### DETAILED CONTENTS

Brief contents i	111
Preface xvii	
About the author	xviii

### CHAPTER 1

AN INTRODUCTION TO SEM AND SMARTPLS 1	
A brief history of the development of SEM 2	
The main fields of SEM research 3	
Types of SEM models 5	
The relationships between variables in SEM models 6	
The concept of SEM analysis 9	
The methods of analysis in SMARTPLS 4 11	
The PLS-SEM method 11	
The CB-SEM method 13	
The PROCESS method 16	
The REGRESSION method 17	
Multiple linear regression analysis 17	
Multiple logistic regression analysis 18	
Necessary condition analysis 19	
Types of research models 20	
Regression models 20	a de la compansión de l
Multivariate models 21	
Complex models 23	
Mediation models 23 Parallel mediators 25	
Sequential mediators 26	
Shared mediators 26	
Moderation models 27	
Moderated mediation models 28	
Sample size determination 30	
Determining sample sizes based on power analysis	30
Determining sample sizes by referring to the	
parameters to be estimated in the model 32	
Determining sample sizes based on the population s	sizes 36
Summary 39	
Exercises 39	

### **CHAPTER 2**

### ANALYZING PLS-SEM MODELS 41

The concept of PLS-SEM 41
Restrictions of PLS-SEM models 42
Non-recursive models are not allowed 42
Shared indicators are not allowed 43
A latent variable without any indicator is not allowed 44
The indicators in a latent variable cannot use different measurement scales
44
The procedure of PLS-SEM analysis 45
The examples for PLS-SEM data analysis 45
EXAMPLE 2-1
ANALYZING A REFLECTIVE PLS-SEM MODEL 45
The effects of leadership skills on work-awareness, work-mindset, and work
efficiency 45
First step: creating a project, importing the data, and drawing the PLS-SEN model 48
Creating the project and importing the data into SMARTPLS 48  Drawing the PLS-SEM model 51
Second step: analyzing the measurement models for validity and reliability
53
Convergent validity and reliability 54
Discriminant validity 57
Fornell-larcker 58
Cross-loadings 58
Heterotrait-monotrait ratio (HTMT) 59
Collinearity analysis 60
Third step: analyzing the structural model for the effects of leadership skills
61 State Isham make regar and to the Isham and repair to the state of
The effects in the structural model 61
The effect sizes 63
Fourth step: analyzing model fit of the multivariate model 64
Fifth step: analyzing the predictive power of the multivariate model 65
PLSpredict 65
Determining the predictive power of the multivariate model 65
Determining the level of the predictive power 67
Cross-validated predictive ability test (CVPAT) 70
Sixth step: analyzing importance-performance of the multivariate model 72
Final step: reporting the results of the PLS-SEM analysis 77

### **EXAMPLE 2-2**

### ANALYZING A PLS-SEM REGRESSION MODEL WITH A MIXTURE OF REFLECTIVE MODELS AND FORMATIVE MODELS 80

The effects of teacher qualities, learning culture and school reputation on school performance 80

First step: creating a project, importing the data, and drawing the PLS-SEM model 82

Creating the project and importing the data into SMARTPLS 82

Drawing the PLS-SEM model 84

Second step: analyzing the measurement models for validity and reliability 86

Construct validity and reliability of the reflective models of learning culture and school reputation 88

Discriminant validity 89

Fornell-larcker 90

Cross-loadings 90

Heterotrait-monotrait ratio (HTMT) 91

Collinearity analysis 91

Analyzing construct validity of the formative models of teacher qualities and school performance 92

The first formative model: teacher qualities 92

Redundancy analysis 92

Collinearity analysis 95

The second formative model: school performance 96

Redundancy analysis 96

Collinearity analysis 97

Third step: analyzing the structural model for the effects of the three predictors on school performance 97

The effects in the structural model 97

The effect sizes 100

Fourth step: analyzing model fit of the regression model 102

Fifth step: analyzing the predictive power of the regression model 102

Determining the predictive power of the regression model 102

Determining the level of the predictive power 103

Analyzing cross-validated predictive ability of the model 106

Sixth step: comparing importance-performance of the predictors in the regression model 107

Comparing importance-performance between the predictors 107

Comparing importance-performance between the indicators in the regression model 109

Final step: reporting the results of the PLS-SEM analysis 111

#### **EXAMPLE 2-3**

### ANALYZING A PLS-SEM MODEL FOR MEDIATING EFFECT AND MODERATING EFFECT 115

The mediating effect of empowerment and the moderating effect of ICT knowledge on the causal relationship between transformational leadership and service quality 115

The concept of mediating effects 117

The concept of moderating effects 119

First step: creating a project, importing the data, and drawing the PLS-SEM model 122

Creating the project and importing the data into SMARTPLS 122

Drawing the model to analyze the mediating effect and the main effect with the existence of the moderator 124

Second step: analyzing the measurement models for validity and reliability 125

Construct validity and reliability 125

Discriminant validity 128

Fornell-larcker criterion 128

Cross-loadings 129

Heterotrait-monotrait ratio (HTMT) 129

Collinearity analysis 130

Third step: analyzing the mediating effect and the moderating effect 130

Analyzing the mediating effect 131

Analyzing the moderating effect 135

The moderating effect 136

The simple slope analysis 137

Final step: reporting the results of the PLS-SEM analysis 138

### **EXAMPLE 2-4**

### ANALYZING A COMPLEX MODEL FOR CROSS-FIELD PREDICTION 14

The cross-field prediction ability of the work performance model in the field of educational psychology 141

First step: creating a project, importing the data, and drawing the PLS-SEM model 143

Creating the project and importing the data into SMARTPLS 143

Drawing the PLS-SEM model 145

Second step: analyzing the measurement models for validity and reliability 146

Construct validity and reliability 147

Discriminant validity 149

Collinearity analysis 150

Third step: analyzing the structural model for the effects of the seven direct and indirect predictors on work performance 152

The effects in the structural model 152

The effect sizes 154

Fourth step: analyzing model fit of the complex model 156

Fifth step: analyzing the predictive power of complex model 157

Determining the predictive power of the complex model 157

Analyzing cross-validated predictive ability of the work performance model 159

Sixth step: comparing importance-performance of the seven direct and indirect predictors in the complex model 160

Final step: reporting the results of the PLS-SEM analysis 163

### **EXAMPLE 2-5**

### ESTABLISHING VALIDITY AND RELIABILITY OF A RESEARCH INSTRUMENT USING CONFIRMATORY FACTOR ANALYSIS 166

Establishing validity and reliability of a research istrument with a formative-reflective two-order model 166

Analyzing the formative-reflective two-order model using the two-stage approach 168

First step: creating the project, importing the data and drawing the formativereflective two-order model 168

Second step: analyzing indicators of the formative-reflective two-order model of work attitude 173

Third step: stage 1 - analyzing the construct validity of the formative firstorder models 176

The formative first-order models of work commitment 176

Redundancy analysis 176

Collinearity analysis 179

The formative first-order models of work engagement and work motivation 180

Redundancy analysis 180

Collinearity analysis 182

Fourth step: stage 2 - assessing construct validity and reliability of the reflective second-order model of work attitude 182

Modifying the hypothesized model 183

Extracting latent variable scores of the models 184

Construct validity and reliability analysis for the reflective second-order model of work attitude 185

Collinearity analysis 187

Final step: reporting the results of the PLS-SEM analysis 188 Exercises 189

### **CHAPTER 3**

#### ANALYZING CB-SEM MODELS 193

Advantages of using CB-SEM 194

Assumptions of CB-SEM 195

Normality of data 195

Sample sizes 198

Identification of parameters 198

Limitations of CB-SEM 198

Characteristics of CB-SEM models 199

Model fit indices 200

Restrictions in CB-SEM models 201

Model modification 201

#### **EXAMPLE 3-1**

### ANALYZING A REGRESSION MODEL USING CB-SEM 202

The effects of humor, IQ, and openness on emotional intelligence 202 First step: creating the project, importing the data and assessing normality of the data 204

pour authorizate and to validation but unbiller tourisation generations

WAIR HAY AUTHO DE ZUR IN AME OT BOILD GETE YOUTEA

BIRTH A ROBIDER SHE SHIRY MARK

2.191216.1822 outstand outstanding

lente vill dispertantemente la politica de la leve bereix de la company

commoltes dei bre assalles

Marin Fibiari a marin de la constante de la co

Creating a project and importing the data 204

Assessing normality of the data 206

Second step: drawing the CB-SEM model 206

Third step: analyzing the measurement models for validity and reliability 209

Construct validity and construct reliability 209

Discriminant validity 214

Fourth step: analyzing relationships between the variables in the structural model 215

Fifth step: analyzing model fit for the CB-SEM model 219

Sixth step: conducting model modification to improve model fit 221

The residual covariances elimination method 221

The error terms correlation method 222

Duplicating the model and drawing covariances between error terms 223

Identifying pairs of error term correlations 225

Modifying the model with the error term correlations method and analyzing model fit 227

Balletini. 1981 I I I I A M. at Indiana beriapan en l'est en sagrage de l'est

Seventh step: assessing the effects in the CB-SEM model 230

Final step: reporting the results of CB-SEM analysis 232

#### **EXAMPLE 3-2**

### ANALYZING THE EFFECTS OF A REFLECTIVE-REFLECTIVE TWO-ORDER MODEL IN A MEDIATION MODEL USING CB-SEM 235

The mediating effect of job commitment on the causal relationship between wellness and job performance 235

First step: creating a project, importing the data and analyzing normality of

the data 237

Creating the project in the workspace 237

Importing the data into SMARTPLS 238

Normality of the data 239

Second step: analyzing the construct validity and reliability of the reflectivereflective two-order model of wellness 239

Drawing the two-order model of wellness 240

Analyzing construct validity and reliability of the two-order model of wellness 243

Convergent validity 243

Construct validity and construct reliability 245

Discriminant validity (HTMT and latent variable correlations) 246

Assessing model fit for the two-order model of wellness 247

Third step: analyzing discriminant validity among variables in the mediation model 249

Fourth step: analyzing validity and reliability of the two single-order models 251

Fifth step: analyzing the effects in the mediation model 252

Sixth step: analyzing model fit and conducting model modification to improve model fit 253

Analyzing model fit 253

Duplicating the model and drawing covariances between error terms 255

Identifying the pairs of error term correlations 256

Modifying the model with the error term correlations method and analyzing model fit 258

Seventh step: analyzing relationships between the variables in the CB-SEM model 260

Final step: reporting the results of the analysis 263

### **EXAMPLE 3-3**

### ANALYZING A NON-RECURSIVE MEDIATION MODEL 266

Confirming the non-recursive relationships between motivation and positive thinking in a mediation model 266

First step: preparing the hypothesized model in SMARTPLS 268

Creating a project, importing the data, assessing normality of data and drawing the CB-SEM model 268

Importing the data into SMARTPLS 269

Drawing the CB-SEM model 270

Second step: analyzing validity and reliability of the measurement models and assessing model fit 272

shom a si laband uitr sorbailw galamaatsb rasia diffi

de serveis de l'exces deux dans elle flexalesses filles et les

streams of the configuration countries

Construct validity and construct reliability 272

Discriminant validity 273

Model fit 274

Third step: model confirmation 275

Fourth step: modifying the non-recursive mediation model 277

Fifth step: assessing model fit of the final mediation model 279

Final step: reporting the results of the analysis 281

Exercises 282

#### **CHAPTER 4**

### ANALYZING MODERATED MEDIATION MODELS WITH CONTROL VARIABLES USING PROCESS 285

Introduction to PROCESS 285

Analyzing moderated mediation models using PROCESS 286

The differences between moderated mediation and mediated moderation 287

Mediated moderation models 288

Moderated mediation models 288

Analyzing moderated mediation models by controlling covariates 289

The assumptions of data for PROCESS analysis 290

Combining PLS-SEM and PROCESS in an analysis 290

### **EXAMPLE 4-1**

## ANALYZING A MEDIATED MODERATION MODEL BY CONTROLLING A SELECTED COVARIATE 291

The effects in the mediated moderation model of work performance after controlling age 291

First step: preparing the model in PLS-SEM 294

Creating a project, importing the data and drawing the PLS-SEM model 294

Importing the data into SMARTPLS 295

Normality of the data 296

Drawing the PLS-SEM model 296

Second step: stage 1 - analyzing the measurement models for validity and reliability 297

Construct validity and construct reliability 298

Discriminant validity 301

Collinearity analysis 301

Third step: generating latent variable scores form the PLS-SEM model 302 Fourth step: stage 2 - analyzing the effects in the mediated moderation model using PROCESS 304

Drawing the PROCESS model 304

Analyzing the mediated moderation model 306

Fifth step: determining whether the model is a moderated mediation model or a mediated moderation model 310

Sixth step: analyzing the mediated moderation model by controlling the covariate age 311

Seventh step: determining the conditional indirect effects in the mediated moderation model by controlling age 314

Eighth step: comparing the effects in the mediated moderation model between controlling and not controlling age 314

Final step: reporting the results of the PROCESS analysis 315

#### **EXAMPLE 4-2**

# VALIDATING A MODERATED MEDIATION MODEL BY CONTROLLING A SELECTED COVARIATE 318

The effects in the moderated mediation model of academic performance by controlling the covariate openness to experience 318

First step: preparing the moderated mediation model in PLS-SEM 320 Creating a project, importing the data and drawing the PLS-SEM model 320

Importing the data into SMARTPLS 321

Drawing the PLS-SEM model 322

Second step: stage 1 - analyzing the validity and reliability of the variables 323

Construct validity and construct reliability 324

Discriminant validity 326

Collinearity analysis 327

Third step: generating latent variable scores form the PLS-SEM model 328 Fourth step: step 2 - analyzing the moderating effect in the mediation model using PROCESS 329

Drawing the PROCESS model 329

Analyzing the moderated mediation model 331

Fifth step: analyzing the model by controlling the covariate openness 335 Sixth step: comparing the effects in the moderated mediation model between controlling and not controlling openness 338 Seventh step: modifying the model 339

Eighth step: analyzing the final model 340

Nineth step: comparing the effects in the final model between controlling and not controlling openness 343

MAIN HAY AUND IN A SHE SAME OF BUILD SETS YBRIDE &

Final step: reporting the results of the PROCESS analysis 344

Reflection: control or not control covariates? 345

Exercises 346

### **CHAPTER 5**

#### NECESSARY CONDITION ANALYSIS 348

The concept of necessary condition analysis 348

The differences between NCA and regression analysis 351

Types of necessary conditions 352

Dichotomy necessary conditions 352

Discrete necessary conditions 353

Continuous necessary conditions 353

Necessary condition analysis using SMARTPLS 353

The necessary condition analysis outputs 353

NCA charts 353

Accuracy 355

The influence of outliers on NCA 356

Ceiling line effect sizes 357

The bottleneck table 357

The NCA permutation analysis outputs 358

Bivariate NCA and multiple NCA 359

The procedure of NCA using SMARTPLS 359

### **EXAMPLE 5-1**

## ANALYZING A MULTIPLE NECESSARY CONDITION MODEL USING NCA 360

The effects in a multiple necessary conditions model of quality of performance 360

Writing the hypotheses for necessary condition analysis 361

First step: creating a project, importing the data and drawing the necessary condition model 362

Creating a project and importing the data into the SMARTPLS 362

Drawing the necessary condition model 364

Second step: analyzing the necessary condition model 366

Third step: determining the accuracy through NCA charts 367

Determining the accuracies of the necessary conditions 368

Determining ceiling line effect sizes 372

Fourth step: determining the significances of the necessary conditions 373 Fifth step: determining the minimum levels of the necessary conditions needed for the required levels of the outcome variable 374 Final step: reporting the results of the necessary condition analysis 377

### **EXAMPLE 5-2**

### COMBINING PLS-SEM AND NCA IN ANALYZING A MULTIPLE-INDICATOR NECESSARY CONDITIONS MODEL 379

The effects of ability and opportunity as necessary conditions on performance in human resource management 379

Analysis the data using SMARTPLS 4 380

First step: stage 1 - establishing validity and reliability of the variabels and analyzing the effects in the regression model using PLS-SEM 381

Creating a project, importing the data, and drawing the hypothesized model 381

Analyzing the three multiple indicators variables for validity and reliability 384

Construct validity and construct reliability 385

Discriminant validity 389

Collinearity analysis 389

Model fit analysis 390

Second step: analyzing the predictive power of the model 391

Determining the predictive power of the model 391

Analyzing cross-validated predictive ability of the model 392

Third step: stage 2 – conducting necessary condition analysis 394

Extracting latent variable scores from the three multiple indicators variables for necessary condition analysis 394

Drawing the necessary condition model 396

Analyzing the necessary condition model 397

Fourth step: determining accuracies, effect sizes and the levels of necessary condition needed using the NCA charts 398

Determining the accuracy of the necessary conditions with ceiling line charts 398

Determining the ceiling line effect sizes 401

Determining the significances of the necessary conditions 401

Determining the minimum levels of the necessary conditions needed for the required levels of the outcome variable 402

ere seda ara esda errasar adat perireramental.

Final step: reporting the results of the necessary condition analysis 405 Exercises 407

### **CHAPTER 6**

#### MULTIPLE REGRESSION ANALYSIS 409

Two types of multiple regression analysis 409

The multiple logistic regression test 410

The concept of multiple logistic regression analysis 411

Assumptions of the multiple logistic regression test 412

The odds ratios and effect sizes of the independent variables on the dependent variable 413

WATE MAY AUTO LESSE HAMS OF BOILD TETS YESTER

Calculating the odds ratio 413

The effect size based on the odds ratio 415

### **EXAMPLE 6-1**

### PREDICTING THE EFFECTS IN A MULTIPLE LOGISTIC REGRESSION MODEL 416

The effects of pollution, gender, lifestyle, personality, smoking habit, radon exposure, location of residence and job type on lung cancer 416

First step: creating a project, importing the data and drawing the multiple logistic regression model 418

Creating a project and importing the data into the SMARTPLS 418

Drawing the multiple logistic regression model 420

Second step: analyzing the multiple logistic regression model 421

Analyzing the effects of the predictors 422

Assessing multi-collinearity and odds ratios of the predictors 424

Third step: modifying the multiple logistic regression model 425

Assessing the effects of the predictors 425

Assessing multi-collinearity and odds ratios of the predictors 426

Fourth step: analyzing the predictive accuracy of the multiple logistic regression model 427

Fifth step: analyzing model fit of the multiple logistic regression model 428
Final step: reporting the results of the multiple logistic regression analysis
430

The concept of multiple linear regression analysis 432
Assumptions of the multiple linear regression analysis 433

### **EXAMPLE 6-2**

### ANALYZING A MULTIPLE LINEAR REGRESSION MODEL 435

The effects of first impression, likable character, romantic personality, passionate character, parental pressure, and physical look on attraction of love 435

First step: creating a project, importing the data and drawing the multiple linear regression model 437

Creating a project and importing the data into the SMARTPLS 437

Drawing the multiple linear regression model 439

Second step: analyzing the multiple linear regression model 440

Third step: determining whether the model meets the assumptions and analyzing the effects in the model 441

Multi-collinearity 442

Heteroskedasticity 443

Model fit 443

The effects of the predictors in the multiple linear regression model 444 Fourth step: modifying the multiple linear regression model 445

Modifying the multiple linear regression model and analyzing the effects in the model 445

Assessing collinearity, heteroskedasticity and model fit 446

The effects of the predictors in the model 447

The regression model derived from the research 448

Final step: reporting the results of the multiple linear regression analysis 448 Exercises 450

Closure 452

### REFERENCES 453

### APPENDIX 458

Table A: Guidelines for PLS-SEM measures 458

Table B: Guidelines for levels of predictive power of PLS-SEM models
459

Table C: Guidelines for CB-SEM model fit indices 459

Table D: Guidelines for ceiling line effect sizes of NCA 460

Table E: Guidelines for total effect sizes for multiple logistic regression analysis 460

Table F: Guidelines for individual effect sizes (odds ratio) for multiple logistic regression analysis 460

是是一个人,我们就是一个人的,我们就是一个人的,我们就是一个人的,我们就是一个人的,我们就是一个人的,我们就是一个人的。我们就是一个人的人的。我们就是一个人的人 第一章

### INDEX 461