RESEARCH
AND
EVALUATION
FOR Business

MARILYN K. PELOSI

THERESA M. SANDIFER

UMA SEKARAN

RESEARCH AND EVALUATION FOR BUSINESS

MARILYN K. PELOSI, PH.D.
Western New England College
Springfield, MA

THERESA M. SANDIFER, PH.D.
Southern Connecticut State University

UMA SEKARAN, PH.D.
Southern Illinois University at Carbondale

This book was set in New Baskerville by Progressive Information Technologies and printed and bound by Courier Companies. The cover was printed by Lehigh Press.

This book is printed on acid-free paper. ∞

PREFACE

OUR GOALS IN WRITING THIS BOOK

Welcome to *Research and Evaluation for Business!* This text was created specifically for your course at the University of Phoenix.

The goal of the text is simple—to introduce statistics in the context of business research. We believe that statistics is best understood by doing it and using it. Introducing business statistics in the context of research will allow you a greater understanding of the role of statistics and why one might want to use it.

Thus, the pedagogical focus of *Research and Evaluation for Business* is data driven, emphasizing statistical reasoning, interpretation and decision making. We want to teach the "practice" of statistics; therefore, the emphasis is on comparison and interpretation rather than rote calculation. To support this approach we include discussions of practice as opposed to theory. For example, we discuss when it is OK to be in violation of an assumption and what to watch out for in applying techniques. In order to focus on decision making, the use of the computer is emphasized to keep students from getting bogged down in the details of the calculations.

All the cases found in *Research and Evaluation for Business* are based on real business situations and data that are relevant. Most chapters begin with a motivating example based on real-world data. This example is then threaded throughout the chapter and to a lesser extent throughout the book. The data used in many of the examples and exercises are based on our consulting experiences. In order to protect the confidentiality of the companies involved, the data may be rescaled or altered, which does not hinder the usefulness of the data from a pedagogical perspective.

We have adopted a conversational tone so that students may learn the material using vocabulary that is familiar to them. The explanations have an *informal* flavor in order to allow the student to see that the techniques make logical sense. When necessary, we deviate from "pure" mathematics in the interest of understanding, being sure to note when this occurs. The student should see *why* and *how* the technique works. With this kind of understanding, students will know *what* technique to use and *when* to use it.

This book is intended for use in a two-semester introductory business research statistics course. Each workshop is marked with a title page listing the chapters to be covered in that workshop.

KEY FEATURES OF OUR ACTIVITY-BASED LEARNING APPROACH

In writing this book, we reflected on our many years of teaching experience and examined how people learn new things. The pedagogical features which follow repre-

sent the activity-based model we have developed over the years in our own class-rooms. We have found that students . . .

• Learn by Trying

Try It Now! Exercises are checkpoints embedded in the text, with spaces provided for students to do them, making sure that they understand the basics before moving on.

TRY IT NOW!

The Glue Company
Selecting a Simple Random Sample

Select a sample of 5 tubes of glue for the glue company. You can assume that each tube of glue has a 5-digit ID number, which the company uses to track its inventory.

Answers are right there (upside down) so that students will have immediate feed-back.

• Learn by Practicing

Learning It! Exercises allow students to practice the basics of computation and include all the techniques covered in the chapter.

2.2.5 Exercises—Learning It!

2.1 The President of the United States wishes to see how popular he/she is after 2 years in office.
  (a) What is the population of interest?
  (b) Identify which of the reasons for taking a sample (listed on page 24) apply in this case. (There are more than one.)
  (c) Identify two variables or characteristics of the members of this population that you may wish to study.

Thinking About It! Exercises emphasize critical thought and ask students to interpret the results of statistical techniques and make decisions based on their analysis.

Thinking About It!

1.1 We have said that quality and statistics go hand in hand. What product or service have you used recently that did not have the quality you thought it should have?
  (a) Describe the product or service and the area in which it was lacking in quality.
  (b) What corrective action would you recommend?

1.2 Describe a situation in which you had a paradigm shift or change.

Doing It! Exercises use large real-world data sets and ask students to per-form the statistical analyses and interpret them to solve a real problem. As students progress in their statistical thinking, these exercises will help them to make judg-ments about "what to do next." The data sets for these exercises are provided on the accompanying CD-ROM in Excel v 4.0 worksheet format.

Doing It!

6.46 The company investigating the golf balls is not satisfied with the limited analysis that it has done. The managers have collected a good deal of data, but they are not sure how to look at them and interpret the output. They decide to hire you to help them understand what the golf balls are doing and how they compare to each other. In addition to measures of the balls' performance, such as the variable *Carry*, the managers know that other factors, both internal (ball-related) and external (environment-related), could affect performance. They tested 36 of each type of ball at three different times using a machine to launch the balls. Data were recorded on 14 different variables. A portion of the data is shown below:

Ball	Model	S1	S2	S3	Wgt	Dw	Dd	Head	Temp	Carry	Tot Dist	Date	Time
1	M1	81	81	82	45.3	0.145	0.0110	686	77	257	270	8/20	8:15
2	M1	83	83	84	45.2	0.151	0.0111	688	77	255	267	8/20	8:15
3	M1	81	82	84	45.2	0.145	0.0105	687	77	256	267	8/20	8:15
4	M1	81	81	83	45.3	0.144	0.0117	688	77	255	271	8/20	8:15
5	M1	83	81	82	45.5	0.146	0.0108	687	77	255	268	8/20	8:15

• Learn by Using the Computer

We have chosen Microsoft Excel because it is the leading analytical software used in the business world. There is a greater chance that students will practice statistical thinking if we show them how to do statistics in a software package that is most likely to be on their desktop at home or at work.

6.7.1 Calculating Summary Statistics in Excel

Suppose that we want to calculate a set of summary statistics for the Golf Ball data. Figure 6.9 shows a portion of that data in an Excel worksheet.

The Data Analysis ToolPak has a function that creates a set of summary statistics for a set of data. To access this function, select **Data Analysis** from the **Tools** menu and choose **Descriptive Statistics** from the list of Analysis tools. The dialog box is

Ball#	Model #	Head	Temp	Carry	Tot Dist	Date	Time
1	M1	686	77	257	270	8/20	8:15
2	M1	688	77	255	267	8/20	8:15
3	M1	687	77	256	267	8/20	8:15
4	M1	688	77	255	271	8/20	8:15
5	M1	687	77	255	268	8/20	8:15
6	M1	687	77	256	267	8/20	8:15
7	M1	687	77	255	264	8/20	8:15
8	M1	690	78	258	269	8/20	8:15
9	M1	686	78	255	257	8/20	8:15
10	M1	687	78	256	268	8/20	8:15
11	M1	687	78	255	263	8/20	8:15

FIGURE 6.9 The golf ball data

When appropriate, the final section of each chapter describes how to implement the techniques taught in the chapter in Excel. In some instances Excel has built-in features to do the necessary statistical calculations. The sections at the end of each chapter walk students through each step in using these features. While Excel does not perform all of the statistical functions found in the text, we have developed some macros to do these calculations. Macros are included on the accompanying CD-ROM and the text explains how to use them.

If students are not familiar with using Excel, we have included a short introduction to the basics in Appendix B.

• Learn by Discovery

In the process of trying things, we often discover ideas that eventually lead to understanding. Within most of the chapters students will find *Discovery Exercises*. These exercises are written to achieve a high level of student understanding by directing their line of thinking, leading to an "aha" discovery of a key concept. They are designed to help students see that statistical thinking within research is logical and that the formulas make sense when students discover where they came from and see why they work.

Discovery Exercise 2.2
INTRODUCTION TO SAMPLING

Suppose the data shown below represent an entire population. They show the number of people in 50 families living in a small college town in New England. (If you did Discovery Exercise 2.1 then you will recognize this as the same data set.) Now a 2-digit ID number has also been included.

New England families: large amount of variability
Average number of people in 50 families: 4.50

ID: 01	1	ID: 02	4	ID: 03	5	ID: 04	7	ID: 05	8
ID: 06	3	ID: 07	9	ID: 08	8	ID: 09	8	ID: 10	8
ID: 11	4	ID: 12	9	ID: 13	9	ID: 14	1	ID: 15	6
ID: 16	4	ID: 17	1	ID: 18	3	ID: 19	9	ID: 20	7
ID: 21	8	ID: 22	2	ID: 23	3	ID: 24	1	ID: 25	9
ID: 26	1	ID: 27	7	ID: 28	5	ID: 29	1	ID: 30	1
ID: 31	1	ID: 32	6	ID: 33	8	ID: 34	2	ID: 35	9
ID: 36	4	ID: 37	1	ID: 38	1	ID: 39	1	ID: 40	3
ID: 41	4	ID: 42	2	ID: 43	4	ID: 44	9	ID: 45	4
ID: 46	1	ID: 47	3	ID: 48	8	ID: 49	1	ID: 50	1

Step 1: Select a sample of 5 numbers from this population. Use the table of random numbers to do this. Record your sample in the table at the top of page 39.

Several of the *Discovery Exercises* are designed to help students apply the techniques and interpret the results in terms of making a business decision. Most of these exercises require them to *write* a memo or short business report to explain their decisions and recommendations.

Most chapters end with summary tables of key terms and formulas. These features are useful when reviewing the material for quizzes and/or exams. Page references are provided so it is easy to return to the more detailed discussion in the chapter.

Key Terms

Term	Definition	Page reference
Biased sample	A **biased sample** is a sample that does not represent the population.	34
Census	A **census** is a study of the population.	24
Continuous data	**Continuous data** are data that can take on any one of an infinite number of possible values over an interval on the number line.	43
Descriptive statistics	**Tools of descriptive statistics** allow you to summarize the data.	45
Discrete data	**Discrete data** are data that can take on only certain values. These values are often integers or whole numbers.	43
Inference	An **inference** is a deduction or a conclusion.	46

CONTENTS: RES 341

WORKSHOP 5   361

CHAPTER 9

SAMPLING DISTRIBUTIONS AND CONFIDENCE INTERVALS (cont.)   363

CHAPTER 10

HYPOTHESIS TESTING: AN INTRODUCTION   403

CONTENTS: RES 342

RES 341: RESEARCH & EVALUATION I

WORKSHOP 1

INTRODUCTION: THE ROLE OF STATISTICAL THINKING IN BUSINESS RESEARCH

QUALITY PRODUCTS

If you asked someone to describe the quality of a product made in Japan in the 1950s, what do you think the response would be? Most likely the person would tell you that the Japanese product made in the 1950s was of low quality, not reliable, and probably junk. Now let's roll forward to the 1990s and ask the same question. The person would most likely tell you that the Japanese product is of high quality, reliable, and of great value.

What happened between 1950 and 1990? During this time period Japanese industries started paying increasingly more attention to the quality of their products. At the same time American companies were enjoying the postwar boom and paying little, if any, attention to quality. Interestingly enough, it was an American statistician named W. Edwards Deming who helped the Japanese focus on quality. Deming tried to get American manufacturers to listen to him but they were not interested at the time. Today, American companies, both service industries and manufacturing concerns, are paying close attention to quality in order to compete internationally.

1.1 CHAPTER OBJECTIVES

You may be wondering why a story about product quality is used as an introduction to a book on statistics. Students often feel that taking a course in statistics causes unnecessary pain and that they will never again use the statistical techniques they learn. The objective of this book is to refute both of these points: The course need not be painful and you will certainly be asked to research problems by collecting and analyzing data in order to make informed business decisions.

The objective of this chapter is to start you down this path. Specifically this chapter covers the following topics:

- Dispelling the Myths About Research and Statistics
- What Managers Should Know About Research and Statistics
- Statistical Thinking—A New Paradigm for Management
- Some Situations That Call for Research and Statistical Thinking
- Types of Research
- Steps in Conducting Business Research
- Key Components of Research and Statistical Thinking
- Organization of This Book

1.2 DISPELLING THE MYTHS ABOUT RESEARCH AND STATISTICS

We should first dispel some of the common myths about research and statistics. Listed below are three myths we have run across regularly:

Myth 1: *"If I had one hour left to live, I would choose to live it in statistics class because it would seem to last forever!"*

A student's lament

Myth 2: *"There are three kinds of lies—lies, damned lies, and statistics."*

Benjamin Disraeli

Myth 3: *"If it moves, it's biology; if it changes color, it's chemistry; if it breaks, it's physics; if it puts you to sleep, it's statistics."*

Bob Hogg, University of Iowa

If you are like most people you can relate to one of these myths about the "S-word," *statistics,* or *sadistics* as some people refer to it. Statistics is boring and not useful! This book will lead you to another view of the dreaded S-word—one that sees statistics not as a sleeping pill but as a way in which to view all sorts of exciting, amazing, and valuable things.

TRY IT NOW!

Myths and Fears
Identifying Some of Your Own

Be honest. Write down your myths and fears about this subject right now. Get them out in the open so you can deal with them directly and put them behind you. To get you started a common student fear is listed at the top of the next page.

- *I am worried about all of the math in this course.*

You have taken the first step. It is easier to combat the myths about research and statistics when we acknowledge them. Good work. Next we need to see why it is important to learn about the tools of research and statistics.

1.3   WHAT MANAGERS SHOULD KNOW ABOUT RESEARCH AND STATISTICS

As a manager you will be making several decisions each day at work. What would help you to make the right decisions? Will it be your experience on the job, your sixth sense or hunch, or will you just trust to good luck? For sure, all these will play a part *after* you have thoroughly investigated or researched the problem, analyzed some data, and generated some alternative solutions to choose from. Whether or not managers realize it, they are constantly engaged in research as they try to find solutions to the day-to-day problems, big and small, that they face at work. Some of the main tools of research are statistical techniques because in attempting to understand a problem you will almost always gather and analyze data. Statistical techniques allow you to see the information in the data. Thus, an understanding of statistics is needed to do the research necessary for you to be a good manager.

The use of statistical techniques has long played an important role in quality control and quality improvement in business and industry. Unfortunately, for too long quality has been relegated to the "quality department" and not integrated into the whole organization. The purchasing department would purchase the raw materials needed at the cheapest price without regard to quality and then would throw the material "over the wall" to the engineers. The engineers would make the product, not worrying about the process, since they knew that the quality department would inspect the product before it went out the door. Businesses in the United States have learned that this way of approaching quality does not work and does not allow them to compete internationally. Quality is everyone's job!

Quality and statistics go hand in hand.

One of the reasons that people prefer to have the quality department handle quality issues is that thinking about quality leads to thinking about data analysis. Data analysis requires the use of statistical techniques, which are often viewed as difficult. But statistical thinking is not difficult to comprehend. Everything we do can be thought of as a series of steps that are connected. Each time we repeat a step it will not be precisely the same. Reducing how much the step changes from time to time is