



Business Statistics

A Textbook

Sandeep Kumar
Pratibha Bala
Sweta Bakshi



Alpha Science

Business Statistics

A Textbook

**Sandeep Kumar
Pratibha Bala
Sweta Bakshi**



Alpha Science International Ltd.
Oxford, U.K.

Business Statistics: A Textbook

414 pgs.

Sandeep Kumar

Department of Management
Tecnia Institute of Advanced Studies
Rohini, New Delhi

Pratibha Bala

Department of Psychology
B.R.A. Bihar University
Muzaffarpur

Sweta Bakshi

12, Himgiri Appartment
Kaushambi, Ghaziabad

Copyright © 2016

ALPHA SCIENCE INTERNATIONAL LTD.

7200 The Quorum, Oxford Business Park North
Garsington Road, Oxford OX4 2JZ, U.K.

www.alphasci.com

ISBN 978-1-84265-918-2

All rights reserved. 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 or otherwise, without prior written permission of the publisher.

Business Statistics

A Textbook

Preface

An effective Business Statistics course helps students to understand “how to think statistically” and provides a statistical tool kit that they can use for ultimately solving the applications, and making the business decisions, that they will subsequently encounter in their careers. In order to provide the focus on business applications, this book provides a strong focus on applications while maintaining a rigorous, mathematically correct presentation and explanation. Clarity is found in the quality of the explanation rather than the quality of words used.

Business Statistics focuses on transforming learning and teaching statistics into its simplest form by adopting learning by application approach. This book is different in its approach, and motivates students to learn the concept and apply them in real-life situations. It is purposely designed for the students of Management, Commerce Science, Arts and Engineering and covers a wide range of syllabi of different universities offering this course.

Practicing with a large number of interesting and engaging problems is the heart of a quantitatively oriented textbook that emphasizes students understanding and retention along with the accurate exposition of its subject. For that reason, having an extraordinary range of practical, challenging problems related to all functional areas and types of business has been included in this book.

The primary objective of writing this book is to explain the concepts of business statistics lucidly along with the solution procedures and analysis of results. Numerous solved business-oriented examples have been presented throughout the text. Unsolved self practice problems with Answers, Review Questions and Multiple Choice Questions have been added in each chapter to strengthen the conceptual as well as practical knowledge of the reader.

This book has been written according to the needs of students who want to grasp the basic statistical techniques and methods in the limited time. The emphasis is on understanding through practice, interpretation of results and their application to the real-life problems.

This book is designed to be self-contained and comprises 18 chapters. It is intended to serve as a core primary text for the students of MBA/CA/ICWA/CS/PGDBM/M.COM. /M.Sc./MA/BBA/B.Com./B.Sc./BA and other professional undergraduate courses. It enables students to understand the fundamental concepts of business statistics and apply formulae directly to business problems.

A number of typical problems from various university examination papers have been solved as illustrations to expose the students to different techniques of tackling the problems and enable them to have a better and thoughtful understanding of the basic concepts of theory and its various applications. At many places, explanatory remarks have been given to widen the reader's horizon.



Dedicated to Our Parents

Late Chandra Bhushan Prasad

and

Smt. Shanti Chandra

– **Sandeep & Pratibha**

Sri Bijaya Kishore Prasad

Smt. Sudha Bakshi

– **Sweta**



Moreover, in order to enable the readers to have a proper understanding of the subject-matter and to fortify their confidence in the understanding and application of methods, a large number of carefully-graded problems, mostly drawn from various university examination papers, have been given as exercise sets in each chapter. Answers to the problems in the exercise sets given at the end of each problem.

While writing this book, we have consulted several books, therefore we express our gratitude to all the authors and publishers of such books. We are extremely grateful to all these authors.

Our sincere thanks to all my family members especially my mother Smt. Shanti Chandra, my brothers Er. Amiya Kumar, GM, Western Coalfield Ltd. Nagpur and Er. Gunjan Kumar, Executive Engineer, Irrigation Deptt, Bihar, Himangi & Shorya (Daughter & Son of Dr. Sandeep and Sweta) for their wishes and generous support.

We are also thankful to our publisher M/s Narosa Publishing House Pvt. Ltd. for their assistance in publishing this book.

All the suggestions and feedback to improve this book are always welcome.

Sandeep Kumar
Pratibha Bala
Sweta Bakshi

Contents

<i>Preface</i>	<i>vii</i>
1. Statistics: An Overview	1.1
Introduction	1.1
Meaning of Statistics	1.1
Main Divisions and Nature of Statistics	1.2
Statistical Methods	1.2
Applied Statistics	1.2
The Nature of a Statistical Study	1.3
Functions of Statistics	1.4
Importance of Statistics in Business	1.5
Use of Statistics in Business	1.6
Limitation of Statistics	1.7
Statistics in Business Management	1.8
Statistics: Science or Art	1.8
Types of Data	1.9
Cross-sectional, Temporal and Spatial Data	1.11
Questions	1.12
Multiple Choice Questions	1.12
2. Data Classification, Tabulation and Presentation	2.1
Objectives of Classification	2.1
Requisites of an Ideal Classification	2.1
Ordered Array	2.2
Methods of Data Classification	2.3
Primary Rules to be Followed While Classifying	2.6
Graphical Presentation	2.7
Types of Diagrams	2.8
One Dimesional Diagram	2.8

Cumulative Frequency Distribution (Ogive)	2.11
Preparation of Discrete Frequency Distribution	2.16
Bivariate Frequency Distribution	2.16
Bar Diagram	2.17
Multiple Bar Diagram	2.17
Questions	2.20
Multiple Choice Questions	2.21
3. Measures of Central Tendency	3.1
Arithmetic Mean	3.1
Ungrouped Data; Weighted Case	3.1
Median	3.6
Median for Grouped Series	3.6
Determining Median Graphically	3.8
Mode	3.10
Determine Mode Graphically	3.12
Questions	3.19
Problems	3.19
Multiple Choice Questions	3.22
4. Measures of Dispersion	4.1
Importance	4.1
Skewness	4.3
Measures of Skewness	4.4
Karl Pearson's Measure	4.5
Bowley's Measure	4.7
Kelly's Measure	4.8
Mean Deviations	4.10
Standard Deviation	4.12
Grouped Data	4.14
Combined Standard Deviation	4.15
Uses of Standard Deviation	4.17
Mean and Standard Deviation	4.18
Combined Standard Deviation	4.20
Questions	4.26
Problems	4.27
Multiple Choice Questions	4.30

5. Time Series Analysis	5.1
Time Series Analysis	5.1
Objective of Time Series Analysis	5.1
Importance of Time Series Analysis	5.2
Components of a Time Series	5.2
The Freehand Method	5.3
The Method of Semi Averages	5.5
The Method of Moving Averages	5.7
Calculation of Moving Averages	5.7
The Method of Least Squares	5.8
Higher Degree Polynomial Trends	5.12
Seasonal Variation	5.15
The Method of Simple Averages	5.15
The Ratio to Trend Method	5.16
The Moving Average Method	5.19
The Link-Relative Method	5.20
Deseasonalisation	5.23
Cyclical Variation	5.24
Irregular Variation	5.29
Method of Semi Averages	5.30
Quarterly Trend Value	5.40
Questions	5.43
Problems	5.44
Multiple Choice Questions	5.45
6. Index Number	6.1
Definition	6.1
Types of Index Numbers	6.2
Characteristics and uses of Index Number	6.3
Problems in Index Number Construction	6.5
Types of Price Index Number	6.5
Laspeyre's Method	6.8
Paasche's Method	6.9
Chain Base Method	6.10
Calculation of Quantity Index	6.11
Fisher's Ideal Index Number	6.19
Questions	6.20

<i>Problems</i>	6.20
<i>Multiple Choice Questions</i>	6.21
7. Correlation	7.1
Importance	7.1
Correlation and Causes	7.1
Types of Correlation	7.2
Graphic Method of Correlation	7.3
Scatter Diagram	7.3
Algebraic Methods of Correlation, (Karl Pearson's Method)	7.4
Correlation of Grouped Data	7.8
Assumption of Karl Pearsonian Correlation	7.10
Limitations of Spearman's Method of Correlation	7.12
Rank Correlation when Actual Ranks are Given	7.15
Questions	7.16
Problems	7.17
Multiple Choice Questions	7.18
8. Regression	8.1
Regression Model	8.1
Advantages of Regression Analysis	8.1
Method of Least Squares	8.2
Checking Accuracy of Regression Line Results	8.3
Regression Coefficient	8.4
Use of Deviations from Assumed Mean	8.4
Regression Coefficient	8.7
Properties of Regression Coefficient	8.9
The Standard Error of Estimate	8.9
Hypothesis Tests about Regression Relationship	8.11
Regression Equations by Normal Equations	8.12
Regression Equations from Direct Method	8.14
Regression Equations from Assumed Mean	8.16
Questions	8.18
Problems	8.18
9. Multiple Regression and Correlation Analysis	9.1
Interpretation of the Regression Equation	9.2
Standard Error of Estimate	9.3

Partial Correlation Coefficient	9.3
Multiple Correlation	9.4
Advantage of Multiple Correlation Analysis	9.4
Limitations	9.5
Questions	9.5
Problems	9.5
10. Probability	10.1
Probability Theory	10.1
Sample Space	10.2
Mutually Exclusive Event	10.2
Collectively Exhaustive Events	10.3
Independent and Dependent Events	10.3
Definition of Probability	10.3
Fundamental Rules of Probability	10.5
Glossary of Probability Terms	10.5
Counting Rules for Determining the Number of Outcome	10.6
Permutations	10.7
Rules of Addition	10.9
Partially Overlapping (or Joint) Events	10.10
Rules of Multiplication	10.11
Statistical Dependent Events	10.12
Bayesian Analysis	10.15
Questions	10.20
Problems	10.20
Multiple Choice Questions	10.21
11. Probability Theoretical Distribution	11.1
Binomial Distribution	11.1
Conditions Necessary for Binomial Distribution	11.2
Fitting a Binomial Distribution Procedure	11.2
Mean and Standard Deviation of Binomial Distribution	11.4
Poisson Distribution	11.5
The Normal Distribution	11.6
Questions	11.13
Problems	11.14
Multiple Choice Questions	11.15

12. Sampling Distributions	12.1
Advantages of Sampling	12.1
Limitations	12.1
Parameter and Statistic	12.1
Types of Sampling	12.2
Systematic Sampling	12.2
Stratified Random Sampling	12.2
Cluster Sampling	12.2
Non Probability Sample Designs	12.3
Sampling Distribution of Mean	12.3
Types of Sampling Errors	12.5
Sampling from Non-normal Populations	12.6
Relationship between Sample Size and Standard Errors	12.7
Sampling Distribution of a Sampling Proportion	12.7
Questions	12.7
Problems	12.7
Multiple Choice Questions	12.8
13. Estimation	13.1
Inferential Statistics	13.1
Types of Estimate	13.1
Criteria of Good Estimator	13.1
Method of Maximum Likelihood (ML)	13.2
Interval Estimation of a Population Mean of Large Samples	13.3
Interval Estimation of a Population Mean – Small Sample	13.5
Interval Estimate of a Population Proportion	13.6
Finite Correction Factor	13.7
Sample Size for Estimating Mean	13.8
Questions	13.11
Problems	13.11
Multiple Choice Questions	13.12
14. Hypothesis	14.1
Null Hypothesis	14.1
Alternative Hypothesis	14.1
Procedure in Hypothesis Testing	14.2
Two Types of Errors in Hypothesis Testing	14.2
Tails of a Test	14.3

One Tail Test	14.4
Hypothesis Test about a Population Mean	14.6
Hypothesis Test about a Population Mean – Small Samples	14.8
Hypothesis Test Concerning Proportion	14.9
Hypothesis Test Concerning the Difference between Two Population Mean	14.10
Hypothesis Test of Difference between Two Proportions	14.11
<i>F</i> -Distribution	14.11
<i>F</i> -Test Distribution in Two Variances	14.12
Hypothesis Test Concerning Proposition	14.18
<i>Questions</i>	14.19
<i>Problems</i>	14.19
<i>Multiple Choice Questions</i>	14.20
15. Chi-square Distribution	15.1
Definition	15.1
The Goodness of Fit Test	15.2
Procedure for Conducting Chi-square Test	15.2
Yate's Correction for Continuity	15.4
Simple Formula for Computing Chi-square	15.6
The Test of Independence	15.7
Additive Property of χ^2	15.8
Chi-square (χ^2) as a Test of Homogeneity	15.8
Precautions about using χ^2 Test	15.10
<i>Questions</i>	15.13
<i>Problems</i>	15.13
<i>Multiple Choice Questions</i>	15.14
16. Analysis of Variance	16.1
Assumptions of Anova	16.1
One Way Classification	16.1
Procedure for Anova	16.1
Two Way Classification	16.5
<i>Questions</i>	16.12
<i>Problems</i>	16.12
<i>Multiple Choice Questions</i>	16.13
17. Non-parametric Statistics	17.1
Advantages of Non-Parametric Methods	17.1
Limitations	17.1

Statistics: An Overview

INTRODUCTION

The word 'Statistics' has been derived from a Latin word 'status' which means political state. It has also been originated from the Italian word "Statista" and German Word "Statistik" both meaning a political state.

For several decades the word statistics was associated solely with the display of facts and figures pertaining to economic, demographic and political situations usually collected and brought out by local governments.

"Gottfried Achenwall (1719-1772), Professor at Marlborough & Gottingen known as 'Fathers of Statistics' is responsible for the development of statistics. He was the first person to use the word 'statistics'. Dr. E.A.W Zimmerman introduced the word statistics in England. In 19th century, the theory of statistics had improved remarkably and was used to signify not only the numbers and quantitative information but also the facts calculated to illustrate the conditions and prospects of the society. During 20th century, the term statistics identified with the quantitative information and today it has become indispensable.

Thus, Statistics is not a body of substantive knowledge but a body of methods for obtaining knowledge. It is a tool in the hands of mankind to translate complex facts into simple and understandable statement of facts.

MEANING OF STATISTICS

The word 'Statistics' is used in two different senses-plural and singular.

In Plural form, it refers to a set of figure i.e. it refers to the numerical data collected in a systematic manner with some definite aim or object in view such as the number of persons suffering from malaria in different colonies of Delhi and so on.

In singular form, it refers to the whole body of analytical tools that are used to collect the figures, organize and interpret from them and finally draw conclusions from them. In other words, 'Statistics' means science of statistics that deals with principles, devices or statistical methods of collecting, analysing and interpreting numerical data.

DEFINITION

'Statistics' has been defined by various authors. 'Spiegel' defines statistics, highlighting its role in decision making, particularly under uncertainty as follows:

"Statistics is concerned with scientific method for collecting, organising, summarising, presenting and analysing data as well as drawing valid conclusions and making reasonable decisions on the basis of such analysis". This definition covers all the aspects and tries to link them with decision making.

Using the term 'Statistics' in plural sense, 'Secrets' defines statistics as "aggregate of facts, affected to a market extent by multiplicity of causes, numerically expressed, enumerated or estimated according to reasonable standard of accuracy, collected in a systematic manner for a predetermined purpose and places and relation to each other". This definition highlights few major characteristics of statistics:

1. Statistics are aggregate of facts. This means that single figure is not statistics. e.g. National income of a country for a single year is not statistics but the same for two or more years.
2. Statistics are affected by a number of factors. For e.g. Sale of a product depends on no. of factors such as its price, quality, competition, the income of consumers and so on.
3. Statistics must be reasonably accurate. Wrong figure if analysed, will lead to erroneous conclusions.
4. Statistics must be collected in a systematic manner.
5. Statistics should be placed in relation to each other. Data should be comparable over time and space.

MAIN DIVISIONS AND NATURE OF STATISTICS

There are two branches of Statistics

- (i) Statistical Methods, statistical techniques or mathematical statistics.
- (ii) Applied Statistics

STATISTICAL METHODS

It provides a set of tools which can be profitably used by different sciences in the most appropriate manner. Thus, they include all the general principles and techniques which are commonly used in the collection, analysis and interpretation of data relating to any sphere of inquiry.

APPLIED STATISTICS

It deals with the application of statistical methods used in various problems in an exact manner.

It can be further divided into two main groups:

- 1. Descriptive Applied Statistics** It deals with data which is known and naturally relate either to the present or the past. Business statistics are descriptive applied statistics as they deal with the analysis, measurement and presentation of business facts relating to past or present. On the basis of these facts, certain decisions about various business problems are usually taken.
- 2. Scientific Applied Statistics** It deals with the formulation of physical and psychological laws on the basis of quantitative data collected for descriptive purposes by use of appropriate statistical methods.

For example, by the use of some business statistics we are in a position to derive certain conclusions, which we use for forecasting the future trend or tendency of that particular phenomenon we are making use of scientific applied statistics.

Types of Statistical Methods:

1. Descriptive Statistics
2. Inferential Statistics.

Descriptive Statistics: It includes statistical methods involving the collection, presentation and characterization of a set of data in order to describe the various features of that set of data. In general methods of descriptive statistics include graphic methods and numeric measures. Bar Charts, line graphs and pie-charts comprise the graphic methods whereas numeric measures include measures of central tendency, dispersion, skewness and Kurtosis.

Inferential Statistics: It includes statistical methods which facilitate estimating the characteristic of a population or making decisions concerning a population on the basis of sample results. Sample and Population are two relative terms. A population is treated as universe and a sample is a fraction or segment of that universe.

The need for sampling arises because in many situations data is sought for a large group of elements such as individuals, companies, voters, households, products, customers and so on to make inferences about the population that the sample represents. Thus, due to time, cost and other consideration data is collected from a small portion of the population called Sample.

The concepts derived from the probability theory help to ascertain the likelihood that the analysis of characteristics based on a sample reflects the characteristic of the population from which the sample is drawn. This helps the decision-maker to draw conclusions about the characteristics of a large population under study.

Following definitions are necessary to understand the concept of inferential statistics:

- (i) A process is a set of conditions that repeatedly come together to transform inputs into outcomes. For e.g. it includes a business process to serve customers, length of time to complete a banking transaction, manufacturing of goods and so on.
- (ii) A population (or universe) is a group of elements or observation relating to a phenomenon under study for which greater knowledge and understanding is needed. The observations in population may relate to employees in a company, a large group of manufactured items, vital events like births and deaths etc. A population can be finite or infinite according to the number of observations under statistical investigation.
- (iii) A statistical variable is an operationally defined characteristic of a population or process and represents the quantity to be observed or measured.
- (iv) A sample is a group of the elements or observations of a population or process. The individual elements of a sample are called *Sampling or Experimental unit*.
- (v) A parameter is a descriptive or summary measure (a numerical quantity) that describes the characteristic of the entire population. A statistics is a numerical quantity that describes the characteristics of sample drawn from a population.

THE NATURE OF A STATISTICAL STUDY

Whether a given problem pertains to business or some other field, there are some well defined steps that are required to be followed in order to reach meaningful conclusions.