Part I

BASIC ASPECTS OF CUSTOMER SATISFACTION SURVEY DATA ANALYSIS

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Standards and classical techniques in data analysis of customer satisfaction surveys

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Customer satisfaction studies are concerned with the level of satisfaction of customers, consumers and users with a product or service. Customer satisfaction is defined as 'The degree of satisfaction provided by the goods or services of a company as measured by the number of repeat customers' (www.businessdictionary.com). Customer satisfaction therefore seems to be an objective and easily measured quantity. However, unlike variables such as revenues, type of product purchased or customer geographical location, customer satisfaction is not necessarily observed directly. Typically, in a social science context, analysis of such measures is done indirectly by employing proxy variables. Unobserved variables are referred to as *latent variables*, whilst proxy variables are known as *observed variables*. In many cases, the latent variables are very complex and the choice of suitable proxy variables is not immediately obvious. For example, in order to assess customer satisfaction with an airline service, it is necessary to identify attributes that characterize this type of service. A general framework for assessing airlines includes attributes such as on-board service, timeliness, responsiveness of personnel, seating and other tangible service characteristics. In general, some attributes are objective, related to the service's technical characteristics, and others are subjective, dealing with behaviours, feelings and psychological benefits. In order to design a survey questionnaire, a set of observed variables must be identified.

In practice, many of the customer satisfaction surveys conducted by business and industry are analysed in a very simple way, without using models or statistical methods. Typical reports include descriptive statistics and basic graphical displays. As shown in this book, integrating a basic analysis with more advanced tools, provides insights into non-obvious patterns and

Modern Analysis of Customer Surveys: with applications using R, First Edition. Edited by Ron S. Kenett and Silvia Salini.
 Published 2012 by John Wiley & Sons, Ltd.

important relationships between the survey variables. This knowledge can significantly affect findings and recommendations derived from a survey.

After presenting classical customer satisfaction methodologies, this chapter provides a general introduction to customer satisfaction surveys, within an organization's business cycle. It then presents standards used in the analysis of survey data. Next it gives an overview on the techniques commonly used to measure customer satisfaction, along with their problems and limitations. Finally, it gives a preview and general introduction to the rest of the chapters in this book.

1.1 Literature on customer satisfaction surveys

Survey questionnaire design, data collection approaches, validation of questionnaires, sampling problems, descriptive statistics and classical statistical inference techniques are covered in many books and papers. This book presents such topics, but also provides a large range of modern and non-standard techniques for customer satisfaction data analysis. Moreover, these various techniques are compared by applications to a common benchmark data set, the ABC 2010 annual customer satisfaction survey (ACSS). For details on the benchmark data set and the ABC company, see Chapter 2.

A non-exhaustive list of relatively advanced books dealing with customer satisfaction data analysis includes Grigoroudis and Siskos (2010), Jacka and Keller (2009), Hayes (2008), Allen and Rao (2000), Johnson and Gustafsson (2000), Vavra (1997) and Biemer and Lyberg (2003). Grigoroudis and Siskos (2010) describe service quality models and the Multicriteria Satisfaction Analysis (MUSA), with examples of satisfaction barometers. Hayes (2008) gives special attention to reliability and validity of questionnaires with a link to customer loyalty. The book by Allen and Rao (2000) is most comprehensive in terms of statistical methods. Although not written by statisticians, it provides a useful and well-written description of techniques of descriptive analysis of univariate, bivariate and multivariate data; it also describes dependent models (linear and logistic regression), explanatory techniques (factor analysis, principal component analysis), causal models (path analysis), and structural equation models. Appendix C of Johnson and Gustafsson (2000) presents an interesting comparison of alternative data analysis methods, in particular considering (1) gap analysis, (2) multiple regression, (3) correlation, (4) principal component regression and (5) partial least squares (PLS). Vavra (1997) covers theories of customer satisfaction and loyalty with several examples of scales, analytic procedures and best practices. Biemer and Lyberg (2003) provide a comprehensive treatment of classical design and analysis of sample surveys.

This book is focused on statistical models for modern customer satisfaction survey data analysis. It addresses modern topics such as web surveys and state-of-the-art statistical models such as the CUB model and Bayesian networks (BN). The book chapters, written by leading researchers in the field, use practical examples in order to make their content also accessible to non-statisticians. Our ultimate goal is to advance the application of best practices in the analysis of customer satisfaction survey data analysis and stimulate new research in this area. As stated in the book foreword by Professor David Hand, we aim to make a difference.

1.2 Customer satisfaction surveys and the business cycle

Statistical analysis is a science that relies on a transformation of reality into dimensions that lend themselves to quantitative analysis. Self-administered surveys use structured questioning

designed to map out perceptions and satisfaction level, using a sample of observations from a population frame, into data that can be statistically analysed. Some surveys target all customers; they are in fact a type of census. In others, a sample is drawn and only customers in the sample receive a questionnaire. In drawing a sample, several sampling schemes can be applied. They range from probability samples such as cluster, stratified, systematic or simple random sampling, to non-probability samples such as quota, convenience, judgement or snowball sampling. For more on the different types of surveys, see Chapters 3 and 7.

The survey process consists of four main stages: planning, collection, analysis and presentation. Modern surveys are conducted with a wide variety of techniques, including phone interviews, self-reported paper questionnaires, email questionnaires, internet-based surveys, SMS-based surveys, face-to-face interviews, and video conferencing.

In evaluating the results of a customer satisfaction survey three questions need to be asked:

1. Is the questionnaire properly designed?
2. Has the survey been properly conducted?
3. Has the data been properly analysed?

More generally, we ask ourselves what is the quality of the data, what is the quality of the data analysis, and what is the quality of the information derived from the data (for more on *information quality*, see Kenett and Shmueli, 2011). Addressing these questions requires an understanding of the survey process, the organizational context and statistical methods.

Customer satisfaction surveys can be part of an overall integrated approach. *Integrated models* are gaining much attention from both researchers and practitioners (Rucci *et al.*, 1998; MacDonald *et al.*; 2003; Godfrey and Kenett, 2007). Kenett (2004) presents a generic integrated model that has been implemented in a variety of industries and businesses. The basic building blocks of the model are data sets representing the voice of the customer, the voice of the process and the voice of the workforce. The integration of these, through BN or other statistical methods, provides links between the variables measured on these three dimensions. These links can show, for example, the extent to which satisfied employees generate happy customers and improved financial performance. As an example, the integration at Sears Roebuck has shown that a 5-point increase (out of 100) in employee satisfaction results in an increase of 1.5 units (out of 5) in customer satisfaction, which resulted in a 0.5% increase in revenue growth (Rucci *et al.*, 1998). For more on integrated models, see Chapter 5.

In handling customer satisfaction, several statements are commonly made on the impact of increased customer loyalty and satisfaction. These are based on practical experience and research (see, for example, http://tarp.com/home.html). Some of the more popular statements are:

1. Growth from retention
   - A very satisfied customer is 6 times more likely to repurchase your product than a customer who is just satisfied.
   - Loyal customers spend 5–6% more of their budget with you than customers who are not loyal.
2. Profit boost from retention
   - An increase in customer retention of just 5% can boost profits by 25–85%.
   - Loyal customers are not as price sensitive.

3. Reducing the cost of acquisition
   - Acquiring a customer costs 5–7 times more than retaining one.
   - Satisfied customers, on average, tell 5 other people about their good experience.
4. The cost of defection
   - The average customer who experiences a problem eventually tells 9 other people about it.
   - 91% of unsatisfied customers will never buy from you again.

Annual customer satisfaction surveys (ACSS) are conducted in order to:

- identify key drivers of satisfaction and prioritize actions;
- compare data over time to identify patterns in customers' experiences;
- disseminate the results throughout the appropriate audiences within the company to drive change within the organization.

In Chapter 2 we present a fictitious but realistic company called ABC, and its ACSS questionnaire. Data collected with this questionnaire will serve as a benchmark for the models presented in the book. By analysing a benchmark data set we are able to compare insights and added value provided by different models.

A typical internet-based ACSS plan, and it deliverables, is presented in Table 1.1. Typical technical service level agreements (SLAs), when conducting an internet-based ACSS, are presented in Table 1.2.

The ACSS is usually part of a larger plan that is designed and approved at the beginning of the financial year. At that point, decisions are made with strategic and budgetary impact. If the financial year starts in January, the kickoff of the ACSS cycle is usually planned in August. In this context, a general framework for conducting ACSS consists of the following activities:

Month	Activity
August	Survey plan and design
September	Survey communication and launch
October	Survey execution
November	Data analysis and report presentation
December	Annual budget process
January	Launch of annual strategic initiatives
February	Monitoring of improvement areas and key performance indicators
March	Review of progress and mid-course corrections
April	Detailed plans and execution
May	Execution
June	Execution
July	Progress review

To operate this annual cycle, one needs an effective steering committee and improvement methodology. For details on such organizational capabilities, see Kenett and Baker (2010).

Table 1.1 Main deliverables in an internet-based ACSS project

	Category	Deliverables

1	Infrastructure	• Questionnaire evaluation (if relevant)
		  ○ An evaluation of effectiveness of previously used questionnaires
		• Questionnaire design and development
		  ○ (Re)design of questionnaire
		  ○ Setting up of a survey website
		  ○ Testing and validation
		• Contact list management

2	Data collection	• Data collection (e-survey and/or phone or one to one interviews) • Open-ended responses through survey or open lines

3	Data analysis	• Data clean-up phase
		• Reporting and analysis
		  ○ Full report with insights and trend analysis
		  ○ Executive summary and management presentations
		  ○ Database for drill-down tools

4	Support and maintenance	• Project manager
		• Technical support for:
		  ○ Monitoring real-time data (during the survey)
		  ○ Resolving problems operating the questionnaire by customers (via email or phone).
		• Conducting the phone surveys (where relevant)
		• Quality management – a function that is responsible for key performance indicators and quality metrics.

Tables 1.1 and 1.2, and the annual plan sketched above, provide the flavour of a typical ACSS, within an overall strategic initiative for achieving operational excellence. When applying an integrated approach, the ACSS initiative is complemented by other initiatives such as employee surveys, dashboards that reflect the voice of the process, and event-driven surveys that are triggered by specific events. Examples of events followed by a satisfaction survey questionnaire include calls to a service centre or acquisition of a new product. Chapters 3, Chapter 5 and 7 present a range of surveys conducted by modern organizations. This book is focused on analysis aspects of an ACSS. The next section presents standards used in planning and conducting such customer surveys.

1.3 Standards used in the analysis of survey data

In the United States, the National Center for Science and Engineering Statistics (NCSES), formerly the Division of Science Resources Statistics, was established within the National Science Foundation with general responsibility for statistical data. Part of its mandate is

Table 1.2 Service level agreements for internet-based customer satisfaction surveys

Subject	Metric
SLA for maintenance Maintenance includes incidents and problems such as: 1. Customer cannot access survey site 2. Customer cannot enter a specific answer/s 3. Survey is not responsive 4. Response time is poor 5. ABC personnel cannot see progress reports	• MTTR (mean time to repair) – 3 hours (working hours, on working days) • MTBF (mean time between failures) – 3 days • MTBCF (mean time between critical failures) – 2 weeks
SLA for system availability	• % Availability – 95%
SLA for performance	• Time until web page is loaded (initially) – 4 seconds • Time until page is refreshed according to user answers – 2 seconds

to provide information that is useful to practitioners, researchers, policy-makers, and the public. NCSES prepares about 30 reports a year based on surveys. In Europe, Eurostat uses several quality dimensions for evaluating the quality of a survey. These are: relevance of statistical concept, accuracy of estimates, timeliness and punctuality in disseminating results, accessibility and clarity of the information, comparability, coherence, and completeness. For more on criteria for assessing information quality see Kenett and Shmueli (2011).

This section draws on standards and guidelines found at NCSES and other government agencies such as Eurostat. The purpose of survey standards is to set a framework for ensuring data and reporting quality. Guidance documents are meant to help increase the reliability and validity of data, promote common understanding of desired methodology and processes, avoid duplication and promote the efficient transfer of ideas, and remove ambiguities and inconsistencies. The goal is to provide the clearest possible presentation of data and its analysis. Guidelines typically focus on technical issues involved in the work rather than on issues of contract management or publication formats.

Specifically, NCSES aims to adhere to the ideals set out by Citro *et al.* (2009). As a US federal statistical agency, NCSES surveys must follow guidelines and policies as set forth in the Paperwork Reduction Act and other legislation related to surveys. For example, NCSES surveys must follow the implementation guidance, survey clearance policies, response rate requirements, and related orders prepared by the Office of Management and Budget (OMB). The following standards are based on US government standards for statistical surveys (see http://www.nsf.gov/statistics/). We partially list them below:

SECTION 1. DEVELOPMENT OF CONCEPTS, METHODS, AND DESIGN

Survey Planning

Standard 1.1: Agencies initiating a new survey or major revision of an existing survey must develop a written plan that sets forth a justification, including: goals and objectives;

potential users; the decisions the survey is designed to inform; key survey estimates; the precision required of the estimates (e.g., the size of differences that need to be detected); the tabulations and analytic results that will inform decisions and other uses; related and previous surveys; steps taken to prevent unnecessary duplication with other sources of information; when and how frequently users need the data; and the level of detail needed in tabulations, confidential microdata, and public-use data files.

Survey Design

Standard 1.2: Agencies must develop a survey design, including defining the target population, designing the sampling plan, specifying the data collection instrument and methods, developing a realistic timetable and cost estimate, and selecting samples using generally accepted statistical methods (e.g., probabilistic methods that can provide estimates of sampling error). Any use of nonprobability sampling methods (e.g., cut-off or model-based samples) must be justified statistically and be able to measure estimation error. The size and design of the sample must reflect the level of detail needed in tabulations and other data products, and the precision required of key estimates. Documentation of each of these activities and resulting decisions must be maintained in the project files for use in documentation (see Standards 7.3 and 7.4).

Survey Response Rates

Standard 1.3: Agencies must design the survey to achieve the highest practical rates of response, commensurate with the importance of survey uses, respondent burden, and data collection costs, to ensure that survey results are representative of the target population so that they can be used with confidence to inform decisions. Nonresponse bias analyses must be conducted when unit or item response rates or other factors suggest the potential for bias to occur.

Pretesting Survey Systems

Standard 1.4: Agencies must ensure that all components of a survey function as intended when implemented in the full-scale survey and that measurement error is controlled by conducting a pretest of the survey components or by having successfully fielded the survey components on a previous occasion.

SECTION 2. COLLECTION OF DATA

Developing Sampling Frames

Standard 2.1: Agencies must ensure that the frames for the planned sample survey or census are appropriate for the study design and are evaluated against the target population for quality.

Required Notifications to Potential Survey Respondents

Standard 2.2: Agencies must ensure that each collection of information instrument clearly states the reasons the information is planned to be collected; the way such information is planned to be used to further the proper performance of the functions of the agency; whether responses to the collection of information are voluntary or mandatory (citing authority); the nature and extent of confidentiality to be provided, if any, citing authority; an estimate of the average respondent burden together with a request that the public direct

to the agency any comments concerning the accuracy of this burden estimate and any suggestions for reducing this burden; the OMB control number; and a statement that an agency may not conduct and a person is not required to respond to an information collection request unless it displays a currently valid OMB control number.

Data Collection Methodology

Standard 2.3: Agencies must design and administer their data collection instruments and methods in a manner that achieves the best balance between maximizing data quality and controlling measurement error while minimizing respondent burden and cost.

SECTION 3. PROCESSING AND EDITING OF DATA

Data Editing

Standard 3.1: Agencies must edit data appropriately, based on available information, to mitigate or correct detectable errors.

Nonresponse Analysis and Response Rate Calculation

Standard 3.2: Agencies must appropriately measure, adjust for, report, and analyze unit and item nonresponse to assess their effects on data quality and to inform users. Response rates must be computed using standard formulas to measure the proportion of the eligible sample that is represented by the responding units in each study, as an indicator of potential nonresponse bias.

Coding

Standard 3.3: Agencies must add codes to collected data to identify aspects of data quality from the collection (e.g., missing data) in order to allow users to appropriately analyze the data. Codes added to convert information collected as text into a form that permits immediate analysis must use standardized codes, when available, to enhance comparability.

Data Protection

Standard 3.4: Agencies must implement safeguards throughout the production process to ensure that survey data are handled to avoid disclosure.

Evaluation

Standard 3.5: Agencies must evaluate the quality of the data and make the evaluation public (through technical notes and documentation included in reports of results or through a separate report) to allow users to interpret results of analyses, and to help designers of recurring surveys focus improvement efforts.

SECTION 4. PRODUCTION OF ESTIMATES AND PROJECTIONS

Developing Estimates and Projections

Standard 4.1: Agencies must use accepted theory and methods when deriving direct survey-based estimates, as well as model-based estimates and projections that use survey data. Error estimates must be calculated and disseminated to support assessment of the appropriateness of the uses of the estimates or projections. Agencies must plan and implement evaluations to assess the quality of the estimates and projections.

SECTION 5. DATA ANALYSIS

Analysis and Report Planning

Standard 5.1: Agencies must develop a plan for the analysis of survey data prior to the start of a specific analysis to ensure that statistical tests are used appropriately and that adequate resources are available to complete the analysis.

Inference and Comparisons

Standard 5.2: Agencies must base statements of comparisons and other statistical conclusions derived from survey data on acceptable statistical practice.

SECTION 6. REVIEW PROCEDURES

Review of Information Products

Standard 6.1: Agencies are responsible for the quality of information that they disseminate and must institute appropriate content/subject matter, statistical, and methodological review procedures to comply with OMB and agency Information Quality Guidelines.

SECTION 7. DISSEMINATION OF INFORMATION PRODUCTS

Releasing Information

Standard 7.1: Agencies must release information intended for the general public according to a dissemination plan that provides for equivalent, timely access to all users and provides information to the public about the agencies' dissemination policies and procedures including those related to any planned or unanticipated data revisions.

Data Protection and Disclosure Avoidance for Dissemination

Standard 7.2: When releasing information products, agencies must ensure strict compliance with any confidentiality pledge to the respondents and all applicable Federal legislation and regulations.

Survey Documentation

Standard 7.3: Agencies must produce survey documentation that includes those materials necessary to understand how to properly analyze data from each survey, as well as the information necessary to replicate and evaluate each survey's results (See also Standard 1.2). Survey documentation must be readily accessible to users, unless it is necessary to restrict access to protect confidentiality.

Documentation and Release of Public-Use Microdata

Standard 7.4: Agencies that release microdata to the public must include documentation clearly describing how the information is constructed and provide the metadata necessary for users to access and manipulate the data (See also Standard 1.2). Public-use microdata documentation and metadata must be readily accessible to users.

These standards provide a comprehensive framework for the various activities involved in planning and implementing a survey in general. Our focus here is on customer satisfaction

surveys and, as such, these standards apply equally well. In the next section we present some special aspects of customer satisfaction surveys.

1.4 Measures and models of customer satisfaction

Models for analysing data from customer satisfaction surveys address two components: the conceptual construct and the measurement process.

1.4.1 The conceptual construct

The concept of customer satisfaction is related to the concept of quality. Quality, however, is different in the case of a product and of a service. Evaluations of service quality are not exclusively linked to the observed output, as for products, but, and to a greater extent, to the whole process through which the service is provided. Consumer evaluation of the service received is determined by factors affected by psychological interactions that are established during the exchange transaction, and by factors connected to technical-specific characteristics of the service. The former factors concern behaviour, sensations and psychological benefits, which are difficult to measure, whilst the latter factors can be evaluated by objective indicators similar to those utilized for product quality.

Knowledge and interpretation of how consumers perceive and evaluate product or service quality are essential for the orientation of the company management and strategy. As a result, the availability of measurements and interpretation models for *customer satisfaction* linked to subjective evaluations of product/service quality is becoming as important as the corresponding objective technological measurements. This subjective input is therefore an important ingredient in the statistical control of a quality system. In general, customer satisfaction, from the relevant measurements and interpretation models, is one of the essential components of modern management since it is the basis of a company's success (Kanji and Wallace, 2000; Kenett, 2004; Kenett and Salini, 2009). Customer satisfaction indicators, at the national level or by economic sectors, are becoming essential in the evaluation of the overall performance of economic systems (see Anderson and Fornell, 2000).

An important paradigm for evaluating service quality is the gap model developed by Parasuraman *et al.* (1985). Following executive interviews and focus groups in four different service business areas, the authors proposed a conceptual model of service quality where consumers' perceptions on service quality depend on gaps between the service provider organization and the consumer environment. Later, they developed in-depth measurement scales for service quality.

Perceived service quality is defined, according to the gap model, as the difference between consumers' expectation and perceptions. This depends on the size and the direction of four gaps in a company's delivery of service. These gaps determine the difference between customer expectations and perceptions – the service quality gap. The key points for each gap can be summarized as follows:

1. the difference between what customers expected and what management perceived about the expectation of customers;

2. the difference between management's perceptions of customer expectations and the translation of those perceptions into service quality specifications and designs;

3. the difference between specifications or standards of service quality and the actual service delivered to customers;
4. the difference between the service delivered to customers and the promise of the firm to customers about its service quality

The gap model clearly determines the two different types of gaps in service marketing, namely the customer gap and the provider gap. The latter is considered an internal gap, within a service firm. This model views services as a structured, integrated model which connects external customers to internal services provided by different functions in a service organization. Important characteristics of the model are the following:

1. The gap model of service quality gives insights into customers' perceptions of service quality.
2. Customers always use dimensions to form the expectation and perceptions of service quality.
3. The model helps predict, generate and identify key factors that cause the gap to be unfavourable to the service provider, in meeting customer expectations.

For more on these models, see Chapters 3 and 7.

1.4.2 The measurement process

Zanella (2001) provides an overview of measures and models of customer satisfaction. He classifies the main features of models and related techniques used for describing customer satisfaction. We provide below a brief description based on Zanella's work.

Composition or formative models

In composition models, customer satisfaction is considered a 'multidimensional attribute', where each component corresponds to a dimension of the conceptual construct, i.e. to an aspect of a product or service considered essential in determining customer satisfaction. The synthesis of the evaluations of the single 'marginal' satisfaction attributes has a defining, and therefore conventional, nature. In fact, there is a lack of explicit research into the functional links of the latent variables that correspond to the various dimensions, and the latent one-dimensional variables associated with the concept under investigation, i.e. customer satisfaction. The latter is turned into a target variable by giving it a value obtained through *composition*, i.e. addition of values of target variables corresponding to the various dimensions. These models thus came to be called *composition models* or *formative models*.

Starting from the fundamental work by Parasumaran *et al.* (1988, 1991), the well-known composition model known as SERVQUAL was developed. The most serious criticism of the original gap model approach was expressed by Cronin and Taylor (1992), who raised doubts about the SERVQUAL indicator being appropriate to describe service quality. This criticism gave rise to another improved model, SERVPERF. A description of these models can be founded in Chapter 7.

Explanatory or decomposition models: Regression models

A self-declared 'questionnaire' provides an overall assessment of customer satisfaction with a specific product or service. The response variables of the underlying customer satisfaction model are typically expressed on a semantic differential scale, with corresponding conventional scores such as a five-point or seven-point scale. However, this scale could also be dichotomous or made so by summarizing judgements in two categories. In Chapters 2 and 20 we use two dichotomizing schemes. The first of these identifies customers who responded '5' on a five-point scale. Their percentage yields a satisfaction index labelled 'TOP5'. At the other end of the scale, customers who responded '1' or '2' are aggregated to form an index labelled 'BOT1+2'. TOP5 represents a measure of excellence. BOT 1+2 is very effective in identifying pockets of dissatisfaction. Some organizations combine the labels 'satisfied' and 'very satisfied' which produce indices with higher values but much reduced resolution. The common use of average response often produces uninformative statistics. Below we present three ways to model data on an ordinal or nominal scale.

Ordinary linear regression model Explanatory variables describe dimensions related to specific aspects of a product or service. These could be, for example, age of equipment or geographical location. This is the case with composition models, that produce data that can be expressed on conventional ordered rating scales. Such data can, however, refer to respondents' personal characteristics, such as age or the number of purchases in a previous period, that are measured on metric scales.

The usual statistical analysis techniques for such data apply the least squares criteria for deriving estimates of the unknown parameters and for determining the goodness of fit.

Regression models and techniques accounting for the ordinal character of the response and of explanatory variables In this context, monotonic regression analysis plays an important role (see Kruskal, 1965). In Zanella (1998) a non-linear regression model with latent variables is presented for deriving a ratio scale representation of the response.

Logistic regression model If one can assume a probability distribution for the response portraying overall satisfaction, the expected value of the response can be presented, with conditioning on the different situations described by the values of the explanatory variables. The logistic regression approach allows us to take into consideration the fact that the values of the response variable are on an ordinal scale. Rasch models, presented in Chapter 14, are a particular case of logistic models.

Linear structural models with latent variables (LISREL)

The LISREL models allow us to establish links between latent variables, which are related to dimensions describing customer satisfaction (Bollen, 1989). This is at the core of the conceptual construct. Thus LISREL provides a complete determination of the construct under study. The model is composed of two systems of equations: *structural equations* and *measurement model.* Baumgartner and Homburg (1996) give comments and recommendations on the basis of cases of complete structural model application in marketing. In particular, they recommend an accurate assessment of the identifiability conditions and the use of a suitable set of indicators

for checking model adequacy, such as chi-square, root-mean-square residual, goodness-of-fit index, and determination coefficients for measurement equations.

Another approach to estimation for this type of models is the PLS method presented in Chapter 16 of this book. The LISREL method is used for calculating the American Customer Satisfaction Index; for more details see Anderson and Fornell (2000) and Kenett (2007). A similar approach is used to compute the European Customer Satisfaction Index. The main problem of the LISREL approach is that metric scales are assumed. In general, however, the variables are measured with ordinal scales. A transformation to obtain metric scales can be used with caution (see Zanella, 2001). The approach here is that we wish to deal with the more realistic assumption that the variables are ordinal. Chapter 4 is devoted to measurement scales.

1.5 Organization of the book

The book is organized into two parts. Part I consists of nine chapters on general topics in customer satisfaction surveys. Part II consists of 12 chapters with new and innovative techniques and models.

Chapter 2 introduces the ABC company and its annual customer satisfaction survey. It provides the background for the case study used throughout the book, including a basic analysis of the ABC 2010 ACSS data.

Chapter 3 discusses the sampling problem. The two main types of surveys, census and sample, are compared and non-sampling errors are listed, focusing on their presence in customer surveys and on their effects on estimates. Data collection methods are also described, linking every method with one or more non-sampling errors. Finally, methods to correct these errors are proposed.

Chapter 4 considers the problem of measurement scales and the problem of scale construction.

Chapter 5 is about integrating data in a business data system, with emphasis on marketing integrated systems.

Chapter 6 introduces different types of web surveys. The main economic and non-economic benefits of web surveys and the main drawbacks associated with online research are presented. The final part of the chapter discusses the application of web surveys to customer and employee satisfaction research projects.

Chapter 7 addresses the interrelated concepts of customer satisfaction, perceived service quality and customer loyalty. The chapter deals with methodological issues relevant in survey collection of customer satisfaction data and evaluates the ABC ACSS questionnaire from the conceptual and methodological points of view.

Chapter 8 is devoted to missing data and their imputation, with a special focus on customer satisfaction data. Imputation, multiple imputation, and other strategies to handle missing data, together with their theoretical background, are discussed. Some examples of and advice on computation are provided using the ACSS example.

Chapter 9 tackles the topics of robustness and multivariate outlier detection in presence of ordinal data. A review of outlier detection methods in regression for continuous data is presented. The second part of the chapter concentrates on ordinal data and illustrates how to detect atypical measurements in customer satisfaction surveys, with application to the ACSS data.

Chapter 10 provides an overview of the approach to the estimation of causal effects based on the concept of potential outcomes, stemming from the work on randomized experiments and then extended in the 1970s to non-randomized studies and different modes of inference.

Chapter 11 introduces BN and their application to customer satisfaction surveys. A theoretical introduction to BN is given, and BN are applied to the ABC 2010 ACSS data set and to the Eurobarometer transportation survey.

Chapter 12 introduces the structuring of categorical data in the form of contingency tables, and then provides a brief introduction to log-linear models and methods for their analysis, followed by an application to customer satisfaction surveys. The focus is on methods designed primarily for nominal data like the data gathered in the ABC 2010 ACSS.

Chapter 13 introduces a class of statistical models, CUB models, based on the psychological mechanism which induces customers to choose a definite item or to manifest an expressed preference towards some object/brand. The approach has been applied to the ABC 2010 ACSS data set and to students' satisfaction towards their university orientation service.

Chapter 14 describes the Rasch model and its use in the context of customer satisfaction surveys. A detailed application based on the ABC 2010 ACSS data is given.

Chapter 15 presents a selection of decision tree methodologies, useful for evaluating customer satisfaction. An illustrative example where tree-based methods are applied to the ACSS data set is provided.

Chapter 16 introduces the partial-least squares estimation algorithm and its use in the context of structural equation models with latent variables (SEM-LV). After a short description of the general structure of SEM-LV models, the PLS algorithm is introduced; then, statistical and geometrical interpretations of PLS are given. A detailed application example based on the ACSS data concludes the chapter.

Chapter 17 describes homogeneity analysis and non-linear principal component analysis (NLPCA), which allow us to set up a synthetic numerical indicator of the level of satisfaction, starting from ordinal responses. Problems connected to the presence of missing data and their treatment are presented. NLPCA is applied to the ABC data and the main aspects and findings of this application are described.

Chapter 18 reviews the basic concepts and methodological results of multidimensional scaling (MDS) methods. It also offers several applications of MDS to customer satisfaction studies. Certain metric MDS models are applied to data collected in the ABC 2010 ACSS.

Chapter 19 is devoted to regression models for ordinal responses, with special emphasis on random effects models for multilevel or clustered data. The last part of the chapter presents an application of random effects cumulative models to the analysis of student ratings on university courses.

Chapter 20 presents an application of methods and standards used in quality management and quality control to the analysis of customer satisfaction surveys. The chapter covers in detail the ISO 10004 standard that provides guidelines for monitoring and measuring customer satisfaction, introduces control charts and describes the corresponding ISO 7870 guidelines. It also discusses how standard control charts (p, c, and u charts) can be used to analyse customer satisfaction surveys to monitor, over time, the number or proportion of satisfied or unsatisfied customers.

Chapter 21 develops a framework that uses fuzzy set theory in order to measure customer satisfaction, starting from a survey with several questions. The basic concepts of the theory of fuzzy numbers are described. A criterion based on the sampling cumulative function, which

assigns values to the membership function with reference to each quantitative, ordinal and binary variable, is suggested. Weighting and aggregation operators for the synthesis of the variables are considered and applied to the 2010 ABC survey data.

1.6 Summary

This book is about modern and applied methods for analysing customer satisfaction survey data. It can be used by practitioners who wish to provide their customers with state-of-the-art methods, and by researchers who wish to dedicate their efforts to this challenging domain. The challenge is inherent in such multidisciplinary fields where quantitative skills need to be combined with methods drawing on psychology and cognitive science, and eventually management theory techniques, so that the surveys generate a measurable and effective impact. Customer satisfaction surveys are a prime example where we explicitly put the customer at the centre of our attention, so that we can improve and achieve high effectiveness and high efficiencies.

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