relationships	332
13.2.	Path Lengths for the Radiation Oncology Project	335
13.3.	Probabilistic Time Estimates for Radiation Oncology Clinic	341
13.4.	Calculation of Expected Time and Standard Deviations on Each Path for the Radiation Oncology Clinic	342
13.5.	Path Completion Probabilities	344
13.6.	Project Completion Probabilities	346
14.1.	Summary Analysis for M/M/s Queue for Diabetes Information Booth	385
15.1.	Simple Simulation Experiment for Public Clinic	396
15.2.	Summary Statistics for Public Clinic Experiment	397
15.3.	Patient Arrival Frequencies	399
15.4.	Probability Distribution for Patient Arrivals	400
15.5.	Cumulative Poisson Probabilities for $\lambda = 1.7$	401
15.6.	Cumulative Poisson Probabilities for Arrivals: $\lambda = 1.7$	402
15.7.	Monte Carlo Simulation Experiment for Public Health Clinic	403
15.8.	Summary Statistics for Public Clinic Monte Carlo Simulation Experiment	405

## FIGURES

2.1.	Seasonal Variation Characteristics	15
2.2.	Cycle Variation	15
2.3.	Random Variation and Trend	15
2.4.	Excel Template Solution: Moving Average ( $MA_3$ ) for OB/GYN Clinic	17
2.5.	Excel Template Solution: Weighted Moving Average ( $WMA_3$ ) for OB/GYN Clinic	20
2.6.	Excel Template Solutions to the OB/GYN Example, Using Single Exponential Smoothing (SES) with $\alpha = 0.3$ and $\alpha = 0.5$	22
2.7.	Excel Template Solutions to the OB/GYN Example, Using Single Exponential Smoothing (SES) with $\alpha = 0$ and $\alpha = 1.0$	24
2.8.	Linear Regression	25
2.9.	Excel Setup – Linear Regression for the Multihospital System Example	27
2.10.	Excel Solution to the Multihospital System Example	28
2.11.	Linear Regression as a Trend	29
2.12.	Excel Linear Trend Graphic Solution to the OB/GYN Example	30

2.13.	Excel Template Solution to the OB/GYN Example	30
2.14.	Excel Template – SEST Solution to Example 2.9	33
2.15.	Seasonality-Removed Trend Data for Heal-Me Hospital Patient Demand	39
2.16.	Alternative Forecasting Methods and Accuracy, Measured by MAD and MAPE	42
2.17.	Linear Trend with Tracking Signal for Patient Visit Forecast, Heal-Me Hospital	43
2.18.	Tracking Signal for Patient Visit Forecast, Heal-Me Hospital	44
3.1.	Decision Tree	67
3.2.	Rollback Method	68
3.3.	Payoff Table Analysis Using Excel Template for Decision Analysis	69
3.4.	Decision Tree and Rollback Procedure Using Excel Template for Decision Analysis	70
4.1.	Total Cost of Alternative Imaging Sites	85
4.2.	Profit Evaluation of Alternative Sites	86
4.3.	Richmond Metropolitan Area Hospitals	94
4.4.	Richmond Metropolitan Area Blood Bank Locations	97
4.5.	Geographic Information Systems	98
5.1.	Available Space for Layout of Long-Term Care Facility	106
5.2.	Closeness Rating Chart for Long-Term Care Facility	107
5.3.	A and X Closeness Representation	108
5.4.	Layout Solution	108
5.5.	Excel Template Solution	115
5.6.	Excel Template Solution and Final Layout for a Small Hospital	115
6.1.	Work Design—A Systems Perspective	124
6.2.	Socio-Technical School Approach	127
6.3.	Random Observation Schedule	147
6.4.	Stabilized Dates and Times	148
6.5.	Valid Dates and Times	149
6.6.	Final Observation Schedule	150
6.7.	Flow Process Chart for Emergency Room Specimen Processing	152
6.8.	Commonly Used Flow Chart Symbols	153
6.9.	Flow Chart for Emergency Room Specimen Processing	154
7.1.	Workload Management	163

7.2. Distribution of Daily Workload on a Nursing Unit	178
7.3. Workload Standard Tolerance Ranges	180
8.1. Comparison of Eight- and Ten-Hour Shifts	189
8.2. Pattern of Alternating Eight- and Twelve-Hour Shifts	190
9.1. Productivity and Quality Trade-Off	223
9.2. Substitution of Physicians and Nurse Practitioners: A Look at Technical Efficiency	226
9.3. Example of DEA Efficiency Frontier Formulation	229
10.1. Graphic Solution for Insurance Company Problem	242
10.2. Excel Setup for the Insurance Company Problem	243
10.3. Excel Solver	244
10.4. Identifying Constraints and Solution Cells	244
10.5. Selection of Solution Reports	245
10.6. Answer Report	246
10.7. Sensitivity Report	247
10.8. Limits Report	248
10.9. Graphic Explanation of Sensitivity Analysis: Shadow Price and its Impact on Alternative Optimal Solutions	249
10.10. Graphic Solution for Minimization Example	250
10.11. Excel Setup for the Minimization Problem	251
10.12. Solution to the Minimization Problem	251
10.13. Minimization Problem Answer Report	252
10.14. Minimization Problem Sensitivity Report	252
10.15. Minimization Problem Limits Report	253
10.16. Integer Programming: Excel Setup for the Staff Scheduling Problem	255
10.17. Identifying Constraints and Integer Values	255
10.18. Solution to the Staff Scheduling Problem	256
10.19. Answer Report for the Staff Scheduling Problem	256
11.1. Health Care Supply Chain	264
11.2. The Inventory Order Cycle for Basic EOQ Model	276
11.3. The Economic Ordering Quantity Model	277
11.4. Excel Solution to the Syringe Problem	282
11.5. Multi-Item Inventory EOQ and ABC Analysis	283
12.1. Quality Measurement	290
12.2. The Deming Wheel/Shewhart Cycle	294

12.3.	Process Capability	297
12.4.	Control Limits, Random and Nonrandom Sample Observations	299
12.5.	ABC Medical Center Infection Control Monitoring	301
12.6.	Holistic Care Corporation's Quality Monitoring	304
12.7.	Use of Mean and Range Charts	305
12.8.	Identification of Runs	310
12.9.	Zone Test	313
12.10.	A Check Sheet and Corresponding Histogram for Emergency Room Wait Times	316
12.11.	Scatter Diagram	317
12.12.	A Flow Chart for the X-Ray Order Process in an Emergency Department	318
12.13.	Cause-and-Effect Diagram	319
12.14.	Pareto Diagram	319
13.1.	Network Representations	333
13.2.	AON Network Diagram for Radiation Oncology	334
13.3.	Activity Start and Finish Times	336
13.4.	Excel Setup and Solution to the Radiation Oncology Project, CPM Version	338
13.5.	Project Completion Probabilities by the Specified Time	343
13.6.	Completion Probabilities for Sixty-Five Weeks	344
13.7.	Excel Setup and Solution to the Probabilistic Radiation Oncology Project	345
13.8.	Project Duration and Compression (Crashing) Costs	348
13.9.	Project Compression	349
13.10.	Total Cost of Compression	353
14.1.	Queue Phenomenon	366
14.2.	Health Care Service Capacity and Costs	367
14.3.	Queuing Conceptualization of Flu Inoculations	368
14.4.	Conceptualization of a Single-Line, Multiphase System	369
14.5.	Multiple-Line Queuing System	370
14.6.	Emergency Room Arrival Patterns	371
14.7.	Measures of Arrival Patterns	372
14.8.	Poisson Distribution	373
14.9.	Service Time for ER Patients	373



14.10.	Excel Setup and Solution to the Diabetes Information Booth Problem	379
14.11.	System Probability Summary for Diabetes Information Booth	380
14.12.	System Performance for Expanded Diabetes Information Booth	382
14.13.	System Performance Summary for Expanded Diabetes Information Booth with M/M/3	383
14.14.	Capacity Analysis	385
15.1.	Random Numbers	401
15.2.	Excel-Based Simulated Arrivals	406
15.3.	Excel Program for Simulated Arrivals	407
15.4.	Performance-Measure-Based Managerial Decision Making	407

## EXHIBITS

5.1.	From-To Chart for a Small Hospital	111
8.1.	Cyclical Staffing Schedules for Four and Five Weeks	192
8.2.	An Example of OR Block Schedule: Surgical Suite Scheduling Method	199
13.1	Gantt Chart for Launching a New Radiation Oncology Service	331
14.1	Queuing Model Classification	374
14.2	Queuing Model Notation	376



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](http://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.

## 2 Quantitative Methods in Health Care Management: Techniques and Applications

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