

Research Methodology & Applications of SPSS in Social Science Research

P. Sundara Pandian
S. Muthulakshmi
T. Vijayakumar

SULTAN CHAND & SONS

Research Methodology
& Applications of SPSS in
Social Science Research

Research Methodology & Applications of SPSS in Social Science Research

P. Sundara Pandian

Principal

*V.H.N. Senthikumara Nadar College (Autonomous).
Virudhunagar. Tamil Nadu*

S. Muthulakshmi

Assistant Professor of Commerce

*V.H.N. Senthikumara Nadar College (Autonomous).
Virudhunagar. Tamil Nadu*

T. Vijayakumar

Assistant Professor of Economics

*V.H.N. Senthikumara Nadar College (Autonomous).
Virudhunagar. Tamil Nadu*



Sultan Chand & Sons

Educational Publishers

New Delhi

SULTAN CHAND & SONS

Educational Publishers

23, Daryaganj, New Delhi-110 002

Phones : 011-23281876, 23266105, 23277843 (*Showroom & Shop*)

011-40234454, 23247051 (*Office*)

E-mail : sultanchand74@yahoo.com; info@sultanchandandsons.com

Fax : 011-23266357; Website : www.sultanchandandsons.com

ISBN : 978-93-91820-18-3-(TC 1256)

Price : ₹ 300.00

First Edition: 2022

EVERY GENUINE COPY OF THIS BOOK HAS A HOLOGRAM



In our endeavour to protect you against counterfeit/fake books, we have pasted a copper hologram over the cover of this book. The hologram displays the full visual image, unique 3D multi-level, multi-colour effects of our logo from different angles when tilted or properly illuminated under a single light source, such as 3D depth effect, kinetic effect, pearl effect, gradient effect, trailing effect, emboss effect, glitter effect, randomly sparking tiny dots, micro text, laser numbering, etc.

A fake hologram does not display all these effects.

Always ask the bookseller to put his stamp on the first page of this book.

All Rights Reserved: No part of this book, including its style and presentation, may be reproduced, stored in a retrieval system, or transmitted in any form or by any means – electronic, mechanical, photocopying, recording or otherwise without the prior written consent of the Publishers. Exclusive publication, promotion and distribution rights reserved with the Publishers.

Warning: The doing of an unauthorised act in relation to a copyright work may result in both civil claim for damages and criminal prosecution.

Special Note: Photocopy or Xeroxing of educational books without the written permission of Publishers is illegal and against Copyright Act. Buying and selling of pirated books is a criminal offence. Publication of key to this is strictly prohibited.

General: While every effort has been made to present authentic information and avoid errors, the author and the publishers are not responsible for the consequences of any action taken on the basis of this book.

Limits of Liability/Disclaimer of Warranty: The publisher and the author make no representation or warranties with respect to the accuracy or completeness of the contents of this work and specifically disclaim all warranties, including without limitation warranties of fitness for a particular purpose. No warranty may be created or extended by sales or promotional materials. The advice and strategies contained herein may not be suitable for every situation. This work is sold with the understanding that the publisher is not engaged in rendering legal, accounting, or other professional services. If professional assistance is required, the services of a competent professional person should be sought. Neither the publisher nor the author shall be liable for damage arising herefrom.

Disclaimer: The publisher have taken all care to ensure highest standard of quality as regards typesetting, proofreading, accuracy of textual material, printing and binding. However, they accept no responsibility for any loss occasioned as a result of any misprint or mistake found in this publication.

Author's Acknowledgement: The writing of a Textbook always involves creation of a huge debt towards innumerable author's and publications. We owe our gratitude to all of them. We acknowledge our indebtedness in extensive footnotes throughout the book. If, for any reason, any acknowledgement has been left out we beg to be excused. We assure to carry out correction in the subsequent edition, as and when it is known.

Printer:

Foreword



Dayananda Sagar University

Shavige Malleshwara Hills, Kumaraswamy Layout
Bangalore – 560078, Karnataka, India

Prof. Dr. K. Muthuchelian
Ph.D., D.Sc., FNABS., FPBS., FZSI., FNESEA., FSBSRD., FIAAM., FIEF (Canada)
89031 11333
[Formerly - Vice Chancellor, Periyar University, Salem]
Pro Vice Chancellor

Tele: 080 42201953 (Dir.)
Mobile: 94433 58790/

Tele: 080 42161706 Extn: 36
Email : kmc@dsu.edu.in

I am very much delighted to review “**RESEARCH METHODOLOGY AND APPLICATIONS OF SPSS IN SOCIAL SCIENCE RESEARCH**”. SPSS, standing for Statistical Package for the Social Sciences, is a powerful, user-friendly software package for the manipulation and statistical analysis of data. The package contains an extensive range of both univariate and multivariate procedures much used in various disciplines. The authors have concentrated both on Research Methodology and Application of SPSS in Social Science and on how to use SPSS to get results and on how to correctly interpret these results. The basic theoretical background of many of the techniques used is also described in separately. The book deals a number of research techniques covering both qualitative and quantitative research methods and how these methods are practically used to understand the real world. Discriminate Analysis and an Overview of Structural Equation Model (SEM) are written in a very simple way with specific examples, to enable the reader to understand the concept and carry out the analysis easily and interpret the results. Throughout the book the authors have used screen snapshots of SPSS Data Editor with variable view and Data view, Dialog boxes and Outputs to illustrate finer aspects of the techniques. Our hope is that researchers and students with such a background will find this book a relatively self-contained means of using SPSS to analyze their data correctly. I congratulate the authors for their

strenuous efforts in bringing out this book as the book is aimed primarily at academic researchers, students of psychology, sociology, psychiatry, doctoral, masters and undergraduate students of mathematics, management and various other social science disciplines, practicing managers, marketing research professionals etc. In a nutshell, it is a simple book for the students who do not have adequate knowledge in the research process or in statistical analysis.

Prof. Dr. K. MUTHUCHELIAN

Preface

Research reveals a formalized interest in a branch of knowledge. It is poking and prying with a purpose. The concept of research has existed since time immemorial. Researchers have always tried to develop a better understanding of the worldly phenomena as well as explore solutions to problem faced by them. A Knowledge of research methodologies is reluctant for advancing our scientific knowledge. Research methodology is taught as a supporting subject in several ways in many academic disciplines such as health, education, psychology, social work, nursing, public health, library and marketing research. It is therefore hardly surprising that research methods have become a core subject in all postgraduate courses in management. The core ideological base for this book comes from the conviction that, although these disciplines vary in constant, their broad approach to a research enquiry is similar. This book “RESEARCH METHODOLOGY & APPLICATIONS OF SPSS IN SOCIAL SCIENCE RESEARCH”, therefore, is addressed to these academic disciplines. The domain of research is ever-widening and new research methods emerge and researchers adopts them.

This book, therefore, has been written to provide information about various methods, procedures and techniques in a simple step-by-step manner. The techniques and procedures uses qualitative and/or quantitative approaches. This book intends to help readers get an in-depth understanding of the research methods and its processes and techniques used especially in Social Studies. The book contains a unique compilation of research methodology and SPSS tools with simple and understandable examples. It makes research scholars attain various insights. Though there are many research books, this book stands with its unique combination of parametric and non-parametric test.

“RESEARCH METHODOLOGY & APPLICATIONS OF SPSS IN SOCIAL SCIENCE RESEARCH” is specially designed to meet the requirements of researchers, students, Scholars, masters and undergraduate students of mathematics, management and various other social science disciplines, practicing managers, marketing research professionals etc. by presenting a comprehensive overview of the conceptual background of research, its process and the ways of analyzing data using univariate, bivariate and multivariate techniques. With this book, we hope that that researchers can analyze the data on their own and appreciate the real use of statistics.

Data Analysis is used with respect to statistical tools and it is mostly done with the help of Software package such as SPSS. The illustrations are based on SPSS 20.0 version. With this book, we hope that that researchers can analyze the data on their own and appreciate the real use of statistics. A stepwise explanation of entering the data and the method to be followed with respect to a particular technique

has also been given. This would enhance students' understanding about the usage of these software in organizations for making decisions. Numerous solved examples discussing the application of various techniques in the field have also been added in the chapters to support the text.

Coverage and Structure

The book on "RESEARCH METHODOLOGY AND APPLICATIONS OF SPSS IN SOCIAL SCIENCE RESEARCH" comprises of 34 chapters. Chapter 1 gives introduction of Research. It gives an overview of scientific research, objectives of research, purpose of research, characteristics of research, application of research and details of research methodology. Chapter 2, *Types of Research*, discusses the types of research and the various modus operandi with special reference to business management. Chapter 3, Steps in Research Process introduces the methodology to formulate the research problem, process and analyze data and the types of research problems encountered by the researcher. Chapter 4 discusses problem identification, Chapter 5 gives an overview of literature review and uses of Mendeley software, Chapter 6 discusses research design it elaborates on the various types of research designs used in both physical and social sciences. Chapter 7 gives an overview of methods of data collection, *Types, sources, and Instruments*. It covers different sources and instruments of data collection including questionnaires, surveys, interviews, and many other techniques. Relevance of these techniques for managerial decision-making has also been discussed in detail. Chapter 8 *Tests of Hypotheses (Parametric and Nonparametric)*, provides discussion on a few parametric and nonparametric statistics along with the test of hypothesis. Chapter 9 *Sampling and Its Application provides discussion on different types of sampling used in research and its application in different situation*. Chapter 10 Introduction to SPSS gives *conceptualization of variables and Measurements*, explains the types of variables and measures of reliability and validity. Different sources of error while measuring variables and quantifying them have also been discussed.

Chapter 11 *Descriptive Statistics*, provides discussion on the meaning and uses of descriptive statistics and helps to understand the situations where this could be used. Chapter 12 Cronbach's Alpha test it helps to check the reliability and validity of the data. Chapter 13 gives the overview of the parametric test its advantages and disadvantages. Chapter 14, 15 and 16 deals on the meaning, assumption and applications of t-test. Chapter 17, 18 and 19 analyses one way ANOVA, Two way ANOVA, Factorial ANOVA and MANOVA and its application as tools for testing the hypotheses. Chapter 21 Chi-square Test provides a detailed analysis of basic concepts and its applications of Chi-square test using cross tabs with examples using SPSS. Chapter 22 introduces non-parametric test and states the difference between parametric and non-parametric test. Chapter 23, 24, 25 and 26 studies about Mann Whitney test, Wilcoxon test, Kruskal Wallis test and Friedman test. Chapter 27 Correlation Analysis, analysis the application of correlation analysis in business and social science and the data is analyzed using SPSS. Chapter 28 Multiple Regression Analysis, describes different forms and application of multiple regression. It also discuss the remedial measures when there is a problem in the process of estimation due to the violation of the assumptions. Chapter 29 Factor Analysis describes the logic and process of condensing different variables into few factors and their uses in decision-making. It also discusses situations where it can be applied. Chapter 30 Cluster Analysis discusses the basic feature of cluster analysis and the process of segmenting markets, customers, or objects using it. Chapter 31 Multi Dimensional Scaling, *Multidimensional Scaling*, explains the nature and process of conducting

this technique. Application of multidimensional scaling using software has also been covered in detail. Chapter 32 Discriminate Analysis distinguishes between simple and multiple discriminant functions and their uses and relates their results in the decision-making process in different situations. Chapter 33 Overview of Structural Equation Model (SEM), *deals* with the objectives of structural equation modeling and the situations where it is applied. Chapter 34 *Report Writing* gives a brief outline on various aspects of report writing and provides formats of different types of reports. It also explains the ethical perspective of research.

The text book provides theoretical information in operational manner about the various principles, methods and practices followed in Research. Researchers begin with a good question and then select a research method than can best help them answer their question. The sometimes-painstaking task of gathering evidence is only the beginning in the research process. Researchers and students must analyze the strengths and weaknesses of the method they have obtained the purpose of this book is to help the top management executives, undergraduate and post graduate students and other social scientists as well as practitioners to carry out research following methodologies.

From past experiences we have learned that research projects are excellent educational tools that have a positive benefit for students, supervisors and business partners. We wish you well in your courses involving research projects. The book will cover a broader audience by appealing beginners since each chapter is simple and clearly written.

P. Sundara Pandian
S. Muthulakshmi
T. Vijayakumar

Acknowledgement

We submit with an overwhelming heart, our love for the compassionate and gracious God, whose mercy and faithfulness, displayed absolute control and power over us, with his mighty arm.

We are very grateful to the Board Members of VHNSN College (Autonomous) and the Principal of our College Dr. P. Sundara Pandian for the care they took in helping us get this book ready for publication. Their advice, suggestions and occasional imperatives have contributed a great deal whatever merits this book may have.

We must also thank Dr. K. Muthuchelian for giving his foreword message and supporting us in all our endeavors. We fondly remember the help rendered by our beloved staff members of Commerce and Economics and the Heads of the Department for having generously accepted our proposal to bring out this book. I thank all the reviewers of our book for giving their valuable suggestions. It is through their sincere encouragement and depth reviews it is made possible to see the birth of this book.

We are always surrounded by knowledgeable and friendly people who extended their helping hands in times of need. We sincerely and deep thanks to our publishers Sultan Chand & Sons, New Delhi for pushing us and providing their valuable contribution and time in typing and correcting the entire manuscript and also offering suggestions for improvement.

We are indebted to our family members for their encouragement helped us in caring out our writing work. At last we would like to express our gratitude to all those who gave us the possibility to complete this book, “RESEARCH METHODOLOGY & APPLICATIONS OF SPSS IN SOCIAL SCIENCE RESEARCH”.

Contents

Foreword	v
Preface	iv
1. Introduction to Research	1
Meaning	1
Definition	1
Research: A Way of Thinking	2
Objectives of Research	2
Purpose of Research	2
Characteristics of Research	3
Significance of Research	3
Application of Research	4
Meaning of Research Methodology	6
Function of Research Methodologies	6
Aims and Objectives of Research Methodology	6
Summary	6
Review Questions	7
2. Types to Research	8
Meaning	8
Pure Research	8
Applied Research	8
Policy Research	9
Action Research	9
Theoretical or Fundamental Research	9
Exploratory Research	10
Quantitative and Qualitative Research	10
Multidisciplinary Research	11
Diagnostic Study	11
Summary	11
Review Questions	12

3. Steps in Research Process	13
Introduction	13
Steps in Research Process	13
Step 1: Formulating the Research Problem	14
Step 2: Extensive Literature Review	15
Step 3: Developing the Objectives	15
Step 4: Preparing the Research Design	16
Step 5: Collecting the Data	20
Step 6: Processing and Analyzing Data	20
Step 7: Reporting and Findings	22
Criteria of Good Research	22
Types of Research Problems Encountered by Researchers	22
Summary	23
Review Questions	23
4. Identification of Research Problems	24
Introduction	24
Problem in Identification and Selection	26
Sources for Identification of Problems	26
Justification for Selecting a Problem	27
Criteria for Selecting a Problem	27
Defining the Problem	28
Steps in Defining a Problem	28
Statement of Problem	28
Delimitations	29
Summary	29
Review Questions	29
5. Review of Literature	30
Introduction	30
Sources of Review of Literature	30
Need and Purpose of Review of Literature	31
How Review is Carried Out?	32
How A Review of Literature is Presented	32
Literature Management with Open Source Tool – Mendeley	33
Major Concerns	33
The Scenarios	33
Summary	62
Review Questions	62
6. Research Design	63
Meaning	63
What is Research Design?	63

Components of Research Design	64
1. Sampling Design	64
2. Data Collection Design	64
3. Statistical Design	64
4. Research Design	64
Need for Research Design	64
Types of Research Designs	65
Exploratory Design	65
Exploratory vs. Formal Design	67
Descriptive Design	67
Diagnostic Design	68
Analytical Design	69
Experimental Design	69
Informal Experimental Designs	70
1. Before and After Without Control	70
2. After-only with Control	70
3. Before and After the Control	71
Formal Experimental Designs	71
Completely Randomized Design (Crd)	71
Randomized Complete Block Design (Rcbd)	72
Factorial Design	72
Case Study Method	72
Longitudinal vs. Cross-sectional Study	73
Summary	74
Review Questions	74
7. Methods of Data Collection	75
Meaning	75
Primary and Secondary Data	75
Choice Between Primary and Secondary Data	75
Documentary Sources	76
Meaning of Document	76
Classification of Documents	76
Advantages of Secondary Sources of Data	78
1. Provides An Insight Into Total Situation	78
2. Helps in the Formulation of Hypothesis	78
3. Helps in Testing Hypothesis	78
4. Provides Supplementary Information	78
Disadvantages of Secondary Sources of Data	78
1. Collected for A Specific Purpose	78
2. Old Data	78
3. Aggregation of Data in Inappropriate Unit	78

Primary Data	78
Survey Method	79
Observation	80
Process of Observation	80
Characteristics of Observation	80
Types of Observation	81
Casual and Scientific Observation	81
Questionnaire	85
Types of Questions	85
Distinction Between Open-ended Questions and Limited – Choice Questions	87
Distinction Between Ambiguous Questions and Filtered Questions	87
Distinction Between Open-ended Questions and Multiple-choice Questions	88
Questions (to be Avoided) Requiring More Diligence	88
Mail Questionnaire	90
Preliminary Steps to Construct A Questionnaire	90
Sixteen Commandments	90
Advantages of the Questionnaire Technique	91
Disadvantages / Limitations of the Questionnaire Technique	91
Summary	91
Review Questions	91
8. Hypothesis	92
Meaning	92
What is Hypothesis?	92
Definition	93
Sources of Hypothesis	93
Characteristics of A Good Hypothesis	93
Functions or Roles of Hypothesis	94
Types of Hypothesis	94
Types of Errors	98
Steps in Hypothesis Testing	98
Summary	99
Review Questions	99
9. Sampling Techniques	100
Meaning	100
Sampling Method	101
Census Method	101
Principles of Sampling	102
Factors Affecting the Inferences Drawn From A Sample	102
Need for Sample / Sampling	103
Characteristics of A Good Sampling Design	103
Terms Used in Sampling	103

Sample	104
Sampling Designs (Sampling Techniques or Sampling Methods)	105
Basis of Representation	105
Technique of Selection Units	105
(I) Probability Sampling	106
(A) Simple Random Sampling	106
(B) Complex Random Sampling Design	107
(C) Cluster Sampling	109
(D) Multi-stage Sampling	110
(E) Multi-stage vs. Multi-phase Sampling	111
(II) Non-probability Sampling	111
(A) Convenience Sampling	111
(B) Judgement Sampling (Deliberate or Purposive Sampling)	112
(C) Quota Sampling	112
(D) Snowball Sampling	113
Sampling and Non-sampling Errors	114
Sampling Error	114
Non-sampling Errors	115
Sample Size	115
Determinants of Sample Size	115
Approaches to Determine the Size of Sample	116
Sampling Distribution, Sampling Bias and Sampling Variance	117
Sampling Distribution	117
Sampling Bias	117
Sampling Variance	118
Confidence Intervals	118
The Normal Distribution	118
Limitations of Sampling	119
Summary	120
Review Questions	121
10. Introduction to Statistical Package for Social Sciences (SPSS)	122
Introduction to SPSS	122
What is Variable?	122
Types of Variable	122
I. Causal Relationship	122
II. From the Viewpoint of the Study Design	123
III. From the Viewpoint of the Unit of Measurement	123
Levels of Measurement or Scale of Measurement	124
Nominal Scale	124
Ordinal Measurement	125
Interval	126

Ratio	126
Opening a Data File in Spss	126
Spss Data Editor	127
Variable View	128
Data View	128
Entering Data into the Data Editor	128
Statistical Analysis	131
SPSS Output	132
Closing SPSS	132
Tutorials in SPSS	132
Importing Data	132
Summary	132
Review Questions	133
11. Descriptive Statistics	134
Meaning of Descriptive Statistics	134
Definition	134
Objectives	134
Measures of Central Tendency	135
Mean	135
Merits and Demerits of Arithmetic Mean	135
Median	136
Characteristics of Median	136
Merits and Demerits of Median	136
Mode	136
Characteristics of Mode	137
Relationship Among Mean, Median and Mode	137
Geometric Mean	138
Merits and Demerits of Geometric Mean	138
Harmonic Mean	138
Merits and Demerits of Harmonic Mean	138
Relationship Between A.M. G.M., H.M.	139
Measures of Variability	139
Purposes of Studying Dispersion	139
Absolute and Relative Measure of Dispersion	139
Measures of Dispersion	140
Range	140
Merits and Demerits of Range	140
Use of Range	140
Mean Deviation	140
Standard Deviation	141
Definition	141
Coefficient of Standard Deviation	141

Coefficient of Variation	142
Application of Descriptive Statistics Using Spss	142
Summary	147
Review Questions	147
12. Cronbach's Alpha Test	148
Introduction	148
Reliability	149
Construct Validity	150
Face Validity	150
Content Validity	150
Criterion-related Validity	150
Scaling	151
Generating Potential Items	151
Evaluating the Potential Items	151
Pilot Testing the Items	152
Scoring the Items	152
Item Analysis	153
Performing the Analysis with SPSS	153
Summary	155
Review Questions	155
13. Parametric Test	156
Introduction to Parametric Test	156
Key Points of Parametric Tests	156
Types of Parametric Tests	156
Applications of Parametric Tests	157
Advantages of Parametric Tests	157
Disadvantages of Parametric Tests	157
Summary	158
Review Questions	158
14. One Sample T-test	159
Meaning of One Sample t-test	159
Key Points	159
Types of Sample 'T' Statistics	159
Assumptions	160
Application Areas	160
One-sample t-test	160
Hypotheses for One Sample t-test	160
Summary	163
Review Questions	164

15. Two-sample T-test or Independent Sample t-test	165
Meaning of Two-sample t-test	165
Assumptions	165
Application Areas	165
Hypotheses for Two-tailed Test	166
Summary	170
Review Questions	170
16. Paired Sample T-test	171
Meaning of Paired Sample T-test	171
Purpose	172
Other Names of This Test	172
Assumptions	172
Application Areas	172
Dependent Variable	172
Hypotheses for Paired Sample t-test	172
Summary	175
Review Questions	175
17. Analysis of Variance (ANOVA)	176
Meaning of Analysis of Variance (ANOVA)	176
Origin of ANOVA	176
Types of ANOVA	176
Uses	177
Hypothesis	177
Assumptions	177
Application Areas	177
Summary	181
Review Questions	181
18. Two-way ANOVA	182
Meaning of Two-way ANOVA	182
Assumptions	182
Application Areas	183
Summary	191
Review Questions	191
19. Factorial Anova	192
Meaning of Factorial ANOVA	192
Assumptions	192
Application Areas	193
Two-way Between-subjects ANOVA	193
Summary	200
Review Questions	200

20. Multivariate Analysis of Variance (MANOVA)	201
Meaning of Multivariate Analysis of Variance	201
Assumptions	201
Application Areas	202
Summary	206
Review Questions	206
21. Chi-square Test	207
Meaning of Chi-square Test	207
Basic Concepts	207
Chi-square Test for Goodness of Fit	208
Chi-square Test for Homogeneity	208
Chi-square Test of Independence	208
Characteristics of Chi-square Test	208
Properties of Chi-square	208
Assumptions	209
Application Areas	209
Hypothesis	209
Test for Goodness of Fit	209
Chi-square Test for Cross Tabs	213
Summary	217
Review Questions	217
22. Non-parametric Tests	218
Meaning of Non-parametric Tests	218
Advantages	218
Disadvantages	219
Characteristics	219
Differences Between Parametric and Non-parametric Tests	220
Summary	220
Review Questions	220
23. Friedman's Test	221
Meaning of Friedman's Test	221
Assumptions	221
Application Areas	221
Summary	224
Review Questions	225
24. Mann-whitney Test or U-test	226
Meaning of Mann-whitney Test or U-test	226
Assumptions	226
Application Areas	227
Characteristics	227

Summary	232
Review Questions	232
25. Wilcoxon Signed Rank Test	233
Meaning of Wilcoxon Signed Rank Test	233
Assumptions	233
Application Areas	234
Summary	237
Review Questions	237
26. Kruskal Wallis Test	238
Meaning of Kruskal Wallis Test	238
Assumptions	238
Application Areas	238
Summary	243
Review Questions	243
27. Meaning of Correlation Analysis	244
Application of Correlation Analysis in Business and Social Sciences	244
Correlation Coefficient	244
Nature of Variables	245
Purpose of Correlation Analysis	245
Assumptions	245
Application Areas	245
Hypothesis	246
Bivariate / Partial Correlation	246
Strengths of Correlations	246
Limitations of Correlations	246
Summary	249
Review Questions	249
28. Multiple Regression Analysis	250
Meaning of Multiple Regression Analysis	250
Multiple Regression Equation	250
Using Multiple Regression Analysis	251
Plotting The Scatter Diagram	251
Assumptions	252
Application Areas	253
Performing Multiple Regression Analysis	253
Statistics Associated With Multiple Regression Analysis	253
Limitations	254
Summary	262
Review Questions	263

29. Factor Analysis	264
Meaning of Factor Analysis	264
Methods of Conducting Factor Analysis	265
Input Data	265
Exploratory and Confirmatory Factor Analysis	265
Extractions	266
Factor Loadings	266
Rotation	266
Communalities	266
Eigen Value and Scree Plot	266
Sample Size Consideration	267
Purpose	267
Assumptions	267
Application Areas	267
Limitations	267
Mathematical Application	268
Summary	279
Review Questions	279
30. Cluster Analysis	280
Meaning of Cluster Analysis	280
Assumptions	281
Application Areas	281
Application Areas	281
Methods	281
Hierarchical Clustering	282
Non-hierarchical (K-means)	282
Data	282
Purpose	282
Summary	287
Review Questions	288
31. Multidimensional Scaling	289
Meaning of Multidimensional Scaling	289
Nature of Mds	290
Features of Mds	290
Assumptions	291
Application Areas	291
Summary	298
Review Questions	299
32. Discriminant Analysis	300
Meaning of Discriminant Analysis	300
Assumptions	300
Application Areas	300

Discriminant Analysis Model	301
Summary	313
Review Questions	313
33. Structural Equations Modelling	314
Introduction to Structural Equations Modelling	314
Research in Action	315
Sem and Other Multivariate Techniques	316
Nature and Objectives of SEM	316
Basic Terminologies of SEM	317
Manifest Variables	317
Latent Variables	317
Error	317
Disturbance	317
Exogenous or Dependent Variable	318
Endogenous or Dependent Variable	318
Measurement Model	318
Structural Model	318
Direct Effect	318
Indirect Effect	318
Confirmatory Factor Analysis	318
Covariance Structure	318
Mean Structure	318
Single-headed Arrow	318
Double-headed Arrow	319
Rectangle or Square	319
Circle or Eclipse	319
Components of Sem	319
Measurement Model (CFA)	319
Structural Model (Path Analysis)	319
Statistical Tests in SEM	319
Assessing the Measurement Model (Through CFA)	319
Check the Goodness of Fit of the Measurement Model	320
CMIN or df	320
CFI, GFI, and NFI	320
PCFI, PGFI and PNFI	320
RMSEA	320
Construct Validity	320
Convergent Validity	320
Rules of Thumb of Convergent Validity are as Follows	320
Discriminant Validity	320

Nomological Validity	321
Assessing The Structural Model	321
Summary	321
Review Questions	321
34. Interpretation and Report Preparation	322
Meaning of Interpretation	322
Need for Interpretation	322
Guidelines for Interpretation	323
Precautions in Interpretation	323
Report Writing	323
Meaning of Report Writing	323
Purpose or Functions of a Research Report	323
Characteristics of a Good Research Report	324
Types of Report	324
Format of Research Report/Project Report	325
Brief Description of the Various Items of a Report	326
Title Page	326
Example 1: Project Report Submitted by an MBA Student	326
Example 2: A Research Report Submitted by a Faculty Member to the AICTE	327
Research Declaration	327
Certificate of Authenticity	327
Acknowledgement	328
Table of Contents	328
Contents	328
Introduction	329
Introduction to Study	329
Introduction to the Organization, Industry or Situation	329
Need or Significances of the Problem	329
Statement of Problem	330
Scope of the Study	330
Objectives of the Study	330
Hypotheses	331
Review of Literature	331
Research Methodology	331
Research Design	331
Sources Of Data	332
Sampling Design	332
Data Collection	332
Data Analysis	332
Limitations of the Study	332

Analysis and Interpretation/Result and Discussion	332
Summary	332
Findings	332
Suggestions	333
Conclusion	333
Future Line of Work	333
References	333
References From Project Report/Dissertation/Thesis	334
Bibliography	334
Appendices	334
Annexures	335
Page Numbering	335
Recap of Salient Points in Executing a Research Project	335
Presentation of Research Report	335
Summary	335
Review Questions	336
Bibliography	337

Glossary

1. **Adjusted R².** A measure of the loss of predictive power in regression analysis. The adjusted R tells us how much variance in the outcome would be accounted for, if the model has been derived from the population from which the sample was taken.
2. **Alternative hypothesis.** Any statement (hypothesis) which is complementary to null hypothesis. This states that the sample mean and population mean are not equal.
3. **ANOVA.** An acronym for the Analysis of Variance. By analyzing the variance in the data due to different sources (e.g. an independent variable or error) we can decide if our experimental manipulation is influencing the scores in the data.
4. **Asymp. Sig. (asymptotic significance).** An estimate of the probability of a nonparametric test statistic employed by computer statistical analysis programs. This is often used when the exact probability cannot be worked out quickly.
5. **Beta weight.** The average amount by which the dependent variable increases when the independent variable increases by one standard deviation (all other independent variables are held constant).
6. **Between subjects.** Also known as independent measures. In this design, the samples we select for each condition of the independent variable are *independent*, as a member of one sample is not a member of another sample.
7. **Bootstrapping.** A sample is used to estimate a population. New bootstrap samples are randomly selected from the original sample with replacement (so an item can be selected more than once). The bootstrap samples, often 1,000 or more, are then used to estimate the population sampling distribution.
8. **Bivariate correlation.** A correlation (relationship) between two variables.
9. **Categorical variable.** Any variable that consists of categories of objects or entities. Test results in a class is a good example because it is classified into pass and fail.
10. **Chi-square distribution.** A probability distribution of sum of squares of several normally distributed variables. It is used to test hypothesis about categorical variable.
11. **Chi-square test.** Generally refers to Pearson's Chi-square test. It is used to find the discrepancy between observed and expected frequency based on some model or to test the independence of two categorical variables.
12. **Confidence interval.** A range of values around that statistic (for example, mean) that are believed to contain, with a certain probability (95%), the true value of that statistic (i.e., mean of population).

13. **Contingency table.** A table classifying the individuals with respect to two or more categorical variables. The levels of each variable are arranged in rows and columns and the number of individuals falling into each category is noted in the cells of the table. For example, if the students in a college are classified with respect to gender and blood group, the contingency table will show the number of males in blood group A, the number of females in blood group B and so on.
14. **Correlation coefficient.** A decimal number between 0 and 1.00 that indicates the degree and direction to which two quantitative variables are related and represented by r .
15. **Covariance.** A measure of how much the deviations of two variables match.
16. **Covariate.** A variable that is related to the outcome variable that is measured. Basically, anything that has an impact on the dependent variable and that cannot be controlled for by design can be a covariate.
17. **Criterion variable.** The outcome variable (dependent) that is predicted in regression analysis or correlation research.
18. **Case.** A row in the Data Editor file; the data collected from a single participant.
19. **Chart Editor.** The feature in SPSS that allows the editing of charts and graphs.
20. **Comparisons.** The results of a statistical test with more than two conditions will often show a significant result but not where the difference lies. We need to undertake a comparison of conditions to see which ones are causing the effect. If we compare them two at a time this is known as pairwise comparison and if we perform unplanned comparisons after discovering the significant finding these are referred to as *post hoc* comparisons.
21. **Component.** The term used in the principal components method of factor analysis for a potential underlying factor.
22. **Condition.** A researcher chooses levels or categories of the independent variable(s) to observe the effect on the dependent variable(s). These are referred to as conditions, levels, treatments or groups. For example, 'morning' and 'afternoon' might be chosen as the conditions for the independent variable of time of day.
23. **Confidence interval.** In statistics we use samples to estimate population values, such as the mean or the difference in means. The confidence interval provides a range of values within which we predict lies the population value (to a certain level of confidence). The 95 per cent confidence interval of the mean worked out from a sample indicates that the population mean would fall between the upper and lower limits 95 per cent of the time.
24. **Contrasts.** With a number of conditions in a study we may plan a set of comparisons such as contrasting each condition with a control condition. These planned comparisons are referred to as contrasts. We can plan complex contrasts for example, the effects of conditions 1 and 2 against condition 3.
25. **Correlation.** The degree to which the scores on two (or more) variables co-relate. That is, the extent to which a variation in the scores on one variable results in a corresponding variation in the scores on a second variable. Usually the relationship we are looking for is linear. A multiple correlation examines the relationship between a combination of predictor variables with a dependent variable.
26. **Critical value.** We reject the null hypothesis after a statistical test if the probability of the calculated value of the test statistic (under the null hypothesis) is lower than the significance level (e.g. 0.05). Computer programs print out the probability of the calculated value (e.g.

- 0.023765) and we can examine this to see if it is higher or lower than the significance level. Textbooks print tables of the critical values of the test statistic, which are the values of the statistic at a particular probability. For example, if the calculated value of a statistic (i.e. a t test) is 4.20 and the critical value is 2.31 (at the 0.05 level of significance), then clearly the probability of the test statistic is less than 0.05.
27. **Cross tabulation.** Frequency data can be represented in a table with the rows as the conditions of one variable and the columns as the conditions of a second variable. This is a crosstabulation. We can include more variables by adding 'layers' to the crosstabulation in SPSS.
 28. **Data Editor.** The feature in SPSS where data is entered. Saving the information from the Data Editor will produce an SPSS .sav file. There are two windows within the Data Editor: Data View and Variable View.
 29. **Data View.** The Data View window within the Data Editor presents a spreadsheet style format for entering all the data points.
 30. **Degrees of freedom.** When calculating a statistic we use information from the data (such as the mean or total) in the calculation. The degrees of freedom is the number of scores we need to know before we can work out the rest using the information we already have. It is the number of scores that are free to vary in the analysis.
 31. **Dependent variable.** The variable measured by the researcher and predicted to be influenced by (that is, depend on) the independent variable.
 32. **Descriptive statistics.** Usually we wish to describe our data before conducting further analysis or comparisons. Descriptive statistics such as the mean and standard deviation enable us to summarise a dataset.
 33. **Discriminant function.** A discriminant function is one derived from a set of independent (or predictor) variables that can be used to discriminate between the conditions of a dependent variable.
 34. **Distribution.** The range of possible scores on a variable and their frequency of occurrence. In statistical terms we refer to a distribution as a 'probability density function'. We use the mathematical formulae for known distributions to work out the probability of finding a score as high as or as low as a particular score.
 35. **Data editor.** The main window in SPSS to name the variable, enter data and carry out analysis.
 36. **Data view.** One of the two ways to view the contents of the data editor. The data view has a spreadsheet for entering data.
 37. **Factor.** Another name for independent variable or predictor that is used in describing experimental designs.
 38. **F-Ratio.** A test statistic with known probability distribution (F-distribution). It is the ratio of average variability in the data that a given model can explain to the average variability unexplained by the same model.
 39. **Equality of variance.** See homogeneity of variance.
 40. **General linear model.** The underlying mathematical model employed in parametric statistics. When there are only two variables, X and Y , the relationship between them is linear when they satisfy the formula $Y = a + bX$ (where a and b are constants). The general linear model is a general form of this equation allowing as many X and Y variables as we wish in our analysis.
 41. **Grouping variable.** In analyzing data in SPSS we can employ an independent measures independent variable as a grouping variable. This separates our participants into groups (such as

- introverts versus extroverts). It is important when inputting data into a statistical analysis program that we include the grouping variable as a column, with each group defined (i.e. introvert as '1' and extrovert as '2'). We can then analyse the scores on other variables in terms of these groups, such as comparing the introverts with the extroverts on, say, a monitoring task.
42. **Goodness of fit.** An index to find how well a model fits the data from which it was generated. Chi-square test is one of the tests to find the goodness of fit.
 43. **Hypothesis testing.** A statistical procedure for testing the null hypothesis against alternate hypothesis. The statistical procedures in hypothesis testing include t , F and χ^2 -square tests.
 44. **Hypothesis.** In statistics, a hypothesis is a statement about a population, such as the nature of the distribution. (There are two kinds of hypothesis, **Null hypothesis** and **Alternate hypothesis**).
 45. **Independent variable.** A variable under study, to determine whether it has a causal effect on the dependent variable. In regression studies, the term is used to denote a predictor variable or regressor.
 46. **Inferential statistics.** Includes a set of statistical tools which enable the researcher to infer or reach conclusions about the data.
 47. **Illustrative statistics.** Statistics that illustrate rather than analyse a set of data, such as the total number of errors made on a reading task. Often we illustrate a dataset by means of a graph or a table.
 48. **Independent or independent measures.** A term used to indicate that there are different subjects (participants) in each condition of an independent variable; also known as 'between subjects'.
 49. **Interaction.** When there are two or more factors in an analysis of variance, we can examine the interactions between the factors. An interaction indicates that the effect of one factor is not the same at each condition of another factor. for example, if we find that more cold drinks are sold in summer and more hot drinks sold in winter, we have an interaction of 'drink temperature' and 'time of year'.
 50. **Intercept.** A linear regression finds the best fit linear relationship between two variables. This is a straight line based on the formula $Y = a + bX$, where b is the slope of the line and a is the intercept, or point where the line crosses the Y -axis. (In the SPSS output for an ANOVA the term 'intercept' is used to refer to the overall mean value and its difference from zero.)
 51. **Item.** When we employ a test with a number of variables (such as questions in a questionnaire) we refer to these variables as 'items', particularly in reliability analysis where we are interested in the correlation between items in the test.
 52. **Kurtosis.** The degree to which a distribution differs from the bell-shaped normal distribution in terms of its peakness. A sharper peak with narrow 'shoulders' is called leptokurtic and a flatter peak with wider 'shoulders' is called platykurtic.
 53. **Levels of data.** Not all data are produced by using numbers in the same way. Sometimes we use numbers to name or allocate participants to categories (i.e. labelling a person as a liberal, and allocating them the number 1, or a conservative, and allocating them the number 2). In this case the data is termed 'nominal'. Sometimes we employ numbers to rank order participants, in which case the data is termed 'ordinal'. Finally, when the data is produced on a measuring scale with equal intervals the data is termed 'interval' (or 'ratio' if the scale includes an absolute zero value). Parametric statistics require interval data for their analyses.
 54. **Likert scale.** A measuring scale where participants are asked to indicate their level of agreement or disagreement to a particular statement on, typically, a 5- or 7-point scale (from strongly agree to strongly disagree).

55. **Linear correlation.** The extent to which variables correlate in a linear manner. for two variables this is how close their scatterplot is to a straight line.
56. **Linear regression.** A regression that is assumed to follow a linear model. for two variables this is a straight line of best fit, which minimises the 'error'.
57. **MANOVA.** Multivariate analysis of variance. It is an analysis of variance (ANOVA) applicable to multivariate (a multivariate data set containing observations on three or more variables dependent variables) situation, for two or more independent variables.
58. **Main effect.** The effect of a factor (independent variable) on the dependent variable in an analysis of variance measured without regard to the other factors in the analysis. In an ANOVA with more than one independent variable we can examine the effects of each factor individually (termed the main effect) and the factors in combination (the interactions).
59. **Mean.** The average of a set of numbers or scores in a distribution. To get the mean, all the values are added up and the sum is divided by the total number of all the values.
60. **Measures of central tendency.** Single numbers that are used to describe a larger set of data in a distribution of scores. The measures of central tendency are mean, median and mode.
61. **Median.** The score or number, which falls directly in the middle of a distribution of numbers or divides the data into two equal parts.
62. **Mean square.** A term used in the analysis of variance to refer to the variance in the data due to a particular source of variation.
63. **Mode.** The number or score, which occurs most frequently in a distribution of numbers.
64. **Multiple correlation.** The correlation of one variable with a combination of other variables.
65. **Multiple regression.** An extension of simple regression in which an outcome is predicted by a linear combination of two or more predictor variables.
66. **Multivariate analysis.** Analysis of variance that involves more than one outcome variable that have been measured.
67. **Multivariate.** Analysis of variance involving more than one outcome variable (multivariate = many variables)
68. **Mixed design.** A mixed design is one that includes both independent measures factors and repeated measures factors. for example, a group of men and a group of women are tested in the morning and the afternoon. In this test 'gender' is an independent measures variable (also known as 'between subjects') and time of day is a repeated measures factor (also known as 'within subjects'), so we have a mixed design.
69. **Nonparametric test.** Statistical tests that do not use, or make assumptions about, the characteristics (parameters) of populations.
70. **Normal distribution.** A bell-shaped frequency distribution that appears to underlie many human variables. The normal distribution can be worked out mathematically using the population mean and standard deviation.
71. **Null hypothesis.** A prediction that there is no relationship between the independent and dependent variables.
72. **Negatively skewed.** Skewness is asymmetry in a distribution. A negatively skewed distribution has most of its scores bunched up at the higher end (right side) of the distribution.
73. **Nominal data.** A data set in which the numbers merely represent names, the numbers have no meaning other than the name.

74. **One-tailed test.** One-tailed test is used to test if the sample mean is significantly greater than population mean or if it is significantly less than that, but not both.
75. **P-value.** The probability value (p -value) of a statistical hypothesis test. It is the probability of getting a value of the test statistic as extreme as that observed by chance alone. Small p -values suggest that the null hypothesis is not true. The smaller the p -value, the more convincing is the rejection of the null hypothesis. p -value indicates the strength of evidence for rejecting the null hypothesis H_0 .
76. **Percentile.** Any distribution could be described in terms of percentiles. 10th percentile is the value in a distribution below which 10% of the values lie. 90th percentile is the value below which 90% of the values lie. So 50th percentile is the median in a distribution.
77. **Positively skewed.** Skewness is asymmetry in a distribution. A positively skewed distribution has most of its scores bunched up at the lower end (left side) of the distribution.
78. **Post-hoc comparisons.** Unplanned comparisons, one wishes to make after the data have been gathered. It is usually carried out if there is significant difference between two groups (pairwise comparisons) covering the different levels of the variable under study.
79. **Predictor variable.** The variable from which the criterion variable is found out in a prediction study.
80. **Probability.** The term probability does not allow a concrete definition; it can be defined in different ways. In simple, probability is the ratio of favourable number of outcomes divided by total number of outcomes in any one trial or experiment.
81. **Qualitative variable.** A character or property, such as blood group, gender or nationality, which can be expressed in kind and not in numbers. It is an attribute and is descriptive in nature.
82. **Quantitative variable.** A variable whose differing status can be expressed in numbers. Characteristics like height, weight, length, etc. are measured quantitatively.
83. **Range.** The difference between the lowest score and the highest score.
84. **Rank.** When a set of data is ordered from lowest to highest, the rank of a score is its position in this order.
85. **Regression.** The prediction of scores on one variable by their scores on a second variable. The larger the correlation between the variables, the more accurate the prediction. We can undertake a multiple regression where the scores on one variable are predicted from the scores on a number of predictor variables.
86. **Reliability.** A reliable test is one that that will produce the same result when repeated (in the same circumstances). We can investigate the reliability of the items in a test (such as the questions in a questionnaire) by examining the relationship between each item and the overall score on the test.
87. **Repeated measures.** A term used to indicate that the same subjects (participants) are providing data for all the conditions of an independent variable; also known as ‘within subjects’.
88. **Residual.** A residual is the difference between an actual score and a predicted score. If scores are predicted by a model (such as the normal distribution curve) then the residual will give a measure of how well the data fit the model.
89. **Sample.** A smaller collection of units from a population used to determine the characteristics or truth of the population.
90. **Sampling distribution.** The probability distribution of a statistics. If a large number of samples are drawn from the population and some statistics calculated, for example mean, we would

create a frequency distribution of mean. The resulting distribution will form the sampling distribution of means.

91. **Scatterplot.** A scatterplot is a plot of points on coordinate axes (X and Y-axis) used to represent and illustrate the relationships between two quantitative variables.
92. **Skewed.** A distribution is skewed if majority of the scores are bunched up at one end or the other.
93. **Spearman's rho.** The most common correlation for use with two ordinal variables or an ordinal and an interval variable. Rho for ranked data equals Pearson's r for ranked data.
94. **Standard deviation.** An estimate of average spread (variability) of a set of data measured in the same units of measurement as the original data. It is the square root of variance.
95. **Standard error.** The standard deviation of the sampling distribution of a statistic. For example, mean is a statistic, standard error tells how much the sample means differ from the population mean. The larger the standard error the greater is the possibility that the sample may not be an accurate reflection of the population from which the sample came.
96. **String variable.** Variable involving words, i.e., letter strings (e.g., gender, blood group, etc.).
97. **Sum of squares.** An estimate of total variability of a set of data. First the deviation for each score is calculated and then this value is squared and summed up. It is denoted by SS .
98. **Syntax.** Pre-defined written commands that instruct SPSS what the user would like to do.
99. **SIG. (2-tailed).** The exact probability of the test statistic for a two tailed prediction.
100. **Significance level.** The risk (probability) of erroneously claiming a relationship between an independent and a dependent variable when there is not one. Statistical tests are undertaken so that this probability is chosen to be small, usually set at 0.05 indicating that this will occur no more than 5 times in 100.
101. **Simple main effects.** A significant interaction in a two factor analysis of variance indicates that the effect of one variable is different at the various conditions of the other variable. Calculating simple main effects tells us what these different effects are. A simple main effect is the effect of one variable at a single condition of the other variable.
102. **Skew.** The degree of symmetry of a distribution. A symmetrical distribution, like the normal distribution, has a skew of zero. The skew is negative if the scores 'pile' to the right of the mean and positive if they pile to the left.
103. **Sphericity.** An assumption we make about the data in a repeated measures design. Not only must we assume homogeneity of variance but homogeneity of covariance – that is, homogeneity of variance of the differences between samples. Essentially, we must assume the effect of an independent variable to be consistent across both conditions and subjects in these designs for the analysis to be appropriate.
104. **Standard deviation.** A measure of the standard ('average') difference (deviation) of a score from the mean in a set of scores. It is the square root of the variance. (There is a different calculation for standard deviation when the set of scores are a population as opposed to a sample.)
105. **Standard error of the estimate.** A measure of the 'average' distance (standard error) of a score from the regression line.
106. **Standard error of the mean.** The standard deviation of the distribution of sample means. It is a measure of the standard ('average') difference of a sample mean from the mean of all sample means of samples of the same size from the same population.

107. **Standard score.** The position of a score within a distribution of scores. It provides a measure of how many standard deviation units a specific score falls above or below the mean. It is also referred to as a *z* score.
108. **Statistic.** Specially, a characteristic of a sample, such as the sample mean. More generally, statistic and statistics are used to describe techniques for summarising and analysing numerical data.
109. **Statistics viewer.** The SPSS Statistics Viewer is the name of the file that contains all of the output from the SPSS procedures. Often referred to (as in this book) as the Output Window.
110. **Subject.** The term used for the source of data in a sample. If people are the subjects of the study it is viewed as more respectful to refer to them as participants, which acknowledges their role as helpful contributors to the investigation.
111. **Sums of squares.** The sum of the squared deviations of scores from their mean value.
112. ***t*-test.** A statistical procedure to find the significance of difference between two groups. The means of both groups are compared to each other.
113. **Test statistic.** The calculated value of the statistical test that has been undertaken.
114. **Two-tailed test.** A prediction that two samples come from different populations, but not stating which population has the higher mean value.
115. **Type I error.** The error of rejecting the null hypothesis when it is true. The risk of this occurring is set by the significance level.
116. **Type II error.** The error of not rejecting the null hypothesis when it is false.
117. **Total sum of squares** An estimate of total variability in a data set. It is the total squared deviations between each observation and from the overall mean of all observations.
118. **Univariate.** A term used to refer to a statistical test where there is only one dependent variable. ANOVA is a univariate analysis as there can be more than one independent variable but only one dependent variable.
119. **Variable view.** One of the two ways to view the contents of the data editor. It has a spreadsheet for entering the name and details of the variable.
120. **Variable.** A property or characteristic on which the data are collected. There are qualitative and quantitative variables.
121. **Variance.** The average amount of dispersion or spread in a distribution. The deviations from the mean are squared and summed up to find variance.
122. **Value labels.** Assigning value labels within the Variable View screen in SPSS ensures that the output is labelled appropriately when grouping variables are used – for example, 1 = males, 2 = females.
123. **Weighting/loading.** The contribution made to a composite value (such as a regression equation or a factor in a factor analysis) by a variable. We use the calculated size of the weighting to assess the importance of the variable to the factor in a factor analysis.
124. **Within subjects.** Also known as repeated measures. We select the same subjects (participants) for each condition of an independent variable for a within subjects design.
125. **Wilcoxon signed-rank test.** A non-parametric test which is used to test the difference between two related samples. It is a non-parametric equivalent to a matched pair *t*-test.
126. **Z-score.** A conversion of a raw score on a test to a standardized score represented in units of standard deviations. This is a commonly used statistical procedure that is used to compare scores of tests that might not be measured on the same scale.

Statistical Methods

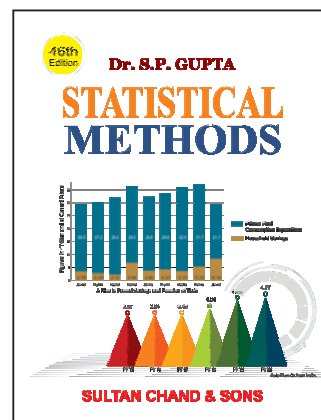
S.P. Gupta

About the Book

Statistical Methods are playing an ever-increasing role in framing suitable policies in a large number of diversified fields covering natural, physical and social sciences. Statistics today has become indispensable in all phases of human endeavour. This book is primarily meant for undergraduate students of Commerce and Economics. This book entitled “Statistical Methods” was first published in 1969.

Salient Features

- The book is written in a very simple and lucid style.
- For the first time the book is being published in the broader form on the initiative of the publisher, Sultan Chand & Sons.
- It caters to the requirements of under-graduate as well as post-graduate students of Commerce, Economics and Management.
- The Engineering, Medical and Research students can also refer to the book to meet their specific requirements.
- The book is non-mathematical in character.
- Besides good theory it contains more than 1,500 Illustrations and about more than 2,000 exercise questions for better understanding of the subject.
- A large number of questions have been picked up from the examination papers of leading Universities.
- Hints to ticklish problems have been given wherever necessary.



Edition: 46th, 2021; Pages: xxiv + 1304; Size: 180 × 240 mm; ISBN: 978-93-5161-176-9 (TC-506)

Fundamentals of MATHEMATICAL STATISTICS

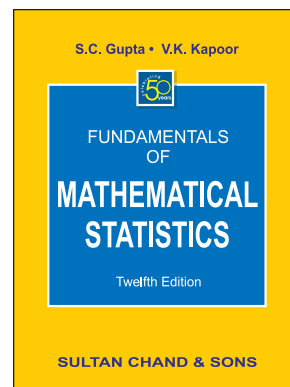
S.C. Gupta • V.K. Kapoor

About the Book

A textbook written completely on modern lines for undergraduate & post graduate courses in Statistics, Mathematics, Economics, Computer Science, Engineering and Indian Civil Services & Indian Statistical Service Examinations. The thoroughly revised, (Golden Jubilee) TWELFTH EDITION of this indispensable, authoritative, well-written & best selling textbook, while retaining its analytical and modern approach now includes a large number of new topics, extensively revised and rewritten material, updated information and various distinct new features.

Salient Features

- The book has been written in a very simple and lucid style. The text material is self-explanatory and even the students learning statistics through distance education can follow it without much stress and strain.
- The treatment is non-mathematical in character and the readers can easily understand the text material without much taxing their minds.
- Besides good theory the book contains a large number of solved illustrations (to be exact, 885). These illustrations have been very carefully selected mainly from the latest examination question papers of various Universities all over India and neighbouring countries.
- This book is primarily meant to cater to the needs of under-graduate and post-graduate students of Commerce, Economics, Management and Professional Courses.



Edition: 12th, 2020; Pages: xx + 1324; Size: 185 × 240 mm; ISBN: 978-93-5161-173-8 (TC 499)

A Textbook of Research Methodology in Management and Social Sciences

P.C. Tripathi

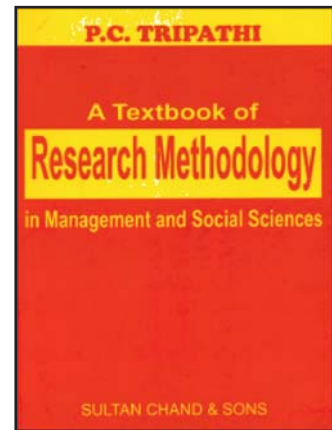
About the Book

Research in social sciences has become very popular in our country in recent years. At the individual level, M.Phil., and Ph.D. programmes have added impetus to research. At the organisational level, new awareness has developed among corporate organisations to take research-based decisions instead of relying on institution. Social research involves a logical series of steps right from selecting a topic to writing a report.

Salient Features

- Comprehensive description of each topic
- Lucid and simple language
- Real world examples
- Solved exercises and objective questions (with answers)
- Conformity to the core syllabus

Edition: 7th, 2014; Pages: xx + 388; Size: 185 × 240 mm; ISBN: 978-93-5161-013-7 (TC 237)



Fundamentals of Applied Statistics

S.C. Gupta • V.K. Kapoor

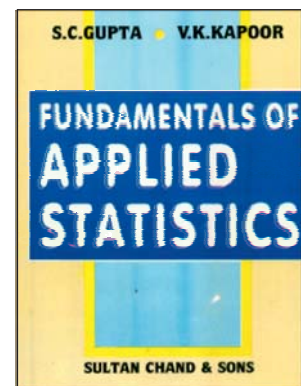
About the Book

The 4th thoroughly revised edition is one of the best-selling textbook for all introductory and advance courses in Applied Statistics, while retaining its analytical and modern approach. The textbook has been written completely on modern lines for undergraduate and postgraduate courses in Statistics, Management, Engineering, Agriculture, Sciences, Economics, Computer Science Courses and Indian Civil Services and Indian Statistical Service Examination

Salient Features

The book provides comprehensive and exhaustive theoretical discussion. All basic concepts have been explained in an easy and understandable manner. 125 stimulating problems selected from various university examinations have been solved. It conforms to the latest syllabi of B.Sc. (Hons.) and postgraduate examinations in Statistics, Agriculture and Economics.

Edition: 7th, 2019; Pages: xx + 708; Size: 185 × 240 mm; ISBN: 978-81-8054-708-8 (TC 502)



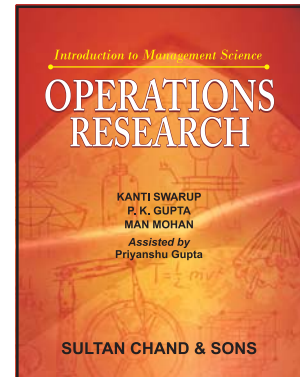
Operations Research

Kanti Swarup • P.K. Gupta • Man Mohan

Assisted by: Priyanshu Gupta

About the Book

For over four decades, Operations Research : An Introduction to Management Science has provided its readers with a sound conceptual understanding of various mathematical approaches and techniques that have shaped management science. Operations research methods / techniques have laid the foundations for a scientific approach to managerial decision-making and have become increasingly popular in recent times. This book aims to make these concepts and methods easily understandable, enabling its readers to appreciate the role of 'Management Science' in the organizational decision-making processes. The book is intended to serve as a core textbook for the students who can equip themselves with a robust understanding of operations research concepts before applying them directly to real-life business problems.



Salient Features

- This thoroughly revised and enlarged edition of the book presents the fundamental concepts of Operations Research in a comprehensive yet easy-to-understand manner.
- The text uses simple language, lucid style, cogent presentation and clarity of exposition. It is self-contained and adopts a practical approach to learning.
- The book focuses on marrying theories and concepts with their practical applications. There is an adequate emphasis on real-life applications from different spheres of business.
- All the chapters have been reorganized and re-written to facilitate an easier grasp of the core concepts being discussed.
- A wide variety of examples and illustrations have been included in the chapters to give hands-on practice in applying the methodology of Operations Research to real-world scenarios.
- At the end of each chapter, conceptual questions in the form of "Test Your Understanding" and a "Review Exercise" are given for adequate practice.
- The chapter on 'Decision Theory' has been thoroughly revised to emphasize problem formulation and structuring of the decision-making problems.
- The chapter on 'Operations Scheduling' has been dealt with at greater length owing to its increasing importance in the current business environment.
- A new chapter on 'Statistical Quality Control' is a fresh addition to this edition of the book. This has been done to recognize the tremendous importance of maintaining the quality of output and processes to the survival of any industry / firm.
- All the critical steps of the computational procedure for the important techniques have been presented in a step-by-step algorithm format. It can not only ease learning but can also serve as a ready reckoner for decision-making situations.
- To enhance the understanding of the subject by readers of various disciplines, a conceptual approach is adopted wherein discussion and presentation of each concept are followed by numerous illustrations from different functional areas of management.
- A novel feature of this text is the inclusion of a chapter on 'Case Problems'. These have been derived from real-life examples of critical decision-making situations that management professionals have encountered.

Quantitative Techniques and Operations Research

P.K. Gupta • S.P. Gupta

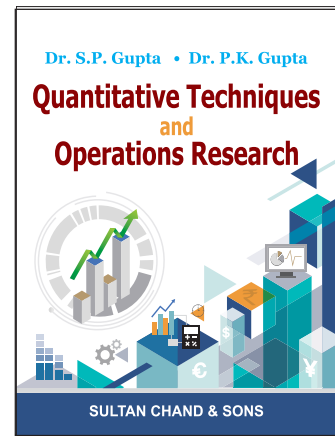
About the Book

This book on Quantitative Techniques and Operations Research provides a conceptual understanding of basic quantitative techniques/methods used in solving managerial problems. It discusses comprehensively the essential topics of quantitative decision-making by using illustrations and examples. With revised and updated contents, this edition of the book will be useful to the students pursuing the undergraduate programme in Management and Commerce.

Salient Features

- The chapters on Linear Programming Problems are rewritten and have been designed to take the reader through gradual increase in complexity. Chapter 2 of part II is completely dealt with the formulation of linear programming models from business and economics.
- Given its importance in the current business environment, chapter on Operations Scheduling has been dealt with at length.

Edition: 4th, 2022; Pages: xvi + 592; Size: 185 × 240 mm; ISBN: 978-93-5161-182-0 (TC 1017)



Business Statistics & Business Mathematics

S.P. Gupta • P.K. Gupta

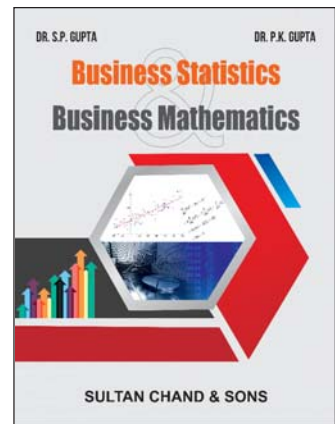
About the Book

This text book covers complete syllabus in Business Mathematics & Business Statistics paper of B.Com. 2nd year students. Book has been designed strictly according with the latest updated syllabus prescribed by University of Delhi. Besides revising and simplifying the text, a number of illustrations and examples are added to explain various concepts introduced in the text. Also, new problems mostly from recent university examinations have been added in this edition. At the same time old stereotype problems have been removed. In fact the whole book has been rewritten and given a new look altogether.

Salient Features

- Book covers complete syllabus in Business Mathematics & Business Statistics paper of B.Com. examination.
- There are detailed self-contained chapters on all the syllabus elements.
- Part I of the book starts with the introduction to Statistics and discusses measures of central tendency and of variation, correlation & regression analysis, index numbers, time series and interpretation of data.
- Part II of the book begins with introducing the concept of matrices and determinants. Their applications to business and economic problems are discussed in this chapter.
- Concept of differentiation & integration along with their applications are given in chapters 3 & 4 of part II.
- The language used in text is simple and the subject matter has been presented in a lucid and straightforward style.
 - Special care has been taken to develop the concepts in an easy to understand manner and are self explanatory.
 - The book does not require any previous knowledge of the subject.

Edition: 5th, 2022; Pages: xxxvi + 740 ; Size: 185 × 240 mm; ISBN: 978-93-5161-143-1 (TC 1131)



About the Book

The edition contains significant additional input in almost every chapter of the book. It provides enhanced insights into issues from emerging countries' business. The practical examples cover all aspects of parametric and non-parametric tests which are relevant for business in emerging countries. This edition includes several new cases and examples which would help students comprehend the research methodologies illustrated in each chapter. This edition will equip students with the knowledge of skills involved in this basic research process.

Overview of the Book

Research methodology is taught as a supporting subject in several ways in many academic disciplines such as education, psychology, social work, library studies and marketing research. The core philosophical base for this book comes from my conviction that, although these disciplines vary in content, their broad approach to a research enquiry is similar. This book, therefore, is addressed to these academic disciplines and business people. This textbook provides the readers with an understanding of the Introduction to Research, Types of Research, Steps in Research Process, Identification of Research Problems, Importance of Review of Literature, Research Design, Methods of Data Collection, Hypothesis, Sampling Techniques, Introduction to SPSS, Descriptive Statistics, Cross tabulation, One Sample t-Test, Paired Sample t-test, One Way ANOVA, Two Way ANOVA, Factorial ANOVA, MANOVA, Chi-Square Test, Non- Parametric Test, MANN Whitney Test, Wilcoxon Test, Kruskal -Wallis Test, Friedman Test, Correlation Analysis, Multiple Regression Analysis, Factor Analysis, Cluster Analysis, Multi - Dimensional Scaling, Discriminate Analysis, Canonical Correlation, Overview of Structural Equation Model (SEM) and Report Writing. It uses simple examples to demystify complex theories and methodologies. This well-organized book deals with the variety of research methods and tools used in management and social sciences with application of SPSS. A Handbook of Research Methodology is recommended for use in undergraduate and postgraduate courses focusing on research methodologies in various disciplines.

About the Authors

Dr. P. Sundara Pandian, M.Com., M.B.A, M.Sc., M.A., M.Phil., P.G.D.C.A., P.G.D.M.I.R., Ph.D., is a writer and thinker in Commerce and Management subjects for more than thirty two years. He is the Principal of V.H.N. Senthikumara Nadar College (Autonomous), Virudhunagar since 2011. He has completed one UGC Major Research Project. He has produced 43 M.Phil., and 17 Ph.D scholars. He has credit in authoring 45 books and published 265 research articles in National, International Journals and in edited books. He was the recipient of Best Teacher Award by Tamil Nadu Council for Higher Education in the year 2007-2008. He has organized a number of UGC, TANCHE and NAAC sponsored programmes for the benefit of faculty members and students. He is one of the accreditation Member in NAAC Peer team.



Dr. S. Muthulakshmi, M.Com., M.Phil., NET, Ph.D., is an Assistant Professor in Department of Commerce, VHNSN College (Autonomous), Virudhunagar. She is having a teaching experience of more than 16 years. She has produced 6 M.Phil., and 2 Ph.D scholars. She has conducted a number of SPSS programmes at State and National Level. To her credit she has authored 4 books and published 40 articles in National, International Journals and in edited books. She has completed a Minor Research Project funded by University Grants Commission. She has organized a number of UGC, ICSSR and RGNIYD sponsored programme for the benefit of student community. She has also been conferred with Michael Aldrich Distinguished Women Researcher Award in commerce from IMRF and Red Talks International.



Dr. T. Vijayakumar is an Assistant Professor in Department of Economics, V.H.N.Senthikumara Nadar College (Autonomous), Virudhunagar, Tamil Nadu. He has over 16 years of experience in teaching, research and consultancy. He has successfully completed Minor Research Project funded by UGC, New Delhi and Student's Research Project funded by Malcom Adiseshiah Trust, Chennai. He has presented and published 24 papers in various National and International level seminars and published 14 articles in UGC Care Journal. He has also been extensively involved in conducting State and National Level workshop on "Applications of Statistics Using SPSS" and "Applications of Bio-Statistics Using SPSS" for research scholars, faculties of Arts and Sciences.



Sultan Chand & Sons
Publishers of Standard Educational Textbooks

23 Daryaganj, New Delhi-110002
Phones : 011-23281876, 23277843, 23266105
Email : sultanchand74@yahoo.com
info@sultanchandandsons.com
Website : sultanchandandsons.com



ISBN 978-93-91820-18-3



TC-1256