UNIVERSIDADE DO ALGARVE

FACULDADE DE ECONOMIA

MODELING CONSUMER BEHAVIOR IN THE PORTUGUESE RECYCLING PROGRAM: THE LOGISTICS AND COMMUNICATION PLANNING IMPLICATIONS

– VOLUME I –

Tese para a obtenção do Grau de Doutor em
Métodos Quantitativos Aplicados à Economia e à Gestão na especialidade de Estatística

PATRÍCIA SUSANA LOPES GUERRILHA DOS SANTOS PINTO OOM DO VALLE

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Faro, 30 de Maio de 2004

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Volume I

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To Inácio and Filipa

TABLE OF CONTENTS

VOLUME I

LIST OF FIGURES

VOLUME I

LIST OF TABLES

VOLUME I

ACRONYMS

ADF	Asymptotically Distribution Free
AGFI	Adjusted Goodness of Fit Index
AMOS	Analysis of Moment Structures
ATM	Automated Teller Machine
CBSM	Community-Based Social Marketing
CFI	Comparative Fit Index
DSP	Dominant Social Paradigm
ECVI	Expected Cross-Validation Index
EU	European Union
GFI	Goodness of Fit Index
GLS	Generalized Least Squares
HOMALS	Homogeneity Analysis by Means of Alternating Least Squares
IFI	Incremental Fit Index
KMO	Kaiser, Meyer and Olkin' Measure
LISREL	Lineal Structural Relations
MCA	Multiple Correspondence Analysis
ML	Maximum Likelihood
NEP	New Environmental Paradigm
NFI	Normed Fit Index
PCA	Principal Components Analysis
PERSU	Strategic Plan of Urban Solid Residues
PGFI	Parsimonious Goodness of Fit Index
PNFI	Parsimonious Normed Fit Index
RevLog	European Group on Reverse Logistics
RFI	Relative Fit Index
RM	Relationship Marketing
RMSEA	Root Mean Square Residual of Approximation
RMSR	Root Mean Square Residual
SEM	Structural Equation Modeling
SIGRE	Sistema Integrado de Gestão de Resíduos de Embalagem
SPSS	Statistical Package for the Social Sciences
SPV	Sociedade Ponto Verde
TLI	Tucker and Lewis Index
TOPB	Theory of Planned Behavior
USA	United States of America
WLS	Weighted Least Squares

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I am pleased to have an opportunity to thank all those people who supported my completion of this thesis. The list is long but starts with my advisors. I wish to express my gratitude first to Professor Elizabeth Reis for her proposal of this thesis theme and for her assistance and valuable suggestions that helped me to surpass the most "critical" parts of my work. With her example of dedication, simplicity and knowledge, Professor Elizabeth Reis has provided me considerable preparation for the career I am trying to set forth. I am also indebted to Professor João Menezes for his constant encouragement, accompaniment, interest and technical support in the management component of this thesis. To him, I also owe the idea of structuring the central chapters of this work as papers, which, at present, I recognize has much enriched my thesis. Finally, I had the honor of working once again with Professor Efigénio Rebelo, who is, for me, an example as an econometrician, as a manager and as a teacher. Besides his moral support and specific technical orientation through my thesis process, Professor Efigénio Rebelo also helped me in my decision to conduct a thesis on the Applied Quantitative Methods area and I am very grateful to him for that.

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I could not fail to refer to the support of the Scientific Committee of the Faculty of Economics. Firstly, this Committee has developed the "Doctoral Thesis Regulation", which is an invaluable help to all those who are trying to successfully reach this long-awaited "finish" line. Secondly, by yearly organizing the "Doctoral Day", the Scientific Committee is allowing doctoral students to present their work and receive some feedback about their investigation, which is very important, not only morally speaking, but primarily in what regards the receptiveness among the scientific community to the research directions that are being followed by each of us. In my particular situation, the "Doctoral Days" truly represented a worthily and positive contribution to the development of my thesis.

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I leave the last part of these pages of acknowledgment to my friends, colleagues and family but especially to my husband, Inácio, who gave me the strength to continue and constant encouragement over the past three years. In addition to leading with his very busy professional life, Inácio was always available whenever I became frustrated and discouraged. To him, my infinite thanks for the time, energy and moral support he always gave me. I also want to thank my little daughter and inspiration, Filipa, for bringing so much joy to my life, helping me to overcome the most difficult times I had to face during these last few years. Finally, I will be forever indebted to my grandfather, José Guerrilha, who unconditionally supported and encouraged my studies ever since I was a child. His presence was essential in shaping the person that I still hope to become.

ABSTRACT

Based on the data of the most recent national survey conducted in Portugal for Sociedade Ponto Verde (SPV) concerning the attitudes and motivations towards household packaging separation and selective disposal for recycling, the main objective of this thesis is to explore the use of multivariate statistical methods to provide a quantitative formative research on the determinants of recycling behavior in the Portuguese case. These statistical methods are: principal components analysis, logistic regression, structural equation modeling, discriminant analysis and homogeneity analysis (HOMALS). In view of the results of this research, it is also intended to discuss some guidelines for planning a future social marketing strategy, in what concerns interventions in the logistics and communication domains.

The mains contributions of this work rely on the application of multivariate statistical methods in contexts where they are very uncommon, like in the reverse logistics or social marketing research, but also in the improvement of the applied quantitative techniques in the area of consumer behavior in recycling programs. In addition, this thesis provides a first deeper analysis on the motivations towards recycling in the Portuguese case and initiates the discussion on innovator aspects in reverse logistics and social marketing areas. These aspects include the research on the role of consumer-service in the reverse logistics system for recycling and the debate around the applicability of relationship marketing in this context of social marketing.

Overall, results from the application of the statistical methods support the conclusion that general environmental attitudes and socio-demographic characteristics are not significant determinants of recycling behavior. Instead, the propensity to participate in the selective collection program is significantly determined by specific attitudes towards recycling and also by variables of logistics nature, which are related with the convenience of the selective-collection system. The statistical methods also evidence the need for improving the overall logistics conditions of the system and the need for rethinking the communication strategy. Moreover, this thesis enables the identification of logistics variables that any intervention should prioritize and points out some problems that may arise from these interventions. At last, it is proposed a renovate communication strategy within this social marketing context and the applicability of relationship marketing in some specific stages of this strategy is discussed.

KEYWORDS: Social marketing, Consumer behavior, Reverse logistics, Recycling Principal components analysis, Logistic regression, Structural equation modeling, Discriminant analysis, HOMALS.

Chapter 1

GENERAL INTRODUCTION

1.1 Introduction

Most of current environmental problems have their genesis in the significant life style changes and in the inherent modifications of production and consumption standards that have been occurring over the past three decades. In effect, the strong economic growth reported in several countries was often accompanied by the unsustainable exploitation of the natural resources and by a notable increase in the amount of solid waste residues that were yearly produced. Nowadays, each habitant of the European Union produces on average from 250 to 620 kg of residues per year. Portugal, in turn, generated 3.34 million tons of solid waste residues in 1997, 4.5 million tons in 2000 and it is expected to produce around 6 million tons in 2010. From the total amount of solid waste residues that are currently yielded in Portugal, around 30% are packaging residues (Sociedade Ponto Verde (SPV), 2003).

Products' packaging have an unquestionable economic and social importance. On one hand, they make their transportation and warehousing easier. On the other hand, they support consumers in their buying decisions, by providing information and promoting the products. It is of crucial interest, therefore, to find the balance between the benefits of packaging usage and the need to conserve the natural resources, by avoiding the excessive production of packaging and packaging residues but also by providing the conditions for their valorization and recycling.

Several definitions have been proposed for the concept of recycling. Kopicki *et al.*, for instance, defined this term as "the process by which materials otherwise destined for disposal are collected, processed and remanufactured into new products" (Kopicki *et al.*, 1993: 3). The recycling of packaging residues is an important mechanism of resources-recovery, which allows the producing of new objects and even new packaging in an almost never-ending cycle, with significant economic and environmental benefits (Lund, 2001). In general terms, the economic advantages inherent to this conservation practice include decreased disposal costs, employment creation and a significant contribution to the national goals of energy saving. On the other hand, the environmental advantages encompass the diversion of waste from landfills and, more importantly, the decreased use of the limited virgin resources.

The need for orienting the world economies towards a global sustainable development was the general point of debate of the Conference on Environment and Development carried out in Rio de Janeiro, 1992. A purpose of this event was discussing guidelines for a balanced management between the need to preserve the ecosystems while keeping the conditions for the economic growth. Some of these orientations had specifically focused on the residues management problematic, highlighting, for instance, the principle of shared environmental responsibility among economic agents.

This international conference and the emergent concept of sustainable development were inevitable references in the subsequent policies of environmental strategy proposed by the European Union and, in particular, those in the domain of the residues management. It was in this framework, and with the particular aim of preventing and reducing the environmental impacts of packaging residues, that the European Directive

94/62/CE, which has guided, since then, each State Member's legislation concerning management and final destination of this sort of residues, was created, in 1994.

Based on the European legislation and also on its transposition to the national jurisdiction ordinance, specific quantitative targets of packaging valorization and recycling were defined for the Portuguese case. To attend these objectives, the Integrated Recovery System of Packaging Waste Management (SIGRE-Sistema Integrado de Gestão de Resíduos de Embalagem), which has been managed by a private company, the Sociedade Ponto Verde, S. A. (SPV), was created in 1997. With the conception of SIGRE and the promotion of recycling, Portugal is giving higher priority to a behavioral solution to the solid waste problem, rather than to technical alternatives, such as waste incineration and landfills disposal, which usually find significant public opposition, in response to the increasing awareness of their potentially negative impacts on public health and on the environment.

Changing consumers' behavior in order to improve their personal welfare and that of society is the main objective of social marketing, a marketing sub-discipline that emerged in the early 1970s with the study of Kotler and Zaltman (1971). Social marketers use similar tools as those employed in traditional commercial marketing but with the purpose of promoting changes in diverse socially important behaviors, such as health promotion, crime prevention and environmental preservation. The same is to say that the challenge of changing consumers' behavior towards the adoption of recycling practices is a typical application of social marketing in the scope of environmental protection.

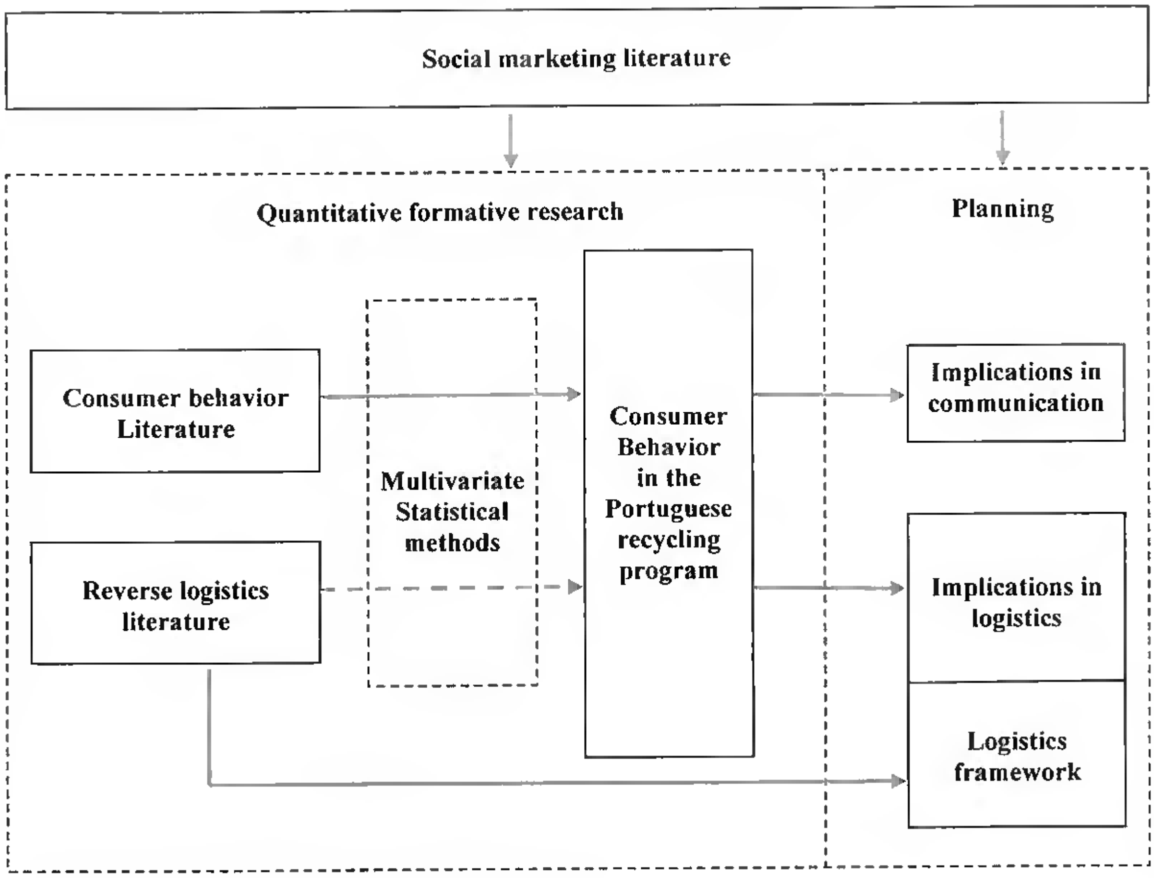
Regardless of the context in which social marketing has to be applied, the definition of a social marketing strategy should begin by identifying and understanding the determinants of the socially beneficial behavior that it is intended to encourage (Macstravic, 2000; Smith, 2000; Andreasen, 1995). This market research, also referred to as the *listening* stage of the strategic social marketing process, should be oriented by a model of consumer behavior and, whenever possible, be based on quantitative analyses (Andreasen, 1995). This study of the main characteristics, needs and motivations of the social marketing audience should provide, as a result, the foundations for the second stage of the strategic social marketing process, that is, for *planning* the strategy itself. As also explained by Andreasen (1995), planning a social marketing campaign involves defining the marketing mission, its purposes and setting the core marketing strategy.

1.2 Objectives and scope of the thesis

Based on the data of the most recent national survey conducted in Portugal for SPV about the attitudes and motivations towards household packaging separation and selective disposal for recycling, the main objective of this thesis is to explore the application of multivariate statistical methods to provide a quantitative formative research on the determinants of recycling behavior in the Portuguese case. In view of the results of this research, it is also intended to discuss some guidelines for planning a future social marketing strategy, in what concerns interventions in the logistics and communication domains.

Figure 1.1 presents an overview of the scope of the present thesis.

FIGURE 1.1
Conceptual model of the thesis



As the rectangle at the top of the figure suggests, the incursion in the social marketing literature provided the general framework for the current thesis. In particular, this literature review of the social marketing setting was needed in order to identify and perceive the stages of strategic social marketing that should be followed to change Portuguese consumers' behavior towards the adoption of recycling practices. As proposed by Andreasen (1995), strategic social marketing should follow six main stages: listening, planning, structuring, pretesting, implementing and monitoring.

The first stage, *listening*, involves understanding consumers' wants, needs and satisfaction levels and offers the basis for the following stages. It must be noted that the term "listening" was replaced in the figure by the expression "quantitative formative research" because, in this thesis, statistical methods are applied in order to understand consumers' behavior in the Portuguese selective-collection program. The second stage, *planning*, also assumes a great relevance in this thesis. Effectively, based on the major results of each quantitative formative research, this thesis derives a set of guidelines for the planning of a new social marketing program. The large broken line rectangle in the figure shows, therefore, the two first stages of this marketing process that are focused on this thesis: formative quantitative research and planning.

With the purpose of identifying the principal potential determinants of recycling behavior, as well as their expected relationship with consumers' adherence to the national selective-collection program, the extant research on this issue was reviewed, most of them carried out within the scope of environmental social-psychology. The importance of this examination of the previous literature – not only to identify possible relevant explanatory variables to be included in the models but also to justify the underlying research hypotheses – is emphasized in Figure 1.1 through the arrow that links the two boxes "literature on consumer behavior in recycling programs" and "consumer behavior in the Portuguese recycling program".

Discussions around the recycling theme have also been conducted in the reverse logistics field. In this analysis perspective, recycling is faced as an option of resources recovering that, otherwise, could be reused, remanufactured or simply disposed of. Although other definitions could be presented, reverse logistics can be perceived as "the process by which organizations recover by-products and residuals for reuse, resale, remanufacturing, recycling or disposal" (Johnson, 1998: 217). The consumers being the initiators of any reverse logistics chain for recycling packaging residues, the discovery of some insights about the predictive influence of logistics consumer service's performance, in its diverse components, in consumers' adherence or participation in the reverse logistics system for recycling, in this research area, was expected. However, despite the importance of this aspect being recognized in a few studies, it had not been especially addressed in any of them. The absence of research on this subject in the reverse logistics literature, in which coverage was expected, is indicated in the figure by the broken line connecting the boxes "reverse logistics literature" and "consumer behavior in the Portuguese recycling program".

Besides revealing this research gap, the review of literature in the reverse logistics area was useful to the understanding of the heterogeneity of activities and concepts that are involved in this rather young sub-discipline of logistics. In particular, it enabled the provision of a framework for the Portuguese reverse logistics system for recycling, by integrating, for instance, its principal motivating factors and intervenients. The relevance of the literature survey, in what regards this aspect, is signed in the figure by the arrow which relates the box "reverse logistics literature" with the box "logistics framework".

The literature review on the determinants of consumers' behavior in recycling programs evidences that no predictive variable seems to act alone and that the relationships among several variables should be considered. This fact suggests the interest of assessing the connection between recycling behavior and the various potentially determinant variables by applying multivariate statistical methods. A clear advantage of dependence multivariate techniques, like logistic regression, discriminant analysis or structural equation modeling, for instance, in comparison to more simple univariate or bivariate analyses, is that they allow the identification of the most and the least important variables which are influencing this pro-environmental behavior. This kind of information, in turn, is the foundation for planning a future social marketing program that aims to increase the recycling rates. The indication that the formative market research on the determinants of recycling behavior in the Portuguese case will rely on the application of multivariate statistical methods is indicated in the figure by the smaller broken line rectangle. As also suggested in the figure, based on these quantitative analyses' results, some contributions will be made to the planning stage of a social marketing campaign, in what regards logistics and communication aspects.

1.3 Motivations, contributions and research questions

Diverse factors have motivated the choice of this thesis theme. Firstly, despite the fact that the last three decades have witnessed a growing research effort on the general problematic of recycling and, more particularly, on the determinants of this sustainable behavior, it represents a very recent subject in the Portuguese case. As suggested earlier, Portugal, as other European countries, faces ambitious quantitative targets of packaging residues valorization and recycling that should be accomplished until the end of 2005. Naturally, meeting these objectives requires an investment in the logistics of the selective-collection system but also in the communication field, which should be oriented by the previous knowledge on the determinants of consumers' behavior in the recycling program as well as on the main relationships among these predictors. To provide insights that could contribute to surpassing this important challenge, imposed by the European and internal legislations, was certainly a major driver of this thesis.

Secondly, this thesis was much motivated by the (egoistic) opportunity it offered to its author to learn and apply five multivariate statistical methods, whose analytical power can be used in so many interesting and new situations. Despite the strength of the previous (altruistic) motivator behind this study, it can not be ignored that the existence of this strong statistical component, in an applied perspective, was decisive in choosing this thesis theme.

Besides these motivator factors, of general nature, this thesis was quite oriented by the attempt of overcoming punctual research gaps that were detected when reviewing the three fields in which the recycling subject has been focused on: consumer behavior in recycling programs, reverse logistics and social marketing. These breaches in the previous studies can be summarized as follows:

(1) Despite the amount of research on consumer behavior in recycling programs, in most of these studies, the quantitative analyses are based on univariate or bivariate statistics. On the other hand, the studies that had proposed dependence models do not mention the results of the misspecification tests that, eventually, have been performed. This fact leaves readers with some doubts about the validity of the presented results;

(2) Even the studies using more advanced statistical methodologies like structural equation modeling are, in some sense, restricted in the analyses they offer because either they combine few variables in the models or because they only test a specific behavior theory, in which, once again, a limited number of variables are articulated;

(3) Although the role of consumer-service performance in achieving consumers' involvement in the reverse logistics system for recycling has been referred before in the reverse logistics research, this topic was not specifically explored yet, with or without the application of quantitative methods;

(4) No reviewed studies in the social marketing area use quantitative methods. Moreover, the discussion around the applicability of relationship marketing, which privileges the development of close and long term relationships with consumers (Berry, 1983), was not conducted before in the context of social marketing and, in particular, as a renovated view of facing the need of increasing consumers' involvement in recycling programs;

In brief, the mains contributions of this thesis rely on the application of multivariate statistical methods in contexts where they are very uncommon, like in the reverse logistics or social marketing research, but also in the improvement of the applied quantitative techniques in the area of consumer behavior in recycling programs. In addition, this thesis provides a first deeper analysis on the motivations towards recycling in the Portuguese case and initiates the discussion on innovator aspects in reverse logistics and social marketing areas.

With the purpose of guiding the attendance of the referred objectives, a series of research questions are formulated. These are:

(1) What are the main direct determinants of Portuguese consumers' involvement in the national selective-collection program?

(2) Is it possible to identify the indirect significant determinants of recycling behavior?

(3) Given an affirmative answer to the previous question, how would these variables interact with the direct determinants in order to improve the understanding of this phenomenon?

(4) What is the relative importance of consumer-service components as determinants of consumers' adherence to the reverse logistics system for recycling?

(5) What are the main trade-offs that arise when intervening in the logistics determinants of consumers' behavior in this reverse logistics system?

(6) Besides the consumers' adherence to the reverse logistics system for recycling, what other factors can affect the success of the Integrated Recovery System in the medium / long term?

(7) Is it possible to plan a social marketing strategy that would be compatible with the principles of relationship marketing, which is considered nowadays as the new marketing paradigm in the commercial sector?

(8) If yes, what would the objectives, the communication means and the targets of this new marketing strategy be?

(9) And how would this marketing strategy interfere in the main determinants of recycling participation, previously identified, in order to foster this socially desirable behavior?

1.4 Thesis outline

This thesis is composed of two volumes. Volume I encompasses the body of the thesis, whereas Volume II contains the appendixes and the annexes.

In Volume I, the current Chapter prolongs itself by providing an overview of the recycling problematic in the Portuguese case. In particular, the legal framework for managing packaging residues in Portugal is pointed out, the structure, mission and objectives of Sociedade Ponto Verde are described and the functioning of the Integrated Recovery System of Packaging Waste Management is examined. This overview also portrays the recent evolution of recycling in the Portuguese case. It ends with the description of the national survey on attitudes and motivations towards recycling that had represented the starting point of this thesis.

The remainder of this Volume is organized as follows.

Chapter 2 reviews the relevant literature streams within the broad areas of social marketing, reverse logistics and consumer behavior in recycling programs. For each of these branches of research, the current point of the debate is made and some directions for further research are pinpointed.

Chapter 3 is dedicated to the five multivariate statistical methods which support the thesis: principal components analysis, logistic regression, structural equation modeling, discriminant analysis and homogeneity analysis (HOMALS). This chapter introduces each of these techniques, presents their main characteristics and describes how each of them was applied, step-by-step, in the following chapters. Also in this chapter, the procedures carried out for dealing with the missing values are justified.

Chapters 4 through 7 encompass the innovative aspects of the thesis and were structured as papers[1].

Chapter 4, titled as "Behavioral determinants of household recycling participation: the Portuguese case", provides a first formative research on the predictors of recycling behavior in Portugal, by estimating, testing and interpreting a logistic regression model that uses dimensions derived from the application of principal components analysis and also a set of dummy variables, as independent variables.

[1] The contents of these chapters are, with some adaptations, the contents of four papers that were presented in national and international conferences, and that were submitted for publication in international journals. These adaptations were needed in order to avoid the repetitions along the thesis and also to provide a uniform structure to the chapters.

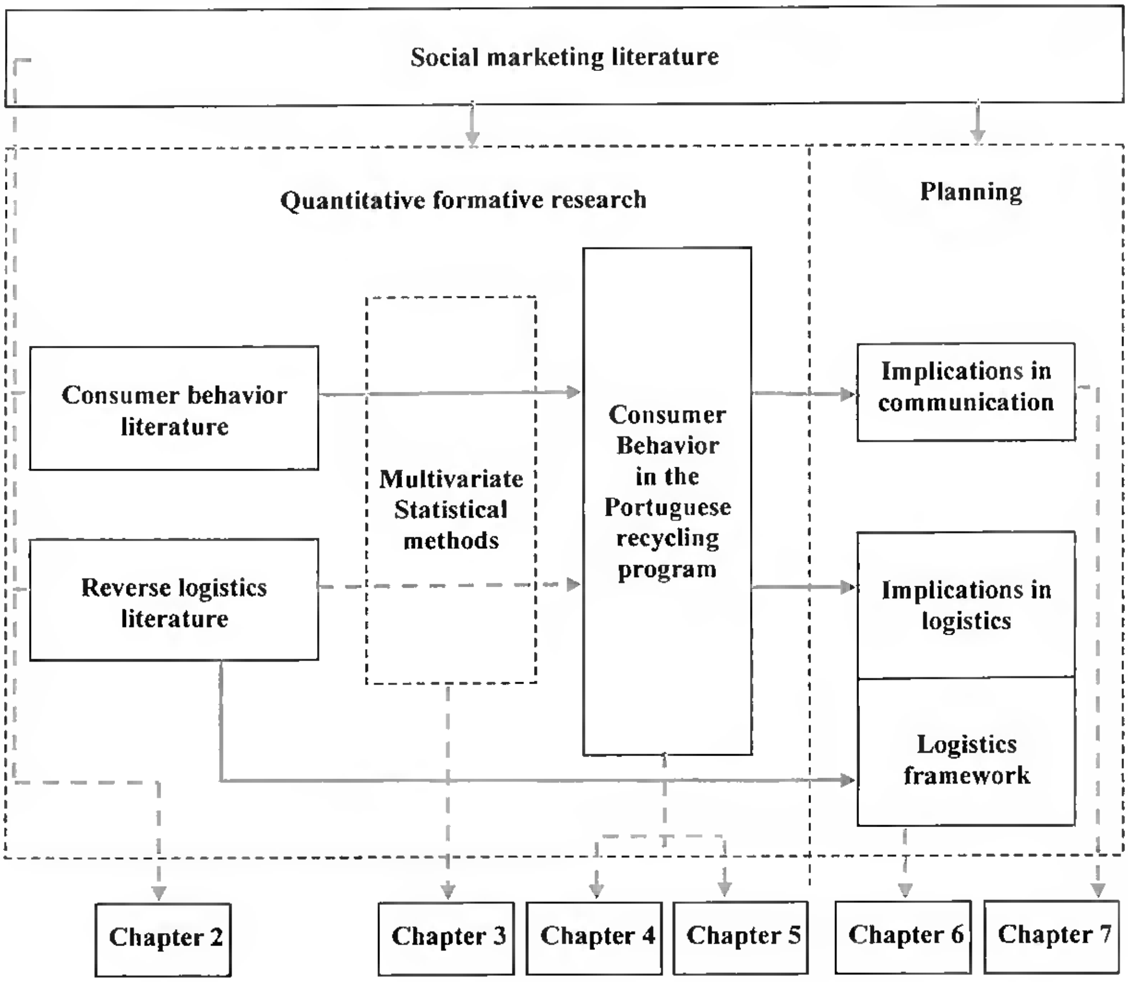
Chapter 5, named "Combining behavioral theories to predict recycling involvement", deeply explores the market research initiated in Chapter 1, by proposing a comprehensive structural equation model of recycling participation. This model establishes and estimates the direct and indirect relationships among a large number of potential determinants of this sustainable behavior, in comparison to those considered in previous models using also this statistical method. Based on their results, both these chapters also offer some contributions to the planning stage of a future social marketing campaign.

Chapter 6, referred to as "The importance of consumer-service in the reverse logistics system for recycling", is dedicated to surpassing one of the gaps pointed out in the literature review on reverse logistics, since it focuses on the role of consumer-service performance in achieving consumers' involvement in the reverse logistics system for recycling household packaging residues. In this chapter, the interest in attending the consumer-service requirements is demonstrated, once again, through the application of multivariate data analysis methods, in this case, principal components analysis and discriminant analysis. In this chapter, the several consumer service dimensions are ordered, taking into account their importance in determining recycling behavior, and the several trade-offs that must be managed in improving these dimensions are analyzed. Effectively, planning a social marketing campaign has to go further than communication and create or improve, as well, the physical conditions for facilitating the adoption of the desired behaviors. Chapter 6, therefore, focusing on the logistics aspects of reverse logistics for recycling, contributes to this specific facet of the social marketing planning. This chapter also discusses the challenges facing the future development of this reverse logistics system, providing therefore, some insights to the still scant literature on this topic.

Chapter 7, "The Applicability of Relationship Marketing in Social Contexts: The Case of Fostering Recycling Behavior", is motivated by the challenge of analyzing the potential of relationship marketing in the specific context of encouraging recycling practices, a research gap detected in the review of the social marketing literature. Based on the application of a few descriptive statistics and also on the application HOMALS, this chapter suggests the lack of success of the current mass marketing strategy that has been followed in Portugal, and proposes guidelines for planning a new social marketing campaign, which could be compatible with the main ideas underlying relationship marketing. Within this framework, this chapter offers some orientations in what regards the definition of the overall goal of a renovated social marketing campaign, its specific objectives, communication means and specification of a targeting option.

Figure 1.2 integrates Chapters 2 to 7 in the general scope of this thesis. As suggested by the description of the contents of chapters 4 to 7, they all have a component of "quantitative formative research", which is, however, stronger in Chapters 4 and 5. Likewise, these four chapters have a component of "planning", that is, nonetheless, reinforced in Chapter 6, concerning reverse logistics aspects, and in Chapter 7, in what regards the communication domain.

FIGURE 1.2
Conceptual model of the thesis and the major focus of Chapters 2 to 7



Chapter 8 provides the main conclusions of this thesis as well as some suggestions for future investigation.

As referred, all appendixes and annexes are presented in Volume II. Appendix A includes some literature review tables. Appendixes B to F correspond to the five multivariate data analysis methods and contain the results of the statistical tests and analyses, which were made in agreement with these methodologies, but were not shown in the Chapters 4 to 7. Appendixes G to I present the results of the missing values analysis carried out in each of these chapters and Appendix J contains results of some statistical tests that were carried out to mislead the initial non-response bias. Lastly, Annex A includes the questionnaire that supported the national survey on attitudes and motivations towards recycling and Annex B holds some information concerning the structure of the sample.

1.5 Recycling in the Portuguese case

1.5.1 Legal framework

The guiding principle of the European Directive 94/62/CE is to harmonize the State-Members' legal frameworks in what regards packaging and packaging residues. The objective of this legislation is twofold. On one hand, it intends to prevent and attenuate the environmental impacts of packaging and packaging residues among all State-Members, ensuring, as consequence, a high level of environmental protection. On the other hand, the Directive aims at avoiding barriers and restrictions to the internal trade and competition among the State-Members.

For attaining this double purpose, the Directive encompasses guidelines that aspire, as a first priority, to preventing the production of packaging residues. Complementarily, this diploma expresses as fundamental principles, the packaging reuse, its recycling and other forms of valorization, in order to reduce the final elimination of this type of residues. Within this framework, a temporal horizon was proposed for each State-Member in which some quantitative targets of packaging valorization and recycling should be accomplished. In the Portuguese case, particularly, it was established that, by the end of 2005, 50% of the overall packaging weight must be recovered and 25% of this must be recycled, with a minimum goal of 15% per material (paper / cardboard, glass, plastic, steel and aluminium and wood).

As imposed by this European Directive, the economic operators must assume the responsibility for managing the packaging and the packaging residues of the products they trade, on the basis of the polluter-pays principle. It was also established that consumers have a key role on this managing process and, as consequence, that they should be properly informed and motivated in order to change their attitudes and behavior.

This European legislation created the foundations for the legal framework that would later be defined by each State-Member in what regards the managing and final destination of their packaging and packaging residues. In Portugal, this legal framework comprised of the Decree n° 366-A/97 and the Ordinance n° 29-B/98, which contains all basic principles and rules of a Packaging Waste Management System for all types of packaging (reusable and non-reusable) traded in the Portuguese market-place, whether they have been used or produced, at a domestic, industrial, agricultural or commercial level, and regardless of their material. Decree n° 366-A/97 of December 20, with the changes introduced by Decree n° 166/2000 of July 20, defines the same packaging valorization and recycling goals that were previous determined by the European Directive.

The Communitarian legislation does not force State-Members to follow a specified management model of packaging residues. Within this context, Decree n° 366-A/97 and Ordinance n° 29-B/98 allow economic operators to transfer their recovery obligations to a nationwide system-operating organization, which, however, in order to carry out its activity, has to be approved by the Ministries of Environment and Economy. In Portugal, until the present, this entity has been the Sociedade Ponto Verde, S.A.

1.5.2 Sociedade Ponto Verde and the Integrated Recovery System

Sociedade Ponto Verde (SPV) was founded by private sector initiative on November 16, 1996, but it was only officially approved to manage packaging residues in Portugal one year later. SPV is a non-profit private company, whose shareholders' structure represents all types of activities involved in the logistics packaging chain for all sorts of packaging materials. In concrete, SPV's shareholders are 148 private companies, grouped into three holdings: EMBOPAR, DISPAR and INTERFILEIRAS. EMBOPAR holds 54.2% of SPV's share capital and represents the filling / packaging companies. DISPAR owns 20% of SPV's share capital and is formed by companies and associations of the distribution sector. Finally, INTERFILEIRAS have 20% of SPV's social capital and represents packaging material manufacturers and recyclers. The remaining share capital is detained by minor shareholders associated with SPV's activities[2].

The SPV's mission is to promote the selective collection, the recovery and the recycling of packaging residues in Portugal. Its fundamental objective is to allow the accomplishment of the national packaging valorization and recycling targets, established by the European Directive 94/62/CE. SPV has six main functions:

(1) To provide Municipalities with technical and financial support, by means of selective-collection and trial programs;

(2) To ensure the take back, the recovering and the recycling of the trialed residues, through the contracts it holds with the packaging materials' producers;

(3) To manage the final destination of the residues that proceed from non-reusable packaging traded in the national marketplace;

(4) To ensure distributors that all non-reusable packaging is embraced by the Integrated Recovery System of Packaging Waste Management (SIGRE);

(5) To promote consumers' awareness and environmental education. In this case, the objective is to achieve the highest possible participation rate and to guarantee the quality of the sorted and collected material;

(6) To support research programs that aim at developing the markets of recycled products and materials.

In order to fulfill its legal and environmental obligations, SPV has organized and dynamized the SIGRE, a complex system that ensures the take back, the valorization and the recycling of the non-reusable packaging residues. SIGRE, vulgarly known in Portugal as "Sistema Ponto Verde", embraces all sorts of packaging and packaging residues (non-hazardous) placed in Portugal, independently from their material. This packaging can be urban (domestic), compared to urban (the most significant are from restaurants, hotels and coffee-shops) or non-urban (industrial, agricultural and of distribution). SPV only got the license to manage compared to urban packaging materials on September, 1999 and non-urban packaging residues on October, 2000.

Like some other European Integrated Systems, the Green-Dot System relies on the articulation of responsibilities and processes among a set of partners, based on the principle of shared environmental responsibility[3]. These partners are: (1) the fillers / packers and importers; (2) the distribution sector; (3) the municipalities; (4) the consumers; (5) and the recycling companies.

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[2] These shareholders are 14 City Halls (each one with 0.2% of share capital), the INESC - Institute of Systems Engineering and Computers (2% of share capital) and the LOGOPLASTE -Technical consulters, SA (1% of share capital).

[3] Overall, there are already 20 countries that share the Green-Point System's philosophy: Germany, Austria, Belgium, Canada, Slovenia, Spain, France, Greece, Hungry, Ireland, Leetonia, Lithuania, Luxemburg, Norway, Poland, Portugal, United Kingdom, Czech Republic, Sweden and Turkey.

On the basis of the polluter-pays principle, *fillers/packers and importers* finance the system, paying a license fee that is calculated according to the amount and weight of the respective packaging material[4]. In return, they get the permission to mark their packaging with the "Green-Dot" symbol[5] which, together with a certificate passed by SPV, ensures that the companies belong to the SIGRE and that they have transferred their recovery responsibilities to an officially recognized system-operating organization. The *distribution sector*, in turn, has a fundamental role in indirectly auditing this system because, in agreement with the legal regulations, only non-reusable packaging marked with the "Green-Dot" symbol can be sold in their commercial platforms.

Consumers' responsibility is to separate the used packaging by type of material and dispose of them in the suitable containers, provided by the *municipalities*. These entities, then, take over the multi-material collection and trial of this sort of residues, using mainly specific containers for a bring-system (also referred to as "drop-off collectors" or, more vulgarly, the "Eco-points"[6]). The term municipality should be perceived in a broad sense, by corresponding to the municipal systems (which are companies that integrate one or more municipalities) that have compromised themselves, by contract with SPV, to carry out the selective-collection and trial. The additional costs incurred by the municipal systems with the selective-collection and trial, in relation to the undifferentiated-collection costs, are supported by SPV, through

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[4] By calculating the license fee according to the weight of the packaging material, SPV is encouraging the prevention of packaging waste. This fee is usually known as the "Green-Dot value".

[5] The "Green-Dot" symbol is an internationally registered brand in more that 170 countries and its user rights are managed by the Packaging Recovery Organization Europe Company (Pro-Europe).

[6] An "Eco-point" is a set of three containers for the selective disposal of packaging residues. Each container receives a type of material: the yellow container collects plastic and metal; the blue container receives paper and cardboard and the green container collects glass. Some municipalities also provide door-to-door collection, also referred to as "curbside" collection. In alternative to these collection-systems, consumers can also deliver recyclable packaging material to the "Eco-centers", which are large parks with big containers which receive the same packaging residues as the "Eco-points" but also other sort of residues, separated by types of material, like wood, white-goods, furniture, tires, etc.

the "counterpart value"[7]. SPV also finances and gives technical assistance to campaigns organized by the municipal systems to foster citizens' participation in their recycling programs. To close the loop, SPV accredits companies (*recycling companies*) to buy the selective-collected residues and that ensures their recycling. To get this certification, these companies have to make an agreement with SPV, on the basis of which they assume to accept the total amount of separated packaging residues forwarded by the municipalities.

Table 1.1 provides a summary of the recycling process, for each sort of material that can be recycled in Portugal. The specific benefits of each type of recycling process, as well as some examples of goods that are produced using each type of recycled material, are outlined in Table 1.2.

TABLE 1.1
Types of recyclable materials and notes on their recycling process

	Paper / cardboard	Glass	Plastic	Metal (steel and aluminium)	Wood
Notes about the recycling process	1 – Paper residues are selectively collected and sorted in trial centers 2 – Recycling is made with or without the addition of raw materials to produce paper paste.	1 – Glass residues are selectively collected but are not sorted in trial centers 2 – Once collected, glass is transported to units of recycling, where it is fragmented, sorted and cleaned 3 – The recycling process involves melting and molding the fragmented glass	1 – Plastic residues are selectively collected and sorted in trial centers 2 – Once separated, these residues are transported to the recycling units, in agreement with the type of plastic 3 – Plastic residues are then cleaned and fragmented, being transformed into granulated secondary material 4 – This material is integrated in the production process of new plastic materials	1 – Metal residues are selectively collected and sorted in trial centers by electromagnetism into two categories: steel and aluminium 2 – Once separated and pressed, metal residues are transported to the corresponding units of recycling 3 – In the recycling units, metal residues are melted with raw materials and transformed into high quality metal bullions	1 – Wood residues are selectively collected and sorted in trial centers 2 – Recycling is made with or without the addition of raw materials and the resulting material is the basis of the agglomerates industry

Source: Adapted from various descriptions provided by SPV (2003).

[7] The counterpart value is calculated according to the type and weight of materials selectively collected and trialed by the municipalities and delivered to the recycling companies accredited by SPV.

TABLE 1.2
Types of recyclable materials, benefits of recycling and the better known goods produced with the recycled material

	Paper / cardboard	Glass	Plastic	Metal	Wood
Specific benefits fof recycling	Avoids cutting trees	Producing new glass from recycled material requires less energy consumption than producing first generation glass	Allows saving raw-materials	Allows saving raw-materials; requires much less energy consumption	Avoids cutting trees
Technical limitations	The recovered fibres can not be recycled more than 4 to 6 times	No technical limitations: the recovered glass can be recycled in an unlimited cycle without loss of quality	No technical limitations if compatible granulated secondary materials are used	No technical limitations for steel and aluminium	No technical limitations
Common goods made of recycled material	Newspapers, paper bags, cardboard, new paper packaging	New bottles and other glass packaging	Pallets for transporting goods, materials for the building sector, packaging (for beverage, food and cleaning products), fibres (for fulfilling wadded products), clothes, toys.	Almost all metal goods currently used	Building material, Furniture

Source: Adapted from various descriptions provided by SPV (2003).

1.5.3 The recent evolution of household packaging recycling in Portugal

The implementation of the national legal framework about packaging and packaging residues, as well as the foundation of SPV, has allowed a clear perception and characterization of the Portuguese situation in what regards the valorization and the recycling of this sort of residues. Until then, the recycling sector in Portugal was not totally regulated and the practical experiences were not often relevant[8]. Moreover, when

[8] Although some practices of selective-collection could be reported before 1994, no quantitative information was available that could enable an analysis of their effectiveness. With the purpose of overcoming this gap, QUERCUS (National Association of Environmental Conservation) conducted a study titled "Recycling is development" in 1994 that allowed the description of the situation of some municipalities towards the selective-collection (QUERCUS, 1994). In particular, for each analyzed municipality, the type of collection that was being implemented, the number of available containers for selective-collection (mainly for collecting glass residues) and the frequency of collection were assessed. Besides the punctual recycling experiences reported in this study, it is important to make a reference to the well succeeded "Projecto-Piloto de Queijas" in Oeiras, 1994, based on door-to-door collection.

compared with the recycling levels in other European countries, the national rates had little expression. As referred in the Strategic Plan of Urban Solid Residues (PERSU), only 2.7% of glass residues and 1% of paper residues, were recycled in 1995 (Ministerial of Environment, 1999)[9].

Since the beginning of its activity, SPV has made a crucial contribution to institute an effective integrated solid waste management policy in Portugal by technically supporting and financially the municipalities that are willing to implement multi-material collection and trial. The efforts of SPV in these matters are visible by observing Table 1.3, which shows the evolution in the application of SPV's resources by its major activities.

TABLE 1.3
Evolution of the application of SPV's financial resources by its main activities (Unit: Euros)

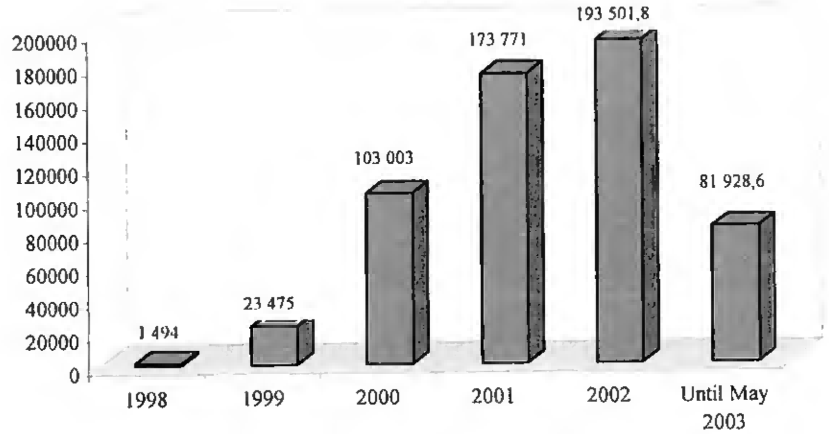
	1998	1999	2000	2001	2002	Total
Counterpart value	74 361	1 614 095	9 258 467	18 265 655	18 833 826	48 046 407
Research and development	0	46 054	193 657	276 793	504 811	1 121 315
Communication campaigns	191 114	1 324 681	3 344 260	3 399 179	2 831 222	11 090 456
Total annual costs	265 475	2 984 830	12 896 384	21 941 626	22 169 862	60 258 178

Source: SPV (2003).

As counterpart of these financial applications, the amount of packaging residues, recovered and forwarded for recycling by SPV, has reported a significant increase. The global results of this evolution are depicted in Figure 1.3. Figure 1.4 illustrates these results by type of collected material.

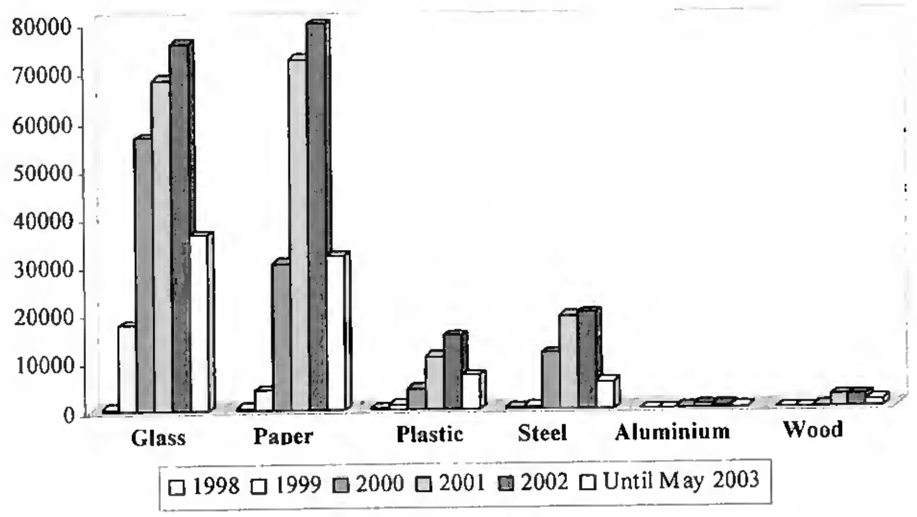
[9] According to SPV, these values are lightly underestimated because the PERSU had overestimated the amount of packaging traded in the Portuguese market-place.

FIGURE 1.3
Evolution of the total amount of packaging residues (tons) recovered and forwarded for recycling by SPV from 1998 to May, 2003



Source: SPV (2003)

FIGURE 1.4
Evolution of the total amount of packaging residues (tons), by type of material, recovered and forwarded for recycling by SPV from 1998 to May, 2003



Source: SPV (2003)

As Figure 1.3 shows, around 193 thousand tons of packaging residues were recovered and delivered for recycling by SPV in 2002, which represents an overall growth of 11.4% in relation to the previous year. It is worth to say that in 2002, 63.2% of the total amount of recovered packaging materials has come from the municipalities, that is, are household packaging residues. These percentages were of 64.1% in 2001 and 87.2% in

2000. In the previous years, only household packaging residues were recovered and forward for recycling by SPV. Also in comparison to 2001, plastic highlights as the type of material that has reported the superior growth rate (39.8%). Glass and paper / cardboard packaging materials, on the other hand, has accounted for a similar growth rate of 10%. Aluminium was the only sort of material whose amount recovered has decreased[10].

Table 1.4 portrays the progress in the amount of packaging residues that were declared and recovered by SPV, since the beginning of its activity. The table shows the total recovered weight and the recovered weight of urban (domestic) residues. While the overall packaging weight that has been recovered has reported a growing trend, it is still quite distant of the target recovered rate of 50% that Portugal should accomplish by the end of 2005. Moreover, at the end of 2002, the SIGRE has only allowed the recycling of 14% of the total packaging weight placed in the national market (SPV, 2003). This value is also far distant of the desired recycling rate of 25% that was established for Portugal, for the end of 2005, by the European Directive.

TABLE 1.4
Evolution in the amount of packaging residues (total and urban) declared and recovered by SPV

	1998	1999	2000	2001	2002
Declared weight (tons)	469 800	635 419	660 603	707 787	764 329
Total recovered weight (tons)	1 494	23 475	103 003	173 770	193 502
Total recovered weight of domestic packaging waste (tons)	1 494	23 475	89 838	111 442	122 217
% of total recovered weight in relation to the declared weight	0.32%	3.69%	15.59%	24.55%	25.32%
% of recovered domestic packaging waste in relation to the declared weight	0.32%	3.69%	13.60%	15.75%	15.99%

Source: SPV (2003).

[10] According to SPV (2003), technical problems, which have restricted the labor scheduling of some trial equipment, justify this result.

The Green-Dot System, managed by SPV, finished the year of 2002 by covering around 72% of the national territory, serving 92% of the population and embracing 82% of the municipalities. As recently noticed, Portugal had more "Eco-points" (15 429) in 2002 than ATM's (SPV, 2003). On the other hand, since the beginning of its function, SPV has already invested more than 11 million Euros in communication campaigns, as reported in Table 1.3. The analysis of these numbers evidences the effort of SPV in attaining the compromises it has assumed.

However, the challenge of successfully facing the standards of packaging recycling imposed by the European Union is rather high, especially because only a few years have passed since the multi-material collection for recycling began to be seriously faced in Portugal. Besides, it is important to emphasize that the European Union is currently working on the definition of new and more ambitious goals of packaging valorization and recycling that should be attained by the State-Members by the end of 2009 and 2012. To overcome these challenges, a significant proportion of Portuguese citizens have to reorient their behavior towards the recycling problematic, which means that investments in logistics infrastructures for collection and well as in the communication domain have, necessarily, to persist.

1.5.4 Promoting household packaging recycling in Portugal

SPV has been strongly involved in the communication field, both by conducting promotional campaigns of its own initiative and by co-financing the awareness campaigns promoted by the municipalities to motivate citizens to the adoption of correct procedures of separation and disposal of packaging residues.

SPV has begun its intervention in the communication area right at the beginning of its activity by means of some advertising actions in the press. This advertising was centered on the SIGRE, by informing about its existence and shortly explaining its main characteristics and objectives. In 1998, no advertising campaign was implemented, but SPV started its field actions by assisting, technically and financially, the communication plans proposed by two municipalities.

At the communication level, the year of 1999 was marked by the use of television as the primary advertising mean. This campaign was intended to inform about the meaning of the "Green-Dot" symbol. In parallel, SPV invested in some advertisements in the press and also in billboards, with the purpose of showing the SIGRE's potential in the environmental preservation. Also in this year, SPV supported three municipal communication plans, initiated field actions in public spaces and commercial platforms and started the distribution of flyers and brochures about the recycling issue. In July, the SPV's official site, which contained diverse information about the company as well as general information about recycling and selective-collection, was presented to the public.

The most prominent advertising campaigns were carried out in 2000. These campaigns were focused on the need of changing consumers' behavior towards the recycling problematic. Based on two television spots, by showing the domestic separation of packaging residues as an easy and natural activity, that a little child or even a monkey could perform, SPV intended, as a *first objective*, to demystify the belief that recycling involves complex behaviors and, as a result, to convert household separation in a spontaneous and instinctive routine. At the end of these television spots, an animation of the selective-collection containers, the "Eco-points", illustrating the specific packaging material that should be placed in each one, was presented. In this way, SPV was aiming to achieve a *second objective*: to increase citizens' knowledge about how to participate in the national recycling program. This national campaign was also supported by the distribution of billboards, with similar messages and images, which were considered the main complement of the television spots. In 2000, SPV has enlarged its local / regional activity at the communication level by supporting 11 communication plans developed by the municipalities.

The advertising campaigns conducted in 2000 were so important to the SPV' intervention in the communication field, that they have determined the latter campaigns. In effect, the purposes of the advertising campaigns carried out in 2001 was "to provide value to the citizens' response to the previous campaign" and "to show the practical results of citizens' new recycling behavior". Likewise, the national campaigns that were implemented during 2002 were simply the reposition of the advertisements carried out during 2000 and 2001.

1.5.5 The survey on consumers' motivations towards household packaging recycling

In order to increase the recovery of packaging residues for recycling, SPV has adjudicated to the Statistics and Data Analysis Research Group (GIESTA) of ISCTE Business School, Lisbon, in the beginning of 2000, the performance of a study on the attitudes and motivations of the Portuguese population in what regards the household packaging separation and selective disposal for recycling. The scope of this study was to perform "a detailed evaluation of the perceived structural importance of the most important variables, which determine the participation in the selective-collection system, to support the definition of a strategy that permits increasing the take back of household packaging residues" (GIESTA, 2000: 4). Its general purpose, therefore, was to gather useful information to support later action plans.

This study focused on the domestic packaging residues and it was based on a structured questionnaire. The conception of this questionnaire, in turn, relied on a review of scientific publications about recycling behavior, mainly articles published in environmental social psychology journals, some interviews with key managers of SPV and also on a search of similar studies performed in other European countries. In particular, the studies with the same purpose that were carried out for the companies *Fost Plus* (Belgium), *Ecoembalajes* (Spain) and *ERRA* (Italy) were consulted and taken into account.

As can be observed in Annex A, the questionnaire embraced questions on six main issues: I – Society and environment; II – Separation of domestic packaging residues; III – Motives for not separating domestic packaging residues; IV – Incentives for separating domestic packaging residues; V – Environmentally friendly consumption; and VI – Characterization of the respondent and of the household.

The target population of this study was households living in Portugal continental in the municipalities belonging to the solid waste management systems embraced by the SIGRE. The initially predicted sample was of 2000 households, which would be distributed by 50 municipalities[11]. The sample procedure was stratified in the

[11] These municipalities are Caminha, Paredes de Moura, Barcelos, Ponte da Barca, Braga, Vieira do Minho, Maia, Porto, Valongo, Santa Maria da Feira, Vila Nova de Gaia, Alfandega da Fé, Mirandela, Marinha Grande, Pombal, Aveiro, Estarreja, Mealhada, Oliveira de Azeméis, Vagos, Mangualde, Viseu, Guarda, Penamacor, Abrantes, Sardoal, Oeiras, Almada, Palmela, Setúbal, Cuba, Vidigueira, Castelo de Vide, Portalegre, Lagos, Olhão, Tavira, Évora, Beja, Amadora, Lisboa, Loures, Paredes, Torres Vedras, Santiago do Cacém, Constância, Santarém, Cascais, Sintra e Lousada.

municipalities' selection within each system, assuring the presence of all systems, and the households were randomly selected from telephone directories. The distribution of the interviews to be made in each municipality was initially proportionally determined to the resident population, but later corrected to make sure that no system had a sample dimension lower than 30 cases. The final sample size was of 2093 households. Table B.1, in Annex B, shows the predicted and the final sample size by each municipality and municipal system considered in the study.

The data were then collected from personal interviews, based on the structured questionnaire, carried out from March to July 2000, to these 2093 households. The questionnaire was sent by mail to the households that agreed to participate in the study in a previous telephone contact. The questionnaire was accompanied by a letter explaining the relevance and purposes of the study and also informing that, a few days after, the household would receive another telephone call in order to fix the date when the interviewer would personally pick up the questionnaire and, if necessary, clarify any doubt regarding its fulfilling.

Around 50% of the initially selected households accepted participating in the first telephone contact but, in fact, only about 30% of these actually answered the questionnaire. Consequently, to get the final sample size of 2093 individuals, around 10500 telephone contacts were performed. The main causes pointed out for the refusal in participating were: (1) too long questionnaire; (2) hard questions; (3) invasion of privacy and (4) lack of time.

In order to test whether or not the late participants would be the least environmentalists, those with a negative opinion towards recycling or even those who do not participate in the recycling program, independent samples t-tests were carried out on the items of the questionnaire which were measuring general environmental attitudes and specific attitudes towards recycling. The results of these tests are presented in Appendix J and evidence very small and non-significant differences between the two groups (earlier respondents versus latter respondents) concerning all the items (for only three items, $0.035 < p < 0.05$; for all the others, $p > 0.05$). Moreover, Chi-square independence tests were carried out to test, first, the hypothesis that the non-responses were independent from self-reported recycling participation in the recycling program and, then, the hypothesis that the non-responses were independent from self-reported adherence level to the recycling program. In both cases, the null hypothesis of independence was not rejected ($p = 0.839$; $p = 0.631$). Based on these results, non-response bias was considered negligible, that is, the participation of the latter respondents was not changing the overall results of the study.

The socio-demographic characteristics of the respondents, along with some household's features, are summarized and presented in Table 1.5. Most respondents are female, have completed at least 12 years of school and live in medium-sized apartments, some of which already owned by the family, others still being bought. Around 55% of households declared their participation in the recycling program. Within the households who declared to participate in the recycling program, the respondent is someone who usually separates and selectively disposes of the packaging residues.

TABLE 1.5
Demographic characteristics of the sample

Characteristic	Distribution of Answers
Respondent's Gender	64.9 % female; 35.1% male
Respondent's Age	14 – 25: 26.7%; 26 – 35: 22.9%; 36 – 45: 20.9%; 46 – 55: 16.0%; 56 – 65 :7.0%; 66 – 94: 6.5%; Mean age: 38 years; Median age: 35 years
Respondent's Education level	4 years: 13.9%; 6 years: 5.8%; 9 years: 9.3%; 12 years: 20.7%; technical/ professional: 12.5%; College or higher: 37.7%; Median education level: 12 years
Respondent's profession	Farmer/fisher: 0.4%; workman: 12.3%; Services worker: 17.6%; Public worker: 4.7%; Teacher: 8.2%; Liberal worker: 7.2%; Manager: 6.3%; Retired: 6.8%; Housewife: 5.8%; Student: 18.2%; Other: 12.5%
Respondent's Marital status	Married: 53.5%; Single: 36.7%; Divorced: 4.9%; Widow:4.9%
Residence type	Apartment: 57%; House: 38%; Farm: 5%
Home ownership	Own/are buying: 71%; Renting: 21%; Familiar: 8%
Number of rooms at home	Zero or one: 7%; Two or three: 71%; Four or more: 21%
Family monthly income	Less than 324 €: 4.2%; 324 € – 499 €: 9.5%; 500 € – 999 €: 32.0%; 1000 € – 1999 €: 34.2%; 2000 € – 2999 €: 12.6%; at least 3000 €: 7.5%

The last questionnaires were received during July, 2000, and the report of results was delivered to SPV at the end of that month. Besides providing an overview on the study's framework, structure and scheduling of the main activities it had involved, this report presented some statistical analyses of the various items and questions included in the questionnaire, essentially by means of descriptive statistics (graphs, tables and individual measures), as well as the most immediate conclusions from the observation of these results. This set of data, which supported this study that was performed by GIESTA for SPV, has also been used for this thesis.

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Chapter 2

REVIEW OF LITERATURE

2.1 Introduction

As the environmentally-related issues came to have an increasingly social and political visibility, the challenging of enhancing the recycling rates have begun to attract the attention of numerous researchers in the social sciences. Approaches to the recycling subject can be encountered in three different fields of literature, each of these emphasizing a somewhat different perspective of the recycling problematic: literature on social marketing, literature on reverse logistics and literature on consumer behavior in recycling programs.

To change consumers' behavior towards recycling is just a classic and particular application of social marketing to the environmental preservation. As a consequence, all generic matters related to social marketing have application to the specific case of recycling and, accordingly, these matters must be reviewed. Thus, the first section of this chapter provides an overview of the social marketing framework, by reviewing its concept and major applications, similarities and differences in relation to the traditional marketing of goods and services and by describing the strategic social marketing process. Still in this first section, the more specific literature on social marketing that has been exclusively centered on environmental issues, and on recycling in particular, is reviewed as well.

In a second vein, recycling can be understood as an option of resources recovery that integrates the scope of reverse logistics, a quite new body of theory in logistics. The second section of this chapter reviews the literature on reverse logistics. It begins by providing an outlook on the main topics involved in this theory still in construction and, afterwards, the studies that have discussed particular issues on reverse logistics for recycling are examined.

Finally, as research on consumer behavior should provide knowledge about the acquisition behavior, it should also extend its focus to the understanding of the antecedents of post-consumption practices, in which recycling behavior should be integrated. The last threes decades have witnessed a growing interest in this issue and numerous studies have focused on the determinants of consumer's recycling involvement. Most of these studies integrate the body of research of environmental social-psychology, while others have been published in marketing management journals. These previous studies that have been centered on the determinants of recycling behavior are reviewed in the third section of this chapter. In particular, the personal and situational predictors of this environmentally friendly behavior are summarized and the role of statistics in analysing consumer behavior in recycling programs is pointed out.

All aforementioned sections end by referring the actual debate of the corresponding research field and by pinpointing some research gaps.

2.2 Social marketing literature

2.2.1 Overview

Origin and concept of social marketing

As social problems have became more complex in developed and developing countries, social campaigns were being designed with the aim of providing solutions in light of the socio-economic and cultural context in which these problems were felt. Examples include the recognition of segments of society especially vulnerable to some diseases, engaging in risky behaviors (such as consuming drugs) or with unfair social systems (with child labor and street children, for instance) (Novartis foundation for sustainable development, 2003).

Within these frameworks, social campaigns have been developed and implemented, enhancing society's awareness towards these problems and identifying their major roots. Most of these campaigns have relied on large-scale information – which can be sufficient in creating public consciousness and even in changing attitudes – but that rarely turned out to be effective in changing behaviors, most of them shaped by old habits, beliefs and values (McKenzie-Mohr, 2000a, 2000b, 1999).

The failure of most of these initiatives and the success of marketing in the commercial sector were the underlying forces for the witnessing of social marketing during the 1970s. This concept was first defined by Kotler and Zaltman as "the design, implementation and control of programs calculated to influence the acceptability of a social idea and involving considerations about product planning, pricing, communication, distribution and marketing research" (Kotler and Zaltman, 1971: 5). However, the potential of applying concepts and tools of generic marketing to the resolution of social problems had already been considered before, by other marketing academics like Weibe (1951), for instance, who discussed the question "whether brotherhood could be sold like soap" and who has proposed that social campaigns could be more successful if they were guided by the marketing principles followed in the commercial sector.

Kotler and Zaltman (1971) proposed that social marketing, as generic marketing, should not be perceived as a theory in itself but rather as a framework that combines insights from many bodies of knowledge (such as psychology, sociology, anthropology and communication) with the aim of changing people's behavior. The idea of extending the domain of marketing to the resolution of social problems was initially questioned in the studies of Laczniak, Lusch and Murphy (1979), Laczniak and Michie (1979) and Luck (1974), but some well succeeded experiences in the early applications of social marketing, especially in family planning campaigns or in disease prevention programs, provided the needed incentive to the development of this marketing framework[12]. Since the 1980s, and until the present, the academics are no longer concerned whether the traditional marketing principles and tools can be applied to solve generic social issues but, instead, how to use them to encourage socially desirable behaviors in the health, social development or in the environmental areas.

Since the concept of social marketing advanced by Kotler and Zaltman (1971), many other definitions have been proposed (Maibach, 2002; Smith, 2000; MacFadyen, Stead and Hastings, 1999; Smith, 1999; Andreasen and Kotler, 1996; Andreasen, 1995; Andreasen, 1994; Ling *et al.*, 1992; Fine, 1990; Lefebvre and Flora, 1988). As an

[12] Andreasen (1995) describes various success stories about the application of social marketing in the heath sector (pp. 18-28) and Bloom, Hussein and Skykman (1995) presents examples in different social areas (pp. 11-15).

example, Andreasen defines social marketing as "the application of commercial marketing technologies to the analysis, planning, execution, and evaluation of programs designed to influence the voluntary behavior of target audiences in order to improve their personal welfare and that of society"[13] (Andreasen, 1995: 7). Regardless of the specificities of the suggested definitions, the focus of social marketing rests on changing behaviors in order to improve the well being of the general society. As explained by Bloom, Hussein and Skykman, as long as this is the most important objective, a program fits the definition of social marketing, "even if increasing sales or improving the corporate image is a secondary goal" (Bloom, Hussein and Skykman, 1995: 10).

Nowadays, social marketing campaigns in a wide range of areas can be reported, such as health promotion (e.g., malnutrition, AIDS, vaccination, anti-smoking, anti-drugs, family planning, donating blood), crime prevention (e.g., family violence, human rights), environment (e.g., energy and water conservation, general anti-pollution, avoidance of CFCs in aerosols, transportation, preservation of forests and natural parks, recycling, reusing, composting), education (e.g., literacy), economy (e.g., training, revitalizing of old patrimony), and in the resolution of other social problems, like excessive population growth and racism (Social marketing network, 2003).

Comparing social marketing with commercial marketing

Social marketing has much in common with the traditional marketing of products (goods and services), usually referred to as "commercial marketing" (Hastings, 2000).

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[13] Social marketing should not be confounded with "Cause-related marketing" or even with "Green marketing". As defined by Bloom, Hussein and Skykman, "cause-related marketing programs tie the money or gifts a company gives to a charitable cause with purchases made by consumers" (Bloom, Hussein and Skykman, 1995: 10). In turn, green marketing "consists of all activities designed to generate and facilitate any exchanges intended to satisfy human needs or wants, such that the satisfaction of these needs and wants occurs, with minimal detrimental impact on the natural environment" (Polonsky, 1994: 2).

Firstly, both marketing approaches aim to inform and influence human behavior. In the case of commercial marketing, this implies conducing consumers to buy the good or service offered by the company, whereas in the social context it involves the engagement in a socially desirable activity. Secondly, either social marketing or commercial marketing are not interested in a one-time behavior but rather in retaining consumers over time. This means the adoption of some life long socially beneficial behavior, in the case of social marketing, and repeated sales, in the case of commercial marketing. Thirdly, both marketing frameworks accept that human behavior is voluntary and affected by rewards, which implies that any attempt of changing behavior must be persuasive, instead of coercive, and offer a valuable return for the consumer. Finally, either in the social or in the commercial marketing setting, it is recognized the importance of the social environment that involves each human being, as a determinant of his / her behavior.

As summarized by MacFadyen, Stead and Hastings (1999), the concept of social marketing presupposes four fundamental elements, which are also shared by all forms of marketing: (1) a consumer orientation (Lefebvre and Flora, 1998; Andreasen, 1995) that requires the establishing of a narrow relationship with consumers, through continuous market research, in all phases of the development of the social marketing program; (2) a philosophy of exchange (Smith, 2000; Lefebvre and Flora, 1998; Smith, 1997; Lefebvre, 1996; Leathar and Hastings, 1987), which means that, for the two or more parts involved in the program, an exchange of values must occur in such a way that all parts get some benefits; and (3) a long-term planning outlook (Andreasen, 1995), based on continuing and strategic, rather then tactic, marketing programs.

The most prominent difference between social marketing and commercial marketing lies in their final objectives. While commercial marketing mainly looks for the maximization of the company's profit, the bottom line of social marketing is the change of behavior that could enhance the society' welfare (Smith, 2002; Hastings, 2000; Smith, 2000; Kotler and Andreasen, 1996; Corson, 1995). However, there are other relevant points of departure between these two marketing frameworks. As MacFadyen, Stead and Hastings (1999) explain, in social marketing "the products tend to be more complex, demand is more varied, target consumers are more challenging to reach, consumer involvement is more intense and the competition is more subtle and varied" (MacFadyen, Stead and Hastings, 1999: 4).

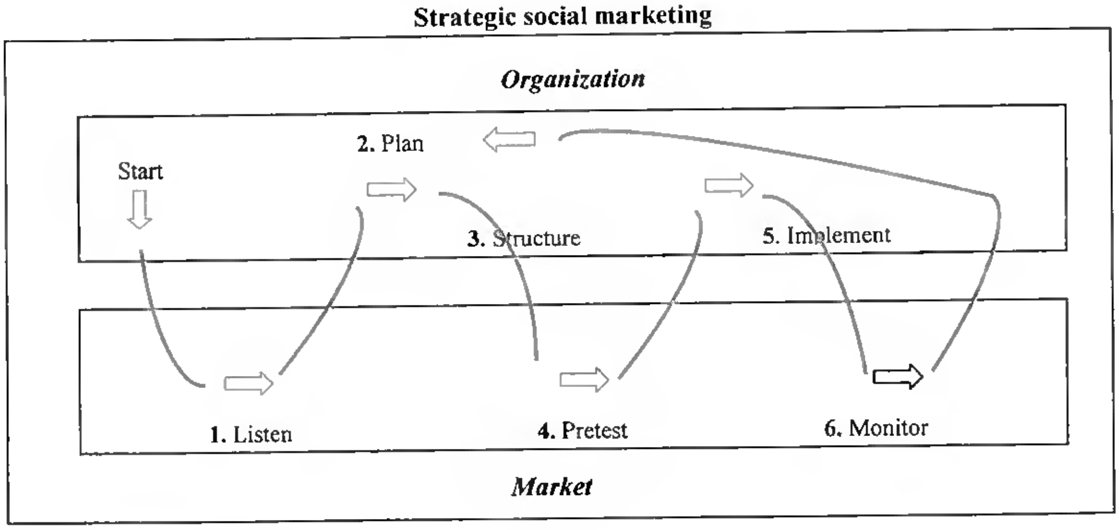
More specifically, the social marketing product is an intended behavior change, which is not always easily conceptualized in terms of its associated benefits for the consumers. In most situations, these benefits are intangible, cannot be personalized and will be felt even by those who do not have the behavior, providing the opportunity for free-riding. Under these conditions, the task of satisfying the need for the product can be very challenging. Secondly, social marketing frequently have to face a negative demand, that is, a strong reluctance to the proposed behavior change. This happens whenever the elements of a target group do not see any problem in their current behavior. Thirdly, the target groups of social marketing are often the hardest and most resistant to reach because, in most cases, they do not possess the resources (psychological, social and physical) needed to make the behavior change.

Fourthly, the behavior changes embraced by social marketing require a high involvement decision. In fact, to begin the behavior proposed by a social marketing campaign frequently involves a lifestyle change. As a consequence, people gather much information before making their choices. In theses cases, the decision process is difficult, time-consuming and requires emotional involvement. Finally, the adoption of a new behavior involves changing behavior patterns that consumers have held, very often, for a lifetime. To face the competition from rooted behaviors is certainly a complex challenge. Besides the competition of past practices, social marketing also have to deal with other sources of competition, such as more enjoyable behaviors, with personal and tangible benefits, and even with the marketing actions from the commercial sector that, very often, is the major promoter of the unhealthy and unsocial behaviors.

The social marketing strategic management process

The definition of social marketing proposed by Andreasen (1995) makes reference to the main steps involved in this marketing framework: (1) analysis, (2) planning, (3) execution and (4) evaluation of the program. Nevertheless, based on his early work (Andreasen, 1992; 1990) and also in Smith's research (Smith, 1993), this author refines these steps and presents the *strategic social marketing* as a six stage process, which is depicted in Figure 2.1.

FIGURE 2.1
Strategic social marketing



Source: Andreasen (1995).

The social marketing strategic management process encompasses, therefore, the following stages: (1) listening, (2) planning, (3) structuring, (4) pretesting, (5) implementing and (6) monitoring. As stressed by its author, two characteristics of this process should be underscored. First, *the process of strategic social marketing is continuous*, that is, it has a cyclical and iterative nature. Since the target behavior is not stable, the six stages should be continually adjusted. In other words, the preliminary research (stage 1) provides the foundation for the action (stages 2, 3 and 5) and its evaluation (research again at stages 4 and 6) should be the basis for any adjustment on the action. Second, *customers are central to the process*. Actually, strategic social marketing begins by identifying and understanding the determinants (motivations and barriers) of the behavior to be changed (stage 1) and continues proposing a strategy based on this knowledge (stages 2 and 3). Afterwards, the strategy is tested using a sample of target consumers (stage 4) and, once its potential in achieving the desired behavior change is demonstrated, the designed strategy is implemented at a full-scale (stage 5). Finally, the progress of the program is always evaluated observing whether or not the defined marketing strategy is really changing the behavior of those it was supposed to reach (stage 6).

Andreasen (1995) offers a detailed description of each of these stages. However, the *Introduction* section of this chapter positioned this thesis in the first two stages of the strategic social marketing process, designed by this author (1995). These two stages were referred to as *quantitative formative research* and *planning*. The use in this thesis of the designation *quantitative formative research,* instead of the original name *listening,* results from the presented research scope, which focuses on the quantitative analysis of the determinants of consumers' behavior, and does not address other issues that also could be embraced by a complete listening analysis, as will be referred below.

As a result, in comparison with the remaining four stages of the strategic social marketing, the first two will receive a special attention in this literature review.

As explained by Andreasen, the *listening* stage deals with "conducting extensive background analysis, including listening intently to target customers" (Andreasen, 1995: 72). Despite accepting the traditional marketing typology that divides any organizational context (or environment) into internal and external, as well as recognizing the importance of listening to all their integrating elements[14], Andreasen stresses that customers are the primary environmental feature that should be considered and analyzed in a social marketing program[15]. In truth, social marketing is customer centered, which means that it attempts to meet the needs and wants of its target audience. To do so, social marketing relies on market research with the purpose of knowing as much as possible about those it intends to reach, by collecting data from primary or secondary sources and then by interpreting and reporting the findings.

As suggested before, market research should be undertaken in the three different stages of strategic social marketing: (1) before the social marketing campaign is planned, with the aim of identifying the determinants of the desired behavior; (2) at the pretest stage, to test the various elements of the strategy before its widespread implementation; and (3) in the monitoring stage, in order to improve the effectiveness and efficiency of the

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[14] The planning models usually distinguish between two types of environment surrounding every organizational action: the internal environment and the external environment. The internal environment refers to the strengths and weaknesses of the own organization that wish to perform the strategy. In contrast, the external environment represents all elements outside the organization (economic, social, legal, technological, political and competitive), which can bring opportunities and threats to the success of the organizational action (Kotler and Andreasen, 1991).

[15] Besides underlying the importance of *listening to customers*, Andreasen (1995) also points out the interest in *listening to the organization* that intents to carry out the social marketing program, in what concerns its objectives and capabilities, in *listening the competition*, that is, in identifying alternative behaviors, and also in *listening other interveners*, such as scientists, politicians and local agents, prior defining the social marketing strategy.

program. The importance of market research as the basis of social marketing, but also in its other phases, is emphasized by various authors (Macstravic, 2000; Smith, 2000; MacFadyen; Stead and Hastings, 1999; Smith, 1999; Weinreich, 1999). For instance, the researchers from the Novartis foundation for the sustainable development state that

> "the starting point of social marketing is getting to know the target audience thoroughly through market research: its social and demographic makeup (economic status, education, age, structure, and so on), its psychosocial features (attitudes, motivations, values, behavior patterns), and its needs. (...) Market research is crucial not only in the planning phase of the program but also during its implementation, as social marketers have to be aware of and responsive to the target groups' changing needs" (Novartis foundation for the sustainable development, 2003: 5).

Andreasen classifies the research carried out before the development (planning) of the social marketing program, using primary data, as *formative research*[16]. As defended by this author, this kind of research must be based on a *model of consumer behavior*, which is a simple way of representing how consumers initiate a new behavior. Another important element of this author's approach to formative research is the relevance conferred to *quantitative formative research*. As he points out,

> "quantitative research is best at yielding statistically reliable estimates of the following kinds of information:
> How many people are not doing the desired behavior?
> Which subgroups of the population are more affected by the problem? Which subgroups are more likely to respond to potential interventions?
> What is the level of awareness to the problem and what are people's feelings toward it?
> What are the characteristics of the subpopulations that we are likely to target?
> What are the media habits of the target audiences? " (Andreasen, 1995: 108).

Within social marketing contexts, most of this quantitative research is based on the application to a representative sample of the target population of a comprehensive survey that will allow gathering information about the knowledge, attitudes, beliefs, values, practices and other relevant data (socio-demographic elements, for example) of the target audience.

The next stage of strategic social marketing is *planning*, that is, using the information from the market research in "setting the marketing mission, objectives and goals and defining the core marketing strategy" (Andresen, 1995: 72). The social marketing *mission* is a generic statement where the type of social marketing program, the type of behavior it intents to change, its target population and the marketing approach which will be used are briefly referred. The *goals*, in turn, are the translation of the social marketing mission into some particular behavioral results and the *objectives* are a quantification of the goals. At last, the *core marketing strategy* is the thorough specification of how the social marketing strategy will allow the accomplishment of the proposed behavior change. It includes the definition of the target market(s) as well as the detailed description of the strategy itself that will be used, in what regards the communication messages, channels and tools, but also concerning how the most important barriers hampering the behavior change will be removed.

In what concerns this aspect, Andreasen (1995) emphasizes that the core marketing strategy goes beyond communication. This point of view is shared and explored in various studies in the social marketing scope (Andreasen, Gould and Gutierrez, 2000; Smith, 2000; Shrum, Lowrey and McCarty, 1994; Geller, 1989). In accordance with these authors, all elements of the marketing mix – product, price, place and promotion – should be taken into account in planning social marketing.

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[16] Data supporting market research may be primary (if they are gathered from surveys, interviews or focus groups) or secondary (if they are based on pre-existing information, for instance, in scientific reviews, newspapers, media or computer databases) (Weinreich, 1999).

As already referred, the *product* in a social marketing context, is the new behavior that the audience should adopt. *Price*, in turn, represents what audience must give up to receive the social marketing program's benefits and, unlike in commercial marketing, price goes beyond monetary costs. *Promotion* includes all forms used to persuade the target audience to adopt the new behavior[17] and *place* refers to the distribution channels or created systems through which the "products" are available for consumers. As Smith (2000) clarifies, "place focuses largely on overcoming important structural obstacles to easy access", (...) "also includes the training of providers" and (...) "the quality of service offered where these products are available" (Smith, 2000: 15).

Stages 3 to 5 of the social marketing process are related with the implementation of the planned strategy. In particular, stage 3, *structuring*, involves "establishing a marketing organization, procedures benchmarks and feedback mechanisms to carry out the core strategy" (Andresen, 1995: 72). The *establishment of the marketing organization* implies designing the organizational hierarchy and affecting activities to the various elements of the staff. On the other hand, the term *benchmarking* is applied in this context to define the indicators that will be utilized later, in the evaluation stage of the program. The *feedback mechanisms*, lastly, include all elements that will be used to track the program, for example, monthly reports.

Once the program is structured, the next stage is the *pretesting*, that is, "trying out key program elements such as core marketing strategy" in a sample of the target population (Andresen, 1995: 72). The pretesting stage implies listening to the consumers again, which will allow the verification of the efficacy of what was planned and, very likely,

[17] The studies carried out by Jones and Rossiter (2002), Bang (2000), Stead and Hastings (1997) and Eadie and Smith (1995) are specific about the relationship between advertising and social marketing.

will provide feedback for some adjustments in the marketing strategy. The following stage is *implementing* or, in other words, "putting the strategy into effect". The strategic social marketing process ends with the *monitoring* stage, which involves "tracking the program process (including more listening to customers) and adjusting strategies and tactics as necessary" (Andresen, 1995: 72).

2.2.2 Social marketing and pro-ecological behaviors

All reviewed theory on the social marketing issue is transversal to the various areas in which this marketing framework has potential to be implemented. However, in contrast with the huge research on the application of social marketing to foster social beneficial behaviors in specific health fields, the research on the use of social marketing in fostering pro-environmental behaviors, like recycling, is scarcer.

Within the studies that addressed the relationship of social marketing and the need of encouraging sustainable behaviors, the research carried out by McKenzie-Mohr (2000a, 2000b, 1999), Shrum, Lowrey and McCarty (1995, 1994), McKenzie-Mohr (1994), Maibach (1993) and Geller (1989), should stand out.

The work of Maibach (1993) underscores the importance of social marketing to promote environmental protection and describes strategies that can enhance the effectiveness of pro-social communication campaigns.

The first study of Shrum, Lowrey and McCarty (1994) focuses explicitly on the use of social marketing in increasing recycling practices and is essentially a literature review study. Basically, this research begins by reinforcing the idea that making consumers adopt recycling practices should be perceived as a social marketing problem and classifies the previous studies on the determinants of consumers' recycling participation into consumer research, pricing research, distribution research and promotional research. In their second study, the domain of research is extended to the adoption of "green practices" and the importance of understanding the intended audience, as thoroughly as possible, is the primary issue under investigation. In this study, Shrum, Lowrey and McCarty (1995) show how the features of the target population can influence all attempts at behavior change, aimed by a social marketing program.

The vital relevance of market research, as the first step of the development of a social marketing campaign, was also the theme of investigation in the studies of McKenzie-Mohr (1994) and Geller (1989). These studies explore the interest of integrating behavior analysis, which should be based on social-psychology principles, in the development of social marketing programs to protect the environment. Unlike the study of McKenzie-Mohr, which is dedicated to residential energy conservation, Geller's contribution has a more generic domain, focusing on the various pro-ecological practices that can promote a more sustainable future.

The most recent work of McKenzie-Mohr (2000a, 2000b. 1999) clearly offers the most comprehensive approach on the application of social marketing principles in encouraging environmentally responsible behaviors. This author presents community-based social marketing (CBSM) as a more effective strategy to foster general sustainable behaviors, in comparison with information-based campaigns or attitude-behavior approaches. The site of CBSM enables visitors to consult abstracts of studies on a wide variety of sustainable behaviors: composting, energy efficiency, hazardous waste, pollution prevention, reuse, recycling, source reduction, transportation and water saving.

McKenzie-Mohr proposed CBSM as a pragmatic and alternative approach to information intensive programs. This process encompasses four stages:

(1)" Identifying barriers to a sustainable behavior;
(2) Designing a strategy that utilizes behavior change tools;
(3) Piloting the strategy with a small segment of a community;
(4) Evaluating the strategy once it has been implemented across the community" (McKenzie-Mohr, 1999: 1).

The stages for the implementation of CSBM do not differ in essence from the steps of strategic social marketing, as proposed by Andreasen (1995), but they are specifically analyzed within the context of pro-environmental behaviors. For instance, the stages (3) and (4) of the CBSM' process have the same purposes as the *pretesting* and *monitoring* stages of Andreasen's approach to social marketing.

As far as barriers are concerned, McKenzie-Mohr (2000a, 2000b, 1999) defends that each type of sustainable behavior has its own and specific barriers and benefits, which should be carefully identified. The barriers, in particular, can be within an individual (e.g., lack of knowledge or unsupportive attitudes) or reside outside the individual (e.g., lack of convenience or monetary resources).

The design of a CBSM strategy is based on the previous detection of the barriers (but also the benefits) of the desired practice. As proposed by McKenzie-Mohr (2000a, 2000b, 1999), the purpose of the designed strategy is to remove the identified barriers. The stage "designing a strategy" comprises of the selection of one or more "tools of behavior change" that previous studies in the environmental social- psychology field have demonstrated to be effective. Among the tools which can be successfully implemented to overcome internal barriers, McKenzie-Mohr emphasizes the importance of "commitment", which involves leading consumers to agree (verbally or by written) in performing the target behavior, “prompts”, which are simple reminders to engage in a suitable behavior, ”norms”, that is, building community support for the behavior, “communication”, which implies creating effective messages, and the use of “incentives” to enhance motivations to act. This stage also includes the definition of actions directed towards removing external barriers.

2.2.3 The current state of the debate and directions for future research

With the expectancy of standardizing and improving the application of social marketing, *The Consensus Conference on the Future of Social Marketing* was organized in 1996, which approved the social marketing model that should provide directions for its future. The presented model possessed 10 elements, as described in Table 2.1, and was simply a ratification of the principles supporting the strategic social marketing process proposed by Andreasen (1995).

TABLE 2.1
Elements of the social marketing model

1. Social marketing programs are designed to respond to the needs, wants and perceptions of the audience
2. The objective of social marketing programs is to promote appropriate behavior change among audience members
3. Research is used to segment and profile target audiences and to identify appropriate distribution and promotion channels
4. Formative research is used to develop and test concepts/ executions
5. Strategies are developed and implemented specifically to meet the perceived needs of the target audiences
6. Ideally, products are delivered through distribution channels identified in audience research
7. Programs are promoted through media and organizational channels identified in audience research
8. There is meaningful tracking of program implementation through process evaluation
9. Audience response is documented through impact or outcome evaluation
10. Evaluation data are used to modify and improve the program

Source: Maibach, Shenker and Singer (1997).

Other important issues also discussed on this conference included the identification of barriers which were limiting the success of social marketing (Maibach, Shenker and Singer, 1997; Novelli, 1997), areas that were requiring more attention from research (Andreasen, 1997) and the most relevant trends that will impact the future of social marketing (Smith, 1997). Since then, this model has been kept unchanged and the recent research on this marketing framework has moved most of its focus, from conceptual issues, to the application of social marketing principles in the resolution of concrete social problems, the majority in the health sector. This is evidenced, for instance, in the studies presented in the *June 2000 Innovations in Social Marketing Conference*[18] and also in the list of books and articles that were published on the social marketing issue, from 1995 until the present[19].

On the other hand, the overall contribution of McKenzie-Mohr (2000a, 2000b, 1999), with special reference to his website, still represent the most important mark in the current discussion on the application of social marketing in the attenuation of environmental problems, in which the recycling problematic can be included.

Nowadays, numerous studies in the commercial marketing field have proclaimed relationship marketing as the new marketing paradigm (Coviello, Brodie and Gronroos, 1998; Brodie *et al.,* 1997; Coviello, Brodie and Brookes, 1996). Among the important expressions characterizing this marketing perspective, are: "maintaining customer relationships", "gaining customer loyalty", "using new information technologies", "direct marketing" and "offering products and services to customers designed to their individual needs and wants". The early discussions on relationship marketing have been

[18] These papers were published in the journal *Social Marketing Quarterly* (2000), 4, 3.
[19] This list of books and articles can be found in Smith (2003).

concentrated in business-to-business situations but some recent studies have begun to analyze its potential and applicability in business-to-consumers frameworks. A gap in research is, therefore, to discuss the applicability of this emerging marketing approach in the contexts of social marketing.

2.3 Reverse logistics literature

2.3.1 Overview

Origin and concept of reverse logistics

Although the earlier discussions on the reverse distribution channels remount to the 1970s (Zikmund and Stanton, 1971), only in the 1990s, with the stress of environmental concerns, did the development of reverse logistics problematic come to receive increasing research attention as an important means of integrating economic and ecological needs. Reverse logistics is quite a fairly new concept in logistics and its definition was first advanced by the Council of Logistics Management in 1992, as "a broader perspective" (...) that "includes all relating activities carried out in source reduction, recycling, substitution, reuse of materials and disposal" (Stock, 1992: i).

Since then, other definitions have been proposed, some of them just emphasising the "movement of goods from a consumer towards a producer" (Murphy and Poist, 1989), Pohlen and Farris (1992) and others also reinforcing the recovery options involved in the reverse logistics concept (Johnson, 1998; Kopicki *et al.*, 1993, Stock, 1992; Stock, 1998). As an example, Johnson defined reverse logistics as "the process by which organizations recover by-products and residuals for reuse, resale, remanufacturing, recycling or disposal" (Johnson, 1998: 217).

In this thesis, the term *reuse* is applied in its narrower sense, meaning the direct reuse of products without prior repair operations (Thierry *et al.*, 1995). Examples include returnable bottles and containers. *Recycling*, in turn, can be defined as "the process by which materials otherwise destined for disposal are collected, processed, and remanufactured in new products" (Kopicki *et al.*, 1993; 3). It implies material recovery without maintaining the product's initial structure. *Remanufacturing* encompasses the operations to bring the products back "as new" (through disassembly, overhaul and replacement operations), conserving their primary identity (Fleischmann *et al.*, 1997). Some examples are remanufacturing of aircraft engines and machines. When the other alternative forms are exhausted, reverse logistics can be used for *disposal*. In this case, incineration with energy recovery is preferred to disposal in landfills (Carter and Ellram (1998).

The most general descriptions of reverse logistics date to the end of the 1990s. In their definition, Rogers and Tibben-Lembke (1999) underscore the objective as well as the logistics processes relating to reverse logistics. They conceptualized reverse logistics as "the process of planning, implementing and controlling the efficient, cost-effective flows of raw materials, in process inventory, finished goods, and related information from the point of consumption to the point of origin for the purpose of recapturing value or proper disposal" (Rogers and Tibben-Lembke, 1999: 130).

A similar but even more embracing definition is that advanced by the European Group on Reverse Logistics (RevLog, 2002)[20]. This group presents reverse logistics as "the

[20] The Project RevLog involves the following Universities: Erasmus University of Rotterdam (Netherlands), Aristoteles University of Thessaloniki (Greece), Eindhoven University of Technology (Netherlands), INSEAD (France), Otto-von-Guericke University of Magdeburg (Germany), and University of Piraeus (Greece).

process of planning, implementing and controlling the flows of raw materials, in process inventory, and finished goods, from a manufacturing, distribution or usage point to a point of proper disposal" (RevLog, 2002: 2). In comparison with the Rogers and Tibben-Lembke's (1999) definition, this one enables the inclusion of more reverse flows since it makes reference to returns from manufacturing and distribution sectors, besides the returns from the points of consumption", and also extents the destination of these returns from just "the point of origin" to "a point of recovery or point of proper disposal".

Building a theory for reverse logistics

Many studies in the reverse logistics area have been published in practitioner-orientated journals, rather than in scientific texts. Even the academic research has been concentrated on very specific industries or products and has approached a particular reverse logistics relating activity. As recently suggested by De Brito and Dekker (2002), reverse logistics is still in process of formation and, thus, it has not yet an established theory.

The main objective of the European Group on Reverse Logistics (RevLog) has been to analyze the fundamental aspects of reverse logistics and to build a framework relating these aspects. This working group has defined the following five basic questions that must be approached by reverse logistics:

(1) "What alternatives are available to recover products, product parts and materials?
(2) Who should perform the various recovery activities?
(3) How should the various activities be performed?
(4) It is possible to integrate the activities that are typical for reverse logistics with classical production and distribution systems?

(5) What are the costs and benefits of reverse logistics, both from an economical and environmental point of view?" (RevLog, 2002: 2).

There is important literature which addresses more or less generally these and other broad issues of reverse logistics, which has contributed to its theoretical growth. As a first reference in this scope, Thierry *et al.*, (1995) provides a thorough description of the various forms of product recovery, from direct reuse to the disposition at landfills. Basically, their contribution integrates the first question point out by the RevLog.

In spite of being mainly a literature review on the contributions of quantitative models (from Operational Research area) for reverse logistics, the study carried out by Fleichmann *et al.* (1997) attempted to provide a framework for this field. In its preliminary sections, this study tries to structure reverse logistics, focusing on its concept and dimensions. In what regards this last aspect, the authors address the ecological and economic *motivations* driven reverse logistics, the different *types* of items that can be recovered, the *forms* of reverse logistics which can take place (direct reuse, repair, recycling and remanufacturing), the *actors* involved in reverse logistics and their corresponding functions. Excluding de forms of reverse logistics which were already addressed, the other three topics will be further approached below.

The study by Carter and Ellram (1998) also reviews the previous research related with reverse logistics, which the authors classified into "general literature", "transportation and packaging literature" and "purchasing literature". From their review of the literature, these authors conclude that, with few exceptions, the research to date has been essentially exploratory and that it lacks a "theoretically grounded and holistic view of reverse logistics" (Carter and Ellram, 1998: 89). Based on this conclusion, the authors attempt to propose a framework of reverse logistics, by presenting a hierarchy for the reverse logistics options (from resource reduction to disposal in landfills) and identifying their main driving forces and constraints (internal and external). The set of propositions based on their model are not empirically assessed and other key issues of reverse logistics, as identified in the five research questions stated by RevLog, are not analyzed.

The research carried out by Dowlatshahi (2000) adds some insights to the theory building of reverse logistics as well. This author presents reverse logistics as an emergent concept in logistics that has gained relevance as a sustainable and profitable business strategy. The focus of this study, however, is not on the key characteristics of reverse logistics. Instead, after providing a review of literature on the reverse logistics field[21], the strategic and operational factors for a well succeeded implementation of reverse logistics systems are listed and described[22].

Rogers and Tibben-Lembke's (2001) study is also a recent and relevant contribution for the development of a theory of reverse logistics. In summary, this article presents a definition for reverse logistics, which is the same as presented by these authors in 1999, examines several reverse logistics practices in the USA and points out barriers hampering their effective implementation. In these authors' opinion, although there are numerous studies on this topic, "little is known about the size and scope of reverse logistics activities" (Rogers and Tibben-Lembke, 2001: 129). Using information

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[21] Dowlatshahi (2000) divides the literature on reverse logistics into "global concepts", quantitative models", "distribution, warehousing and transportation", company profiles" and "applications",

[22] Within the strategic factors, Dowlatshahi includes "strategic costs", "overall quality", "customer service", "environmental concern" and "legislative concerns". In turn, the operational factors that should be considered in implementing reverse logistics activities encompass "cost-benefit analysis", "transportation, warehousing, supply management", "remanufacturing and recycling" and "packaging". Besides making some considerations regarding each of these factors, Dowlatshahi also indicates previous studies where the importance of these elements was referred.

gathered from more than 150 interviews, carried out on managers with reverse logistics responsibilities, Rogers and Tibben-Lembke identify five reverse logistics activities (remanufacturing, refurbishing[23], recycling, recycling, landfill and repackaging) and distinguish between reverse logistics flows of products and reverse logistics flows of packaging. In agreement with these authors, *products* enter the reverse flow for a wide range of reasons, for instance, for being remanufactured or refurbished or even because a customer returned it. These returns are also known as commercial returns and usually are not saleable at the initial price. Unlike products, *packaging* usually flows back for being reused (e.g., pallets) or because legislation limits its disposal. The major part of packaging, in this last situation, may be recycled.

The most important contribution of this study of Rogers and Tibben-Lembke lies, however, in their analysis on the costs and benefits of reverse logistics, in an economic perspective. As stated by the authors, most of the previous work on the field has mainly focused on environmental issues, rather than the "economic and supply chain issues relating to reverse logistics" (Rogers and Tibben-Lembke, 2001: 129).

Actually, several early studies have highlighted the environmental benefits of reverse logistics, in reducing the use of raw materials or in decreasing the amount of residues being disposed of at landfills (Ferrer (2000), Giuntini (1996), Giuntini and Andel (1995). The contribution of reverse logistics to sustainable development is an issue which is also pointed out by RevLog (2002). As referred by this group, reverse logistics "refers to all logistics activities to collect, disassemble and process used products, products parts, and / or materials in order to ensure a sustainable (environmentally

[23] Under "refurbishing", "the product / component is upgraded such that it meets higher quality and / or operational standards than the original product" (RevLog, 2002).

friendly) recovery" (RevLog, 2002: 2). In what concerns this aspect, De Brito and Dekker (2002) add that, "reverse logistics can be seen as part of sustainable development". (…) "In fact, one could regard reverse logistics as the implementation at the company level by making sure that society uses and re-uses both efficiently and effectively all the value that has been put in products" (De Brito and Dekker, 2002: 4)[24]. The role of reverse logistics in achieving the goals of sustainable development is also referred by Dowlatshahi (2000), who points out both the environmental and economic goals of reverse logistics, or by Carter and Ellram, which underline that the potential of reverse logistics in making companies more environmentally efficient.

The effort of Rogers and Tibben-Lembke (2001) in understanding the economic issues relating to reverse logistics is an answer, in some degree, to the fifth research question proposed by RevLog. Rogers and Tibben-Lembke (2001) address these central topics by analyzing the importance and the role of reverse logistics. They provide insights about the *importance* of reverse logistics by estimating its relative weight in the total logistics costs[25] and stressing how reverse logistics activities can be crucial to some firms, especially for those dealing with large valuable products or with large return rates. In what the *role* of reverse logistics is concerned, Rogers and Tibben-Lembke show that reverse logistics allows the recovering of goods, which was worth more than $39 billion dollars in 1999.

[24] Reverse logistics differs from "Green logistics" and also from "Waste management" (De Brito and Dekker, 2000). Green logistics considers and tries to control the long-run environmental impacts from all logistics activities involved in the forward supply chain. For instance, it aims an environmental conscious manufacturing instead of just manufacturing and is concerned with issues like packaging reduction or air and noise emissions (Rogers and Tibben-Lembke, 2001). In turn, waste management concentrates on the collection and processing of goods that cannot have a new use (waste), whereas reverse logistics focuses on goods that have yet some value and which can to be recovered.

[25] Around 4% for the companies studied on their research, which represents approximately one half of a percent of the USA GDP.

Rogers and Tibben-Lembke (2001) also use their survey's results to describe the main barriers limiting reverse logistics activities. Important barriers that were identified include: the "importance of reverse logistics relative to other issues", that is, the reverse logistics is not considered a priority for the company; the "company policies", which drive firms to destroy all returns because they do not want to divert resources (space, financial) from their first quality products; "lack of systems", not only physical but also information systems; "management inattention"; "lack of personal and / or financial resources" and, finally "tension between retailers and manufacturers". This last barrier occurs because retailers usually want to return more goods than the manufacturers would like to take back.

The recent study of De Brito and Dekker (2002) is comprehensive and the most recent approach to the theory of reverse logistics. In these authors' perspective, the previous studies in this field, even some of the more general that were aforementioned and summarized, have a too restricted focus and, therefore, there is a need to give "order to theory in this area" (De Brito and Dekker, 2002: 4). Much of De Brito and Dekker's (2002) approach can be perceived as a response to the first three questions that reverse logistics must deal with, as they were formulated by RevLog (2002): the "what-who-how" of reverse logistics. Before analyzing these topics, De Brito and Dekker (2002) discuss the "why" of reverse logistics and their contribution ends with the proposal of a decision framework, in what concerns strategic, tactic and operational decisions for this field. The characterization of reverse logistics offered by these authors allows a good systematization of previous studies that had also addressed these topics, although in a narrower sense.

Motivations supporting reverse logistics

Several authors have referred one or more reasons for companies becoming active in reverse logistics (Daugherty, Autry and Ellinger, 2001; Fleischmann *et al.*, 2001, Rogers and Tibben-Lembke, 2001; Blumberg. 1999; Meyer, 1999; Rogers and Tibben-Lembke, 1999; Vandermerwe and Ollif, 1999; Johnson, 1998; Giuntini and Andel, 1995; Byrne and Deeb, 1993).

De Brito and Dekker (2002) classify these motivations into two categories: (1) "drivers behind reverse logistics" and (2) "return reasons". The first set of motivations reflects the receivers' point of view, that is, the reasons why companies and other organizations want to accept and recover returns. The drivers behind reverse logistics included in this set were categorized into three groups:

(1) Economics, which can arrive from innumerous sources, some of them already mentioned: direct profits from recovery actions (due to abating costs and the recovering of valuable spare parts of material), prevention of competition (by recovering their products or products' parts, companies may impede others from obtaining their technology) and / or creation or enhancement of a social responsible image among consumers (taking advantage of the growing environmental consciousness of society);

(2) Legislation, due the existence of environmental laws that are forcing companies to recover and treat their products or packaging[26];

(3) Extended responsibility, resulting from the companies' values and principles that press them to act in accordance and, thus, to practice reverse logistics activities.

[26] The Portuguese reverse logistics system for non-reusable household packaging is primarily motivated by legal reasons, which is in accordance with the European Directive 94/62/CE for packaging.

The second set of reasons behind reverse logistics is related with the returners, that is, the initiators of the reverse supply chain. Under this perspective, products are returned or discarded because they either have operation problems or because they are no longer necessary. De Brito and Dekker (2002) classify returns into "manufacturing returns", "distribution returns" and "customer / user returns", depending on the position in the supply chain in which they take place.

Types and features of returned goods

Another issue systematized in De Brito and Dekker's (2002) study concerns the "what" of reverse logistics, that is, the types and features of returned goods. These authors state that what affects recovery are the characteristics of the product, concerning its composition (ease of disassembly and transportation, homogeneity of constituting elements, presence of hazardous materials), product use pattern (location, intensity and duration of use) and deterioration status (intrinsic deterioration, reparability, homogeneity of deterioration and economic deterioration).

In their research, De Brito and Dekker also propose a typology of products that can be helpful for reverse logistics' purposes. In particular, they point out the following product types: food, civic objects (buildings, etc), consumer goods, industrial and professional equipment, transport equipment, oil and chemical products, pharmaceuticals and military equipment. This is a more general categorization than those proposed by Fleichmann *et al.* (1997) which only includes three types of items: packaging, routable spare parts and consumer goods (e.g., electric household devices and computers)[27].

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[27] The SIGRE only focus on packaging residues.

Actors and processes in reverse logistics

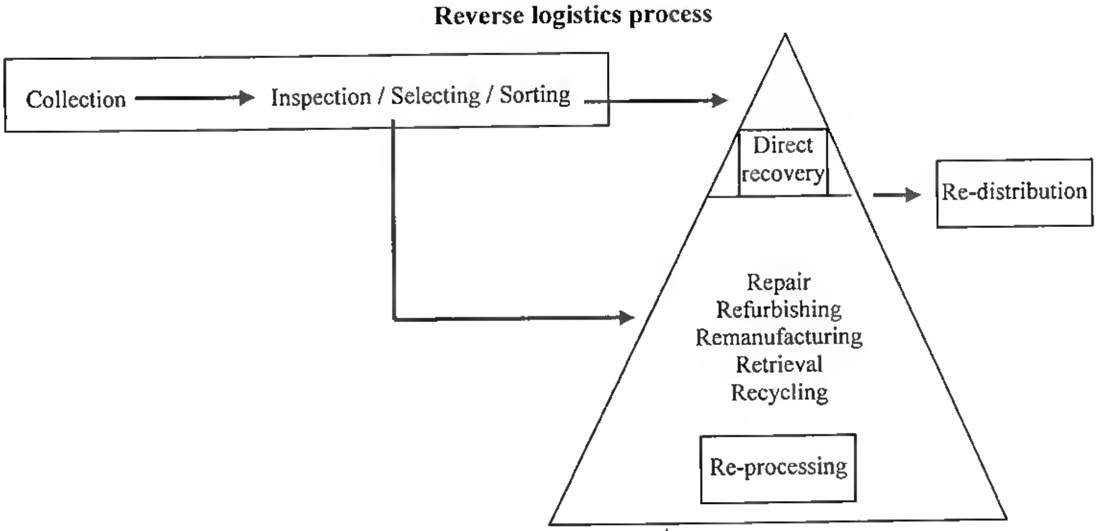
De Brito and Dekker (2002) analyze the "how" of reverse logistics by identifying its actors and processes. In what concerns the actors, they distinguish among "returners", "receivers", "collectors" and "processors", each of them with their own purposes and responsibilities. *Returners* are the initiators of the reverse logistics flows and do not necessarily have to be consumers. *Receivers* can be found in the entire supply chain. They can be suppliers, manufacturers, wholesalers and retailers. *Collectors*, in turn, can be specific recovery companies, public or private, or municipalities. Finally, *processors* are the companies with direct responsibility by the recovery option.

Some years before, Fleishmann *et al.* (1997) had provided a more general approach to the topic of reverse logistics' actors, by distinguishing between "reuse by the original producer" and "reuse by a third party". Andel (1997) has referred to these reverse logistics systems as closed and open, respectively. In the *closed systems*, the materials are returned and reprocessed (reused, recycled, refurbished, remanufactured or disposed) internally by the same original producer. Closed systems are frequent in e-commerce firms, in catalogue-selling business (Daugherty, Autry and Ellinger, 2001; Meyer, 1999) and in industries whose activity is the production of commercial aircrafts, computers, automobiles or chemicals (Dowlatshahi, 2000; Meyer, 1999) reports that several companies are managing in-house reverse logistics very effectively, but the challenges they have to face are also significant. In turn, companies that chose *open reverse logistics systems* are those which give main relevance to their core business and outsource the returns recovery process (DiMaggio, 2000)[28].

[28] The Portuguese reverse logistics system for household packaging is essentially an open system, due the fact that the national packers / importers transfer their recovery responsibility to the SIGRE. The actors of this system are the consumers, the municipalities, the distribution sector, the packaging manufacturers and recyclers, the packers / importers and SPV.

The four major reverse logistics processes identified by De Brito and Dekker (2002) are depicted in Figure 2.2. They were classified into "collection", "inspection / selection / sorting process", "re-processing / direct recovery" and "redistribution". *Collection* is the process of bringing the recovered goods from the point of origin. In the next phase, returns are *inspected*, in what concerns their quality state, and then they are *separated* taking into account the planned recover option. The next step can be the *re-processing*, which encompasses five options (repair, refurbishing, remanufacturing, retrieval[29] and recycling), or *direct recovery*, that includes reuse and re-sale. At a final stage, the recovered goods are *re-distributed*, that is, they are delivered to new users.

FIGURE 2.2
Reverse logistics process



Source: Adapted from De Brito and Dekker (2002).

2.3.2 Reverse logistics for recycling

As suggested by the previous overview, recycling should be perceived as a resources recovery option that integrates the heterogeneous and still rather young scientific field of reverse logistics. It enables the use of part or all materials from the returned goods,

[29] Retrieval is the recovery of selected parts of goods (Thierry *et al.*, 1995).

either by their original producer(s) or by other industries (RevLog, 2002). The recycling process essentially encompasses two stages (Jahre, 1995). The first one can be broadly titled as "the collection service" and includes all the necessary tasks to make recyclables available for further reprocessing. The second is the "reprocessing process" itself, that is, the industrial procedures through which the collected materials are incorporated in the production process, replacing the use of primary raw materials. Table A.1, in the Appendix A, lists the studies which have explored particular issues on reverse logistics for recycling.

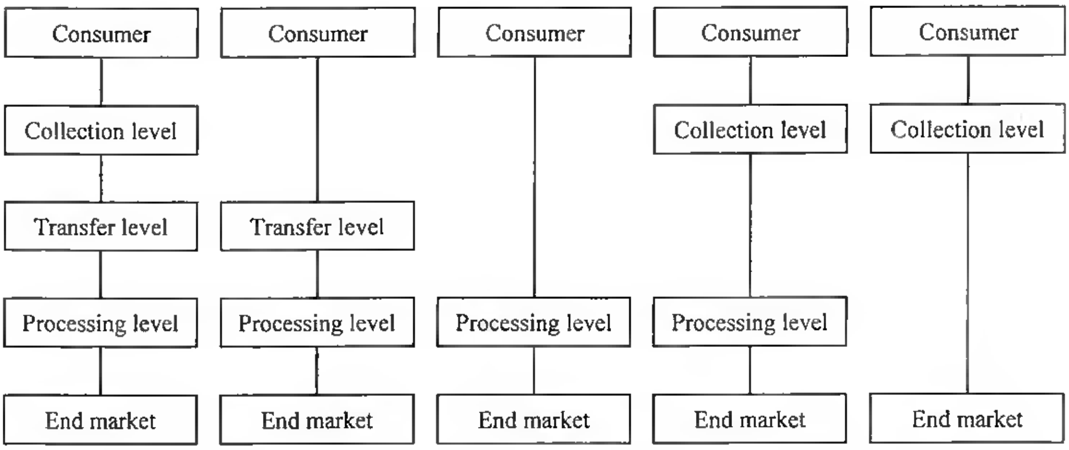
Although the concept of reverse logistics has only been defined in the 1990s, the structure of logistics channels for recycling had begun to be discussed far before. Guiltinan and Nwokoye (1975), in an early study, identified the major types of logistics structures, functions and members in this distribution channel. They also pointed out a number of key factors for the future development of recycling channels, like "expanded efforts in identifying potential markets and buyers of recycled materials; more extensive contact with, and promotion to, final buyers; expanded capacity for moving increased volumes of material to achieve and maintain scale economies; and improved flexibility in transportation" (Guiltinan and Nwokoye, 1975: 35).

While the study of Guiltinan and Nwokoye does not focuses upon a specific recyclable material, Table A.1 shows that other contributions have addressed very particular reverse logistics networks for recycling. Pohlen and Farris (1992), for instance, address the set-up of recycling networks for plastics and propose a somewhat more complex structure for this reverse channel, in comparison to the general structure proposed by Pohlen and Farris. In their analysis, Pohlen and Farris also discuss the main questions that affect the redefinition of reverse logistics channels for recycling, the factors that may improve the efficiency of these channels and the most usual ways of improving the recyclables market. Following the study of Guiltinan and Nwokoye, Pohlen and Farris analyzed the changes that should occur to develop the channels for recycling.

As evidenced by Table A.1, some of the remaining studies that have analyzed the organization of recycling networks have focused on public networks, whereas others have described private systems. In the first case, reverse logistics is mainly motivated by environmental concerns and waste disposal legislation. On the contrary, private reverse logistics networks deal with residues or end-of-life products, for which recycling is economically attractive. Private processors finance the transportation of these materials as well as the recycling process itself. For recycling to be economically viable, a significant amount of discarded products (or parts) have to be processed.

One conclusion that stands out from the studies analyzing the design of a network for recycling is that there are some differences among the distribution channels for recycling distinct materials but even also among those channels organized to recycle the same type of goods. As an example, Jahre (1995) identified five alterative reverse logistics channels for recycling household waste, as depicted in Figure 2.3. As stated by this author, the distribution channels have a vertical and a horizontal dimension. The vertical dimension is characterized by the number of distribution levels of the channel and the horizontal dimension depends on the number of points in each level. Naturally, more levels and more points imply a more complex structure.

FIGURE 2.3
Alternative reverse logistics channels for recycling household waste



Source: Jahre (1995).

Other issues that have been analyzed within the reverse logistics literature exploring recycling as a recovery option include the planning and control of recovery activities (i.e., the decisions about what exactly should be collected, disassembled and processed and in what quantities, how, when and where), their information and communication systems (e.g., software, data requirements), the logistics implications of recycling and the implementing of programs to increase the procurement (purchase) of recyclable materials. As supported by Table A.1, the studies examining these issues are narrowed to a single type of recyclable material.

A final aspect that has been researched in the scope of reverse logistics for recycling concerns the incentives that may be used to stimulate a desired behavior of certain members of the reverse channels. These incentives look for stimulating / enforcing partners to receive or, instead, to deliver goods for recovery. In the first case, companies may have some goods that they wish to get rid of, and, thus, use incentives to influence others (e.g., the goods' providers) to accept them, in order to avoid the high costs of their disposal. The second case includes the situations in which the purpose is to stimulate others (final users, in general) to send goods (products, parts, packaging) that a company would like to recover. As reported in Table A.1, three types of non-economic incentives were identified: timely and clear information, general convenience and the availability of an easy and simple method of supply.

Incentives are of particular relevance in the context of stimulating consumers' behavior of separation and proper disposal of household packaging residues for recycling. As made clear by Figure 2.3, the consumer is the starting point of any reverse logistics for recycling household waste and, therefore, their participation is a needed condition for the system existence.

Dowlatshahi (2000) classifies consumer-service as a strategic factor in planning a reverse logistics network. Moreover, the interest in identifying and fulfilling consumer-service requirements has been recognized by several other logistics researchers (Emerson and Grimm, 1998; Marien, 1998; Byrne and Deeb, 1993; Giuntini and Andel, 1995; Kopicki *et al.*, 1993; Stock, 1992; Murphy, 1986; Fuller, 1978; Zikmund and Stanton, 1971). Emerson and Grimm (1998), as an example, refer that consumer-service is complex, formed by multifaceted attributes such as the overall product (or service) quality. The authors add that good consumer-service usually yields several benefits for a company such as customer satisfaction, loyalty and increased sales.

Consumer-service in the recycling framework is translated by the convenience that the recycling program's managers offer to consumers. In the recycling contexts, convenience can be enhanced by providing any one or a combination of the following aspects: (1) closer proximity of disposal containers, (2) reliable frequency of collection, (3) hygienic, aesthetic and safe disposal locations, (4) minimal complexity in storing and storage of recyclable materials that is demanded of consumers, and (5) availability of the needed information about what to recycle and where to dispose of the recyclable materials. These dimensions of convenience represent consumer-service offerings that are fundamental in the consumer's decision to participate in a recycling program.

Although the questions related with the features or elements of consumer-service in collection systems integrate the scope of reverse logistics, the relative importance of these elements, as facilitating conditions to stimulate consumers' behavior in the reverse channels for recycling, is an overlooked issue in the reverse logistics research. Instead, this aspect has been investigated in rather diverse scientific fields, primarily within the environmental social-psychology area, which have analyzed the predictive effect of specific consumer-service dimensions in recycling behavior, in isolation, or in articulation with other potential determinants of this environmentally friendly behavior.

2.3.3 The current state of the debate and directions for future research

As this overview on the literature evidence, the scientific field of reverse logistics is still in a structuring process and general basic topics are still receiving attention from recent research. There are already significant and comprehensive contributions for some important aspects of this framework such as the "why, what, who and how" of reverse logistics. Other general issues, however, still deserve a deeper investigation. For instance, some authors make reference to the significant costs of redesigning, implementing and managing the reverse supply chain (Turner, Lemay and Mitchell, 1994) but this issue was only examined with more detail by Rogers and Tibben-Lembke (2001), based on a survey that focused solely on American companies. Future research should further explore this issue.

In addition to the fundamental and general questions that should be treated within the scope of reverse logistics research, RevLog (2002) proposes five specific areas that should be deeply investigated. The first three areas are more operational / tactical oriented and encompass: distribution research (e.g., about locations and distribution networks), production planning and inventory control research (e.g., about planning and control, integration and uncertainties) and information technology research (e.g., about product tracking and third parties involvement). The other areas are more general / strategic and include: business economics research (e.g., about design, accounting and economic consequences) and research on the integration of reverse logistics issues (e.g., about trends and impacts of reverse logistics). Most of the recent case-studies in the reverse logistics field have been orientated to address these very particular topics. For instance, De Brito, Flapper and Dekker (2002) review over sixty recent case-studies that have discussed the following operational topics: reverse logistics network structures, reverse logistics relationships, inventory management issues, planning and control of recovery activities and application of information and communication technologies for reverse logistics activities.

In what concerns the particular discussion of reverse logistics systems for recycling, one gap that remains is the comprehensive investigation of the main elements of consumer-service as determinants of consumer's adherence to selective-collection programs, in a reverse logistics perspective. This analysis would provide fundamental information about the most critical consumer-service elements in which the (limited) resources should be employed with priority.

2.4 Consumer behavior literature

2.4.1 Overview

Understanding buying and post-consumption behaviors

The primacy of consumer in the modern marketing has enhanced the importance of information for companies, which use market research in order to increase their knowledge about consumers and, therefore, to identify new market opportunities. Rivas (2000) provides a simple view of the marketing process. As stressed by this author, the marketing process begins by analyzing the market, in order to identify the needs and wants of consumers, and ends by satisfying them, which, in general, enables the accomplishment of the company's business purposes. This marketing research should be centered on consumer, on their characteristics, motivations, barriers and behaviors.

Market research on consumer behavior has been focused on, almost exclusively, on the buying behavior. As underscored in a few studies in the marketing field, an effort should be made in understanding the full consumption cycle, in particular, the antecedents of post-consumption behaviors, such as composting, reuse or recycling (Pieters, 1991; Thogersen, 1994).

In his research, Pieters (1991) uses results of the participation of consumers in waste separation programs in the Netherlands and Germany to describe the role of consumer behavior in these programs and to analyze consumers' decisions towards recycling (of initiation, performance and continuation). Pieters stresses the importance of understanding the target behavior of consumers and the determinants of this behavior in the development of the marketing strategy. In agreement with this author, the main dimensions influencing consumer participation in a recycling program are "motivation", which includes attitudes and intentions, and “ability”, which encompasses task knowledge and habits.

On the other hand, Thogersen (1994) states that marketing has long been essentially interested in the purchase of products by consumers and that more research into the patterns by which consumers engage in recycling programs is needed. Using data from the Danish selective-collection programs, this study offers a theoretical framework for understanding consumer behavior in recycling programs, which represents an upgrading of Pieters’s approach. In the Thogersen’s framework, three main determinants are identified: “motivation” (including values, beliefs, attitudes, intentions and social norms), “ability” (comprising habits and task knowledge) and “opportunity” (involving the situational conditions).

At least four causes have been proposed to explain why the application of the existing buying behavior models to pro-ecological practices is so problematic and why it has been so difficult to understand and predict consumers’ involvement in recycling programs. The first possible explanation relies on the nature of the motivations shaping pro-environmental practices that are quite different than those involved in consumer buying behavior (McCarty and Shrum, 2001; Thogersen, 1994). In predicting the buying intention of a specific product or service, most models assume that the consumer is self-interested in that purchase and that he / she assesses the direct benefits of that product or service to him / her or to their family in relation to its costs. However, in adopting ecologically compatible behaviors, such as recycling, only the costs, financial and behavioral (nuisance and inconvenience), are immediately realized. The environmental benefits that accrue from recycling are not immediately visible, will probably not benefit the person that has the behavior directly or may even never be attained. Only a minority of consumers believe that they can get direct private benefits, for example, more space in the waste bin, and the recycling programs that use monetary rewards are, at present, quite uncommon. Even the products made from recycled materials are sometimes perceived as more expensive and with lower quality.

Second, recycling is often considered as an instrumental activity, in the sense that it is not a purpose in itself but just a way to attain a greater objective: to protect the natural environment (Thogersen, 1994). Nevertheless, there are other alternatives, less inconvenient, to contribute for the environmental preservation, for instance, reusing or buying environmentally friendly products. Third, it is difficult to evaluate how much the individual's effort in separating waste materials will contribute to the solid waste reduction at the national level. As Uusitalo points out, "the causal link between pro-environmental behaviors and the outcome is often complicated and ambiguous, and it turns out to be hard for the consumer to obtain the information necessary for a rational choice" (Uusitalo, 2000: 2). Finally, because the environment is a public or collective good (it can be consumed without being purchased and can be produced only in cooperation), it provides the opportunity for *free-riding* (Uusitalo, 2000; Bratt, 1999). Actually, even those consumers who do not participate in a recycling program will benefit from the expected collective benefits of recycling, for example, a better environment.

In this review, only the studies focusing on consumer behavior in recycling programs will be considered. For the pointed reasons, the models of consumer behavior in regarding purchase are not suitable for explanation purposes of this pro-environmental behavior. Accordingly, the review of these models and corresponding literature is outside the scope of this chapter. On the other hand, recycling is a special case of environmentally friendly behavior, since the participation in a selective-collection program requires a considerable effort from consumers (inherent to the source separation of materials and their adequate disposal). Consequently, as stated by Boldero (1995), the antecedents of recycling behavior are necessarily different from those usually associated to other pro-ecological practices, such as energy or water conservation. In agreement with this reminder, the present review strictly analysis the specific research on recycling behavior and makes no reference to the studies addressing different or general pro-environmental practices.

Perspectives and typology of the determinants of consumer behavior in recycling programs

In contrast with the scant number of studies in the marketing scope that have focused on understanding consumer behavior in recycling programs, huge research can be encountered about this problematic within the environmental social-psychology field. The environmental social-psychology perspective captures the interplay between individuals' environmental concern and action with their attitudinal, demographic features and other potential determinants. In general, the environmental social-psychology studies on recycling behavior have tried to identify, through experimental design experiences or data analysis of surveys, the variables or determinants that shape consumers' participation in recycling programs[30]. Besides this literature, the topic of consumer behavior in selective-collection programs has been central in a few studies in the solid waste management area. Studies in this second set of literature compare the effectiveness of specific strategies used in some recycling programs and, based on these

[30] A detailed analysis on the role of psychology in environmental preservation can be found, for example, in Oskamp (2000), McKenzie-Mohr and Oskamp (1995) or Geller (1989).

comparative analyses, suggest potential predictors of recycling behavior. This section reviews the studies on recycling behavior which have been carried out in these two bodies of research.

As summarized by Schultz, Oskamp and Mainieri (1995), consumer behavior in recycling programs is influenced by many factors, which can be classified into two categories: personal and situational. *Personal factors* include the characteristics of consumers that have been associated with a higher level of recycling participation. The personal variables most frequently analyzed in the recycling context are socio-demographic attributes, personal values, general pro-environmental attitudes, specific attitudes towards recycling and knowledge. Instead, the *situational factors* encompass the external conditions of the recycling program that may encourage or obstruct consumers' recycling behavior. Situational variables include the consumer-service dimensions that characterize the collection stage of the recycling program as well as the strategies that can be used to encourage recycling behavior. These strategies were divided into eight categories: rewards, punishments, public education programs, communication, prompting, social pressure, commitment, goal setting and feedback. Both personal and situational determinants of recycling behavior are referred in the following sections. The present review ends with some comments on the statistical methods that have been used to model consumer behavior in recycling programs.

2.4.2 Personal determinants of recycling behavior

Previous research on recycling behavior shows that some individual characteristics of consumers are likely to be implicated in recycling behavior. Tables A.2 to A.6, in Appendix A, list the studies that have addressed the personal determinants of recycling behavior, regarding the target variable under analysis, participants, statistical research methods and findings.

Socio-demographic attributes

Numerous studies have focused on the relationship between socio-demographic attributes and recycling behavior. As evidenced by Table A.2, much research has been conducted in the past decades to elucidate the potential importance of gender, age, education and family income as determinants of recycling participation. In what concerns these factors, this table shows a very inconsistent connection between age or education level and the participation in selective-collection programs. In contrast, gender has been systematically dissociated from recycling behavior, whereas family income has been revealed a reliable predictor of this sustainable practice. Other socio-demographic attributes, much less investigated, include race, political orientation, presence of children in the household, household dimension and home ownership.

Personal values

As defined by McCarty and Shrum, "personal values are statements of the ideal and represent beliefs that particular modes of conduct or end-states of existences are preferable to others" (McCarty and Shrum, 2000: 272). Values encompass "broad dispositions or orientations that seem nearly as basic as personality itself" (Stern, Dietz and Guagnano, 1995: 727). This view of personal values as personality attributes is well patent in the model of environmental attitudes and behavior proposed by Grob (1995), in which personal psychological values were measured by means of two components: materialistic values and creativity or open thinking.

As suggested by Table A.3, little investigation has addressed the personal values of consumers adopting recycling practices. Among the personal values that have been studied, social conscience has been the most intensively analyzed. Within the recycling setting, this factor reflects, for instance, the well being in developing a responsible environmental behavior, the satisfaction in helping to build a better environment for future generations or the consideration of the impacts of one's behavior on others.

On the other hand, De Young (1984) suggested that intrinsic motivations could be more effective in increasing participation in recycling programs than extrinsic rewards. These statement were further analyzed by the author (De Young, 1986, 1985-86), who empirically showed that recycling behavior was related to personal satisfaction in being frugal (i.e., in carefully using the resources, avoiding wasteful practices and in undervaluing personal economic prosperity) and in participating in activities that make a difference in the long term.

General environmental attitudes

Over the past three decades, numerous definitions have been proposed for the term "attitude". As defined by Thurstone (1928), still an important reference in the modern attitude measurement theory, attitudes represent man's inclinations and feelings about any specified topic[31]. As referred by Engel, Blackwell and Miniard (2000), the recent trend is to link more the concept of attitude to feelings rather than to beliefs. Values and attitudes differ in that attitudes represent beliefs or feelings towards a specific object or situation, whereas values are more general and abstract in nature (McCarty and Shrum, 2000).

[31] On the other hand, an opinion is the verbal expression of an attitude (Thurstone, 1928).

Corraliza and Berenguer have specifically defined pro-environmental attitudes "as people's predispositions, relatively durable and relatively organized, to pay attention to, be concerned about, and, ultimately, to act in the name of environmental protection" (Corraliza and Berenguer, 2000: 833). Table A.4 lists the studies that have assessed the relationship between general attitudes about the environment and recycling behavior. In the majority of reported studies it was hypothesized that consumers who were more aware of general environmental issues were also more likely to participate in recycling programs. However, only exceptionally, a positive but weak connection was encountered between these variables.

Specific attitudes towards recycling

Considerable attention has been given to the relationship between attitudes specifically related with recycling and the adoption of this sustainable behavior. Within this context, attitudes can be extremely negative and, in this case, the person could feel indifference about recycling or perceive this practice as a very difficult or excessively inconvenient behavior. The lower part of Table A.5 presents studies that analyzed the potential effect of negative attitudes concerning recycling. Although only somewhat investigated, negative attitudes have often been significantly associated with lower levels of recycling participation.

Vining and Ebreo (1992) used the constructs of Schwartz's (1977) model of altruistic behavior as measures of specific attitudes towards recycling[32]. This orientation was also followed in this thesis.

[32] This model will be explained in Chapter 5.

With his model, Schwartz intended to explain why personal norms of altruistic behavior often do not conduct to corresponding behavior. With this aim in mind, Schwartz proposed that behavior is determined by the relationships among four main dimensions: personal norms, social norms, awareness of consequences and ascription of responsibility. With a few exceptions, research suggests that attitudinal dimensions, related to the *awareness of recycling benefits*, are significant predictors of recycling behavior. This is evidenced by observing the first line of Table A.5.

In agreement with Schwartz, *social norms* represent beliefs regarding whether or not specific referents (family members, friends, neighbors or social groups) think the individual should or not perform the behavior. Instead, *personal norms* represent the beliefs held by the individual regarding how he / she must act. On the other hand, in Schwartz's perspective, the cause-effect link between personal norms and behavior would only be effective if *awareness of consequences* and *ascription of responsibility* were activated. In other words, those who feel morally obligated to recycle would only engage in the act if they believe in the positive consequences of recycling and feel personally responsible for these consequences.

Table A.5 lists the studies which have focused on the relationship between the four attitudinal dimensions of the Schwartz's model and recycling behavior. Some studies demonstrate the interest in considering personal norms in explaining recycling behavior. The predictive effect of this variable has been shown in the studies that have tested the Schwartz's (1977) activation model of altruistic behavior in the recycling framework (Bratt, 1999; Hopper and Nielsen, 1991) but also when the potential importance of personal norms was analyzed independently from this model (Schultz, 1999; Vining and Ebreo, 1992). However, in the study of Hopper and Nielsen (1991) and Vining and

Ebreo's (1992) research, mixed results were encountered. In the first case, personal norms only positively and significantly affected the recycling behavior of participants with high awareness of recycling consequences. Otherwise, no significant link was detected between personal norms and recycling behavior. In turn, although personal norms had revealed a positive but non-significant predictive effect in recycling behavior in the study carried out by Vining and Ebreo, an interaction term, resulting from the product of personal norms by awareness of recycling consequences, was significantly and positively related with recycling participation. In this sense, awareness of consequences acted as a moderator of the relationship between personal norms and behavior.

As also clear from Table A.5, previous research evidences the relevance of subjective norms, also referred to as "social norms", in explaining consumers' recycling compliance. In 1999, Tucker (1999) presented a study that has specifically examined the influence of social norms in household waste recycling. This research has revealed a positive, although moderate, effect of these norms, with or without the deliberate simulation of interventions. Even with the strongest intervention simulated (free distribution of smaller recycling bags plus social pressure introduced by block leaders[33]) only around 7% of the population reported a behavior change. This value seems particularly small especially because, in a survey previously conducted, 20% of the population agreed to be potentially susceptible to social pressure.

The perceived control over the performance of recycling is also an attitude variable that has been associated with this conservation behavior. This attribute was defined as "a

[33] Block leaders are community members recruited and briefed to influence others' opinions and behavior through personal contact.

basic belief about humans' relationships and interactions with their environment" or as "people's beliefs about their ability to influence future outcomes" (McCarty and Shrum, 2001: 94). In the case of recycling, the central idea is that recyclers perceive the importance of their behavior, no matter how "small" it seems, and feel that they do make a difference. As conceptualized by Ajzen (1985), perceived behavior control reflects the individual's belief of control over the behavior in question and his / her perceived difficulty level in carrying it out. These two dimensions of perceived behavior control were considered in the Chapter 5 of this thesis. As Table A.5 shows, at least four studies have evidenced a positive relationship between perceived behavior control and recycling behavior. In the study of McCarty and Shrum (2001), locus of control positively influenced the beliefs about the importance of recycling that, in turn, predicted recycling participation.

In what also concerns the relationship between specific attitudes and recycling behavior, the predictive effect of the feeling of satisfaction in recycling has been little investigated. Nevertheless, as Table A.5 makes clear, in the few occasions in which this connection was considered, mixed results were revealed.

Knowledge

As Table A.6 shows, research findings concerning the link between general knowledge about conservation issues and recycling behavior are rather ambiguous. In contrast, most of reviewed studies evidence a positive and significant connection between high standards of recycling involvement and knowledge about the specificities of the recycling program, that is, about what, how, when and where to recycle. That is, given appropriate knowledge, consumers seem willing to overcome some personal inconvenience and adopt recycling behavior.

2.4.3 Situational determinants of recycling behavior

As suggested by the previous review on the personal determinants of recycling behavior, socio-demographic attributes are, in general, weak predictors of recycling behavior and some inconsistency has also been found in the relationship between pro-environmental concern and recycling participation. Moreover, even consumers with strong specific attitudes towards recycling sometimes fail in adopting this environmentally friendly behavior. In short, personal variables, in isolation, do not seem to guarantee action.

As stressed by Thogersen, "it is necessary to establish conditions – through the system design – that facilitate the carrying out of the good intentions" (Thogersen, 1994: 145). In effect, past research shows that recycling behavior may be facilitated or hampered by some external conditions or situational variables. In result, these potential motivators and / or barriers should be taken into account in designing a recycling program. In this section, the consumer-service dimensions, as well as the interventional strategies that have been used to enhance recycling participation, are reviewed. Studies that have focused on the situational determinants of recycling behavior are listed and described in Tables A.7 and A.8, in Appendix A.

Consumer-service dimensions

As referred in the review of literature on reverse logistics, the dimensions of consumer-service in the recycling framework define the convenience of the recycling program in what concerns the collection stage. As inferred from Table A.7, the dimensions that have been analyzed are the proximity of disposal containers, the complexity in separating and storage de recyclable materials, the frequency of collection, the specific information about recycling and the distribution of free bins for recyclables. In general, the review studies suggest that the convenience of the selective-collection program is a positive and consistent determinant of recycling behavior.

Intervention forms as predictors of recycling behavior

The research on the situational determinants of recycling behavior have yielded scattered evidence that some intervention forms, listed in the first column of Table A.8, can enhance participation in recycling programs or, at least, reduce certain barriers limiting the access to participation. McKenzie-Mohr (1999) classifies these intervention forms as tools of behavior change and notes that they are usually most effective when used in combination with one another.

Rewards and punishments: A wide variety of studies have investigated the use of economic rewards or punishments to encourage individuals to participate in recycling programs. Rewards have assumed several forms: payments for material delivered for recycling (Jacobs and Baley, 1982), raffle tickets (Witmer and Geller, 1976; Geller, Chaffe and Ingram, 1975), lottery tickets (Diamond and Loewy, 1990; Jacobs and Baley, 1982; Luyben and Cummings, 1981-82), food or retail coupons (Wang and Katzev, 1990; Katzev and Pardini, 1987), monetary prizes in recycling contests (Witmer and Geller, 1976; Geller *et al.*, 1975), or discounts on disposal fees (Folz and Hazlett, 1991). The application of punishments (e.g., fines), for improper separation of material or participation refusal, has been a widespread practice in mandatory programs and the pointed studies show that communities where this strategy has been adopted usually experience high levels of citizens' participation.

In general terms, economic rewards have the property of enhancing considerably but temporarily recycling behavior. Nonetheless, De Young (1984) points out some problems inherent to the use of economic rewards in recycling programs. First, usually this strategy is not cost effective. In the study conducted by Jacobs and Bailey (1982-83), for instance, the value of the recovered material in the residential recycling program was not enough to cover the value of the monetary incentives that were used. Second, recycling programs based on rewards are often characterized by an abrupt cessation of the intended behavior, right after the external incentives have been removed. For instance, in the experiment of Geller, Chaffe and Ingram (1975), recycling behavior turned to the baseline levels immediately after the elimination of incentives. Needleman and Geller (1992) also show that changes in recycling behavior, due to short-term incentives, are only extensive to the specific material that is targeted by the reward.

Public education programs: As De Young refers, the main purpose of a recycling education program "is to increase society's knowledge about waste reduction and recycling behavior, develop a positive attitude about such behavior, and encourage non-participanting households to begin and participating households to increase that behavior"(De Young, 1990: 253). The use of public education programs revealed to be particularly useful in some voluntary recycling programs analyzed by Folz (1991).

Very often, the information provided in these education programs aims at increasing consumers' awareness towards the need and importance of recycling. This can be accomplished either using threatening messages, emphasizing, for instance, the serious environmental consequences of the growth of solid waste or, instead, revealing the inherent benefits of recycling (Lansana (1991). A different approach, with potentially better results, in accordance with De Young (1989), is to provide specific information about how to recycle (i.e., what materials should be recycled, where correctly dispose of this materials and how much time and space is usually involved in waste separating process). In a more recent study, Nyamwange (1996) has suggested that a combination of the two approaches is important in enhancing recycling behavior. Thogersen (1994), in turn, added that the education programs should also focus on mitigating the citizens' exaggerated expectations about the inconvenience associated with this practice.

Communication: Other studies have analyzed the impact of communication in consumers' involvement in recycling programs. Printed or broadcasted ads, brochures, posters and leaflets have been the main communication tools used in previous research to promote recycling participation. Within this context, the purpose of communication has been twofold: (1) to persuade non-recyclers to engage in the recycling program and / or (2) to convince recyclers to go on participating. As in the education programs, persuasive communication can draw upon positive messages, underscoring the recycling benefits, or be based, mainly, on fearful messages.

Prompting: Prompts are short visual or auditive announcements that remind consumers to engage in sustainable behaviors which, otherwise, might be forgotten (McKenzie-Mohr, 1999). Prompts may be presented in flyers, newspapers, posters or directly above a recycling container. As evidenced by Table A.8, in most cases, prompts have been effective in reminding consumers to recycle.

Social pressure (Block-leaders): Concerning recycling, block leaders' mission is to visit non-recyclers who live close by and attempt to persuade them to start participating in the recycling program. The principle underlying a block leader intervention is that personal contact is a means of reinforcing social norms that, in turn, support sustainable behavior. As McKenzie-Mohr refers, "if we observe members of our community acting sustainably we are more likely to do the same" (McKenzie-Mohr, 2000:3). Excluding the study carried out by Oskamp *et al.* (1991), research reveals some consistency about the positive impact of block leader interventions in encouraging the adoption of recycling behavior. For instance, in the studies performed by Burn (1991) or Hopper and Nielsen (1991), the block leader treatment had the most impressive effect on recycling behavior, exceeding a prompting strategy.

Commitment: Under a commitment intervention, individuals must agree with a small single request. It can be to use a button saying that they participate in the recycling program or an oral or written declaration agreeing to perform this desirable behavior. Some authors have tried to establish a comparison between different commitment interventions. Pardini and Katzev (1983-84), for instance, showed that written commitment was more effective than a simple oral request. Wang and Katzev (1990), in turn, concluded that individual commitment yielded better results than group commitment.

Goal setting and feedback: Establishing recycling goals and providing members of a community with the results of their recycling performance (feedback) seems to be a very prominent strategy in increasing participation in recycling programs. As evidenced by Table A.8, most studies that have investigated the predictive effect of these interventions have reported positive results. This suggests that defining recycling targets, for a household or for a community, and providing feedback about the effectiveness of their behavior, can enhance motivation for the adoption of this environmentally friendly practice.

2.4.4 The use of statistical methods in analyzing recycling behavior

Previous studies on recycling behavior have used a variety of statistical techniques. By observing the last column of Tables A.2 to A.8, recycling research can be classified into five groups, in what concerns the complexity of the data analytical tools that have been employed. The first group includes the simplest studies, which have provided a descriptive and comparative analysis of the design and management of some recycling programs, based on survey responses from recycling coordinators. In these cases, the success of each program has been evaluated by measuring the proportion of citizen's participation and the percentage of the local waste collected for recycling.

In the second group, studies can be found which have been based on the comparison of effects of one or more intervention strategy (or treatment) against a baseline. That is, part of participants are targeted by a specific intervention (e.g., to receive a monetary reward for recycling) and, some time later, their recycling performance (e.g., volume of materials delivered for recycling) is compared with the recycling rate of participants who were provided with some other different intervention or even with the recycling level of those participants who have not received any treatment (the baseline group).

The third group encompasses the studies whose conclusions have been based on univariate or bivariate statistical analyses. Most of these studies use simple correlations, chi-square independence tests, independent samples t-tests or ANOVA tests. The problem of basing the analysis uniquely on these methods is that the relationship between recycling behavior and each potential predictor is assessed without considering the influence of other also likely important determinant variables.

A fourth group of studies have analyzed, simultaneously, various determinants of recycling behavior, by means of a dependence statistical method, like multiple regression or logistics regression. The major advantage of these studies, in relation to the previous ones, is that they allow the comparing of the predicted and isolated direct effect of each independent variable considered in the model and, therefore, to identify the most and the least important determinants of recycling behavior. This kind of information, in turn, is crucial in planning a future social marketing program that aims to increase the recycling rates.

The final group of studies contains the most comprehensive and advanced models, which enable analyzing and testing complex inter-relationships among the different variables, by means of structural equation modeling (SEM). Along with the direct effects, structural equation models take into consideration the indirect effects between variables and, thus, are likely to enrich the theoretical and empirical understanding of recycling behavior. Another key advantage of using SEM is the possibility of including unobserved or latent variables in the analysis. The use of latent variables to improve knowledge about what factors motivate the adoption of recycling practices makes all sense because unobservable concepts – like attitudes and values – are necessarily involved in modeling this particular phenomenon.

Tables A.9 to A.11, also in Appendix A, review the key features of studies that have used multivariate methods to study consumer behavior in selective-collection programs.

As can be observed, the dependence techniques that have been used in the recycling research include multiple regression, logistic regression, discriminant analysis and SEM. Table A.9 lists the research in which only personal determinants of this conservation behavior were considered. Table A.10, instead, presents the few studies that were limited to situational determinants of recycling participation. In the end, studies that have used both personal and situational variables are summarized in Table A.11.

The observation of studies listed in Table A.9 allows the conclusion that research on the personal determinants of recycling behavior has been quite limited to a few categories of personal variables. Berger (1997), for instance, only considered socio-demographic attributes and Webster (1975) combined this type of characteristics with some personal psychological values. On the other hand, in the study of Bratt (1999), just specific attitudes towards recycling were analyzed. As a final example, the work of Cheung, Chan and Wong (1999) is restricted to specific attitudes and knowledge. Similar patterns characterize the remaining studies listed in the table.

In the nine occasions revised in Table A.11, personal and situational variables were used to model consumer behavior in recycling programs. In their study, Hopper and Nielsen (1991) investigated the predictive role of specific recycling attitudes as well as the importance of some intervention strategies, like prompting and social pressure (through block leaders). However, in this study, a multiple regression model was used to investigate first the potential influence of the situational variables, whereas the personal variables were analyzed, afterwards, by means of a different regression equation. The main problem with this approach is that if the two types of variables were explanatory variables, each equation would incur in a misspecification problem, which would invalidate the subsequent statistical inference[34].

All the remaining studies presented in Table A.11 have combined personal and situational variables in the same model. Excluding the contributions of Guerin, Crete and Mercier (2001) and Corral-Verdugo (1997, 1996), the other studies were dedicated to test a specific behavioral theory[35]. In the study of Guagnano, Stern and Dietz (1995), for instance, Schwartz's (1977) model was analyzed in the recycling framework – which relates only personal variables – but the potential predictive effect of a situational variable (having or not received a free bin for recyclables) was also considered.

Boldero (1995), as well as Taylor and Todd (1995a, 1995b), tested, in turn, the Theory of planned behavior (Ajzen, 1985), which establishes relationships among attitudinal dimensions[36]. In their analysis, these authors also introduced some situational factors, which were related to logistical dimensions of consumer-service. Notice that the Theory of planned behavior was also analyzed in the study of Cheung, Chan and Wong (1999). In this case, however, only personal-level variables were considered, as reported in Table A.9. As a last reference, Pelton *et al.* (1993) applied SEM to test the importance of two potential situational predictors (rewards and punishments) of consumers' willingness to recycle, taken from the Stimulus-response theory, and a mix of a personal

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[34] See Stewart (1999: 64-65) for a comprehensive approach of the consequences of omitting relevant explanatory variables in a multiple regression model.

[35] In the studies of Corral-Verdugo, the variable "competencies for recycling" was measured by asking respondents to complete the recycling process of cans, glass and batteries. The variable "motives to recycling" was assessed by summing participants' scores (1 – yes, 0 – no) in the items "It is my custom", "I like to recycle" and "I save money". Lastly, the variable "conservation beliefs" was evaluated using two statements about general conservation practices (with which participants expressed their agreement or disagreement). In short, the variable "competencies for recycling" measures specific knowledge about recycling, the variable "motives to recycling" can be compared with specific attitudes towards recycling and the variable "conservation beliefs" has much in common with general environmental attitudes.

[36] This theory will be explained in Chapter 5.

and a situational predictors (subjective norms and opportunities), taken from the Differential-association theory[37].

2.4.5 The current state of the debate and directions for future research

Much empirical research has been conducted in the past three decades to clarify the determinants of consumers' behavior in recycling programs. Past studies have identified a number of variables, personal and situational, that seem likely to be implicated in this conservation behavior. Specific attitudes towards recycling and specific knowledge about recycling stand out among the most consistent personal determinants of recycling participation. On the other hand, previous research also evidence the importance of a good logistics consumer service, in its several components, as well as the interest in using some intervention tools, like prompting, social pressure and feedback, in the recycling context.

Moreover, broad-behavioral theories have been tested, which employ different combinations of these variables. However, for some of these variables, the results about their predictive role in recycling behavior are quite contradictory, which leaves doubts about their real importance or potential influence as predictors of recycling participation. This finding suggests that the debate around this issue still deserves current and future research attention.

Some aspects can be hypothesized to be behind these divergent results about the influence of some specific variables. First, as is clear from Tables A.2 to A.8, the dependent variable "recycling behavior" has been measured in rather different ways. In some studies, it represents whether the individual recycles or not; in others, it may

[37] A description of these theories can be found, for instance, in Pelton *et al.* (1993: 65-66).

measure the amount of recyclable materials delivered for recycling. It can also represent the frequency of recycling or even the quality of materials collected in the recycling program. Second, some studies have been based on self-reported recycling behavior, whereas others have relied on observed recycling. Third, the participants in the studies have also been very different. Only in some cases, a representative sample of the population has been used. In general, the samples are small and restricted to limited groups (e.g., students) or communities. Fourth, several studies only address one type of material, which leaves doubts about their generalization to distinct recyclable materials. Finally, the use of different statistical methods can also lead to disaccording conclusions.

On the other hand, even the most complex and complete models that have tried to explain consumers' behavior in recycling programs, which were based on the application of multivariate methods, have some limitations too, whose overcoming must orient future research.

As a first limitation, all reviewed models are restricted to a limited set of variables or to a specific behavioral theory. Potentially important personal determinants, such as personal psychological values and knowledge, were not yet combined with other more intensively investigated personal-level variables, like general environmental attitudes or specific attitudes towards recycling.

Second, studies based on multivariate data analysis methods, in which personal and situational variables were jointly analyzed, have only considered one set of variables that can be managed by the entities responsible for implementing and attending a recycling program: the logistics dimensions of consumer-service at the collection stage of the reverse logistics system for recycling. Moreover, as reported in Table A.11, only a restrict number of these dimensions has been considered in the reviewed studies. It would be of great value, therefore, to perform a more extensive analysis, in which the potential predictive importance of these and other logistics dimensions would be jointly examined with a wider set of personal variables and where the potential impact of some interventional strategies (e.g., communication), which were identified in Table A.8, would be also taken into account.

Another finding of this literature review, which is not evidenced in the tables, is that studies based on multiple or logistic regressions do not make any reference to the misspecification tests that have been performed, which provides some uncertainly about the results' validity. On the other hand, in the study in which discriminant analysis was applied, no reference is made to whether the previous conditions for the application of this multivariate method, which will be described in the following chapter of this thesis, were or not satisfied. The use of SEM in the recycling framework reveals, however, more care. In general, several approaches have been employed to evaluate the proposed models' goodness of fit, in their diverse components.

As a last reference, Guerin, Crete and Mercier (2001) offer a renovated view of the determinants of recycling behavior. In particular, these authors intended to provide a better understanding of recycling behavior in 15 countries of the European Union, by using both personal and contextual variables. The personal variables they have considered are summarized in Table A.11. In what concerns the contextual variables, they were measured at a national level, and included each country's environmental performance in waste management (variable "waste legislation and policy"), the country's percentage of citizens who belong to an association for the protection of the environment (variable "percentage of membership"), the country's percentage of people who have been involved in a local environmental initiative (variable "collective action") and the country's average rate of deforestation (variable "deforestation"). The results of their model indicated the variable "percent of membership" as the most important determinant of recycling behavior, at a country level, suggesting that citizens' average participation in the country's recycling activities is higher in countries with more environmental activists. Anther significant determinant variable was "waste legislation and policy", indicating that higher levels of recycling participation can be found in countries that have promulgated environmental legislation and policies to discourage the use of landfills and facilitate recycling.

The inclusion of determinant variables, measured at a country-level, certainly represents a step further in the recycling research that can also orient the following debate on this issue.

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Chapter 3

MULTIVARIATE DATA ANALYSIS METHODOLOGIES

3.1 Introduction

This chapter presents the five multivariate statistical data analysis methodologies that are used in the Chapters 4 to 7 of this thesis: principal components analysis, logistic regression, structural equation modeling, discriminant analysis and HOMALS. In particular, this chapter introduces each of these techniques, reviews their primary characteristics and describes the major methodological stages that guided their application in this thesis. This chapter ends by describing the method for dealing with missing data that was implemented in this thesis. Most results from these analyses, which are not presented in the referred chapters, can be encountered in the Appendixes B to F, in what concerns the application of the five multivariate statistical methods, and in Annexes G to I, in what regards the missing values analysis.

3.2 Principal Components Analysis

3.2.1 Overview

On several occasions the researcher has a large number of measurements of a particular phenomenon. Principal components analysis (PCA) can be applied to examine the nature of the relations among these measurements in order to determine whether they can be condensed into a smaller set of representative dimensions or principal components. In other words, the goal of PCA is parsimony, that is, to reduce the dimensionality of an original data set (Dunteman, 1989). PCA can be classified within the scope of the interdependence statistical methods since it does not distinguish between dependent and independent variables (Latin, Carrol and Green, 2003).

PCA was first introduced by Pearson (1901), but it owes much of its analytical development to Hotelling (1933). Since then, this method has been addressed by several authors and has been applied in almost every research field including biology, geology, medicine and social sciences. The studies carried out by Latin, Carroll and Green (2003), Jolliffe (2002), Hyvarinen *et al.* (2001), Gnanadesikan (1997), Affifi and Clark (1996), Mardia, Bibby and Kent (1995) are important recent references in the study of PCA.

Formally, the final purpose of PCA is to reduce an original set of p variables to a smaller set of new k variables that account for most of the information in the original variables, maximizing their total variance. Despite this objective, the application of this method, at a first stage, gives rise to p principal components, which are linear combinations of the original variables. Mathematically, the model of PCA can be represented as

$$\begin{aligned} y_1 &= a_{11}X_1 + a_{12}X_2 + \ldots + a_{1p}X_p \\ y_2 &= a_{21}X_1 + a_{22}X_2 + \ldots + a_{2p}X_p \\ &\ldots \\ y_p &= a_{p1}X_1 + a_{p2}X_2 + \ldots + a_{pp}X_p \end{aligned} \tag{1}$$

where $X_1, X_2, \ldots, X_p$ are the original variables and $y_1, y_2, \ldots, y_p$ are the principal components. In (1) the coefficients or weights a_{ij} $(i = 1, \ldots p; j = 1, \ldots, p)$ are derived maximizing the variance of the original data set, ensuring the independence (orthogonality) of the principal components. The principal components are ordered with respect to the variance they retain of the original p variables. The first component is the most important because it accounts for the most variance of the data. The second component is the one that explains the major part of the remaining variance, under the condition of being uncorrelated with the first component. Successive components account for smaller and smaller amounts of variance. This process continues until as many components as variables have been determined.

The most important statistics produced by a PCA are the vector of weights of each principal component and its associated variance, represented by λ. For a specific principal component y, the weights are used to interpret that component and the value of λ gives information on how well the component accounts for the variability of the original data. This relationship between λ and the amount of variance accounted for by the component can be easily understood by looking at the process of deriving the principal components.

Taking in account (1), the first principal component can be expressed using matrix algebra as

$$y_1 = a_1'X \tag{2}$$

where $a_1' = [a_{11} \;\; a_{12} \;\; \ldots \;\; a_{1p}]$ and $X' = [X_1 \;\; X_2 \;\; \ldots \;\; X_p]$. Applying PCA to the vector X, it results that

$$\mathrm{Var}(y_1) = a_1'\Sigma a_1 \tag{3}$$

where Σ is the variance and covariance matrix of the p variables.

The first principal component is derived determining the vector of weights, a_1, that maximizes the variance of y_1 given the constraint that $a_1'a_1 = 1$. It could be easily demonstrated that the resolution of this maximization problem, using the method of the Lagrange's multipliers, yields the following matrix equation

$$\Sigma a_1 = \lambda a_1 \tag{4}$$

where λ is a latent root (also called eigenvalue) of the variance and covariance matrix and a_1 the corresponding latent vector (also called eigenvector). The p eigenvalues are such that $|\Sigma - \lambda I| = 0$. Associated with each eigenvalue there will be an eigenvector, which can be obtained solving the system $[\Sigma - \lambda I]a_1 = 0$. Since the purpose is to maximize the variance of the principal component, the largest eigenvalue will be select. Actually, it can be shown that the variance of the component is equal to that eigenvalue:

$$\mathrm{Var}(y_1) = \mathrm{Var}(a_1'X) = a_1'\Sigma a_1 = a_1'(\lambda a_1) = \lambda a_1'a_1 = \lambda . \tag{5}$$

Then, the vector of weights, a_1, will be the eigenvector associated with that larger λ, which can be represented by λ_1.

The second principal component is determined by a similar process, but considering two restrictions: $a_2'a_2 = 1$ and $a_1'a_2 = 0$. This second constraint ensures the absence of correlation between this component and the previous one. The process of deriving principal components ends when p components are derived.

The model of PCA presented in (1) can be expressed using matrix algebra as

$$Y = A'X \tag{6}$$

in which $A'A = A'A = I$. On the other hand, defining Λ as the $(p \times p)$ diagonal matrix that includes the p eigenvalues, (4) can be generalized to the p components as:

$$\Sigma A = A\Lambda . \tag{7}$$

PCA allows to decompose the matrix of variances and covariances among the original variables (which is nothing but the matrix of correlations if the variables are standardized), that is, to explain the variance accounted in Σ by means of the principal component weights (the eigenvectors), as well as in terms of the variances of these components (the eigenvalues). Effectively, the generalization of (5) gives rise to

$$\mathrm{Var}(Y) = \mathrm{Var}(A'X) = A'\Sigma A = \Lambda \tag{8}$$

which, after some matrix algebra manipulation, is equivalent to:

$$\Sigma = A\Lambda A' . \tag{9}$$

Based on this development, four important properties involving the principal components can be summarized:

(1) The sum of the variances of the principal components equals the sum of the variances of the original variables. In fact:

$$\sum_{j=1}^{p} \mathrm{Var}(y_j) = \sum_{j=1}^{p} \lambda_j = \mathrm{tr}(\Lambda) = \mathrm{tr}(A'\Sigma A) = \mathrm{tr}(AA'\Sigma) = \mathrm{tr}(\Sigma) = \sum_{i=1}^{p} \mathrm{Var}(X_i); \tag{10}$$

(2) If the variables are standardized, the sum of variances of the principal components is equal to the number of original variables. Actually, since each standardized variable has variance 1, Σ is nothing but the matrix of correlations among the original variables. Therefore,

$$\mathrm{tr}(\Lambda)=\sum_{j=1}^{p}\lambda_j = p \qquad (11)$$

In other words, given equation (10), also $\sum_{i=1}^{p}\mathrm{Var}(X_i)=p$

(3) The proportion of variance of the original variables which is accounted for by the first k principal components is:

$$\sum_{j=1}^{k}\lambda_j \Big/ \sum_{j=1}^{p}\lambda_j ; \qquad (12)$$

(4) The proportion of variance of the original variables which is accounted for a single principal component is:

$$\lambda_j \Big/ \sum_{j=1}^{p}\lambda_j . \qquad (13)$$

3.2.2 Stages in the application of method

PCA is one of the most important multivariate data analysis techniques used in Chapters 4 and 6 of this thesis. This subsection describes the main methodological steps considered in the application of this method.

Analyzing the application conditions

The use of PCA to a set of original variables should be based on a previous diagnosis of a few application conditions (Latin, Carroll and Green, 2003; Jiménez *et al.*, 2000; Martinez, 2000; Reis, 1997; Hair *et al.*, 1995). These conditions were assessed in the aforementioned chapters, based on the results provided by the software SPSS 10.0 (SPSS Inc., 1999), and can be summarized as follows:

(1) One requisite that should be accomplished for the application of PCA is that the original variables be strongly correlated. Accordingly, in all situations in which PCA was used, the correlations among the variables were analyzed and their statistical significance was evaluated. The Bartlett's (1947) test of sphericity for the overall significance of all correlations was also carried out. In this test, the null hypothesis establishes that the correlation matrix is equal to an identity matrix, a situation in which the use of PCA would not make sense. The statistic of this test has the following form

$$\chi^2 = -\left[n - 1 - \frac{1}{6}(2p + 5)\right] \ln|R| \tag{14}$$

where n is the sample size, p the number of original variables and R the correlation matrix. Under the null hypothesis, this statistic is asymptotically distributed as a chi-square with $\frac{p(p-1)}{2}$ degrees of freedom.

(2) Another indicator of the pertinence of using PCA is the measure of sample adequacy proposed by Kaiser (1970), which is also known as the Kaiser, Meyer and Olkin or KMO statistic. This measure ranges from 0 to 1 and compares the magnitude of the simple correlations between all pairs of variables with the magnitude of their partial correlations. A high KMO index is indicative of the interest in the application of PCA. This index is computed with the formula (15), where r_{ij} is the simple coefficient of correlation between the variables i and j, a_{ij} is the partial coefficient of correlation between these variables and n is the sample size.

$$KMO = \frac{\sum_{i=1}^{n}\sum_{j\neq i} r_{ij}^2}{\sum_{i=1}^{n}\sum_{j\neq i} r_{ij}^2 + \sum_{i=1}^{n}\sum_{j\neq i} a_{ij}^2} \tag{15}$$

Table 3.1 provides the classification of PCA as a function of the KMO's value.

TABLE 3.1
The KMO index and the PCA

KMO	PCA
0.9 – 1	Marvelous
0.8 – 0.9	Meritorious
0.7 – 0.8	Middling
0.6 – 0.7	Mediocre
0.5 – 0.6	Miserable
< 0.5	Unacceptable

Source: Kaiser (1974).

(3) SPSS provides another indicator of the sample adequacy for the use of PCA, which is the anti-image matrix. In this matrix, the elements outside the principal diagonal are the symmetric of the coefficients of partial correlation and, thus, their absolute value should be low. Instead, in the principal diagonal, the measures of sample adequacy (MSA) can be found, which are also referred to as the KMO's statistic for each single variable (Hutcheson and Sofroniou, 1999). The computation formula of a MSA is very similar to the computation formula of the KMO index for multiple variables and the criteria for the classification of PCA, with regard to the MSA's values, can also be found in Table 3.1. However, while the KMO for multiple variables enables a global appreciation of the sample adequacy, each MSA makes an evaluation for each individual variable. Variables with a MSA lower than 0.5 should be eliminated from the analysis. For the variable i, the MSA can be defined as:

$$\mathrm{MSA}_i = \frac{\sum_{i \neq j} r_{ij}^2}{\sum_{i \neq j} r_{ij}^2 + \sum_{i \neq j} a_{ij}^2}. \tag{16}$$

Extracting the principal components

The p dimensions that can be extracted from the application of PCA are exact mathematical transformations of the original p variables and, as previously described, the method used in their extraction ensures that they are independent, that is, they are orthogonal or uncorrelated. Nevertheless, the interest in using PCA is to reduce data and so there is not any advantage in retaining all the p dimensions. So, a crucial question in the use of this multivariate method is how many dimensions or principal components should be retained. Although the nature of this decision is arbitrary, various methods have been developed that can be used as a guide. Since these methods were considered in Chapters 4 and 6, they are now briefly reviewed:

(1) The Kaiser (1960) criterion. When dealing with standardized variables, they all have variance 1. Then, the total variance in the correlation matrix, which can potentially be extracted, will be equal to p, that is, to the number of original variables. As earlier explained, each eigenvalue measures the variance of its associated dimension. The Kaiser's criterion states that only the dimensions that extract at least as much variance as any one of the original variable, that is, with an eigenvalue higher that 1, should be retained;

(2) The proportion of explained variance. When consecutive dimensions are derived, they account for less and less variability. Another criterion, more subjective, suggests that only the dimensions that account for, at least, 70% of the total variance should be retained. In this way, it is ensured a fixed percentage of total explained variance;

(3) The scree plot (Cattell, 1966). This is a graphical method, in which the eigenvalues are plotted for the several p dimensions. In agreement with this criterion, when the shape of the resulting curve starts becoming an almost horizontal line, the corresponding principal components should be excluded.

(4) The interpretable solution. Many times the previous criteria enable the identification of a different number of relevant principal components. In such situation, the preferable option is analyzing if a particular solution is interpretable. This implies examining various solutions, with different number of dimensions, and choosing the one that seems to be the most reasonable, that is, the one that allows interpreting the components in the most meaningful manner. In Chapters 4 and 6, whenever the match of the previous three methods produced a different solution regarding the ideal number of dimensions, this more subjective criterion of the interpretable solution would be considered.

Rotating and interpreting the principal components

As referred to above, besides the eigenvalues, the eigenvectors are the most important statistics produced by a PCA. Each eigenvector contains the weights of the associated principal component. However, these are not the values that are interpreted in a solution of PCA. In interpreting the results of a PCA what is really analyzed are the *principal component loadings*, which are obtained from the original principal component weights. The relationship between the loadings of a principal component y_j, included in the vector a_j^*, and the corresponding weights, included in the vector a_j, is:

$$a_j^* = \sqrt{\lambda_j} a_j \qquad j = 1,\ldots,p . \tag{17}$$

While the sum of squares of the principal component weights is 1, the sum of squares of the principal component loadings is λ_j. As can be easily demonstrated,

$$\left(a_j^*\right)' a_j^* = \left(\sqrt{\lambda_j} a_j\right)' \left(\sqrt{\lambda_j} a_j\right) = \lambda_j a_j' a_j = \lambda_j. \tag{18}$$

The use of loadings allows a very suggestive interpretation of the principal components, since each of these values is the correlation between that component and the associated original variable. Actually, the covariance between an observed variable X_i and a principal component y_j is given by

$$\mathrm{Cov}\left(y_j, X_i\right) = \mathrm{Cov}\left(y_j, \sum_{j=1}^{p} a_{ij} y_j\right) = a_{ij} \mathrm{Var}(y_j) = a_{ij} \lambda_j. \tag{19}$$

and, thus, their coefficient of correlation is:

$$r_{y_j, X_i} = \frac{\mathrm{Cov}\left(y_j, X_i\right)}{\sqrt{\mathrm{Var}(y_j)}.\sqrt{\mathrm{Var}(X_i)}} = \frac{a_{ij}\lambda_j}{\sqrt{\lambda_j}.1} = a_{ij}\sqrt{\lambda_j} = a_j^*. \tag{20}$$

While the sum in column of the squares of the principal component loadings is λ_j, their sum in line is equal to the proportion of variance for each variable which is accounted for by the selected principal components. Obviously, if the p dimensions were retained, all of the variance in the data would be accounted for and, as a consequence, these proportions of variance for each variable would equal 1. This is why, in the initial solution of any PCA, these proportions are equal to 1. Nevertheless, in a k-dimensions model, only a lower percentage of the variance of the data is accounted for and, thus, these proportions of variance for each variable are lower than 1. In this sense, these values give an indication about the importance of each variable in the PCA solution, suggesting which variables should be eliminated from the analysis, and were also evaluated in Chapters 4 and 6.

On several occasions, looking at the initial loadings extracted by default in a PCA, the researcher finds that there are many variables correlated with a same single dimension, which makes the interpretation of results difficult. The rotation of the components enables the overcoming of this problem, yielding a clearer pattern of loadings, by showing dimensions that are more marked by high loadings for some variables and low loadings for others.

Geometrically, the principal components are just another set of coordinate axes that allow representing the observations of the original variables. To rotate the components means to find a new set of coordinate axes in the same subspace spanned by the principal components, without loss of information. As explained by Dunteman,

> "like the principal components, the new coordinate axes are also defined by their correlations (loadings) with the original variables, but hopefully the pattern of loadings on the rotated coordinated axes will be more conceptually appealing, thus allowing for a simpler interpretation of the rotated components" (Dunteman, 1989: 49).

There are orthogonal and oblique rotation methods. The former methods keep the perpendicularity of the principal components, whereas the second methods give rise to a new set of non-perpendicular axes. Typical orthogonal rotation strategies include varimax, quartimax and equimax. If these methods are used, the proportion of variance accounted for by the retained principal components will not change. In these cases, the rotated loading matrix is an orthogonal transformation of the original loading matrix, that is, it can be represented as

$$L_r = LT . \qquad (21)$$

In (21), L_r is the $(p \times k)$ rotated loading matrix, L is the $(p \times k)$ original loading matrix and T is the $(k \times k)$ orthogonal transformation matrix that maximizes the rotation criterion. In the SPSS software, the matrix T is referred to as the "component transformation matrix".

Varimax rotation was used in Chapters 4 and 6. As its name suggests, this method maximizes the variance of the new axes or, in other words, it maximizes the variability between the loadings of each dimension [Kaiser (1958)]. As consequence, the number of variables with high loadings in each component will be minimal, which, consequently, will facilitate its interpretation. In this rotation method, the matrix T, which allows the determining of the rotated principal component loadings, results from an iterative algorithm that maximizes the following function

$$G = \sum_{j=1}^{k} \left[\sum_{i=1}^{p} lr_{ij}^4 - \frac{1}{p} \left(\sum_{i=1}^{p} lr_{ij}^2 \right)^2 \right] \tag{22}$$

where lr_{ij} represents the elements of the rotated loading matrix L_r.

Once the rotated principal component loadings are obtained, the next step is to assess their importance. Variables with larger loading, in absolute size, will be more important in interpreting the principal components. As summarized by Hair *et al.* (1995), principal component loadings with absolute size from 0.3 to 0.4 surpass the minimal level; loadings ranging from 0.3 to 0.4 are more important; and loadings exceeding 0.5 (in absolute size) are considered significant. The variables with higher loadings are the most important and are determinant on the name chosen to represent the principal component. This was the criterion used to interpret the principal components in Chapters 4 and 6.

Computing the principal component scores

Once the retained principal components are interpreted, the actual values of individual cases for the dimensions can be determined. The computation of principal component scores, within the context of Chapters 4 and 6, was very important because they could be used to perform subsequent analyses involving the underlying main dimensions that were identified in the PCA. More specifically, the principal component scores on the retained dimensions were used as the observations of the new subset of variables (the principal components) that entered, in a following step, as independent variables in a logistic regression model, in the case of Chapters 4, and in a discriminant analysis model, in the case of Chapter 6.

In PCA, the k principal component scores for each observation, in the subset of k dimensions, are given by

$$P = Z.C \tag{23}$$

where P is the line vector of k principal component scores for that observation, Z is the line vector of p standardized values of the original p variables and C is a $(p \times k)$ matrix of principal components. In the SPSS software, the matrix C is referred to as the "component score coefficient matrix" and is computed using the transformation

$$C = R^{-1}.F\,. \tag{24}$$

in which R is the correlation matrix of the original variables and F is the $(p \times k)$ matrix of the rotated principal component loadings.

3.3 Logistic Regression

3.3.1 Overview

Logistic regression or logit modeling is a dependence data analysis method that may replace multiple regression when the equation to be estimated has a dichotomous dependent variable. In this circumstance, the estimation of the model by ordinary least squares would bring various problems – nonlinearity, nonsensical predictions, nonnormality and heteroscedasticity – which would invalidate the analysis[38]. Similarly to multiple regression, both continuous and discontinuous independent variables can be entered in a logistic regression model. As also with multiple regression, the discontinuous independent variables are included in the model by defining dummy variables.

The origin of the logistic regression model can be traced to the research of Berkson (1951, 1944), although, as reported by Finney (1971), the discussion of models with a binary dependent variable had begun much earlier, in the 1860s. The book of Cox (1970) was decisive in the divulgation of logit modeling that, since then, has found widespread application in the social sciences, with special focus on the marketing field. Within this last context, logistic regression has revealed itself particularly useful in modeling consumer buying behavior of some products or services and in the analysis of the success of introducing new products. Logistic regression has been addressed by numerous works, which have developed and / or disseminated this multivariate data analysis technique. These include, for example, Latin, Carroll and Green (2003), Pampel (2000), Vizcaíno (2000), Hutcheson and Sofroniou (1999), Long (1997), Affifi and Clark (1996), Menard (1995), Davidson and MacKinnon (1993) and Greene (1993).

[38] The problems of using ordinary least squares to estimate a model with a binary dependent variable are discussed, for instance, in Dougherty (2001: 2-4), Pampel (2000: 1-10), Vizcaíno (2000: 432-435), Long (1997: 22-25), or Menard (1995: 5-7).

Logistic regression has many analogies with linear multiple regression. Similar to multiple regression, logistic regression fulfills the purposes of prediction and explanation (Hutcheson and Sofroniou, 1999). Effectively, it allows the making of predictions for the dependent variable as well as to evaluate the relevance of a single or a set of independent variables.

In the logistic regression model, the dependent variable y can only take values of 1 and 0. It assumes the value 1 if an event occurs and the value 0 otherwise. In the simple logistic regression, there is just one independent variable, whereas in multiple logistic regression two or more independent variables are considered. In Chapter 4, a set of research hypotheses are tested within the context of a multiple logistic regression model. In accordance to this, this model is presented in the section.

As stated by Long (1997), the logistic regression model can be developed as a model with a latent dependent variable or as non-linear probability model. These two perspectives are described above since both were considered in Chapter 4, although in different settings. The first approach was useful in interpreting the model and the second one in analyzing the potential model misspecification.

In the first approach, the logit model is derived from a model involving an unobserved or latent variable, y^*, that is assumed to be linearly related to the observed variables through the following structural equation

$$y_i^* = \alpha + \beta_1 X_{1i} + \beta_2 X_{2i} + \ldots + \beta_p X_{pi} + \varepsilon_i \quad (i = 1,2,\ldots,n) \tag{25}$$

where $X_1, X_2, ..., X_p$ are the continuous or dummy independent variables and ε is the error term. Equation (25) also can be represented using matrix algebra, in the following form

$$y^* = X\beta + \varepsilon \tag{26}$$

where y^* is a $(n \times 1)$ vector, X is a $(n \times (p+1))$ matrix of observations on the p independent variables and in the constant term, β is a $((p+1) \times 1)$ vector of parameters to be estimated and ε is a $(n \times 1)$ vector of errors.

In turn, the value of y^* determines the value of the observed dependent variable, y, according to the relationship

$$y_i = \begin{cases} 1 & \text{if } y_i^* > \tau \\ 0 & \text{if } y_i^* \leq \tau \end{cases} \tag{27}$$

where τ is the threshold or cut point.

In (25) and (26), the latent variable y^* can be perceived as the underlying propensity that generates the observed value for the dependent variable, that is, whether or not the event measured by the dependent variable will occur. As Long points out, "those who have larger values of y^* are observed as $y = 1$, while those with smaller values of y* are observed as y = 0" (Long, 1997: 40)[39].

To fully understand the link between y^* and y, the following example is presented. Suppose that the dependent variable represents the buying behavior of a certain product.

[39] Long offers a good graphical explanation for the link between the latent variable y^* and the observed variable y (Long, 1997: 40-46).

This variable only observes two values: the individual buys the products ($y = 1$) or he / she does not buy it ($y = 0$). Although two individuals may have the same behavior in what concerns the dependent variable (i.e., both decide to buy the product) and, so, for both cases, this variable will take the value 1, they certainly do not perform this act with the same conviction. Actually, the former individual may be very firm in his / her decision to buy such good (i.e., he / she has a high buying propensity), whereas the second one can be very close to the decision of not doing it (i.e., he / she has a lower buying propensity). However, both may decide to acquire the product and, then, in both situations, the same value will be observed for the dependent variable: it will take the value of 1. A third individual, however, may totally dislike the product or find it too much expensive. He has not, therefore, any buying propensity and, accordingly, he / she declares not to buy the product (the dependent variable will take, as a consequence, the value of 0). In short, although the buying propensity is not observable, at some point, a change in its value will produce a change in what is observable, that is, whether or not an individual purchases a product.

As suggested by Greene (1993), the propensity to take a certain action may be understood as the result of the individual's reflection over the difference between the marginal benefits and the marginal costs of that action. Davidson and Mackinnon provide a similar interpretation. As these authors point out, "we could think of y_t^* as an index of the (net) utility obtained from some action. If the action yields positive utility, it will be undertaken; if not, then it will not be" (Davidson and Mackinnon, 1993: 524).

Since y^* is not observable, the logistic regression model cannot be estimated by O.L.S. Instead, this model is fitted using maximum likelihood estimation, which will be addressed in a following section. This estimation method requires some assumptions about the distribution of the errors. In the case of logit modeling, the errors are assumed to have a standard logistic distribution with mean 0 and variance $\pi^2/3$. Specifically, the probability density function and cumulative distribution function for the logistic distribution are given by

$$\lambda(\varepsilon) = e^{\varepsilon}/(1 + e^{\varepsilon})^2 \tag{28}$$

and

$$\Lambda(\varepsilon) = e^{\varepsilon}/(1 + e^{\varepsilon}) \tag{29}$$

respectively[40].

Besides the assumptions about the mean and the variance of the errors, logistic regression also requires that the threshold in the equality (27) be set to 0. These requirements are necessary for identification purposes[41]. As Long explains, "these assumptions are arbitrary, in the sense that they cannot be tested, but they are necessary to identify the model. (...) Since a latent variable is unobserved, its mean and variance cannot be estimated" (Long, 1997: 47)[42].

As a result of (27) and assuming $\tau = 0$, the probability of $y = 1$ for a given combination of $X_1, X_2, ..., X_p$ can be represented by

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[40] The standard logistic probability density function has the same form but is flatter than the standard normal distribution. It resembles the t distribution with 7 degrees of freedom. The distribution of the errors is the main aspect that distinguishes logit modeling from probit modeling, an alternative form of dealing with a dichotomous dependent variable. The probit regression assumes that the errors have a normal distribution with mean 0 and variance 1.

[41] Long presents four critical ideas about the concept of identification. "First, a parameter is unidentified when it is impossible to estimate a parameter regardless of the data available. (...) Second, models become identified by adding assumptions. (...) Third, it is possible for some parameters to be identified while others are not. (...) Finally, while individual parameters may not be identified, combinations of those parameters may be identified " (Long, 1997: 24).

[42] For a more detailed discussion of these assumptions, see Long (1997: 47-50; 122-123).

$$p(y=1|X)=p(y^*>0|X) \quad (30)$$

or, taking into account (26),

$$p(y=1|X)=p(X\beta+\varepsilon>0|X). \quad (31)$$

The equality (31) is also equivalent to

$$p(y=1|X)=p(\varepsilon>-X\beta|X). \quad (32)$$

or, since the logistic distribution is symmetric,

$$p(y=1|X)=p(\varepsilon<X\beta|X). \quad (33)$$

Thus, the probability of an event occurring, given the observed valued for the independent variables, equals the cumulative density of the error distribution at $X\beta$. Consequently,

$$p(y=1|X)=F(X\beta) \quad (34)$$

where F is the logistic cumulative distribution function for the logit regression.

The second approach to logistic regression uses a non-linear model that relates the independent variables $X_1, X_2, ..., X_p$ to the probability of an event through the following structural function:

$$p(y=1|X)=e^{\alpha+\beta_1X_1+\beta_2X_2+...+\beta_pX_p}/\left(1+e^{\alpha+\beta_1X_1+\beta_2X_2+...+\beta_pX_p}\right). \quad (35)$$

The odds ratio and the logit are key concepts in logistic regression. The *odds ratio* is defined as the quotient of the probability of an event happening to the probability of such event not occurring and has the following algebraic representation:

$$\mathrm{odds}(y=1|X)=p(y=1|X)/(y=0|X)=e^{\alpha+\beta_1X_1+\beta_2X_2+\ldots+\beta_pX_p}. \tag{36}$$

On the other hand, the *logit* is the natural logarithm of the odds and is defined as:

$$\mathrm{logit}(y=1|X)=\alpha+\beta_1X_1+\beta_2X_2+\ldots+\beta_pX_p. \tag{37}$$

Equations (35) to (37) evidence how a non-linear relationship between a dichotomous dependent variable and a set of explanatory variables can be linearly expressed[43].

3.3.2 Stages in the application of the method

Logistic regression was undertaken in Chapter 4, considering as independent variables the principal components previously extracted from PCA and also a set of dummy variables. The use of logistic regression in that chapter has relied on four methodological stages that are described in this section.

Specifying and estimating the model

Unlike other multivariate techniques for modeling a dichotomous dependent variable, logistic regression allows for the inclusion of continuous and discontinuous explanatory variables in the model. This was the criterion for choosing logit modeling, instead of discriminant analysis, for instance, in Chapter 4. In this chapter, the logit model was specified as a linear model in a latent dependent variable, for the purpose of interpreting the parameters of the model, as well as a non-linear model, similar to (35), for the purpose of misspecification analysis.

[43] Hutcheson and Sofronious (1999: 122) provide a graphical illustration of the transformation of a S-shaped distribution (which corresponds to a structural equation as (35)) into a linear one (which corresponds to a structural equation as (37)), when only one independent variable is considered in the logistic regression model.

As referred to earlier, a logistic regression model is estimated using the maximum likelihood technique. In accordance to this method, the value of a function, the log-likelihood function, is maximized and indicates how likely it is to get the observed data for the dependent variable, given the values of the explanatory variables and the parameters of the logistic regression equation.

Defining p_i as

$$p_i = \begin{cases} p(y_i = 1|X_i) & \text{if } y = 1 \text{ is observed} \\ 1 - p(y_i = 1|X_i) & \text{if } y = 0 \text{ is observed} \end{cases} \tag{38}$$

where $p(y_i = 1|X_i)$ is expressed by the equality (34), the likelihood function, for n independent observations, can be defined as follows

$$L(\beta|y, X) = \prod_{i=1}^{n} p_i = \prod_{y=1} p(y_i = 1|X_i) \prod_{y=0} [1 - p_i(y = 1|X_i)] \tag{39}$$

or even as

$$L(\beta|y, X) = \prod_{y=1} F(X_i\beta) \prod_{y=0} [1 - F(X_i\beta)] \tag{40}$$

as a result of (34). In turn, taking logs of (40), the following log-likelihood function is obtained:

$$\ln L(\beta|y, X) = \sum_{y=1} \ln F(X_i\beta) + \sum_{y=0} \ln[1 - F(X_i\beta)]. \tag{41}$$

While the use of maximum likelihood estimation for multiple regression allows a direct solution for the estimates of the model[44], for the case of logistic regression the solution

[44] Assuming that the disturbances are normally distributed, both the OLS and the maximum likelihood estimates for the coefficients of a linear regression model are given by the direct solution $\hat{\beta} = (X'X)^{-1}X'y$.

is found by applying an iterative process. It begins with an initial solution, which is slightly revised until the change in the log likelihood function, from one step to the next, becomes minimal. The solution is said to converge, when there is no possibility of further improving of the value of the log-likelihood function[45]. The maximum likelihood estimates have three desired properties: they are consistent, asymptotically normal and asymptotically efficient. Concerning the sample size required for the application of maximum likelihood estimation in models with binary outcomes, Long (1997) refers the rule of at least 100 cases, with a minimum of 10 cases per parameter to be estimated. This requirement was accomplished when estimating the logistic regression model, by the maximum likelihood method, in Chapter 4. This model was estimated using the direct method, that is, all independent variables entered the equation simultaneously[46].

Analyzing the model misspecification

Although logistic regression has less stringent assumptions than other statistical techniques for categorical dependent variables, some requirements still apply. As for multiple regression, it assumes absence of strong multicollinearity among the explanatory variables, inclusion of all relevant variables in the regression model and exclusion of all irrelevant variables. It also requires linearity and additivity between the logit of the dependent and the independent variables as well as absence of outliers and influential cases (Hutcheson and Sofronious, 1999; Menard, 1995). This section describes how the accomplishment of these assumptions was treated in Chapter 4.

[45] Long (1997: 54-57) reviews various numerical methods that may be used to determine the estimates which maximizes the log likelihood function.
[46] As for multiple regression or discriminant analysis, SPSS offers stepwise estimation methods.

(1) Absence of strong multicolinearity. High multicollinearity is problematic because it affects the results of the tests about the individual significance of each regression coefficient. Variables that evidence high correlation with each other will offer little unique information and the standard errors of the logit coefficients will become inflated. In order to identify whether or not there was one or more variables strongly correlated with the others, the method proposed by Stewart (1991) was implemented in the logistic regression model of Chapter 4. This method implied the performing of a linear regression of each continuous independent variable in all the other variables of the model and to report the corresponding coefficient of determination (R^2). If any of these R^2 was close to 1, it would have evidence of serious multicollinearity (Stewart, 1991);

(2) Linearity. Logistic regression assumes that the logit of the dependent variable is a linear combination of the independent variables and also that the relationship between them is additive. This is clear from (37). To assess linearity, Hosmer and Lemershow (1989) propose adding polynomial contrasts (of second and third order) to the logist regression model and, then, testing their statistical significance. Accordingly, to test the existence of polynomial contrasts of second order (also called quadratic effects), the proposed model was compared with a larger model that encompassed, besides the original independent variables, the square values of these variables. In the same way, to test third order effects (or cubic effects), the cube of the original independent variables was computed, these new variables were added to the model and their statistical significance was tested. In agreement with Long (1997), the likelihood ratio test was used to test each hypothesis in which a set of coefficients were simultaneously equal to zero and, therefore, to test these polynomial contrasts. This test was based on the computation of the G^2 statistic, which was easily determined using the standard outputs of SPSS 10.0, the software used to estimate the logistic regression.

The G^2 statistic is a function of the difference of the log-likelihoods of the two models being compared. In this statistic, each log-likelihood is multiplied by (-2) because $-2\ln L$ has approximately a chi-square distribution with degrees-of-freedom equal to the number of parameters in the model[47] and, therefore, can be used for purposes of significance testing. The use of $-2\ln L$, which is called the deviance of the model, allows the testing of the contribution of an individual explanatory variable as well as the contribution made by a group or even by all independent variables. As Hutcheson and Sofronious explain, the difference in the deviance between two models "represents the effect that the explanatory variables have (that is, the improvement in the model fit which can be attributed to the explanatory variables)" (Hutcheson and Sofronious, 1999: 140). Basically, the G^2 statistic compares the fit of nested models and has the following form

$$G^2 = -2\ln L_{dif} = \left(-2\ln L_p\right) - \left(-2\ln L_{p+q}\right) \tag{42}$$

where $-2\ln L_p$ is a measure of deviance of the smaller or nested model and $-2\ln L_{p+q}$ is a measure of deviance of the larger model. Under the null hypothesis, the G^2 statistic has an asymptotically chi-square distribution with degrees of freedom equal to the difference in the number of terms between the two models (i.e., q). This test is usually called the "likelihood ratio test" or the "chi-square difference test";

(3) Additivity. As suggested by (37), logistic regression does not include interaction effects unless when they are explicitly introduced as additional independent variables in the model[48]. To test the additivity between the logit and the set of explanatory variables, which implies the absence of significant interaction effects, interaction terms were

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[47] Excluding the constant.
[48] There must be a theoretical justification for the inclusion of such effects.

added to the proposed model in Chapter 4 and their statistical significance was assessed using, as previously, the likelihood ratio test. The interaction terms have resulted from the product of each continuous variable of the original model by the dummy variables[49];

(4) Inclusion of all relevant variables. Omitting relevant explanatory variables is a serious problem within the logistic regression analysis, since it results in biased estimates for the regression coefficients. A linear specification of a non-linear model or even an additive specification of an interactive model is equivalent to the omission of relevant independent variables (Menard, 1995). Nevertheless, to assure that the logistic model of Chapter 4 did not incur in the omitted variables bias, the Ramsey's (1969) reset test was also undertaken. In agreement with this test, the dependent variable was regressed, simultaneously, in the original set of explanatory variables and in two additional variables[50]: the square and the cube of the fitted values for the dependent variable[51]. Then, the statistical significance of these two additional variables was tested using the likelihood ratio test, as presented in (42);

(5) Exclusion of all irrelevant variables. Including one or more irrelevant independent variables in a logistic regression model is not as problematic as omitting relevant variables because the estimates for the model coefficients are still unbiased. However, in this case, their standard errors tend to be overestimated and, as a result, the subsequent statistical analysis will be affected. The likelihood ratio test was performed

[49] Dummy variables were included in the model in order to analyze of the explanatory ability of some categorical explanatory variables, like gender and education level. For each categorical variable with k categories, k -1 dummy variables were defined. An interaction effect that is obtained, for example, by multiplying a metric variable like "age" by the dummy variable "gender" will allow to analyze whether the effect of age in the propensity to take the action represented by the dependent variable (to participate in the recycling program, in the current thesis) will be different for men and women.

[50] Using logistic regression.

[51] In the case of logistic regression, the fitted values are the estimated probabilities, which are a standard output of this type of analysis.

to test the joint elimination of all variables individually non-statistically significant in the original model that, in turn, were identified using the Wald test.

The Wald statistic provides a test to the significance of a single independent variable and is a standard output of logistic regression. It tests the null hypothesis that the regression coefficient for an independent variable X_k is zero with the following statistic

$$W_k = \left(\hat{\beta}_k / \hat{\sigma}_{\hat{\beta}_k}\right)^2 \tag{43}$$

where $\hat{\sigma}_{\hat{\beta}_k}$ is the standard error of $\hat{\beta}_k$. Under the null hypothesis, this statistic has a chi-square distribution with 1 degree of freedom.

It is important to note that when a model includes irrelevant variables, the statistical inference becomes conservative. This means, for instance, that it is more difficult to reject the null hypothesis that there is no relationship between the dependent variable and each independent variable, even when this hypothesis is false. This problem can be surpassed by performing all the tests based on the initial model using a significance level higher than the usual ones (1% or 5%), for instance, a 10% significance level. Using a higher significance level, the rejection region becomes larger and the conservative trend of the tests is, therefore, confined. This care was taken in the performance of the likelihood ratio test and also the Wald's tests in all contexts previously described;

(6) Absence of outliers. The logistic regression model was also submitted to residuals analyses in order to identify the observations that the model fits poorly (outliers). This diagnosis was performed by computing the Pearson or Standardized residuals that are equal to

$$r_i = \frac{y_i - \hat{p}(y_i = 1|X_i)}{\sqrt{\hat{p}(y_i = 1|X_i)\left[1 - \hat{p}(y_i = 1|X_i)\right]}} \tag{44}$$

where $\hat{p}(y_i = 1|X_i)$ is the estimated probability that $y_i = 1$, computed from the model for the i-th case, and y_i is the corresponding observed value for the dependent variable[52]. For large samples, r_i should have a standardized normal distribution. Large positive or negative standardized residuals suggest cases for which the model fits poorly. Considering the distribution function of these residuals, around 95% of the cases should be between -2 and 2 and 99% should range from -2.5 to 2.5.

(7) Absence of influential cases. The objective of the influential cases analysis was to identify the observations that had strongly affected the estimates of the logistic regression model. This analysis was conducted determining the *Dbeta* values, which measure, for an independent variable k, the standardized change in the regression coefficient β_k that results from the elimination of the i-th observation. Each Dbeta is given by:

$$\text{Dbeta}_{ik} = \frac{\Delta_i \hat{\beta}_k}{\sqrt{\hat{\text{Var}}\left(\hat{\beta}_k\right)}} \tag{45}$$

[52] Besides the analysis of the standardized residues, Menard (1995) also suggests the observation of the deviance as well as the studentized residuals (see Menard (1995: 72-74) for the computation formulas for these residuals). However, as this author observes "the advantage to the Pearson residual is that, because it has larger values than the deviance residual, outlying cases sometimes stand out more sharply with the Pearson residual than with the deviance or studentized residuals" (Menard, 1995: 79).

High Dbeta values (close to 1) suggest that the i-th case has a large influence on the estimate of β_k, which deserves a closer examination.

Evaluating the model goodness-of-fit

There are various ways in which the goodness-of-fit of a logistic regression model can be evaluated. This section describes the goodness-of-fit measures that were used in Chapter 4. These measures had included the computation of a pseudo-R^2, the performance of some statistical tests as well as the evaluation of the predictive power of the model through the analysis of a classification table.

(1) The pseudo-chi-square. In logistic regression there is no standard measure of fit with a clear interpretation in terms of explained variation as the coefficient of determination (R^2) in linear regression. There have been several attempts to develop a similar measure to R^2 that could be used in models with binary outcomes, but no consensus has emerged on the best one. McFadden's (1973) pseudo-R^2 is probably the most popular single measure of fit in models with binary dependent variable and it was computed in Chapter 4 as a first indicator of goodness of fit. This pseudo-R^2 compares the log-likelihood for the proposed model, $\ln L_p$, with the log-likelihood for the model that is estimated only with an intercept (the null model), $\ln L_\alpha$, using the following equation:

$$\text{Pseudo} - R^2 = 1 - \ln L_p / \ln L_\alpha . \qquad (46)$$

McFadden's (1973) pseudo-R^2 does not have a natural interpretation. It only indicates the proportion by which $\ln L_\alpha$ is higher, in absolute size, than $\ln L_p$ and there is not a standard rule to judge if the founded value is "high enough";

(2) The test to the overall significance of the explanatory variables included in the model. In this test, the null hypothesis is that the coefficients of the p independent variables are all jointly equal to 0 the test is performed by using the log-likelihood statistic, similar to (42)

$$G^2 = -2\ln L_{dif} = (-2\ln L_{\alpha}) - (-2\ln L_p); \tag{47}$$

(3) Hosmer and Lemershow's (1989) goodness of fit test. This is a test of the null hypothesis in which the data were generated by the model specified by the researcher and is also routinely provided by SPSS. In this test, the cases are divided into ten groups (also called deciles of risk) based on predicted probabilities. The fist decile contains the $n_1 = n/10$ cases with lowers estimated probabilities and the last decile includes the $n_{10} = n/10$ cases with higher predicted probabilities. If the logistic model is good, most of the cases with outcome 1 in the dependent variable will be in the higher deciles and vice-versa. Afterwards, a Chi-square statistic is computed from observed and expected frequencies, based on the formula

$$\hat{C} = \sum_{g=1}^{10} \frac{\left(o_g - n_g \bar{p}_g\right)^2}{n_g \bar{p}_g \left(1 - \bar{p}_g\right)} \tag{48}$$

where n_g is the number of cases in group g, o_g is the number of cases within the group g for which the dependent variable takes the value 1 and $\bar{p}_g$ is the ratio between the sum of the n_g estimated probabilities, based on the model, for the n_g cases included in the group g and n_g. Under the null hypothesis, this statistic has a chi-square distribution with 8 degrees of freedom.

(4) Analysis of the predictive power of the model. This evaluation is carried out by observing the classification table that is also provided by the logistic regression output. This table shows the total number of correct and incorrect estimated probabilities. In line, the two observed values for the dependent variable are presented, while the predicted values are placed in column and they are divided into two groups. The first group contains all cases whose estimated probability is lower than a specified cut-point (usually 0.5) and that, as a consequence, are classified as not having the feature measured by the dependent variable. The second group includes all cases whose estimated probability is, at least, equal to the cut-point, which are classified as possessing the characteristic represented by the dependent variable. The classification table has the following form:

TABLE 3.2
Classification table

Observed cases	**Predicted cases**		**Totals**
	$y=0$	$y=1$	
$y=0$	a	b	$(a+b)$
$y=1$	c	d	$(c+d)$
Totals	$(a+c)$	$(b+d)$	n

Based on the cells of the Table 3.2, some indexes can be computed to assess the predictive ability of the model (Vizcaíno, 2000).

- Proportion of correctly classified cases: $(a+d)/n$;
- Proportion of incorrectly classified cases: $(b+c)/n$;
- Proportion of false negatives: $c/(a+c)$;
- Proportion of false positives: $b/(b+a)$.

Huberty (1984) proposes a test that can be used to assess how good the classification results are, which was carried out in Chapter 4[53]. In this test, the null hypothesis states that the number of cases correctly classified, as a result of the application of logistic regression, is equal to the number of cases correctly classified by chance. The Huberty's test can be applied to the whole sample as well as to each single group defined by the dependent variable. For the whole sample, the test's statistic is given by

$$Z^{*} = \frac{(n_c - e)\sqrt{n}}{\sqrt{c(n-e)}} \tag{49}$$

where

$$e = \frac{1}{n}\sum_{g=1}^{2} n_g^2 \tag{50}$$

and, for a particular group, it has the form

$$Z_g^{*} = \frac{(n_{cg} - e_g)\sqrt{n_g}}{\sqrt{e_g(n_g - e_g)}} \tag{51}$$

where $n_c = a + d$, n_{cg} is the total number of cases in group g that were correctly classified and

$$e_g = \frac{n_g^2}{n}. \tag{52}$$

Under the null hypothesis, both statistics (49) and (51) follow a standardized normal distribution.

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53 Menard (1995: 24-32) discusses other measures for evaluating a logistic regression model based on a classification table.

Interpreting the model

The *interpretation of the estimated parameters* is the major difficulty that arises from the adjustment of any logistic regression model. This happens because the structural form of the model that relates the dependent and the independent variables is not linear and, thus, the effect of each independent variable in the estimated probability is not a constant. On the contrary, each of these effects is influenced by the assumed values of all the remaining explanatory variables in the model.

This fact can be easily understood observing the non-linear functional form of the logistic model, presented in equation (35). Actually, the partial derivate of $p(y=1 \mid X)$ with respect to the explanatory variable X_k is different from β_k but, rather, a much more complex expression. As a consequence, β_k cannot be interpreted as the change in the probability of the event represented by the dependent variable occurring, given a unit increase in the corresponding X_k, holding all the other variables constant.

From the several methods that have been proposed to interpret the coefficients estimates of this kind of model (Long, 1997), the interpretation approach used in Chapter 4 was based on the development of the logistic regression model as a latent variable model, as described before (Long, 1997; Davidson and Mackinnon, 1993; Greene, 1993). In agreement with this strategy, equation (25) evidences that the relationship between the propensity of the dependent variable to take the observed values, represented by the latent variable y^*, and the set of independent variables is assumed to be linear, which implies that each non-standardized coefficient estimate can be interpreted as the expected change in the propensity to take the considered action for a unit change in the associated explanatory variable, holding all the other variables constant. Effectively, since the partial derivate of y^* with regard to each independent variable is constant, and given by the corresponding coefficient ($\partial y^* / \partial X_k = \beta_k$), the interpretation of the coefficients of the model, using this approach, is very simple and suggestive.

Moreover, in order to make the comparison possible between the predicted effects of the several independent variables in the propensity of the dependent variable – or, in other words, in the latent variable y^* – standardized estimates were computed for the parameters of the model.

Each fully standardized estimates, $\hat{\beta}_k^*$, was determined using the following transformation

$$\hat{\beta}^* = \hat{\sigma}_k \hat{\beta}_k / \hat{\sigma}_{y^*} \tag{53}$$

where $\hat{\beta}_k$ and $\hat{\sigma}_k$ represent, respectively, the unstandardized coefficients estimates and the estimated standard deviations of the X_k's $(k = 1,2,...,p)$. In turn, $\hat{\sigma}_{y^*}$ is the estimated standard deviation of y^* and was computed through the quadratic form

$$\hat{Var}(y^*) = \hat{\beta}' \hat{Var}(x) \hat{\beta} + Var(\varepsilon) \tag{54}$$

where $\hat{Var}(X)$ represents the covariance matrix of the independent variables and $Var(\varepsilon) = \pi^2/3$. Each fully standardized estimate was interpreted as the expected increase in the latent variable y^*, in terms of standard deviations, for a standard deviation increase in the corresponding X_k, holding all other variables constant.

For the dummy variables, no fully standardized coefficient estimate was computed, because a standard deviation change in these variables does not make substantive sense. In this case, the y^* standardized estimates of these coefficients, computed with the formula

$$\hat{\beta}^{**} = \hat{\beta}_k / \hat{\sigma}_{y^*} \tag{55}$$

were presented. Accordingly, the y^* standardized estimate for the coefficient of a dummy variable was interpreted as the expected increase in the latent variable y^*, in terms of standard deviations, for a unit increase in X_k, holding all other variables constant. Because X_k is a dummy variable, a unit increase in its value means the occurrence of the event for which the dummy takes the value of 1.

3.4 Structural Equation Modeling

3.4.1 Overview

Structural equation modeling (SEM) combines three knowledge fields within a single analytical framework. Firstly, SEM uses insights from path analysis, which was invented by the biometrician Sewall Wright (1921, 1918). A path analysis is a methodology for analyzing systems of simultaneous equations that encompasses three elements: (1) a path diagram, that is, a pictorial representation of the system of equations, (2) a set of equations that define the covariances (or correlations) between each pair of variables, in terms of the model's parameters and, finally, (3) the decomposition of the effects of one independent variable on a dependent variable into direct effects, indirect effects and total effects (Bollen, 1989). Despite the striking applications of path analysis shown by Wright, this analytic tool was initially neglected by most statisticians and econometricians and even by sociologists. Only in the late 1960s and early 1970s was path analysis rediscovered by the sociology field and diffused into numerous empirical studies, which were published in important scientific journals of social sciences.

Secondly, SEM also shares the principles of the measurement models spawned by Spearman (1904), in the psychology area. These models were concerned with the relationship between latent or unobserved factors and observed variables and provided the groundwork for the contemporary confirmatory factorial analysis. Thirdly, SEM uses knowledge of the simultaneous equations models with observed variables proposed within the econometrics field.

During the 1960s, some studies empirically showed the potential of using latent factors, instead of observed variables, in the simultaneous equations models developed by the econometricians. In this new approach to simultaneous equation models, the latent variables were linked to one or more observed variables through a measurement model, similar to those used in psychometrics.

However, the major boost to structural equation modeling came only in the early 1970s with the works of Joreskog (1973), Wiley (1973) and Keesling (1972) that provided the mathematical support, namely the matrix representation, for a general model that could be applied to any specific situation. The software LISREL (**Li**near **S**tructural **Rel**ations), developed by Joreskog and Sorbom in 1984, enabled the popularization of SEM, which has been, since then, intensively used in numerous publications in the scope of social sciences. These three studies, as well as the invention of LISREL, were so important that, even nowadays, the recommended symbols to represent a structural equation model with latent variables still rely on the "LISREL notation".

Several models have been proposed that could be included within the general reference of structural equations models (Salgueiro, 1995; Long, 1983). In Chapter 5, the proposed model was estimated on the basis of the most general SEM approach, referred to as the "hybrid model" (Kline, 1998), which allows for the estimating of, simultaneously, the set of hypothesized relations among the latent variables (through a structural model), as well as the relationships between them and the observed variables (through a measurement model).

A structural equation model has two major features (García and Martinez, 2000; Hair *et al.*, 1995) Firstly, based on a theoretical model that must be defined on a priori ground, SEM allows the estimating simultaneously of a set of separate but interdependent multiple linear regressions, in which the same variable may be independent in one equation and dependent on another. When expressed mathematically, the proposed relationships form the *structural model*, which is no more than a system of equations, similar to linear regressions, one for each dependent variable.

Secondly, SEM enables the inclusion of latent variables in the analysis. A latent variable is not directly observable but can be indirectly measured or inferred through one or more observed or indicator variables. Due to the impossibility of perfectly measuring an unobservable concept, there is always a measurement error. Sources of measurement error can be, for instance, inaccurate responses of participants in a survey or improper selection of the indicators to measure the latent variable. The relations between the various latent variables and the corresponding indicators and measurement errors are represented by the *measurement model*.

SEM distinguishes between latent dependent (or endogenous) variables and latent independent (or exogenous) variables. *Latent dependent variables* are those explained by, at least, another latent variable in the structural model. In turn, the observed variables that are used to measure the latent dependent variables, through the measurement model, are referred to as *dependent observed variables*. On the other hand, any latent variable that is not explained by any other latent variable in the structural model is called an *independent latent variable* and the corresponding indicators are known as *independent observed variables*. In short, all variables in SEM fall into one of four possible categories: m endogenous latent variables ($\eta_1, \eta_2, ..., \eta_m$), n exogenous latent variables ($\xi_1, \xi_2, ..., \xi_n$), p endogenous indicators ($y_1, y_2, ..., y_p$) and q exogenous indicators ($x_1, x_2, ..., x_q$).

The first component of SEM is, therefore, the *structural model* that can be represented by the matrix equation:

$$\eta = B\eta + \Gamma\xi + \zeta . \tag{56}$$

In equation (56), η is a $(m \times 1)$ vector of endogenous latent variables, ξ is a $(n \times 1)$ vector of exogenous latent variables, B is a $(m \times m)$ matrix of coefficients that indicate the influence of the endogenous latent variables on the other endogenous latent variables, Γ is a $(m \times n)$ matrix of coefficients that indicate the influence of exogenous latent variables on the endogenous latent variables and ζ is a $(m \times 1)$ vector of errors in prediction of the m endogenous latent variables equations. As in multiple regression, ζ_i

represents the variables that influence η_i, but that are excluded from the corresponding structural equation.

On the other hand, the second component of SEM, the *measurement model*, may be written in matrix notation using the equations:

$$y = \Lambda_y \eta + \varepsilon \tag{57}$$

$$x = \Lambda_x \xi + \delta . \tag{58}$$

In equations (57) and (58), y $(p \times 1)$ and x $(q \times 1)$ are vectors of observed variables (endogenous and exogenous, respectively). Λ_y is a $(p \times m)$ matrix of coefficients (factor loadings) that indicate the influence of the endogenous latent variables on the endogenous indicators and Λ_x is the $(q \times n)$ matrix of coefficients (factor loadings) that represent the influence of the exogenous latent variables on the exogenous indicators. Finally, $\varepsilon(p \times 1)$ and $\delta(q \times 1)$ are vectors of the errors in measurement for the endogenous and exogenous latent variables, respectively.

Besides the matrices B, η, Λ_x and Λ_y, SEM uses four additional matrices of parameters, symbolically represented by: Φ, Ψ, Θ_ε and Θ_δ. Φ is a $(n \times n)$ matrix of covariances among the exogenous latent variables, Ψ is a $(m \times m)$ matrix of covariances among the endogenous latent variables, Θ_ε is a $(p \times p)$ matrix of covariances of the measurement errors of the endogenous indicators and Θ_δ is a $(q \times q)$ matrix of covariances of the errors in measurement of the exogenous indicators.

The general structural model is based on a set of assumptions (Long, 1983): (1) the expected value of the vectors η, ξ, ζ, y, x, ε and δ is zero; (2) the errors of measurement are uncorrelated with the latent variables; (3) the errors of measurement are uncorrelated with each other and uncorrelated with ζ; (4) the disturbance vector ζ is uncorrelated with ξ; and (5) the matrix $(I-B)$ is nonsingular. As the equalities (57) to (59) suggest, SEM also assumes that all relationships among the variables, latent and observed, are linear in the parameters.

A fundamental difference between multiple regression and SEM is that while the former technique focus on the individual observations, SEM deals with covariances (Bollen, 1989). Actually, when performing a linear regression, the estimates for the regression coefficients and for the error variance are derived by minimizing the sum of the squared differences between the predicted and the observed values of the dependent variable for each case. SEM uses a diverse rationale. It minimizes the difference between the sample covariances of the observed variables and the covariances predicted by the model. This last matrix is referred to as the *implied covariance matrix* and consists in a covariance matrix among the endogenous and exogenous observed variables, in terms of the model parameters. The implicit covariance matrix is given by:

$$\sum(\theta)=\begin{bmatrix} E(yy') & E(yx') \\ E(xy') & E(xx') \end{bmatrix}$$

$$=\begin{bmatrix} \Lambda_y(I-B)^{-1}(\Gamma\Phi\Gamma'+\Psi)\left[(I-B)^{-1}\right]'\Lambda_y'+\Theta_\varepsilon & \Lambda_y(I-B)^{-1}\Gamma\Phi\Lambda_x' \\ \Lambda_x'\Phi\Gamma'\left[(I-B)^{-1}\right]'\Lambda_y & \Lambda_x\Phi\Lambda_x'+\Theta_\delta \end{bmatrix} \tag{59}$$

As the sample covariance matrix of the observed variables, the implied covariance matrix has $\frac{1}{2}(p+q)(p+q+1)$ non-redundant elements (those in the lower or upper half of the covariance matrix plus those in the diagonal). From (59), it is also clear that this later matrix depends on the set of parameters contained in a vector θ, which are those included in the eight parameter matrices previously defined. SEM distinguishes between free and fixed parameters. The *free parameters* are those that will be estimated in the model and that the researcher believes to be different from zero. Inversely, *fixed parameters* are those that are forced to assume, at a priori ground, some specified value.

3.4.2 Stages in the application of method

This section summarizes the several methodological stages of SEM that were followed in Chapter 5 of this thesis.

Specifying the model

The first stage in the application of SEM is specifying the relations among the variables that are considered important to understand the phenomenon under research. SEM may be used to confirm or to compare alternative models, which should be based on a solid theoretical background. Only in a case in which the proposed model is supported by a well founded theory, the results from its estimation and interpretation can be further generalized to different settings. As Hair *et al.* state, using SEM "in an "exploratory" manner is invalid and misleads the researcher more often than it provides appropriate results" (Hair *et al.*, 1995: 592). In specifying the model, it is very important to consider all the potentially relevant variables to describe the problem being investigated.

In Chapter 5, the exercise of model specification included two steps. In the first step, a path diagram was depicted to easily visualize all the relations among the variables of the model. As is generally accepted in path analysis, the latent variables, the measurement errors and the errors in prediction were represented through ellipses and the observed variables were symbolized with rectangles. On the other hand, straight arrows were used to indicate the direct causal relationships and curved arrows were used to depict the correlations between any two latent variables. Besides the *direct effects*, which were explicitly represented in the path diagram, such a picture enabled the visualization of the indirect and total effects among the variables. An *indirect effect* is the effect of an independent variable on a dependent variable that is mediated by at least one intervening variable. In general terms, this effect is captured by multiplying the corresponding structural coefficients. In turn, a *total effect* of an independent variable on a dependent variable is the result of the sum of the direct and indirect effects that connect them.

In the second step, the path diagram was converted into a set of equations representing the structural and measurement models, in agreement with equalities (56) to (58). In some software for SEM, like LISREL, the mathematical conversion of the model is an indispensable task. AMOS, on the contrary, only requires the path diagram to specify the model. Despite AMOS 4.0 (Arbuckle and Wothke, 1999) being used in this thesis, for a deeply understanding of the model, this effort in its formal specification was considered important and was carried out in Chapter 5.

Assessing the identification of the model

Identification is concerned with whether a single solution to each individual parameters in the model can be achieved from the input data, that is, from the variances and covariances of the observed variables. There is no single rule to verify that a model is identified. However, two rules can help in the identification process: the t-rule and the two steps rule (Bollen, 1989).

The *t-rule* is a necessary but not sufficient condition for identification. It establishes that the number of parameters to be estimated in the model (t) should be less than or equal to the number of non-redundant elements of the input data matrix, that is, $t \leq \frac{1}{2}(p+q)(p+q+1)$. The difference between t and the number of non-redundant elements of the sample covariances matrix is equal to the number of degrees of freedom for the proposed model.

Inversely, the *two-steps rule* is a sufficient but not a necessary condition for identification. The first step relies on testing the identification of the measurement model, which implies, for the case of models in which each indicator loads on a single latent variable and the measurement errors are independent[54], that (1) the number of parameters to be estimated would be less or equal than the number of observations, (2) every latent variable would have a scale and (3) any latent variable would be measured by, at least, two indicators (Kline, 1998).

To fix the scale of the latent variables, AMOS requires fixing the path coefficient of one indicator per latent variable to equal 1.0, which confers to the latent variable the same metric as the indicator. The same procedure should be applied to the residual path coefficient from an error in prediction to an endogenous latent variable. As Kline explains "an endogenous variable in a path model is seen as an indicator of its disturbance, and fixing the residual path coefficient to 1.0 is the same as assigning the disturbance the same metric as its indicator" (Kline, 1998: 205). Due to the same motive, the path coefficient from a measurement error to the corresponding indicator should be set to 1.0. In the two-steps rule, the second step is to evaluate the

[54] The specified model in Chapter 5 has these characteristics.

identification of the structural model, which is performed ensuring that the model is recursive, that is, that all causal effects are unidirectional.

Assessing the identification of a model that does not corroborate with the two-steps rule can be very difficult. Theoretically, identification can always be assessed by algebraically solving the equations that express each parameter in terms of the known values, but for complex models this process usually becomes very difficult and tedious. However, the AMOS software enables an empirical check on identification, providing warnings if any identification error has occurred. In Chapter 5, the t-rule was used as a first diagnosis for identification. However, since the two-steps rule was not satisfied, the identification of the model was empirically assessed by AMOS.

Estimating the model

In SEM, the estimation problem rests in determining values for the free parameters contained in the vector θ so that the implied covariance matrix, $\sum(\theta)$, is as close as possible to the sample covariance matrix of the observed variables, S. The estimation of the free parameters of the model results from the minimization of a discrepancy function between these covariance matrices. This fitting function can take several forms, depending on the estimation method that is applied. The most frequently used estimation methods are maximum likelihood (ML) and generalized least squares (GLS). Both these methods produce consistent estimates for the parameters of the model, but their use is based on the assumption that the observed variables have a multivariate normal distribution (West *et al.*, 1995).

Considering the nominal nature of some scales in Chapter 5, these traditional estimation methods could not be applied. As Schumacker and Lomax summarize, "in dealing with noninterval variables, the research indicates that only when categorical data show small skewness and kurtosis (in the range of -1 to 1) should normal theory be used. When these conditions are not met, several options (...) are recommended. These include the use of tetrachoric, polyserial and polychoric correlations (...) or the use of the distribution-free or weighted procedures" (Schumacker and Lomax, 1996: 105). The AMOS software does not offer these specific correlations, but LISREL does, through the PRELIS processor (Joreskog and Sorbom, 1988). However, the simulation study carried out by Yuan and Bentler (1994) shows that these correlations only yields satisfactory results for sample sizes of, at least, 2000 cases. Although the total number of participants in the national survey that supports this thesis had exceeded this number, due to the existence of some missing values, less than 2000 cases were actually available for the research. To overcome these limitations, the model was estimated using the weighted least squares (WLS) estimation method. This is an asymptotically distribution free (ADF) method, insensitive to the non-normality of the data, which yields asymptotically unbiased estimates of the parameter estimates and standard errors. The WLS or ADF adjustment function is given by

$$F_{WLS} = [s - \sigma(\theta)]' W^{-1} [s - \sigma(\theta)] \quad (60)$$

where s is a vector of variances and covariances of the observed variables, $\sigma(\theta)$ is a vector of the variances and covariances predicted by the model and W is the covariance matrix of residues, that is, the matrix of the differences between each observed variance / covariance and each variance / covariance predicted by the model. As the simulation study carried out by Curran *et al.* (1996) shows, this method produces valid results if at least a sample of 500 cases is made available. Moreover, to use this method, AMOS obliges that the sample size exceeds $\frac{1}{2}(p+q)(p+q+1)$ cases, where $p+q$ is the total number of observed variables in the model. Both these conditions were met in estimating the model in Chapter 5.

Evaluating the model goodness-of-fit

To evaluate the model fit, the procedures suggested by Hair *et al.* (1995) were followed. These procedures are based on first assessing the overall model and then the measurement and structural models individually. Measures of *overall model fit* include absolute, incremental and parsimonious fit indexes. Table 3.3 summarizes the several measures of fit that were used to evaluate the proposed model in Chapter 5.

The best known index of *absolute fit* is the result of the Chi-square goodness-of-fit test, whose purpose it is to test whether the implied covariance matrix of the specified model is equal to the observed covariance matrix. A low Chi-square value, which gives rise to significance levels higher than 0.05, suggests that the difference between the observed and the predicted covariance matrices is not statistically significant. However, the Chi-square test is quite sensitive to the sample size, especially when it exceeds 400 cases, indicating statistically significant differences between these matrices in any specified model (García and Martinez, 2000). Thus, besides the Chi-square test, Table 3.3 shows four adjunct overall absolute fit indexes that were also reported in Chapter 5.

Incremental fit measures, in turn, compare the proposed model with the independence or null model, that is, the worst baseline model that can be fitted. In the AMOS software, all observed variables of this model are assumed to be uncorrelated with each other. From the several incremental fit measures provided by AMOS, Table 3.3 lists six that were used to evaluate the model's fit in Chapter 5. In the formulas, the subscript p indicates the proposed model, whereas the subscript 0 identifies the null model.

The purpose of *parsimonious fit* measures is to establish the relation between the goodness of fit of a given model to the number of estimated parameters needed to attain that level of fit. For this purpose, three indexes were computed in Chapter 5.

TABLE 3.3
Evaluation of the overall model fit

Goodness of Fit Criterion	Computation Formula	Interpretation/ Recommended Acceptance levels
Absolute fit measures		
Chi-square test (*)	$\chi^2_p = F.(n-1)$	Tests $H_0 : S = \sum(\theta)$ against $H_a : S \neq \sum(\theta)$ p > (considered significance level)
GFI (Goodness of fit index) (Joreskog and Sorbom, 1986)	$GFI = 1 - tr(\sum^{-1}S - I)^2 / tr(\sum^{-1}S)^2$	Ranges from 0 (no fit) to 1 (perfect fit) / values higher than 0.9
RMSEA (Root mean square residual of approximation) (Steiger, 1990)	$RMSEA = [Max\{\chi^2_p - (df_p / n - 1), 0\}/df_p]^{1/2}$	Values lower than 0.08 indicate a good fit
Incremental fit measures		
AGFI (Adjusted goodness of fit index) (Joreskog and Sorbom, 1986)	$AGFI = 1 - [(p+q)(p+q+1)/2df_p](1 - GFI)$	Ranges from 0 (no fit) to 1 (perfect fit) / values higher than 0.8
NFI (Normed fit index) (Bentler and Bonnet, 1980)	$NFI = (\chi^2_0 - \chi^2_p)/\chi^2_0$	Ranges from 0 (no fit) to 1 (perfect fit) / values higher than 0.9
TLI (Tucker and Lewis index) (Tucker and Lewis, 1973)	$TLI = [(\chi^2_0/df_0) - (\chi^2_p/df_p)]/[(\chi^2_0/df_0) - 1]$	Ranges from 0 (no fit) to 1 (perfect fit) / values higher than 0.9
IFI (Incremental fit index) (Bollen, 1988)	$IFI = (\chi^2_0 - \chi^2_p)/(\chi^2_0 - df_p)$	Ranges from 0 (no fit) to 1 (perfect fit) / values higher than 0.9
RFI (Relative fit index) (Bollen, 1986)	$RFI = [(\chi^2_0/df_0) - (\chi^2_p/df_p)]/(\chi^2_0/df_0)$	Ranges from 0 (no fit) to 1 (perfect fit) / values higher than 0.9
CFI (Comparative fit index) (Bentler, 1990)	CFI $= 1 - Max[(\chi^2_p - df_p), 0]/Max[(\chi^2_0 - df_0), (\chi^2_p - df_p), 0]$	Ranges from 0 (no fit) to 1 (perfect fit) / values higher than 0.9
Parsimonious fit measures		
PNFI (Parsimonious normed fit index) (James *et al.*, 1982)	$PNFI = (df_p/df_0)NFI$	Ranges from 0 (no fit) to 1 (perfect fit) Adequate to compare alternative models; The model with the highest PNFI is the best
Normed Chi-square (Joreskog, 1969)	Normed Chi-square $= \chi^2_p/df_p$	Less than 1 is a poor model fit; higher than 5 reflects a need for improvement

(*) In the Chi-square test, *F* indicates the value of the fitting function and *n* indicates the sample size.

In *evaluating the measurement model*, each latent variable was analyzed regarding reliability and validity. *Reliability* is concerned with the internal consistency of a construct, that is, whether the observed variables selected to indicate the construct are actually measuring the same (unobserved) concept. Bollen (1989) discusses several methods to estimate the reliability of a latent variable. From these, this author demonstrates that the Cronbach's alpha coefficient (Cronbach, 1951) has the least limitations and, so, it was used in Chapter 5 as a first measure of reliability. If $x_1, x_2, ..., x_k$ are indicators of a latent variable ξ and $H = \sum_{i=1}^{k} x_i$, the alpha coefficient for the latent variable ξ is given by:

$$\rho^2_{\xi H} = [Cov(\xi, H)]^2 / [Var(\xi)Var(H)] = (k/(k-1))\left[1 - \sum_{i=1}^{k} Var(x_i) \Big/ Var(H)\right] \quad (61)$$

On the other hand, García and Martinez (2000), as well as, Hair *et al.* (1995) suggest two additional measures of reliability that must be determined separately for each construct: the construct composite reliability and the variance extracted. Both of these measures were also computed in Chapter 5. Defining $\lambda^s_i \ (i = 1,2,...,k)$ as each standardized loading of the measurement equations, which relates x_i with the latent variable ξ, and δ_i as the corresponding measurement error, the construct reliability and the variance extracted can be determined as follows:

$$\text{Construct reliability} = \left(\sum_{i=1}^{k} \lambda^s_i\right)^2 \Bigg/ \left[\left(\sum_{i=1}^{k} \lambda^s_i\right)^2 + \sum_{i=1}^{k} \delta_i\right]; \quad (62)$$

$$\text{Variance extracted} = \sum_{i=1}^{k} (\lambda^s_i)^2 \Bigg/ \left[\sum_{i=1}^{k} (\lambda^s_i)^2 + \sum_{i=1}^{k} \delta_i\right]. \quad (63)$$

Although no rigid minimum acceptance level has been proposed for the reliability, Kline (1998) proposes some guidelines. In accordance with this author, reliability coefficients around 0.9 may be classified as "excellent", around 0.8 as "very good" and around 0.7 as "adequate". A reliability value below 0.5 suggests that the measures are unreliable and, therefore, they must be avoided. Sharma (1996), on the other hand, considers the value 0.7 as the adequate minimum acceptance level for the composite reliability of a construct and the value 0.5 for the variance extracted.

For latent variables measured by a single indicator, the reliability can not be estimated. In this situation, two possibilities are recommended (Hair *et al.*, (1995). Either the reliability is fixed to equal 1.0, which means that the observed variable has no measurement error, or the researcher estimates the reliability and attributes the estimated value to the unique-item observed variable. Concerning this last approach, which was applied in Chapter 5, the *square multiple correlation coefficient* for the indicator, as suggested by Bollen (1989), was used as a straightforward measure of reliability. In general terms, the reliability of the indicator y, measuring a latent variable η, can be expressed by

$$R_y^2 = 1 - \mathrm{Var}(\varepsilon)/\mathrm{Var}(y) \tag{64}$$

which is equivalent to

$$\mathrm{Var}(\varepsilon) = \left(1 - R_y^2\right)\mathrm{Var}(y)\,. \tag{65}$$

So, in Chapter 5, the reliability of the latent variable that was being measured by a single indicator – which, in turn, had resulted from the product of two observed variables – was introduced in the model by fixing the variance of the corresponding measurement error as indicated in the equality (65). In this case, the reliability of the single composite indicator, R_y^2, was assumed to be equal to the Cronbach's alpha coefficient, which was previously computed for the set of two observed variables.

Validity is concerned with whether an observed variable is really measuring the construct that the researcher believes it does. Several levels of validity have been proposed in the literature (Kline, 1998; Bollen, 1989). Bollen defines the validity of a measure x_i of ξ_j "as the magnitude of direct structural relation between ξ_j and x_i" (Bollen, 1989: 197). As this author adds, "in this definition, for a measure to be valid, the latent and observed variable must have a direct link" (Bollen, 1989: 197). Bollen proposes both the unstandardized and the standardized factor loadings as validity measures. Accordingly, in Chapter 5, there would be evidence of constructs' validity if all observed variables were loaded significantly, and at least moderately, into their corresponding latent variables.

In analyzing the *structural model fit*, the most important is examining if the parameters estimates have the correct sign and are statistically significant. AMOS computes unstandardized and standardized parameter estimates as well as their standard errors and associated t-values. Standardized estimates remove scaling information and are useful to compare the parameters' effect in the model.

In Chapter 5, most of the proposed hypotheses were tested examining the statistical significance of the corresponding direct paths in the structural model. Only one of these hypotheses was tested evaluating the statistical significance of an indirect path. While the matrix Γ includes the direct effects of the exogenous latent variables on the endogenous latent variables, the matrix representation of an indirect effect is:

$$I_{\eta\xi} = \left[(I - B)^{-1} - I\right] \Gamma \tag{66}$$

In addition to the analysis of the significance of the structural paths, the reliability coefficient of the most important structural equation in Chapter 5 was also indicated. This coefficient (provided by AMOS) is called a *squared multiple correlation* and is similar to the overall coefficient of determination in multiple regression. It shows how well the proposed relationship is represented, indicating the proportion of variance in the latent variable that is accounted for by the corresponding structural equation. Thus, for the structural equation predicting η_1, the squared multiple correlation can be defined as

$$R^2_{\eta_1} = 1 - \mathrm{Var}(\zeta_1)/\mathrm{Var}(\eta_1) \tag{67}$$

where ζ_1 is the disturbance term in the structural equation for η_1.

Still concerning the evaluation of the *structural model*, García and Martinez (2000) refer the interest in observing the correlations among the latent variables. If these correlations were very high (exceeding 0.9 or even 0.8), this would mean that some latent variables would be "explaining" the same concept. In such case, one of them is redundant and, hence, it should be eliminated from the model. The observation of the correlations among the latent variables was also performed in Chapter 5.

Multiple group analysis

One research hypothesis proposed in Chapter 5 was tested through the results from a multiple group analysis. In this type of analysis, the sample covariance matrix of each group (S_g) is compared with the corresponding implied covariance matrix ($\sum_g(\theta_g)$). This evaluation is performed simultaneously for all groups of two different models: the model that allows all parameters to be different among the groups (also referred to as the unrestricted model) and the model which establishes that some (or all) parameters are equal for the groups (also called the restrict model). The closer the two matrices are for all groups on both analyses, the better the corresponding model will fit. Each of these analyses provides a chi-square statistics for all groups. In both cases, a composite fit function in the several groups is minimized so that, for the WLS estimation method, has the following form:

$$F_{gWLS} = \left[s_g - \sigma_g(\theta)\right]' W_g^{-1} \left[s_g - \sigma_g(\theta)\right] \tag{68}$$

Then, the analysis of the statistical significance of the difference in the chi-squares of the two models, which is itself a chi-square statistic, indicates whether the imposed constraints should be rejected or not.

Interpreting the model

As previously noted, any software for SEM yields unstandardized and standardized estimates for the parameters of the structural model included in matrices B and Γ as well as for the factor loading of the measurement model included in the matrices Λ_y and Λ_x. While the unstandardized estimates are affected by the units in which the variables are scaled, their standardized version permits the comparison of the relative effects of any independent variable throughout the model since it eliminates scaling information. Accordingly, in Chapter 5, an unstandardized estimate should be interpreted as the number of units change in the endogenous variable which is due to a unit change in the exogenous variable, when all exogenous variables are held constant. On the other hand, a standardized estimate measures the number of standard deviations in the endogenous variable per a unit standard deviation shift in the exogenous variable, when all the remaining exogenous variables are held constant. The standardized estimates are a function of the unstandardized estimates and are defined as:

$$\hat{\beta}^{s}_{ij} = \hat{\beta}_{ij}\left(\hat{\sigma}_{jj} / \hat{\sigma}_{ii}\right)^{1/2} \qquad (69)$$

$$\hat{\gamma}^{s}_{ij} = \hat{\gamma}_{ij}\left(\hat{\sigma}_{jj} / \hat{\sigma}_{ii}\right)^{1/2} \qquad (70)$$

$$\hat{\lambda}^{s}_{ij} = \hat{\lambda}_{ij}\left(\hat{\sigma}_{jj} / \hat{\sigma}_{ii}\right)^{1/2} \qquad (71)$$

In (69) to (71), the superscript s identifies the standardized estimates, the subscript i the endogenous variable and the subscript j the exogenous variable. In turn, $\hat{\sigma}_{ii}$ and $\hat{\sigma}_{ij}$ represent the variances predicted by the model of the i-th and j-th variables, respectively.

3.5 Discriminant Analysis

3.5.1 Overview

Discriminant analysis is a multivariate data analysis technique that allows investigating the differences among groups of cases based on several observed characteristics of each case (Klecka, 1980). Discriminant analysis is a dependence statistical method, where the observed characteristics are the independent or discriminant variables and the dependent variable is categorical, with two or more categories, depending on the number of groups to be distinguished (Hair *et al.*, 1995). After defining the simplest way to separate the groups, through the estimation of one or more discriminant functions, this statistical method permits the analysis of the differences among groups, to determine which variables best discriminate them and also to classify new cases based on their scores on the observed variables.

Fisher (1936) introduced discriminant analysis by developing the idea of linearly combining variables with the purpose of discriminating groups. The studies performed by authors as Huberty (1994), McLachlan (1992), Huberty (1984) and Mardia, Bibby and Kent (1995) are important references in the analytical development of discriminant analysis[55]. This statistical instrument has been widely applied in a variety of settings, from biological and medical sciences to social sciences, with particular focus on psychology and educational testing.

Discriminant analysis has two major objectives (Reis, 1997). First, it can be used as an *analysis* instrument, evaluating the possibility of distinguishing mutually excusive groups based on a set of observed variables, identifying how well these variables separate the groups and which have the strongest discriminating ability. Second, discriminant analysis may be used for *classification* purposes. In this case, through the development of one or more linear combinations of the observed discriminating variables, discriminant analysis allows the identification of the group to which a case most likely belongs.

In discriminant analysis, the independent or discriminating variables have to be metric, that is, they have to be measured at the interval or at the ratio level. Instead, the dependent variable has to be categorical with as many categories as the number of groups to be distinguished. In *simple discriminant analysis*, the dependent variable has only two categories, whereas in *multiple discriminant analysis* the number of categories

[55] For a computational approach to this method see, for example, Affifi and Clark (1996).

of the dependent variable is three or more. This main difference between both analyses falls upon the number of discriminant functions to be derived. In the first case, where the purpose is to distinguish between two groups, a single discriminant function is determined. In the case of multiple discriminant analysis, the number of discriminant functions to be derived equals the minimal value between the number of groups minus one and the number of discriminating variables. In multiple discriminant analysis, the first function will be the most powerful in separating the groups, but later functions may also represent additional significant dimensions of differentiation. The various functions are orthogonal, that is, uncorrelated with one another.

The research hypotheses formulated in Chapter 6 are tested through the application of a simple discriminant analysis. Therefore, this section proceeds focusing on the mathematical formulation of this discriminant model and how their coefficients are determined.

For two groups G_1 and G_2 from a population G and a set of p discriminating variables, the *canonical discriminant function* has the form

$$y = a_0 + a_1X_1 + a_2X_2 + ... + a_pX_p \tag{72}$$

where $X_1, X_2, ..., X_p$ are the unstandardized discriminant variables and $a_0, a_1, ..., a_p$ the unstandardized coefficients of the discriminant function. Using matrix algebra, (72) can be written as

$$y = a'X \tag{73}$$

where $a' = [a_1 \ a_2 \ \dots \ a_p]$ and $X' = [X_1 \ X_2 \ \dots \ X_p]$.

If the two groups are different with respect to the p discriminating variables, it can me imagined that each one forms a separate swarm of points in a p-dimensional space. The *centroid* of each group is an imaginary point whose coordinates are the group's means on the p variables and can be perceived as a summary of the group's position. Discriminant analysis determines the function that allows maximizing the separation of the groups' centroids. If the variability within each group is low but the variability between the groups is high (i.e., the groups' centroids are sufficiently separated), the discriminant function will have a strong discriminant power and vice-versa.

This rationale is beyond the mathematical procedures proposed by Fisher (1936) to determine the coefficients of the discriminant function when only two groups are involved. Accordingly, under the assumption that the true means of G_1 and G_2 in the p discriminant variables are included in the vectors μ_1 and μ_2, respectively, and also that the matrices of variances and covariances of the discriminant variables for the two groups are equal ($\Sigma_1 = \Sigma_2 = \Sigma$), the coefficients of the discriminant function can be obtained maximizing the differences between the means of the linear combinations for the two groups with respect to the variance. In other words, the ratio between the variability between the groups and the variability within the groups should be as large as possible. Formally, the purpose is to maximize Δ, where

$$\Delta = \frac{(a'\mu_1 - a'\mu_2)^2}{a'\Sigma a}. \tag{74}$$

From the maximization of (74), it results that:

$$a = \Sigma^{-1}(\mu_1 - \mu_2). \tag{75}$$

Since the elements of the vectors μ_1, μ_2 and the elements of the matrix $\sum$ are unknown parameters, their corresponding punctual estimators, in the vectors $\bar{x}_1$ and $\bar{x}_2$, and in the matrix S, have to be used. As a consequence, the discriminant function is estimated as:

$$\hat{y} = \hat{a}' X \tag{76}$$

where

$$\hat{a} = S^{-1}\left(\bar{x}_1 - \bar{x}_2\right). \tag{77}$$

3.5.2 Stages in the application of method

A simple discriminant analysis was carried out in Chapter 6, considering the dimensions previously determined by a PCA as the discriminating variables. The application of discriminant analysis within the context of Chapter 6 is justified because it was intended to understand the relationship between a binary dependent variable and three metric discriminant or independent variables. The valid sample for the use of discriminant analysis was randomly divided into two approximately equal parts[56]. As underlined by Fernández and Martinez (2000), the first set of cases was used as the *analysis sample* to estimate the discriminant function and the second set of cases, usually referred to as the *holdout sample*, was considered to validate the analysis. This section presents the main methodological steps that were followed in the use of this statistical method.

[56] "Approximately", because the initial valid sample had an odd number of cases.

Analyzing the application conditions

The application of discriminant analysis requires that some basic assumptions be accomplished (Fernández and Martínez, 2000; Reis, 1997; Hair *et al.*, 1995; Klecka, 1980). These conditions, which were evaluated in Chapter 6, are:

(1) Each group must be a sample from a population that follows a multivariate normal distribution concerning the p discriminant variables. This condition is important for purposes of significance testing. Multivariate normality implies that the univariate distributions are normal and that the joint distributions of any combinations of the variables are also normal. When a distribution is normal, skewness and kurtosis equals 0 and 3, respectively. The SPSS software provides tests for these hypotheses. Besides these tests, the univariate normality was assessed by observing the Q-Q plots, in which an expected normal value was compared with the observed value for each case. If the variable had a normal distribution, the points for all cases would fall along the diagonal line, running from the lower left to upper right of the plot.

Although the previous analyses not providing evidence that the univariate distributions of the discriminant variables would not be normal, they were not able to give any information about the normality of the conjoint distributions of the combinations of these variables and, thus, they could not be used to state that the variables would have a multivariate normal distribution. Mardia (1970) developed a test of multivariate skewness and kurtosis, but the AMOS software offers the results for this test concerning only the multivariate kurtosis. Mardia's coefficient of multivariate kurtosis has the following form

$$K = \frac{1}{n}\sum_{i=1}^{n}\left[\left(x_i - \bar{x}\right)' S^{-1}\left(x_i - \bar{x}\right)\right]^2 - \frac{p(p+2)(n-1)}{(n+1)} \tag{78}$$

where x_i is the vector of observations for the i-th case on the p discriminant variables, $\bar{x}$ is the vector of the sample means for these variables and S is the sample covariance matrix. Assuming normality, this coefficient has a mean of zero and a standard error equal to $\sqrt{8p(p+2)/n}$. The test's statistic is obtained by dividing (78) by its standard error. In large samples, the observed value for this statistic has a standard normal distribution.

Since the multivariate skewness could not be evaluated, it was not possible to conclude that the variables would have a multivariate normal distribution. However, Lachenbruch (1975) shows that discriminant analysis is robust against minor violations of this assumption[57] if there are less than six independent variables and the smallest group has more than 20 cases. Both of these conditions were met in Chapter 6;

(2) The covariance matrices for each group formed by the dependent variable must be equal. Otherwise, distortions will occur in the canonical discriminant functions and, consequently, in the classification matrices. This assumption was assessed through Box's (1954) M test, which quite is sensitive to departures from multivariate normality. Under this test, the null hypothesis is the equality of the groups' covariances matrices. The statistic of Box's M test is defined as

$$M = (n-g)\ln|S| - \sum_{j=1}^{g} v_j \ln|S_j| \tag{79}$$

[57] This note regards the situation in which the variables have an approximate multivariate distribution.

where n is the total sample size, g is the number of groups, S is the total covariance matrix and $v_j = n_j - 1$ represents the number of degrees of freedom associated to each group.

SPSS gives an approximation of this test to a F distribution with v and v_0 degrees of freedom, in which $v = p(p+1)(g-1)/2$ and $v_0 = (v+2)/(a_2 - a_1^2)$. In turn,

$$a_1 = 1 - C \tag{80}$$

$$C = 1 - \frac{2p^2 + 3p - 1}{6(p+1)(g-1)}\left(\sum_{j=1}^{g}\frac{1}{v_j} - \frac{1}{n-g}\right) \tag{81}$$

and

$$a_2 = \frac{(p-1)(p+2)}{6(g-1)}\left[\sum_{j=1}^{g}\frac{1}{v_j^2} - \frac{1}{(n-g)^2}\right]. \tag{82}$$

(3) No or low multicollinearity should exist among the discriminating variables. Perfect multicollinearity implies that two or more variables are perfectly correlated, which means that at least one variable is redundant. Since discriminant variables in Chapter 6 were the principal components extracted from the application of PCA, they were orthogonal and, thus, uncorrelated. However, since the valid sample size was reduced in 4% of cases, the correlation between each pair of variables being slightly different from zero it was expected. Therefore, to confirm this suspicion, the correlations matrix for the discriminant variables, considering the set of valid cases, was determined and analyzed;

(4) The remaining assumptions are related to the sample used for the application of this multivariate method. Firstly, there must be two or more mutually exclusive groups. Secondly, at least two cases for each group are required and a minimum of twenty cases is recommended for discriminant variable. Finally, the maximum number of discriminant variables should be $n-2$, where n is the sample size.

Estimating the canonical discriminant function

SPSS provides two methods for estimating a discriminant function: the direct method and the stepwise method. In the *direct or simultaneous method*, all variables are jointly considered in the analysis, regardless of their discriminant power. Instead, the *stepwise method* begins by including the variable that best distinguishes the groups and, subsequently, it selects variables to the function, one at a time, in agreement with a previously specified criterion. Through this method, a variable already entered in an earlier step can be subsequently excluded and replaced by o new one, as long as this increases the chosen criterion. In SPSS there are various criteria for entering and removing variables at each step: Wilk's lambda, unexplained variance, Mahalanobis' distance, smallest F ratio and Rao's V.

In the application of discriminant analysis in Chapter 6, the direct method was considered preferable to the stepwise method because it was expected that all discriminant variables could significantly distinguish the two groups. However, since the results of the application of this method have evidenced a variable with low discriminant ability, the stepwise method was then applied to check if this variable could be excluded from the discriminant function. In this case, the Wilks' lambda criterion was used to select the variables. In agreement with this criterion, the variable that minimizes the Wilks' lambda is the one that first enters the function[58]. The Wilks' lambda, Λ, is given by

$$\Lambda = \frac{\text{SQB}}{\text{SQT}} = \frac{\text{SQB}}{\text{SQW} + \text{SQB}} \tag{83}$$

where SQB is the sum of squares between the groups, SQT is the total sum of squares and SQW is the sum of squares within the groups. The Wilks' lambda ranges from 0 to 1.

Analyzing the significance of the discriminant function

After estimating the discriminant function, the following step was to analyze the statistical significance of this function, that is, if it would permit the significant discrimination of the groups. SPSS provides a statistical test to the overall significance of the discriminant function, which is based on the approximation of the Wilks' lambda criterion to a chi-square distribution. In this test, the null hypothesis states that the g groups have the same mean in the discriminating function. Under the null hypothesis, this test's statistic is given by

$$\chi^2 = -[n - 1 - (p + g)/2]\ln \Lambda\,. \tag{84}$$

with $(p-k)(g-k-1)$ degrees of freedom, where k represents the number of discriminant functions.

[58] A detailed explanation of the conditions for selection and elimination of variables in the stepwise method can be found, for instance, in Reis (1997: 227-229).

Validating the discriminant analysis

The Wilks' lambda allows for the testing of the statistical significance of the discriminant function, but it does not inform about its predictive ability. In fact, in sufficiently large samples, the means of the groups for the discriminant function can be almost identical and, even in this cases, the discriminant function be statistically significant. To assess the predictive power of the discriminant function, the *classification matrix* should be analyzed. In this matrix, the number of cases correctly classified within each group is placed on its principal diagonal, whereas the incorrectly classified cases appear outside this diagonal. When prediction is perfect, all cases will lie on this diagonal. The percentage of cases on the principal diagonal is the percentage of correct classifications and is called the *hit ratio*.

The construction of the classification matrix implies the previous determining of the *discriminant score* for each case, which is the value resulting from applying the formula (72) to the data for that case. The discriminant scores are then compared with the *optimal cutting point*, whose computation formula depends on whether the size of the groups is equal or not. For groups with unequal size, as those in Chapter 6, the optimal cutting point, y_c, is determined using the following formula

$$y_c = \frac{n_2 \bar{y}_1 + n_1 \bar{y}_2}{n_1 + n_2}. \tag{85}$$

where n_i and $\bar{y}_i$ represents is the size of the group and the centroid, respectively, of group i $(i = 1,2)$. Each group's centroid is the mean value for the discriminant scores for the corresponding category of the dependent variable.

In constructing the classification matrix, the individual discriminant scores are compared with the optimal cutting point. Cases with a discriminant score lower than the optimal cutting point will be classified into the first group. Otherwise, cases will be classified in the second group. In Chapter 6, this analysis was performed both for the cases included in the analysis sample and the cases belonging to the holdout sample, yielding, therefore, two classification matrices.

The hit ratio measures the predictive accuracy of the discriminant function. Nevertheless, in a specific situation, the researcher has to know if the obtained predictive accuracy may be considered acceptable. For doing so, the hit ratio should be compared with the percentage of correctly classified cases that would be obtained by chance, that is, without the application of discriminant analysis. Two criteria are usually suggested for a first evaluation of the goodness of the predictive accuracy. These criteria, which the hit ratio should exceed, are the *maximum chance criterion* and the *proportional chance criterion.*

The maximum chance criterion is the percentage of cases in the larger group. Instead, the proportional chance criterion takes into account the proportion of cases in all groups. In particular, in the case of two groups, this last criterion can be expressed by

$$C_{pro} = p_1^2 + p_2^2 \tag{86}$$

where p_i is the percentage of cases in group i $(i = 1,2)$.

To make sense the interpretation of a discriminant function in order to identify the groups' profile, the classification accuracy should exceed the expected classification by chance. But how large should the difference between these classification results be? Although there is not any single consensual rule to answer this question, some guidelines have been suggested and were followed in the discriminant analysis performed in Chapter 6. These guidelines are now summarized:

(1) The first one fixes an acceptable minimum level of predictive accuracy. In agreement with this guideline, the hit ratio should be at least 25% greater than the classification by chance criteria;

(2) The Press's Q statistic can be used to test whether the discriminating ability of the classification function is significantly higher than the classification by chance. The null hypothesis in this test is that the number of cases correctly classified as result of the discriminant analysis does not exceed the number of cases correctly classified by chance. The Press's Q statistic is given by

$$Q = \frac{[n-(n_c g)]^2}{n(g-1)} \tag{87}$$

where n_c is the total number of cases correctly classified. The observed value for this statistic is compared to a critical value based on the chi-square distribution for 1 degree of freedom, at the selected confidence level;

(3) Huberty (1984) proposed another test with the same purpose of the Press's Q test, which can be applied to the whole sample as well as to each single group. The statistics for these tests were already presented in the section describing the logistic regression methodology, by the formulas (49) and (51);

(4) Huberty (1984) also suggests an index to assess how much better than chance the classification by discriminant analysis can be. This index is called the practical significance index and is computed using the formula

$$\mathrm{PSI} = \frac{n_c/n - e/n}{1 - e/n}.100 \tag{88}$$

where

$$e = \frac{1}{n}\sum_{g=1}^{g} n_g^2 . \tag{89}$$

Interpreting the discriminant function

As already noted, the *unstandardized coefficients* of the discriminant function are used to compute the discriminant scores for each case that, in turn, are needed for classification purposes. Each of these coefficients simply informs about the absolute contribution of the associated variable in determining the discriminant scores, which may be ambiguous when the variables are measured in a different unit. In this case, a one unit change in a variable will not be the same as a one unit change in other variable and, as a consequence, these coefficients can not be compared.

The *standardized coefficients* of the discriminant function allow for the analyzing of the relative contribution of each discriminant variable to the discriminant function and can be used to compare the importance of the variables in discriminating the groups. The variables with higher standardized coefficients, in absolute value, have a stronger unique contribution to the discriminating function. On the other hand, the sign of a coefficient just indicates if that contribution is positive or negative. Each standardized coefficient, a_j^*, is determined from the unstandardized coefficient, a_j, using the transformation

$$a_j^* = a_j \sqrt{\frac{w_{jj}}{n-g}}. \tag{90}$$

where w_{jj} represents the sum of squares for variable j.

While the standardized coefficients indicate the partial contribution of each variable to calculating the discriminant scores, controlling for other independent variables entered in the discriminant function, the *structure coefficients* indicate the simple correlation between the variables and the function. These coefficients are also referred to as the discriminant loadings and represent a measure of what the function shares with each variable. The most important variables in the discriminant function are, therefore, those with higher structure coefficients. Hair *et al.* (1995) suggest that structure coefficients exceeding 0.3 (in absolute size) should be considered significant.

For an indication of the importance of variables in the discriminant function, both the standardized coefficients and the structure coefficients were analyzed in Chapter 6.

3.6 HOMALS

3.6.1 Overview

To understand and simultaneously describe the structure of interrelations among the categories of a set of three or more categorical variables, with conclusions about the interrelated categories, two multivariate data analysis techniques are usually referred: the Multiple Correspondence Analysis (MCA) and the HOMALS (**Homo**geneity analysis by means of alternating least squares). In spite of the differences in the mathematical procedures supporting these techniques, they produce similar geometrical displays and, hence, permit analogous conclusions concerning the data interpretation (Carvalho, 2000). However, unlike MCA, HOMALS can be performed using the SPSS software, which contains all survey data and was already used in most of the previous statistical analyses. This reasoning supported the adoption of HOMALS, instead of MCA, in Chapter 7.

Overall, the aim of HOMALS is to analyze the relationships between the categories of a set of qualitative variables. As MCA, HOMALS is basically an exploratory and descriptive technique, which uncovers and describes the associations in large contingency tables. In other words, this method allows the performing of multivariate analyses with qualitative data.

The conceptual formalization of HOMALS is attributed to American researchers of the University of Leiden – the GIFI team – during the 1980s. This research team also developed the procedures for the implementation of this statistical method in the SPSS software. The studies of Geer (1993a, 1993b, 1985) are fundamental references in the divulgation of this multivariate data analysis technique.

As Multiple Correspondence Analysis, HOMALS may be described as a method somewhat free of assumptions. The only constraint is that data elements must be non-negative numbers (Clausen, 1998). Nevertheless, authors such as Van Der Heijden *et al.* (1994) refer that the method can be used to graphically express almost any contingency table on the assumption that there is an association to be described. In addition, the contingency table should be relatively large.

Through the application of a mathematical algorithm, HOMALS transforms the categorical input data so that an optimal quantification is attributed to each category of the variable and to every individual observation. The first type of quantification is referred to as the *quantification of categories* and the quantifications of the objects are called *object scores*. As suggested by its acronym, HOMALS uses an algorithm of the *alternating least squares* type, which means that, in every iteration, least squares estimates are produced either for the quantifications of the categories or for the objects scores. The interactive process is complete when an underlying loss function is minimized. In this final stage, the optimal quantification for both categories and objects is achieved. Before presenting this function, whose minimization converges to the *optimal solution* for both categories and objects, some general notations used in HOMALS are presented:

- n: number of objects (observations) in the research;
- m: number of qualitative variables in the research;
- k_j: number of categories of the qualitative variable j ($j = 1,2,...,m$);
- p: sum of the number of categories of the m qualitative variables, that is, $p = \sum_{j=1}^{m} k_j$;
- r: number of retained dimensions ($r = 1,2,...,r_{max}$).

The HOMALS procedure starts with an *input matrix*, that is, a $(n \times m)$ matrix in which the n objects are classified in accordance to the m categorical variables. In this matrix, the k_j categories of the qualitative variable j – that ought to be mutually exclusive and exhaustive – are codified with natural numbers within the interval $[1,k_j]$. Besides the input matrix, a set of *auxiliary matrices* are involved in HOMALS:

- G_j: binary $(n \times k_j)$ matrix associated with each qualitative variable j. In each line, code 1 will be assigned if the object reports the property represented by the category of the variable represented in column; otherwise, code 0 will be attributed;
- G: matrix $(n \times p)$ that results from the juxtaposition of the G_j matrices, that is, $G = [G_1 \mid G_2 \mid ... \mid G_m]$;
- D: diagonal $(p \times p)$ matrix reporting the frequency of occurrences for each category;
- M_j: binary and diagonal $(n \times n)$ matrix associated with each qualitative variable j. In each line, code 1 will be assigned if there is one occurrence in the interval $[1,k_j]$ and code 0 if the occurrence does not take place in the interval;
- $M_\bullet$: matrix $(n \times n)$ that results from the sum of the m matrices M_j, that is, $M_\bullet = \sum_{j=1}^{m} M_j$. Hence, this matrix reports the total number of valid answers for each object;

The *loss function* (σ) that allows the determining of the optimal quantification for both categories and objects can be expressed as

$$\sigma(X, Y) = m^{-1} \sum_j SSQ(X - G_j Y_j) \tag{91}$$

where X is a matrix $(n \times r)$ of the object scores ($r = 1,2,...,r_{max}$) and Y_j is a matrix $(k_j \times r)$ of the quantification of the k_j categories of the variable j ($j = 1,2,...,m$).

As suggested by (91), the optimal solution minimizes the square distance between the object scores and the respective category points.

The algorithm of HOMALS applies interactively the *reciprocal means principle*, which assures a reciprocity relationship between the quantifications of the categories and the object scores[59]. Accordingly, the quantification of each category corresponds to the mean of the scores of all objects that share that category and each object score is proportional to the mean quantification of the categories to which it is associated. The presence of this principle may be perceived in the formulas that describe this quantification process. Indeed, the quantification of the p categories of the m variables is given by the following relation

$$Y \cong D^{-1}G'X \tag{92}$$

where Y is matrix $(p \times r)$ of the quantification of the p categories in r dimensions.

On the other hand, the object scores can be defined as a function of the categories quantification as follows

$$X \cong GY/m \tag{93}$$

or, in alternative,

$$X \cong M_{*}^{-1}GY\,. \tag{94}$$

A fundamental characteristic of HOMALS is that it allows the representing of the optimal results geometrically, that is, as points within a low-dimensional space denominated *perceptual map*. This particularity of HOMALS facilitates the data

[59] A detailed description of this algorithm can be found, for instance, Carvalho (1998: 117-124).

interpretation. The relative position of the categories (through their quantifications) translates the nature of interrelations among them in this space. Categories with similar distributions will be represented as points that are close in the space and this means that they are associated. On the contrary, categories that have very dissimilar distributions will be positioned far apart in the perceptual map, which means that they are not related. Due to the reciprocity between the object scores and the quantifications of the categories, the points representing the categories will be at the gravity center of the object scores that share the same category. As a result, objects with similar profiles, that is, associated with the same categories, will be located close in the space and, thus, defining homogeneous groups. This explains why this multivariate data analysis tool is denominated as Homogeneity Analysis.

3.6.2 Stages in the application of the method

In Chapter 7, a HOMALS was undertaken with the purpose of describing the relationships among the categories of a set of categorical variables. The use of this multivariate method relied upon the methodological steps that are explained in this section.

Preliminary analyses

The application of HOMALS was preceded by the performance of Pearson's chi-square tests in order to verify the independence between each pair of variables under analysis. With the exception of the chi-square tests involving one of these variables, in the remaining ones the hypothesis of independence was rejected. The previous carrying out of these tests was important because, as already noted, a condition for the application of HOMALS is that the categorical variables under analysis report some association.

Accordingly, the variable not significantly associated with the others was excluded from the HOMALS application.

Another important question that should be evaluated in the application of HOMALS concerns the status provided to the missing values. Should the cases with missing values be simply eliminated from the analysis or, instead, should the non-answers be considered as active categories of the corresponding variables? There is not consensus regarding this issue. Following the procedure proposed by Carvalho (1998), the two approaches were carried out. In the application of HOMALS considering the non-answers as active categories, results showed a great proximity (almost an over-placement) of the non-answer category of all variables. Moreover, the relative positions of the remaining categories (the truly important ones) were very similar in the two versions of HOMALS (eliminating the cases with missing values or, instead, considering the non-answers as an active category of the associated variable). Consequently, and since the perceptual map including exclusively the valid categories was more perceptible, only the corresponding results from HOMALS were effectively considered and interpreted. In other words, as in the application of the previous multivariate methods, the missing values were treated by the listwise method[60].

Evaluating the number of dimensions to be selected

HOMALS provides the possibility of defining *multiple quantifications* for the same category or object depending on the number of selected dimensions to describe the input categorical data. In turn, the number of dimensions to be selected will be determined by the purposes underlying the HOMALS application. If the research goal is solely to

[60] This option concerning the missing values treatment is explained in the following section.

quantify the categorical variables in order to use them in a further analysis – that is, to use HOMALS as a first step (Gifi, 1996) – the most common is to focus on the first dimension because, as it will be explained bellow, it is the one that explains the higher proportion of the data variability. On the other hand, when the objective is to take advantage of the graphic potential of HOMALS in describing the nature of relationships between the categorical variables, two or more dimensions should be retained, in order to enable the representing of the input data (the category and object points) in a plane geometric display.

In HOMALS, the maximum number of dimensions in which the quantification of the input data (categories of the variables and objects) may be represented, is given by the formula

$$r_{max} = \min\{(n-1),(p-m)\} \tag{95}$$

but, in practice, it equals $(p-m)$ because the number of objects (n) is generally higher than the total number of categories (p).

However, it should be noted that "increasing the number of dimensions does not require a revision of the quantification in preceding dimensions" (Geer, 1993b: 21). In other words, the quantification for the p categories in the first dimension, for instance, will be always the same regardless of whether the number of selected dimensions is $r = r_{max}$ or $r < r_{max}$.

It should also be referred that there is not a unanimous criterion for supporting an objective decision about the number of dimensions to retain in the analysis. Carvalho

(2001) suggests the previous observation of the *eigenvalues* in a higher number of dimensions and this criterion was followed in Chapter 7. Each eigenvalue can be interpreted as a measure of the importance of the corresponding dimension in explaining the variance of the input data. Since the first eigenvalues are the largest, the most frequent procedure is to base the interpretation of HOMALS on the quantifications of the categories and objects of the first two or three dimensions. For dimension s, the eigenvalue is given by

$$\lambda_s = \frac{\lambda_s^2}{m} \qquad s = 1,2,\dots,r_{max} \tag{96}$$

where λ_s^2 represents the sum of the discriminating measures of the m categorical variables in each dimension s. This concept of discriminating measure is explained in the following point.

Analyzing the discriminating measures

As a quantification is computed for each category and for each object, a quantification is also provided for each categorical variable in each dimension. Each of these quantifications is referred to as the *discriminating measure* of the variable j in the dimension s and, overall, they represent important elements in the interpretation of the results from HOMALS. Each discriminating measure ranges from 0 to 1 and corresponds to the variance of the correspondent variable after the optimal quantification. The discriminating measure for a variable j in the dimension s can be expressed by:

$$\eta_{js}^2 = \frac{1}{n} Y'_{js}\, D_j Y_{js} \quad j = 1,2,\dots,m\,;\; s = 1,2,\dots,r_{max} \tag{97}$$

The discriminating ability of the variables determines the level of homogeneity of the object groups. Variables with strong discriminating power will produce groups which are more distant in the perceptual map, which will make the data interpretation easier. As Geer points out, "if a discriminating measure is large, category points are far away from each other on that dimension, and object points are close to their category points" (Geer, 1993b: 22). Under this circumstance, the possibility of achieving homogeneous groups is enhanced. This is why it is wise to initiate the interpretation of HOMALS analyzing of the discriminating measures (Carvalho, 1998).

In HOMALS, each eigenvalue equals the arithmetic mean of the discriminating measures in the associated dimension. As a consequence, Carvalho (1998) proposes that the greatest relevance should be provided to the variables with discriminating measure, in each dimension, at least equal to the corresponding eigenvalue, that is, with a contribution equal to or higher than the expectable contribution of these variables assuming that they have a uniform distribution. This procedure was followed in Chapter 7.

Interpreting the perceptual maps

HOMALS produces two perceptual maps, one for the quantifications of the categories and another one for the object scores. The decision to base the interpretation exclusively on the perceptual map for the categories quantification was made. Two reasons supported this decision. Firstly, the sample dimension would not allow a clear understanding of the perceptual map for the object scores. Secondly, in accordance with the reciprocity among categories quantification and object scores, provided by the formulas (92) to (94), the geometrical displays of both sets of points would be proportional. However, despite the perceptual map of the object scores not being interpreted, the confirmation of the non-existence of *outliers* was observed.

The interpretation of the perceptual map for the point categories in Chapter 7 followed the HOMALS standard procedures. The purpose of observing this map was to understand the meaning of the spatial distribution of the category points. As explained above, the position of these points reflected the interrelations among the correspondent categories of the variables, which could be of association (for point categories close in the space) or of opposition (for point categories distant in the space).

3.7 Missing Values Analysis

3.7.1 Overview

Missing values are commonly encountered in multivariate analysis. Sometimes, they may be planned by the researcher, that is, they may integrate the research design. This happens, for instance, in a situation in which the respondents are asked a second question only if they answer "yes" to a first question. At other times, however, missing observations occur due events beyond the researcher's control such as the explicit refusal by the respondents to answer to one or more specific questions (Kline, 1998). The missing values problem was also presented in the data that supported the Chapters 4 to 7 of this thesis and they occurred due to unplanned factors.

There are various procedures used in the handling of missing data and all of them have inherent advantages and limitations (Acock, 2002). In selecting the procedure to deal with missing observations, two aspects must be addressed (Kline, 1998; Hair *et al.*, 1995). The first one concerns the prevalence of the problem, that is, the proportion of the data that is missing. More importantly, the second aspect focuses on the nature of the pattern of the missing data, analyzing whether it is systematic or random.

Missing values in one variable that are *systematic* imply that cases with non-answers are different from those with valid answers in that variable. In this situation, the pattern of missing data is non-ignorable and the conclusions regarding the group of cases with scores on the variable cannot be generalized to the cases with missing values. Inversely, random missing data can be divided into two categories: data that are missing at random (MAR) and data are missing completely at random (MCAR). In the case of *MAR*, the probability of answer versus non-answer to a question is unrelated to the respondents' true positioning on that variable. The *MCAR* condition is stronger than the MAR condition. In this circumstance, the missing data in one question are independent of that question and also of other questions in the data set. Either in MAR or in MCAR, the process that gives rise to the missing values acts randomly, that is, subjects with missing values in a variable will only differ by chance from those with valid scores in that variable. As a consequence, the conclusions based on the valid scores in that variable can be generalized to the cases with missing data.

For instance, if the participants fail to answer an item that intends to measure general environmental attitudes because they are less pro-ecological, then the missing values will be systematic. But if they do not answer the item because they are non-recyclers, then the missing values will be MAR. A third possibility is to consider that the absence of scores in the item is unrelated with the ecological positioning of the respondent but also with the other variables used in the study, for instance, the adherence level to the recycling program or socio-demographic features. In this last case, the missing values will be MCAR.

When the pattern of missing observation is systematic there is no statistical procedure to correct the problem and the cases with incomplete data will distort the results, hampering the generalization of the results. Actually, the options that have been proposed to lead with missing values assume that the pattern of data loss is random and, for most of them, that this pattern is MCAR. For instance, the listwise deletion of missing cases, the pairwise deletion and the imputation of missing observations (by the sample mean, by multiple regression, by expectation maximization (EM) or by pattern matching) requires the assumption of MCAR (Little and Schenker, 1995; Roth, 1994; Little and Rubin, 1989, 1987; Rubin, 1987). More sophisticated methods, such as the full information maximum likelihood estimation using Structural Equation Modeling, can be applied, provided that the data are MAR (Arbuckle, 1996).

Another problem in dealing with missing values is that the most powerful approaches available in software to the treatment of missing values are limited to continuous variables (Acock, 2002). For instance, the imputation methods offered by the SPSS module (replacement by the mean, imputation with estimated values using regression and the EM method) cannot be applied to categorical variables. On the other hand, the full information maximum likelihood estimation using Structural Equation Modeling is also based on the normal theory.

This last aspect was decisive in the option concerning the choice of the method to deal with the missing values in this thesis. Effectively, in Chapters 4 to 7, one or more nominal variables were present in the analysis, which would exclude the possibility of applying the most sophisticated methods for handling incomplete data, like the EM imputation or the full information maximum likelihood estimation. The final choice would rest, therefore, between the listwise and the pairwise deletion and the former method was considered preferable to the latter. While in *pairwise deletion*, cases are eliminated if they have missing values in the variables involved in a particular computation, in *listwise delection*, cases are excluded if they report any missing value in the set of variables under analysis. Both these methods are easy to implement and are available by default in most statistical packages. The most important advantage of listwise deletion in comparison to the pairwise deletion is that all statistical analyses are applied to the same cases. On the other hand, the pairwise method often conducts towards a covariance matrix that is not positive definite. This is a potential drawback for the application of certain multivariate methods, like structural equation modeling (Acock, 2002; Kline, 1998).

The use of listwise deletion to deal with incomplete data has some inherent problems too. The most serious is to eliminate so many observations that the final sample size would be inappropriate for the application of the intended multivariate method. Another problem is loss of power because the standard errors depend on the sample size. Finally, listwise deletion only produces unbiased estimates when the missing values are MCAR.

3.7.2 Stages in the application of the method

Once the listwise procedure was selected as the less potentially problematic method (within the available ones considering that some variables in the chapter were categorical), the following concern was to ensure a sufficient number of complete cases for the performance of the multivariate analyses in each chapter and also that the missing values were MCAR. In summary, the missing values analysis in the following chapters was carried out in accordance with the following five main steps:

(1) The number of valid and missing cases per variable was reported. Most variables have valid data for 80% or more of cases. The variables with higher proportion of incomplete data are those corresponding to the last questions of the questionnaire. This fact suggests the length of the questionnaire, not the nature of each question, as the primary reason for the occurring of the non-answers and can be perceived as a first indication of their randomness;

(2) The evaluation of the patterns of missing values considering all variables that were presented in the Chapters 4 to 7 was intended, but this joint analysis was not carried out due to software limitations inherent to the presence of a very large number of variables. Instead, the distribution of patterns of missing data was analyzed separately for each group of items measuring the same dimension or latent variable. These analyses had no evidenced any predominantly missing data pattern that could impact the further analyses. In general, the majority of participants did not answer one item or, on the contrary, did not answer all items measuring that dimension or latent variable. Of those cases missing two or more items, the frequencies for the combinations were relatively low. This last aspect occurred primarily in the last questions of the questionnaire, specially those measuring socio-demographic features or in items of very similar nature;

(3) The Spearman correlations were computed to assess the correlation of missing data for some pairs of variables of interest. These correlations appear in the Appendixes G to I in the tables referred to as "correlations of valid / missing dichotomous variables". For each variable in this analysis, a binary variable was created, which assumed the value 1 for all cases with valid answer in the original variable and the value 0 for all cases with missing values on that variable. In each analysis, each of these new dichotomous variables was correlated to other five binary variables that identify with the value 1 if the participant had responded to the questions measuring *recycling behavior*, *gender*, *age*, *education* and *income level* and the value 0 otherwise. These variables were selected due of their potential interest in this thesis. In fact, a major objective of this research is to identify the main determinants of *recycling behavior* and, therefore, this is a critical variable in all analyses. On the other hand, the literature review carried out in Chapter 2 evidences that gender, age, education and income level are the socio-demographic attributes more investigated as potentially related to recycling participation.

The purpose of this evaluation was to assess the degree of association between the missing values on each pair of variables. It made it possible to understand if the lack of answers to a specific item was related to the lack of answers in these five important variables. For the purposes of the current investigation, the correlations with these five variables were considered more informative than the correlations within the items measuring the same factor of latent variable, which were obviously larger since they are essentially measuring the same concept. Although statistically significant, the founded correlations were very low, suggesting a low association between the missing data pattern for each pair of variables[61];

(4) The Spearman correlations were determined to assess the correlation of missing data in each variable under analysis and the five variables previously referred: the primary variable measuring recycling behavior and the variables representing gender, age, education and income level. These correlations were referred to as "correlations

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[61] If the correlation between each valid / missing dichotomous variable and the valid / missing dichotomous variable "recycling behavior", for instance, was large, the conclusion would be that the subjects that answer to that item are those who predominantly answer to the variable "recycling behavior".

between valid / missing dichotomous variables and some variables of interest"[62]. Since all the correlations were weak, it was concluded that no consistent missing values pattern was present in data[63];

(5) The mean of each metric variable for participants from recycler and non-recycler households in two situations was computed. First, these means were determined considering all available data for that variable. Second, they were computed using only the cases with valid answers in the items that would be used in each multivariate analysis. Then, the profile of answers to each item in these two situations was compared through a profile graph. As can be observed in the Appendixes G to I, these profiles are almost identical, suggesting that the deleting of missing cases in each multivariate analysis was not biasing the results. On the other hand, in what concerns the non-metric variables, the proportion of cases in each category in the initial sample was compared to the homologous proportions in the final sample used to apply each multivariate analysis and no important differences were encountered;

(6) At last, it was evaluated whether the final sample in each following chapter was large enough to properly use the intended multivariate data analysis method. Despite the large number of cases eliminated in some analyses, all the needed observations for the adequate application of each method in every chapter was ensured and surpassed.

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[62] If the correlation between each valid / missing dichotomous variable and the binary variable "recycling behavior", for instance, was large, the conclusion would be that the subjects that answer to that item are predominantly recyclers, that is, the missing values could not be classified as MCAR.

[63] An alternative procedure to achieve a similar objective would be to use the valid / missing dichotomous variables to perform independent samples t-tests for each metric item. These tests would allow identifying significant differences between cases with complete scores and cases with missing values on other relevant variables.

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Chapter 4

BEHAVIORAL DETERMINANTS OF HOUSEHOLD RECYCLING PARTICIPATION: THE PORTUGUESE CASE

Abstract

Recycling is an effective resource-recovery mechanism with significant economic and environmental benefits. The success of SIGRE depends on a growing and sustained participation of consumers through the correct separation and disposal of recyclable waste. Within this framework, the present chapter applies principal components analysis and logistic regression with the purpose of identifying dimensions able to motivate consumers to participate in the selective-collection program. This chapter provides a first analysis of this theme in the Portuguese case. On the other hand, the detailed quantitative analysis which is carried out represents a contribution for the consumer behavior research concerning the adoption of recycling practices. Results suggest differences between recyclers and non-recyclers concerning specific attitudes towards recycling and also the need of improving the provided logistics service. This chapter proposes also some guidelines that may be considered in future communication and intervention strategies, designed to promote recycling participation.

4.1 Introduction

Excessive solid waste production is a serious problem of contemporary societies and its proper management a priority within the social and environmental policies of most developed countries. The consumerism society and the emergence of new products with very short life cycles explain the growing weight of packaging waste in the global amount of solid waste generated each year. In Portugal, for instance, the proportion of paper/cardboard, glass and plastic packaging residues in a household waste bag increased from 20%, in the 1980s, to 45%, in the beginning of the 1990s (SPV, 2003). In a time when the solid waste management technical solutions, like incineration or landfill disposal, usually arise some polemic, the management strategies based upon the promotion of individual or social behaviors, such as recycling, reuse or source reduction, are receiving an increased interest from politicians and academics.

The present research is a first analysis on the motivations for recycling of household packaging solid waste in Portugal. Specifically, this study uses knowledge of previous research concerning determinants of recycling behavior to model this conservation practice among Portuguese population. In particular, the predictive effect of a set of explanatory variables representative of (1) general pro-ecological attitudes; (2) specific attitudes towards recycling; (3) the satisfaction level with the provided logistics system; (4) and the existence or not of some available space at the household, are compared. Additionally, the potential influence of some socio-demographic attributes (gender, age, education and income level) on recycling participation is also evaluated. This diagnosis is a vital tool in the design of a more effective social-marketing plan (Andreasen, 1995; Geller, 1989).

As in other research (Guerin, Crete and Mercier, 2001; McCarty and Shrum, 2001; Bratt, 1999; Cheung, Chan and Wong, 1999; Scott, 1999; Berger, 1997; Corral-Verdugo, 1997; Corral-Verdugo, 1996; Boldero, 1995; Guagnano, Stern and Dietz, 1995; Taylor and Todd, 1995a; Taylor and Todd, 1995b), this one uses multivariate techniques to overcome the limitations of some statistical analyses used in several previous studies about recycling behavior. These earlier studies, essentially based on bivariate correlations, do not allow the identification of the cofactors that strongly contribute to the dependent-variable explanation. In the present study, principal components analysis and logistic regression are combined to analyze recycling behavior in Portugal.

The approach in this chapter differs, however, from the study of Boldero (1995), in which logistic regression was also applied, concerning the extensive use of statistical methods and tests to guarantee an adequate model and, consequently, sustained conclusions concerning the interpretation of results. This concern with intensely testing the adequacy of the proposed model is not visible in the previous investigation on predictors of recycling behavior.

This chapter is organized as follows. The next section summarizes the literature that investigated the potential influence of environmental attitudes, specific attitudes towards recycling, features of the provided logistics service and socio-demographic characteristics in recycling behavior. Based on this past research and taking also into account a recent study carried out in Portugal, some study hypotheses are then formulated. The subsequent section indicates the research methods and, afterwards, results are presented and discussed. Finally, the last section concludes and proposes some topics that could be considered in future social-marketing communication plans in order to improve household recycling standards.

4.2 Review of literature

4.2.1 General pro-environmental attitudes

Several measuring instruments have been developed to assess general environmental attitudes (Weigel and Weigel, 1978; Maloney, Ward and Braucht, 1975; Maloney and Ward, 1973). However, as Stern, Dietz and Guagnano (1995) refer, the New Environmental Paradigm (NEP) (Dunlap and Van Liere, 1978) has been the most widely used scale. As Vining and Ebreo point out, the NEP Scale "measures a constellation of attitudes that represent the respondents' adherence to a worldview of the relationship between humanity and the environment" (Vining and Ebreo, 1992: 1582).

The NEP arises in opposition to the Dominant Social Paradigm (DSP), in which the values of progress, prosperity, faith in science and technology and commitment to a '*laissez-faire*' economy were emphasized (Dunlap and Van Liere, 1984).

Although, intuitively, one might expect that a high pro-ecological sensitivity would have a direct and positive counterpart in recycling behavior, the empirical findings are quite ambiguous. For instance, in the recent research carried out by Guerin, Crete and Mercier (2001), a reduced but significant influence of global environmental concern on recycling behavior was reported. This result contrasts with some previous research in the field, in which no significant relationship between these variables was found (Gamba and Oskamp, 1994; Vining and Ebreo, 1992; Oskamp *et al.*, 1991; Vining and Ebreo, 1990).

4.2.2 Specific attitudes towards recycling

In the absence of a consistent relationship between general environmental attitudes and recycling behavior, some authors suggest the importance of more specific attitudes in explaining this conservation practice. Several empirical researches sustain this premise.

In the beginning of the past decade, Simmons and Widmar (1990) investigated the role of altruistic attitudes specifically related to recycling and identified "conservation ethic" as a potential predictor of recycling behavior. This dimension reflected the recycling contribution for the wise use of natural resources. In contrast, Howenstine (1993) studied the potential effect of negative attitudes concerning recycling, such as "indifference" and "nuisance". McCarty and Shrum (1994), Vining and Ebreo (1990), and, more recently, McCarty and Shrum (2001) have shown that two attitudinal constructs – general attitude about the importance of recycling and the belief about the inconvenience of this sustainable practice – were significantly related to recycling participation. Evidence of the importance of specific attitudes towards recycling was also achieved, for instance, in the research carried out by Werner and Makela (1998), Guagnano, Stern and Dietz (1995) and Gamba and Oskamp (1994).

Vining and Ebreo (1992) used the constructs of Schwartz (1977) normative activation model, not with the purpose of testing the adequacy of the model, but as measures of specific attitudes concerning recycling. These authors expected that recyclers and non-recyclers differed in their rates on attitude scales, with the first denoting higher scores in "personal norms", "ascribed responsibility" and "awareness of consequences". In general, their expectations were confirmed, but "ascription of responsibility" was not significant in predicting self-reported recycling behavior. Concerning this result, the authors suggested that intentions might be an important variable linking these dimensions. The possibility that recycling intentions may precede effective recycling behavior was subsequently the subject of Boldero's (1995) research. The results from this research suggested that attitudinal dimensions, related to the benefits of recycling, were not indirect predictors (through intentions) of recycling behavior. However, the two negative attitudinal dimensions considered ("inconvenience" and "lack of conviction about purchasing") were found to be significant predictors, via intentions. Specific attitudes towards recycling were also predictors of recycling intention, for instance, in the studies carried out by Cheung, Chan and Wong (1999) and Taylor and Todd (1995a; 1995b). In this last study, recycling intentions predicted, subsequently, the recycling behavior.

4.2.3 The logistics concept of the recycling program

Previous research shows that the performance of the provided logistics service and the perceived system convenience may directly influence consumers' participation level. In opposition to the scanty research on the logistics (reverse) area about the consumer service / convenience of the selective-collection system (Menezes, Reis and Valle, 2001a; 2001b), this problematic has been approached primarily within marketing and social-psychology empirical studies.

In general terms, past research shows that one way of improving the recycling standard is to provide curbside collection (Vining and Ebreo, 1992; De Young, 1990). The physical proximity of containers is the fundamental reason that justifies the success of this type of collection (Ludwig, Gray and Rowell, 1998; Margai, 1997). On the other hand, less demanding recycling programs, concerning, for instance, the number of recyclable materials that should be sorted, report frequently a higher participation level (Gamba and Oskamp, 1994).

To inform consumers about recycling benefits and how to recycle is also a strategy with positive results in promoting recycling engagement (Leroux, 2000; Nyamwange, 1996; Thogersen, 1994; Austin *et al.* 1993; De Young, 1990; De Young, 1989; Burn and Oskamp, 1986; Jacobs, Balley and Crews, 1984; Luyben and Cummings, 1981-82; Arbuthnot *et al.*, 1976-77; Reid *et al.* 1976). Although with ambiguous results, the recyclables collection frequency is another component of the provided logistics service that was investigated in past research (0'Connor, 1993; Folz, 1991; Foshay and Aitchison, 1991).

Finally, De Young (1989) pointed out that having insufficient storage space is a factor able to attenuate recycling generalization. This statement was confirmed by Derksen and Gartrell (1993). As opposed to this, Corral-Verdugo's (1996) study about recycling and reusing practices in Mexico demonstrated exactly the inverse situation. In respect to this contradictory result, the author says that people with increased space in their households are using this opportunity to enhance consumption and waste generation rather than improving the recycling standards.

4.2.4 Socio-demographic attributes

Several studies assessed the relationship between socio-demographic attributes and recycling behavior. Generally, these attributes include gender, age, education and family income. More exceptionally, ethnicity, political ideology, family structure or standards of living indicators (e.g., home ownership and type of dwelling) were also considered. In general, research is very inconsistent regarding the predictive effect of these variables.

Most studies that analyzed the effect of gender on recycling behavior have not found a significant relationship between these variables (Werner and Makela, 1998; Boldero, 1995; Gamba and Oskamp, 1994; Hopper and Nielsen, 1991; Oskamp *et al.*, 1991; Vining and Ebreo, 1990). The effect of age in recycling participation is quite ambiguous. Actually, although some studies have revealed a non-significant association between the two variables (Werner and Makela, 1998; Corral-Verdugo, 1996, Oskamp *et al.*, 1991), others evidence a positive relationship (Guerin, Crete and Mercier, 2001; Scott, 1999; Margai, 1997; Gamba and Oskamp, 1994; Folz and Hazlett, 1991; Vining and Ebreo, 1990).

Conclusions concerning the influence of education on recycling behavior are quite similar to those referred regarding the effect of age. In a first set of studies, education level was not significantly related to recycling behavior (Werner and Makela, 1998; Corral-Verdugo, 1996; Gamba and Oskamp, 1994; Hopper and Nielsen, 1991; Oskamp *et al.*, 1991). However, other research suggests a positive relationship between both variables (Guerin, Crete and Mercier, 2001; Owens, Dickerson and Macintosh, 2000; Folz and Hazlett, 1991; Vining and Ebreo, 1990; Jacobs, Balley and Crews, 1984). Concerning the predictive effect of family income on recycling participation, several studies show that households with higher income levels are more propitious to engage in such pro-ecological behavior (Guerin, Crete and Mercier, 2001; Owens, Dickerson and Macintosh, 2000; Berger, 1997; Oskamp *et al.*, 1991; Vining and Ebreo, 1990; Jacobs, Balley and Crews, 1984).

4.3 Research hypotheses

This review of literature suggests an inconsistent relationship between general environmental attitudes and recycling behavior. In Portugal, no similar study was conducted yet, but one conclusion of the most recent national survey about environmental conceptions and practices (Observa, 2001) was that most Portuguese consumers (72.9%) reveal a high degree of concern and awareness about environmental problems. Therefore, in the present study, it is expected that respondents from participant and non-participant families in the recycling program report a similar profile concerning general environmental attitudes. However, this national survey also suggests that people feel unable to convert their concerns into practical actions, primarily due to lack of information about how to perform it. So, it is expected that respondents from adherent and non-adherent households differ significantly in their perceived ability to contribute to solve the environmental problems.

Opposing the dubious relationship between general environmental attitudes and recycling behavior, several pointed studies consistently evidence a significant link between specific attitudes towards recycling and this resource-conservation practice. Likewise, numerous past studies show the convenience of the recycling program, strongly related with the provided logistics service, and the existence of some available space in the household to store the recyclable materials, as potential determinants of consumers' recycling participation.

At last, research on socio-demographic determinants of recycling participation indicates a weak relationship between gender and recycling behavior. The predictive effect of age, education level or family income is equivocal, but several studies have found a significantly positive relationship between these variables and recycling involvement.

In agreement with these considerations, seven research hypotheses will be tested in this study:

H_1: The general ideological position towards the environmental problematic is not a significant predictor of recycling behavior.

H_2: The perceived ability to contribute to the environmental problems resolution is a significant predictor of recycling behavior.

H_3: The specific attitudes towards recycling are significant predictors of recycling behavior.

H_4: The satisfaction level with the provided logistics service is a significant predictor of recycling behavior.

H$_5$: The existence of some available space in the household is a significant predictor of recycling participation.

H$_6$: Gender is not a significant predictor of recycling participation.

H$_7$: Age, education level and household income are significant predictors of recycling participation.

4.4 Method

4.4.1 Sample procedures and participants

The data collection procedures as well as the sample description are presented in Chapter 1, section 1.5.5.

4.4.1 Instruments

This study presents the main conclusions of the statistical analysis of a set of questions. In the first one, a list of thirteen items was designed to assess respondents' general environmental attitudes, using a Likert four-point scale (1 – totally disagree, 2 – disagree, 3 – agree, 4 – totally agree). These items are shown in Table 4.1. Items 7, 8, 9 and 12 are consistent with values of the Dominant Social Paradigm and the item 11 aimed to assess respondents' awareness concerning the environmental-problems resolution. The remaining items were taken from the NEP scale. To evaluate the specific attitudes towards recycling, twenty items were included, measured by a Likert three-point scale (1 – totally false, 2 – partially true, 3 – totally true). These items are presented in Table 4.2. Similarly with Vining and Ebreo's (1992) research, items from the Schwartz's (1977) normative model were used, not with the purpose of testing the adequacy of this model, but to assess specific recycling attitudes. These items are identified with the following numbers: 1, 2, 5, 7, 8, 10 to 13, 15, 16, 18 and 20. In addition, eight more items were also included. Items 3 and 4 tried to evaluate respondents' expectations concerning friends and neighbors' recycling involvement. The purpose of including the item 5 was to extend items 1 and 2 to the respondents' family expectations. Items 6 and 9 were included to better evaluate respondents' awareness of recycling benefits and the item 14 to measure their opinion regarding the possibility of recycling participation becoming mandatory. At last, items 17 and 19 were added to assess the attitudes of difficulty and indifference towards packaging separation.

The third question included eleven items, listed in Table 4.3, to measure the respondents' satisfaction level with the several components of the logistics consumer service and, in this case, a Likert four-point scale was used (1 – unsatisfied, 2 – little satisfied, 3 – satisfied, 4 – very satisfied). A fourth aspect investigated the existence or not of some available space in the household to store provisionally the separated recyclables, before their disposal in the suitable containers. The fifth aspect measured recycling behavior. Here, participants were asked if their household separate domestic waste and dispose it properly for further recycling. Fourth and fifth aspects were measured using a binary scale (1 – yes, 0 – no). Finally, information concerning respondents' gender, age, education and family income level was analyzed, as well.

4.4.3 Statistical data analysis methodology

Data analysis in this chapter proceeded in two main steps. In the first step, Principal Components Analysis was applied to the items of the first three groups of questions with the purpose of reducing data. In the second analytical step, the quantitative contribution of each of the continuous variables (the principal components and the variable representing the respondent's age) and also of the set of dummy variables assess the influence of the existence of some space to store recyclables at home and the other socio-demographic variables) on recycling behavior were compared through the adjustment of a logistic regression model. These statistical methods were applied by following the methodological steps described in Chapter 3, sections 3.2.2 and 3.3.2.

4.5 Results

4.5.1 Principal components analysis

The use of Principal Components Analysis allowed the reduction of the original thirteen items to measure general environmental attitudes into four new dimensions, together accounting for 51.7% of the total variance (KMO = 0.762; Bartlett test: $p = 0.000$). These results are summarized in Table 4.1. In accordance with the meaning of the corresponding items with higher loadings, the encountered principal components were labeled *PC1 – Balance and limits of nature*, *PC2 – Incapability and lack of knowledge*, *PC3 – Importance of life style change* and *PC4 – Man over nature*.

The internal consistency of the four dimensions was measured by the corresponding Cronbach's alpha coefficients. For the first two dimensions, the Cronbach's alpha exceeds 0.64, which can be considered reasonable in exploratory research (Hair *et al.*, 1995). Although the remaining dimensions report low Cronbach's alphas, it was considered that they should be used in the further analysis, instead of the individual items, for two reasons. First, the items with significant loadings on each dimension (those presented in Table 4.1) allow a clean interpretation of the corresponding dimension, that is, the scales observe the dimensionality criterion (Hair *et al.*, 1995). Second, the independent samples t-tests analysis made with the original four items (which showed no significant differences between respondents from participant and non-participant households, as noted in Table 4.1) provides similar conclusions of the independent samples t-tests made with the dimensions *PC3 – Importance of life style change* and *PC4 – Man over nature*, that is, the scales observe the validity criterion (Hair *et al.*, 1995).

TABLE 4.1

Principal components of general environmental attitudes items (after varimax rotation) and means differences

Items and Principal Components	Loadings	% Variance Explained	Means (Recyclers)	Means (Non-Recyclers)	Means Difference (a)
PC1 – Balance and limits of nature			0.119	-0.073	0.192
1 – Humans are severely abusing the environment	0.694		3.570	3.500	0.07 (*)
2 – To maintain a healthy economy, we will have to develop a "steady-state" economy where industrial growth is controlled	0.688	18.8%	3.360	3.290	0.07(*)
3 – The balance of nature is very delicate and easily upset	0.609	Cronbach α	3.310	3.230	0.08(*)
4 – People must live in harmony with nature to survive	0.597	= 0.683	3.690	3.620	0.07(*)
5 – When people interfere with nature, it often produces disastrous consequences	0.531		3.280	3.210	0.07(*)
6 – There are limits to growth beyond which our industrialized society cannot expand	0.514		3.160	3.150	0.010
PC2 – Incapability and lack of knowledge			-0.099	0.086	-0.185
7 – I feel incapable to act in the environmental problems resolution attempt	0.834	14.0%	2.470	2.580	-0.11(*)
8 – I don't have a complete knowledge to act consciously in the environmental problems resolution	0.776	Cronbach α = 0.641	2.450	2.620	-0.17(*)
9 – The environment deterioration will proceed and only afterwards something can be done	0.629		2.180	2.240	-0.060
PC3 – Importance of life style change			0.003	-0.003	0.006
10 – We are approaching the limit of the number of people the earth can support	0.663	9.7%	2.700	2.720	-0.020
11 – Solving environmental problems will require significant lifestyle changes	0.572	Cronbach α = 0.290	3.210	3.150	0.060
PC4 – Man over nature			0.080	-0.035	0.115
12 – Science and technology will solve our problems in the next 20 years	0.775	9.2%	2.340	2.320	0.020
13 – People have the right to modify the natural environment to suit their needs	0.578	Cronbach α = 0.290	2.410	2.430	-0.020

(*) Independent samples t-test: $p < 0.05$

(a) For both groups, mean agreement level with the items ranges from 2 (disagree) to 4 (totally agree), decreasing in all items revealing a non-ecological worldview. Although the means differences are very small, results of independent samples t-tests, performed to each item, reported some significant differences ($p < 0.018$), marked in the list of items with the symbol (*). This occurrence may be explained by an over-estimation of the observed value of the t-statistics, due to the high number of observations (groups dimension) in each test. Mean differences between respondents from adherent and non-adherent households concerning both first dimensions are also small but significant ($p = 0.000$). The former group presents a high mean agreement level in the more pro-ecological dimension (*PC1 - Balance and limits of nature*) and an opposite mean ponderation in the less pro-ecological one (*PC2 - Incapability and lack of knowledge*).

Principal Components Analysis allowed the reduction of the original twenty items used to evaluate specific attitudes towards recycling to four new dimensions, together accounting for 53.2% of the total variance (KMO = 0.821; Bartlett test: $p = 0.000$). Results are presented in Table 4.2. Considering the meaning of the items with higher loadings in each dimension, these dimensions were labeled *PC5 – Social norm*, *PC6 – Awareness of recycling benefits*, *PC7 – Personal norm* and *PC8 – Difficulty and indifference*. Cronbach's alpha for the first two dimensions exceeds 0.78, indicating a good degree of internal consistency within each of these dimensions. The internal consistency level of the last dimensions can be considered reasonable.

TABLE 4.2

Principal components of specific attitudes towards recycling items (after varimax rotation) and means differences

Items and Principal Components	Loadings	% Variance Explained	Means (Recyclers)	Means (Non-Recyclers)	Means Difference (a)
PC5 – Social norm			0.195	-0.224	0.419(*)
1 – My neighbors expect me to recycle household materials	0.833		1.610	1.370	0.240(*)
2 – My friends expect me to recycle household materials	0.833	23.7%	1.730	1.450	0.280(*)
3 – I expect that my friends recycle household materials	0.762	Cronbach α	2.200	1.800	0.400(*)
4 – I expect that my neighbors recycle household materials	0.757	= 0.850	2.170	1.780	0.390(*)
5 – My family expects me to recycle frequently my household materials	0.561		2.080	1.550	0.530(*)
PC6 – Awareness of recycling benefits			0.076	-0.093	0.169(*)
6 – Household recycling is a major way to reduce lavishness	0.733		2.840	2.770	0.070(*)
7 – Household recycling is a major way to reduce litter	0.730	14.5%	2.760	2.670	0.090(*)
8 – Household recycling is a major way to conserve energy	0.719	Cronbach α	2.640	2.560	0.080(*)
9 – Household recycling is a major way to reduce pollution	0.706	=0.789	2.880	2.830	0.050(*)
10 – Household recycling is a major way to reduce the wasteful use of land for dumps	0.679		2.730	2.680	0.050
11 – Household recycling is a major way to conserve natural resources	0.606		2.800	2.760	0.040(*)
PC7 – Personal norm			0.307	-0.321	0.628(*)
12 – I feel a strong personal obligation to recycle a large proportion of my household's recyclables	0.650		2.520	1.910	0.610(*)
13 – I would feel guilty if I didn't recycle regularly my household's recyclables	0.624	8.5%	2.150	1.830	0.320(*)
14 – I consider that the household waste separation should be compulsory by law	0.622	Cronbach α	2.280	2.160	0.120(*)
15 – I am willing to go blocks out of my way to recycle household materials on a regular basis	0.611	= 0.596	2.510	1.910	0.600(*)
16 – For me, recycling is just a matter of money: I wouldn't recycle materials I didn't get paid for	-0.475		1.050	1.150	-0.100(*)
PC8 – Difficulty or indifference			-0.329	0.369	-0.698(*)
17 – For me, to recycle household waste is a very difficult task	0.695	6.5%	1.500	1.980	-0.480(*)
18 – Almost no one I know recycles any household materials	0.560	Cronbach α	2.060	2.430	-0.370(*)
19 – To recycle household waste is not up to me	0.557	=0.510	1.220	1.640	-0.420(*)
20 – Households like mine are responsible for a very large part of the materials disposed of in landfills	0.538		2.170	2.290	-0.120(*)

(*) Independent samples t-test: $p < 0.05$

(a) For both groups, mean agreement level ranges from 2 (disagree) to 4 (totally agree). Excepting the item "household recycling is a major way to reduce the wasteful use of land for dumps", the results of independent sample t-tests show significant differences regarding all other items ($p < 0.05$). Also, independent samples t-tests between respondents of non-participant and participant families suggest significant differences concerning all dimensions resulting from Principal Components Analysis ($p = 0.000$), with the latter group presenting a superior mean agreement level with the dimensions that translate a more pro-recycling attitude (*PC7 - Personal norm*, *PC5 - Social norm* and *PC6 - Awareness of recycling benefits*). The magnitude of these differences is very small concerning the dimension *PC6 - Awareness of recycling benefits* and reasonably high regarding the remaining ones.

Finally, the results of the application of Principal Components Analysis to the eleven items selected to measure the satisfaction level with the selective-collection logistics service are presented in Table 4.3. These items were reduced to three new dimensions that jointly explain 74.7% of the data total variance (KMO = 0.912; Bartlett test: p = 0.000). These dimensions were labeled *PC9 – Disposal conditions*, PC10 – System adequacy and information and PC11 – Disposal containers location. The Cronbach's alpha coefficients range from 0.82 to 0.90, visibly showing a very good degree of internal consistency within each of these scales.

TABLE 4.3
Principal components of logistics service satisfaction items (after varimax rotation) and means differences

Items and Principal Components	Loadings	% Variance Explained	Means (Recyclers)	Means (Non-Recyclers)	Means Difference (a)
PC9 – Disposal conditions			0.072	-0.053	0.125(*)
1 – Frequency of waste collection	0.851		2.437	2.123	0.314(*)
2 – Emptying regularity	0.815	30.4%	2.429	2.143	0.286(*)
3 – Cleaning and maintenance	0.814	Cronbach	2.367	2.014	0.353(*)
4 – Local safety	0.695	$\alpha = 0.90$	2.577	2.203	0.374(*)
5 – Number of disposal containers	0.564		2.221	1.768	0.453(*)
PC10 – System adequacy and information			0.212	-0.276	0.488(*)
6 – Information availability	0.841	23.6%	2.304	1.873	0.431(*)
7 – Support and claim service	0.838	Cronbach	1.858	1.588	0.270(*)
8 – System adequacy to lifestyle	0.691	$\alpha = 0.82$	3.346	1.941	1.405(*)
9 – Number and type of accepted waste materials	0.608		2.546	2.242	0.304(*)
PC11 – Disposal containers location		20.7%	0.259	-0.281	0.540(*)
10 – Distance to the disposal containers	0.859	Cronbach	2.561	1.943	0.618(*)
11 – Disposal containers location	0.782	$\alpha = 0.87$	2.551	2.025	0.526(*)

(*) Independent samples t-test: $p < 0.05$

(a) For both groups, the mean satisfaction level with most of the items ranges from 2 (little satisfied) to 3 (satisfied), decreasing substantially for respondents from non-adherent households. All the reported mean differences are significant (independent samples t-test p = 0.000). Respondents from participant and non-participant families differ significantly in all dimensions (independent samples t-tests p = 0.042, p = 0.000 and p = 0.000, respectively).

4.5.2 Logistic regression

In order to compare the predictive effect of the dimensions resulting from the Principal Components Analysis on household recycling participation, a logistic regression model was estimated. The self-reported behavior in separating and disposing household recyclable material, measured by a binary scale (1 – yes; 0 – no), was used as a dependent variable. In addition to the eleven dimensions defined above, the variable *Age* and a set of dummy variables were included as explanatory variables. The purpose of the dummies was to assess the predictive effect of the available space at the household to store the recyclable materials and the remaining socio-demographic attributes. These dummy variables were named *Space to store, Gender, Medium-education, Technical-education, Higher-education, Medium-income and Higher-income* level.

The dummy *Space to store* identifies all the respondents who declare to possess some disposable room to store recyclables with the value 1. In the other dummies, the value 1 is attributed to women (*Gender* = 1), respondents with education level ranging from 7 years to 12 years (*Medium-education* = 1), respondents with technical/ professional education (*Technical-education* = 1), respondents with high school (*Higher-education* = 1), respondents belonging to families with monthly income ranging from 500 € to 1999 € *(Medium-income* = 1) and respondents from families with a monthly income of at least 2000 € (*Higher-income* = 1). When the three dummies representing education level take simultaneously the value 0, this means that the respondent has a low education level (equal to or lower than 6 years of school completed). Similarly, respondents from very low income families (less than 500 €) were identified through the value 0, in both dummies representing family's monthly income.

The maximum likelihood estimates (unstandardized) of the logistic regression model, the standard errors, and the respective results of the Wald tests are presented in Table 4.4.

TABLE 4.4
Results of the estimation of a logistic regression model with the initial independent variables

Independent Variables	$\hat{\beta}$	S.E.	Wald	p
PC1 – Balance and limits of nature	0.028	0.163	0.030	0.862
PC2 – Incapability and lack of knowledge	0.179	0.168	1.140	0.286
PC3 – Importance of life style change	0.136	0.152	0.804	0.370
PC4 – Man over nature	0.114	0.161	0.498	0.480
PC5 – Social norm	0.727	0.159	20.908	0.000
PC6 – Awareness of recycling benefits	0.079	0.153	0.263	0.608
PC7 – Personal norm	0.955	0.168	32.407	0.000
PC8 – Difficulty or indifference	-1.490	0.192	60.122	0.000
PC9 – Disposal conditions	0.110	0.147	0.560	0.454
PC10 – System adequacy and information	0.407	0.150	7.362	0.007
PC11 – Disposal containers location	0.480	0.158	9.255	0.002
Space to store	0.845	0.319	7.015	0.008
Gender	0.226	0.305	0.547	0.459
Age	0.022	0.013	2.738	0.098
Medium-education	0.415	0.546	0.579	0.447
Technical-education	-0.425	0.681	0.390	0.532
Higher-education	0.250	0.558	0.201	0.654
Medium-income	-0,056	0.520	0.011	0.915
Higher-income	0.195	0.602	0.105	0.745
Constant	-1.223	0.143	1.709	0.191

The aforementioned linear regressions (twelve, in this case) were carried out, in order to assure the absence of strong multicollinearity among the independent variables and in no situation it was recorded a R^2 higher than 0.317. To assess that the model is correctly specified, the predictive effect of polynomial contrasts was tested. In particular, to test quadratic effects, the likelihood of the proposed model was compared with the likelihood of the model that also includes the square values of these variables (excluding the dummy variables)[64]. The observed value for the G^2 statistic, with 12 degrees of freedom, shows that the coefficients of the variables associated with the quadratic effects are jointly non-statistically significant ($p = 0.387$). Similar results were obtained when testing cubic effects, that is, there is no evidence of non-linearity between the logit of the dependent variables and the set of independent variables ($p = 0.125$). To test the non-additivity between the logit and the explanatory variables, 84 interaction terms were added to the model and their statistical significance was tested using the likelihood ratio test (these terms resulted from the product of the twelve quantitative variables by each of the seven dummy variables). In this case, the observed value for the G^2 statistic, with 84 degrees of freedom, evidences that the coefficients of the variables associated with the interaction terms are jointly non-statistically significant ($p = 0.131$) and, therefore, there is statistical evidence in favor of the hypothesis of additivity between the logit of the dependent variable and the independent variables.

As previously referred, a linear specification of a non-linear model or even an additive specification of an interactive model is similar to omitting relevant independent variables. Since none of these problems is patent in the proposed model, they are not sources of incorrect omission of explanatory variables. However, to get additional evidence that the model doesn't incur in the omitted variables bias, Ramsey's test was performed, too. In this case, the observed value for the G^2 statistic, with 2 degrees of freedom, demonstrates that the coefficients of the square and the cube of the fitted values are not jointly significant ($p = 0.149$) and, thus, there is statistical evidence in favor of the non-omission of relevant explanatory variables. Finally, concerning the specification of the model, the observation of the p-values associated with the Wald

[64] The square of a dummy variable is equal to that dummy variable. Therefore, if both were included in the model, perfect multicollinearity would occur and the regression would not run.

statistic in Table 4.5 (last column) suggested the inclusion of irrelevant explanatory variables, since the coefficients of several independent variables, and also the constant term, are not individually statistically significant ($p > 0.1$). However, for now, these variables will remain in the model, in order to allow the testing of the set of research hypotheses formulated in this study. These tests will be performed using a 10% significance level to minimize the effect of the inclusion of irrelevant variables[65]. Finally, in the proposed model, 94.3% of the *Standardized residuals* range from –2 to 2 and all *Dbeta* values are far from 1, suggesting no problems concerning residuals or influential cases.

In testing the first research hypothesis, **H$_1$**, that "the general ideological position towards the environmental problematic is not a significant predictor of recycling behavior", the null and the alternative hypotheses are $H_{01}: \beta_1 = \beta_3 = \beta_4 = 0$ and $H_{a1}: \exists \beta_i \neq 0 \quad i = 1,3,4$, respectively. The non-rejection of H_{01} means a widespread acceptance of the New Environmental Paradigm between recyclers and non-recyclers, that is, the general environmental concern is not an important determinant of recycling behavior. This test was performed comparing the likelihood of the model with all the independent variables (the unrestricted model) with the likelihood of the model without the variables *PC1 – Balance and limits of nature*, *PC3 – Importance of life style change*, *PC4 – Man over nature* (the restricted model). In this case, the observed value for the

[65] When a model includes irrelevant variables, the statistical inference using, for instance, the Wald statistic, becomes conservative. This means that it is more difficult to reject the null hypothesis that there is no relationship between the dependent variable and each independent variable, even when this hypothesis is false. This problem can be overcome if all the tests based on the initial model are performed using a significance level higher than the usual ones (1% or 5%), for instance, a 10% significance level. Using a higher significance level, the rejection region becomes larger and the conservative trend of the tests will be, therefore, confined.

G^2 statistic, with 3 degrees of freedom, does not allow the rejection of H_{01} ($p = 0.763$), that is, there is statistical evidence in favor of $\mathbf{H_1}$.

To test the second hypothesis, $\mathbf{H_2}$, that is, that "the perceived ability to contribute to the environmental problems resolution is a significant predictor of recycling behavior", the null and the alternative hypotheses are $H_{02}:\beta_2 = 0$ and $H_{a2}:\beta_2 \neq 0$, respectively. If H_{02} is rejected, recycler and non-recycler households differ significantly in their perceived ability to contribute to the environmental problems resolution, measured by the independent variable *PC2 – Incapability and lack of knowledge*. However, based on the observed value for the G^2 statistic, with 1 degree of freedom, H_{02} should not be rejected ($p = 0.284$), that is, there isn't statistical evidence in favor of $\mathbf{H_2}$.

Concerning the third hypothesis, $\mathbf{H_3}$, that "the specific attitudes towards recycling are significant predictors of recycling behavior", the null and the alternative hypotheses are $H_{03}:\beta_5 = \beta_6 = \beta_7 = \beta_8 = 0$ and $H_{a3}:\exists\beta_i \neq 0 \;\; i = 5,6,7,8$, respectively. Now, the rejection of H_{03} demonstrates a significant relationship between specific attitudes towards recycling and recycling participation. In this situation, the observed value for the G^2 statistic, with 4 degrees of freedom, sustains the rejection of H_{03} ($p = 0.000$), that is, there is statistical evidence in favor of $\mathbf{H_3}$.

Regarding the fourth hypothesis, $\mathbf{H_4}$, that "the satisfaction level with the provided logistics service is a significant predictor of recycling behavior", the null and the alternative hypotheses are $H_{04}:\beta_9 = \beta_{10} = \beta_{11} = 0$ and $H_{a4}:\exists\beta_i \neq 0 \;\; i = 9,10,11$, respectively. In this case, the rejection of H_{04} indicates that the convenience of the recycling program, strongly related to the satisfaction with the provided logistics service, is a significant predictor of recycling participation. In this case, the observed value for the G^2 statistic, with 3 degrees of freedom, supports the rejection of H_{04} ($p = 0.000$), that is, there is statistical evidence in favor of **H₄.**

To test the fifth hypothesis, $\mathbf{H_5}$, that "the existence of some available space in the household is a significant predictor of recycling participation", the null and the alternative hypotheses are $H_{05} : \beta_{space} = 0$ and $H_{a5} : \beta_{space} \neq 0$, respectively. If H_{05} is rejected, the existence of some available space in the household to store the recyclable materials is a determinant of the adoption of recycling practices. In agreement with the observed value for the G^2 statistic, with 1 degree of freedom, H_{05} should be rejected ($p = 0.007$), that is, there is statistical evidence in favor of $\mathbf{H_5}$. Similarly, in testing $\mathbf{H_6}$ that "gender is not a significant predictor of recycling participation", the null and the alternative hypotheses are $H_{06} : \beta_{gender} = 0$ and $H_{a6} : \beta_{gender} \neq 0$, respectively. In this case, the non-rejection of H_{06} provides evidence in favor of a non-statistically significant association between gender and recycling participation. Indeed, the observed value for the G^2 statistic, with 1 degree of freedom, suggests that H_{06} should not be rejected ($p = 0.459$) and, thus, there is statistical evidence in favor of $\mathbf{H_6}$.

At last, to test $\mathbf{H_7}$ that "age, education level and the household income are significant predictors of recycling participation", the null hypothesis is $H_{07} : \beta_{age} = \beta_{medium\_education} = \beta_{technical\_education} = \beta_{higher\_education} = \beta_{medium\_income} = \beta_{higher\_income} = 0$. The rejection of this hypothesis indicates a statistically significant relationship between these socio-demographic attributes and recycling involvement. In this case, the observed value for the G^2 statistic, with 6 degrees of freedom, supports the non-rejection of H_{07} ($p = 0.327$) and, consequently, there isn't statistical evidence in favor of $\mathbf{H_7}$.

After testing the seven research hypotheses, the likelihood ratio test was applied to eliminate the variables incorrectly included in the initial model (Table 4.5). The first tested hypothesis was that all independent variables, whose Wald statistic reported a p-value higher than 0.1, are irrelevant variables. In accordance with the observed value for the G^2 statistic, with 12 degrees of freedom, this hypothesis should not be rejected ($p = 0.691$), which confers credibility to the hypothesis that these variables must be jointly eliminated. Nevertheless, in the model estimated without these variables, the p-value associated to the Wald statistic of the variable *Age* is now greater than 0.1. The G^2 statistic was then used indeed to test the elimination of *Age* from the model. In this case, $H_0 : \beta_{age} = 0$ and $H_a : \beta_{age} \neq 0$. According to the observed value for the G^2 statistic, with 1 degree of freedom, there is statistical evidence in favor of H_0 ($p = 0.144$), that is, this variable should also be eliminated from the model.

Table 4.5 shows the maximum likelihood estimates (unstandardized, fully standardized and y* standardized for the dummy variable) of the final logistic regression model, their standard errors and the corresponding results of the Wald tests. The McFadden's pseudo-R^2 is also presented.

TABLE 4.5
Results of the estimation of a logistic regression model with the final independent variables

Independent Variables	$\hat{\beta}$	$\hat{\beta}^*$	S.E.	Wald	P
PC5 – Social norm	0.774	0.287	0.153	25.501	0.000
PC7 – Personal norm	0.945	0.342	0.158	35.779	0.000
PC8 – Difficulty or indifference	-1.384	-0.507	0.177	61.428	0.000
PC10 – System adequacy and information	0.379	0.141	0.142	7.112	0.008
PC11 – Disposal containers location	0.399	0.148	0.147	7.347	0.007
D – Space to store	0.725	0.273	0.304	5.675	0.017
Constant	-0.166	-------	0.987	4.743	0.320

McFadden's pseudo-$R^2 = 0.61$

In the final model, the p-values of the Wald tests show that the six independent variables are individually statistically significant. This model was also submitted to all the misspecification tests performed in the initial unrestricted model and the hypotheses of non-linearity, non-additivity and omission of relevant variables were rejected. In addition, the analysis of the residuals and influential cases does not suggest the presence of outliers or influential cases. In the test to the overall significance of the explanatory variables included in the model, the null hypothesis was rejected ($p = 0.000$). The Hosmer and Lemershow's goodness of fit test was also conducted. In this test the null hypothesis is that the model adjusts well to the data and this hypothesis was not rejected ($p = 0.713$). On the other hand, the predictive capability of the restricted model is very reasonable, since 85.3% of households that participate in the recycling program and 72.3% of non-adherent households were correctly classified. The overall percentage of rightly classified cases is 79.7%.

In this case, each standardized estimate of Table 4.5 must be interpreted as the expected increase (or decrease, if negative), measured in terms of standard deviations, in the household propensity to participate in the recycling program for a standard deviation increase in the associated independent variable, holding all the remaining variables constant. For instance, a standard deviation increase in the satisfaction with the "System adequacy and information" increases the propensity of the household to participate in the selective-collection program by 0.148 standard deviations, holding all the other variables constant. Concerning the dummy variable *S – Space to store*, the y^* standardized estimate of 0.273 should be interpreted as the estimated increase in the propensity of household to participate in the selective-collection program, which results from the fact that the household possesses some space to temporarily store the recyclable materials, compared with the no-space availability situation, keeping all the other variables constant.

4.6 Discussion

Concern with environmental deterioration represents an important force shaping the economy and the policies of the most developed countries. Independent from its underlying causes, the excessive production of solid waste integrates this general problem. Recycling packaging waste represents a very interesting strategy within the general framework of environmental management and, in particular, in the solid waste valorizing policy. In addition to direct environmental and economic benefits, it is possible, through recycling, to reduce substantially the amount of residues that, alternatively, would be disposed at landfills or incinerated. In this way, recycling contributes to minimize the social problems inherent to the need of waste treatment.

The design of a social-marketing communication plan that fosters the adoption of "sustainable behaviors" in the recycling context (i.e., the household separation of recyclable materials and its dispose of in the suitable containers) should be based on a previous analysis of its potential audience. Assessing consumers' general environmental attitudes and specific attitudes towards recycling and also measuring consumers' satisfaction level with the performance of the provided logistics service of the selective-collection system are important elements of this market research.

The first finding of this study emerges directly from the interpretation of the coefficients of logistic regression. A superior propensity to participate in the selective-collection program is positively related to the existence of some available space in the residence to store the recyclable materials, with strong positive specific attitudes towards recycling

(*PC7 – Personal Norm* and *PC5 – Social Norm*) and with a higher satisfaction level with the logistics issues of the selective-collection system (*PC11 – Disposal containers location* and *PC10 – System adequacy and information*). On the other hand, households in which the respondent values more the difficulty in participating or is more indifferent to the recycling problematic (*PC8 – Difficulty or Indifference*) report a negative propensity to engage in the selective-collection program. Given the absolute size of this standardized coefficient estimate, *PC8 – Difficulty or indifference* is the variable that strongly explains (negatively) the household propensity to contribute to the recycling program.

Another important finding is that members of adherent and non-adherent Portuguese households report a similar awareness level regarding environmental problems, measured by the NEP scale. In other words, recycling behavior is not determined by citizens' general ideological position towards environmental issues. However, the expectation that members of participant and non-participant households differ significantly in their perceived ability to contribute to environmental problems resolution, measured by the variable *PC2 – Incapability and lack of knowledge,* was not statistically confirmed. The same happened with socio-demographic attributes. Some explanations could be proposed for the absence of these relationships. Firstly, citizens in general may believe that their individual contribution is too insignificant when compared with the problem magnitude and, therefore, it will have no practical effect on its resolution. This generalized feeling becomes stronger when citizens assume that others are not participating as well. Secondly, the idea that it is the government, not the general public, who has the responsibility, the necessary knowledge and the capability of solving environmental problems is widespread.

Besides, citizens often value excessively the effort required to participate in the recycling program, either because the logistics service of the selective-collection system it excessively inconvenient or even due to the lack of general and specific information about how to participate. The statistical analysis performed in this research suggests that this point of view sustains, in strong sense, why there is no convergence between Portuguese population ideological positions towards the environment and their effective behavior. In fact, it is clear from Table 4.5 that respondents more satisfied with the provided logistics service (represented by the variables *PC11 – Disposal containers location* and *PC10 – System adequacy and information*), respondents who do not value strongly the necessary effort to separate and properly dispose their recyclable waste (symbolized by the variable *PC8 – Difficulty or Indifference*) and those who have some available space in the residence to store these materials (represented by the dummy variable, D – *Space to store*) belong to families with higher propensity to participate in the recycling program. In addition, the positive relationship between the variables *PC7 – Personal Norm* and *PC5 – Social Norm* and a superior propensity to contribute to the selective-collection program show that members of adherent households tend to possess a strong positive attitude towards recycling.

4.7 Final conclusions and implications

While much work has been done on predictors of recycling behavior, the effort in promoting recycling practices in Portugal was evaluated, at a national level, only now. In most cases, the results of the study are consistent with the formulated hypotheses and, thus, with the previous research on the subject. Additionally, the interesting findings of this research clearly sustain the idea that the statistical modeling is an important device in a well-founded decision process, in this case, in the communication and in the logistics planning of the selective-collection-system. The sequence of statistical methods and also the chosen interpretation approach represent a potential contribution for research, not only in the recycling area, but also in other areas in which the estimation of a logistic regression model seems pertinent.

The following relevant question is how to take advantage of the knowledge of the reported results in order to improve the recycling participation standards within Portuguese households.

An unquestionable aspect is the need to improve the performance of the consumer logistics service of the selective-collection system. This service should be reevaluated, in its several perspectives, and special attention must be paid to the disposal-containers location, support and claim services availability and general information provided. This is very important, since respondents from non-adherent households report systematically a lower satisfaction level with all the items that characterize the logistics service.

On the other hand, as previously mentioned, this analysis is a starting point in the identification of useful guidelines to consider in future communications and intervention strategies, designed to foster recycling participation. In general terms, a social-marketing plan should demystify negative attitudes towards recycling and reinforce more positive ones. Within this framework, the nature of the provided information is a crucial issue.

To reduce the attitude of *Difficulty*, which represents one of the strongest negative attitudes affecting recycling participation, specific information about the specificities of the recycling process should be presented. This information must clarify the selective-collection process, identifying all materials that should be separated and in which containers they should be deposited of. In this information effort, it is important to make reference to the materials that are less frequently used and, as a consequence, raise more doubts concerning their recyclability. Clarifying the recycling process and the specific tasks that the consumers are expected to perform is the easiest way to make it less complex in the consumers' perspective. This factor may potentially moderate the belief that it is difficult to participate in the recycling program.

The attitude of *Indifference* is also negatively related to the participation in the selective–collection program. It comprises the items "to recycle household waste is not up to me", "almost no one I know recycles any household materials" and "households like mine are responsible for a very large part of the materials disposed of in landfills" represented by the variable *PC8 – Difficulty* and *Indifference* (Table 4.2). In order to attenuate this attitude, it is very important to show that all citizens are responsible for the national problem of the excessive solid waste production, providing information, for instance, about the amount of waste each family produces annually, on average. Therefore, households that do not participate in the selective-collection program "are really responsible for the large part of the materials disposed of in landfills". The purpose of this kind of message is also to show that, if all citizens originate the problem they all must contribute for its attenuation. This may reduce the feeling that "to recycle household waste is not up to me", which contributes to the *Indifference* attitude as well.

It is also important to show that the adoption of recycling behaviors is far from being an isolated action, only performed by a limited number of citizens. This purpose may be achieved by revealing, for instance, the numbers that show the evolution in the amount of packaging residues recovered and delivered for recycling to SPV, in the last few years, or presenting the national and local recycling results. In this way, it is possible to mitigate the idea that "almost no one recycles any household materials", which is in the genesis of the *Indifference* attitude as well.

The social-marketing plan should also reinforce *Personal norms,* the other kind of positive attitude towards recycling. In this sense, to show how serious the excessive production of solid waste is and how the adoption of recycling behaviors may contribute to solve this problem is something that should be emphasized. It might be also of great value to explore the idea of the packaging intrinsic value, that is, how the packaging residues, through the recycling process, give rise to a new set of useful goods that everyone recognizes. The purpose of this type of message is not simply to offer information about the multiple and positive effects of the generalization of recycling practices, even though the study shows that recyclers and non-recyclers do not differ significantly regarding *PC6 – Awareness of recycling benefits*. The objective of this message is to activate the *PC7 – Personal norms*, that is, the feeling of pride in participating in a project with beneficial environmental and economic impacts and some guilt and sense of responsibility for the serious consequences of the passivity.

The implications of the encountered results were analyzed concerning the nature of the information that should be provided, in order to promote recycling behavior. It would be interesting to extend this investigation to the analysis of the best forms to carry out the proposed messages, deeply assessing the relevance of the communication strategy in motivating citizens to participate in selective-collection programs.

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Chapter 5

COMBINING BEHAVIORAL THEORIES TO PREDICT RECYCLING INVOLVEMENT

Abstract

This chapter merges insights from two well-known attitude-behavior theories – the theory of planned behavior (Ajzen, 1985) and the model of altruistic behavior (Schwartz, 1977) – with elements from two broader models from environmental psychology – the model of environmental behavior (Grob, 1995) and the model of environmental concern (Stern, Dietz and Guagnano, 1995) – to propose a comprehensive structural equation model to explain recycling behavior. The articulation of these theories allows for a better understanding of the direct and indirect relationships among important determinants of recycling behavior investigated in previous studies. Knowledge of the main features of the marketing strategy conducted in Portugal to foster recycling enabled the inclusion in the model of the potential influence of a communication component. The specified model is estimated using the available data on the subject. In general, results support the use of the theory of planned behavior as a basis for modeling recycling participation. However, the integration of this theory with the Schwartz's model is only partially achieved. Another important finding of this study is that recycling behavior is indirectly determined by personal psychological features, like social conscience, but not by general ecological attitudes. Finally, this chapter suggests the lack of success of the communication strategy followed up in Portugal to encourage recycling practices in attaining one of its most important objectives.

5.1 Introduction

Previous research is quite consistent in the idea that awareness of ecological issues is widespread and that most consumers are conscious of the recycling potential in improving the environmental quality. However, these studies also demonstrate that there is no convergence between the general ideological position towards the environment and this pro-environmental behavior (Scott, 1999; Gamba and Oskamp, 1994; Vining and Ebreo, 1992; Oskamp *et al.*, 1991; Vining and Ebreo, 1990). In other words, although nearly everyone has positive beliefs with regard to environment, only a restricted group behaves accordingly.

Considering the weak or dubious relationship between general pro-ecological attitudes and recycling participation, research has invited further inquiry on the role of more specific attitudes in determining such ecological practice. However, as pointed out by Stern, Dietz and Guagnano (1995), "attitude-behavior theories have proven useful in predicting certain specific pro-environmental behaviors, but they have so far left unspecified the effects of the social and institutional contexts that shape the relevant attitudes and behavior" (Stern, Dietz and Guagnano, 1995: 738). Despite this recommendation, no research on the recycling behavior setting was subsequently undertaken to address this important gap in the literature.

Without suggesting that unique models should be considered in order to understand environmental behaviors, the main purpose of the current study is to propose a more extensive framework to predict recycling participation, in which important constructs assessed in previous studies on the attitude-behavior relationship (specific attitudes towards recycling / awareness of recycling benefits, subjective norms, personal norms, perceived behavior control, specific knowledge and perceived convenience) could be related to psychological personal values and general environmental awareness.

Specifically, this study combines insights from two prominent attitude-behavior theories – the *theory of planned behavior* (Ajzen, 1985) and the *model of altruistic behavior* (Schwartz, 1977) – with elements from two broader models from environmental psycho-sociology – the *model of environmental behavior* (Grob, 1995) and the *model of* *environmental concern* (Stern, Dietz and Guagnano, 1995) – to develop an integrated structural equation model to explain consumers' recycling compliance. A main purpose of this integration is to get a better understanding of recycling behavior by fulfilling, in the recycling framework, the research gap identified by Stern, Dietz and Guagnano (1995).

The influence of the main features of the communication strategy, followed in the Portuguese recycling program, in some constructs of the proposed model will be considered, as well. Because the characteristics of the Portuguese selective-collection program are not uncommon, it is expected that the proposed model may also be used to better understand and predict recycling practices in other countries, in which selective-collection is also based on drop-off systems. Moreover, since controllable extrinsic variables – perceived convenience and communication – will be included in the model, some managerial implications from this research will be derived. The inclusion of these two types of controllable extrinsic variables in a structural equation model of recycling behavior also represents a contribution to the research on this topic. Actually, all previous studies that have modeled recycling behavior through the application of SEM have considered only a few variables that can be managed by the entities responsible for implementing and attending a recycling program, such as the "resource-facilitation conditions" (Taylor and Todd, 1995a: Taylor and Todd 1995b).

This chapter is organized as follows. In the first section, the four mentioned models are reviewed. The theory of planned behavior (TOPB) receives a special emphasis because it represents the starting point for the proposed model. In the following section, the conceptual framework that posits relationships among the constructs taken from the four examined models, and including the communication component, is designed and a set of research hypotheses is defined. Subsequently, the theoretically proposed model is empirically tested by means of the application of structural equation modeling (SEM) to the available data. Results are then presented and discussed, and in the final section, some of their managerial implications are pointed out.

5.2 Review of literature

5.2.1 The theory of planned behavior (Ajzen, 1985)

The theory of planned behavior (TOPB) has its foundation in the *theory of reasoned action* (TRA) (Ajzen and Fishbein, 1975), which is based on two basic premises. The first states that individuals act rationally and, therefore, use and process the information at their disposal to make the decision to perform the behavior. Once this intention has been formed, the individual will behave accordingly. The second premise establishes that behavior intention is determined by the attitude towards the specific behavior and by subjective norms. Although this theory has demonstrated an impressive predictive value in numerous applications on social and behavioral sciences, it was criticized in several occasions especially because it assumes that the target behavior is completely under the subjects' volitional control, which means that the individual has all the conditions to perform the task in question.

The TOPB is just the broadening of TRA to include the perceived behavior control, another exogenous predictor of behavior intention. In this sense, TOPB extends TRA to the more realistic situation of non-volitional behavior by encompassing those individuals requiring opportunities, resources and specific knowledge. In agreement with this theory, the construct perceived behavior control predicts the specific behavior directly and indirectly through intentions.

Within the predictive models that have been proposed to understand recycling behavior, TOPB appears to be a quite acceptable framework and, so, a promising starting point for the current research. Three reasons sustain the choice of the TOPB as the base of the proposed model. First, the TOPB enables the establishment of relationships (direct or indirect) among five relevant predictors of recycling behavior identified in previous research in the field: the attitude towards the act, subjective norms, perceived behavior control, specific knowledge and perceived performance / convenience of the provided logistics service[66].

The second reason why the proposed model will be founded on the TOPB is because the prediction ability of this theory is more accurate when specific attitudes towards the behavior in question are considered, rather than moral global attitudes. In what concerns recycling, this means that general attitudes towards the environment are not necessarily significant (direct) determinants of recycling participation. This premise is in accordance with the previous studies on predictors of recycling behavior that, on one hand, consistently show the predictive importance of more specific attitudes and, on the other hand, underline the absence of a reliable (direct) relationship between more global attitudes towards environmental issues and recycling involvement. In truth, the

[66] The importance of these predictors is evidenced in Chapter 2, section 2.4.2 and 2.4.3. As explained in this chapter, several measurements of specific attitudes towards recycling have been considered, such as the *awareness of recycling benefits*, *subjective norms* and *perceived behavior control*. In this chapter, the latent variable attitude towards the act will be measured by using items representing beliefs about the benefits of recycling. Therefore, this latent variable could have been referred to as *awareness of recycling benefits*. However, to keep a strait connection with the TOPB, the designation *attitude towards recycling* was considered preferable.

predictive effect of general pro-ecological attitudes in recycling participation has been feeble or inconsistent[67].

One last reason for choosing the TOPB as a starting point for this research is that this theory does not take into account the influence of socio-demographic attributes, which, as previous research shows, are poorly or doubtfully related to recycling behavior[68].

5.2.2 The model of altruistic behavior (Schwartz, 1977)

In agreement with this model, behavior is explained by the inter-relations among four main dimensions: personal norms, social norms, awareness of consequences and ascription of responsibility. Schwartz's model's central idea is that the influence of *social norms* on the individual-behavior is not direct but, instead, mediated by *personal norms* of altruistic behavior. Taking the recycling framework as a reference, *personal norms* reflect the idea that the individual should recycle because he / she feels that it is the right thing to do. As described in Hopper and Nielsen, "To violate a personal norm engenders guilt, and to uphold a personal norm engenders pride" (Hopper and Nielsen, 1991: 200). On the other hand, *social norms* represent values and beliefs regarding whether or not specific referents (family members, friends, neighbors or social groups) think the individual should or not perform the behavior. In conformity to the model, the cause-effect link between the personal and social norms will only be effective if *awareness of consequences* and *ascription of responsibility* are activated. In other words, those who feel morally obligated to recycle will only engage in the act if they believe in the positive consequences of recycling and feel personally responsible for these consequences. The belief that *personal norms* mediate the link between *social*

[67] See Chapter 2, p. 76-77.
[68] See Chapter 2, p. 75.

norms and recycling behavior was assessed in at least two occasions and, in both, this hypothesized relationship was confirmed (Bratt, 1999; Hopper and Nielsen, 1991). When assessed independently from the model of altruistic behavior, *personal norms* were also related to recycling behavior (Vining and Ebreo, 1992; Oskamp *et al.*, 1991).

5.2.3 The model of environmental concern (Stern, Dietz and Guagnano, 1995)

Stern, Dietz and Guagnano (1995) consider that environmental social-psychology has focused too restrictively on the socio-economic determinants of general pro-environmental concern or, alternatively, on the relationship between more specific attitudes and pro-environmental behaviors. The *model of environmental concern* they proposed was, therefore, a first attempt to integrate research into the relationship between specific attitudes and environmental behavior with broader pro-environmental attitudes, values and social structure.

Under this model, environmental behavior is preceded by four major constructs: (1) behavior commitments and intentions, (2) specific attitudes, (3) general attitudes (world-view / folk ecological theory), (4) values and (5) position in the social structure (i.e., the institutional constraints and incentives). Without excluding the possibility of feedback effects, the authors believe the major flow of causation starts from construct (5) and that the strongest causal influences are between adjacent constructs. As empirically shown in their study, the general attitudes about the human-environment relationship are well captured by the New Environmental Paradigm (NEP) scale (Dunlap and Van Liere, 1978). General attitudes are, subsequently, antecedents of more specific attitudes or attitudes towards the environmental behavior in question. As the authors refer "in many situations, including responding to a survey, people use cognitive processes that ignore details and problem specific information (Dietz and Stern, 1995). Instead, they classify a topic and make reference to general attitudes and values in responding and filtering information" (Stern, Dietz and Guagnano, 1995: 729). Specific attitudes are then predictors of more proximate causes of a particular action – intentions, for instance – that, finally, will directly determine the environmental behavior.

5.2.4 The model of environmental behavior (Grob, 1995)

As the *model of environmental concern*, the *model of environmental behavior* proposed by Grob (1995) was not specifically applied to the recycling behavior problematic yet. It suggests a set of four interrelated determinants of general environmental behavior: (1) personal-psychological values, (2) environmental awareness, (3) perceived control and (4) emotions. In accordance with this model, the four variables are direct determinants of environmental behavior. In addition, personal values also predict environmental awareness, perceived control and emotions. Environmental awareness also explains perceived control.

5.2.5 The apparent compatibility of the four behavioral models

As Boldero (1995) points out, the concept of *social norms* in Schwartz's (1977) model of altruistic behavior is comparable with the notion of *subjective norm* in the TOPB. Similarly, *awareness of consequences* has a similar meaning of *attitude towards the act* in the TOPB. The existence of such analogous concepts in both models supports the suspicion that they can be integrated to better predict recycling behavior.

Furthermore, the model of environmental concern proposed by Stern, Dietz and Guagnano (1995) also shares some points with the TOPB. As the TOPB, this model agrees with environmental behavior being preceded by *behavior intentions* that, in turn, are determined by *specific attitudes* towards the act. However, this model goes somewhat beyond and proposes that *specific attitudes* are explained by *general environmental attitudes*, which, in sequence, are predicted by *personal values*. These specific relationships of the model of environmental concern sustain the extension of TOPB to encompass two additional potential predictors of recycling behavior: *personal values* and *general pro-ecological attitudes*.

On the other hand, the link between *personal values* and *general environmental attitudes* is also part of the model of environmental behavior suggested by Grob (1995). In addition, this model proposes that *personal values* predict *perceived behavior control* that, in turn, explains environmental behavior. The relationship between *personal values* and *perceived behavior control* may also be used to enlarge the TOPB and, so, to develop a more comprehensive and integrated model to predict recycling behavior.

5.3 Research hypotheses

The proposed comprehensive structural equation model of recycling behavior is presented in Figure 5.1. The rationale behind this conceptual framework and the research hypotheses (most of them placed in their corresponding paths) will now be discussed. The description of the observed variables that are used to measure each latent variable can be found in the following section[69].

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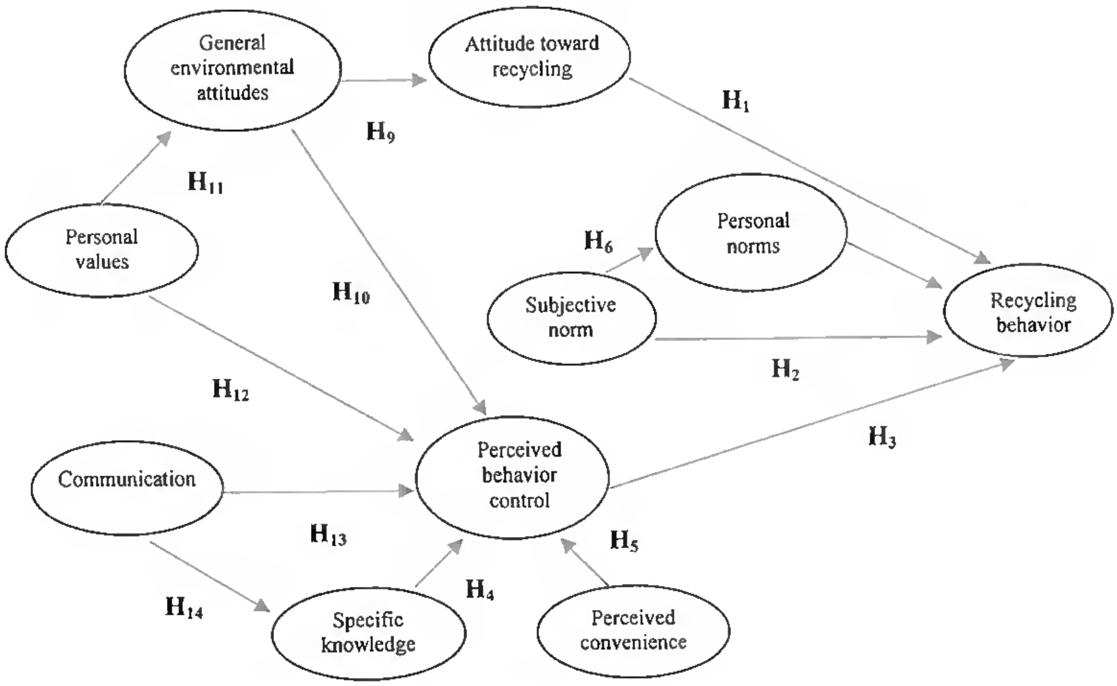
[69] Due to the sake of parsimony in representing the model, the correlations among the exogenous latent variables (personal norms, subjective norms, communication and perceived behavior control) were not depicted in the figure.

FIGURE 5.1
The comprehensive model of recycling behavior



The model incorporates characteristics from all four models outlined above. First, it demonstrates a clear resemblance to the TOPB since it considers *attitude towards recycling*, *subjective norm* and *perceived behavior control* as antecedents of recycling behavior. It was an objective of this study to consider the TOPB as originally proposed by Ajzen (1985), which means that recycling intentions should precede recycling behavior. However, the survey used for the data collection, which will sustain the testing of the proposed model, only enables the evaluation of the respondents' future intention to recycle and not the previous decision or determination that guided the current behavior. Therefore, considering the impossibility of measuring recycling intentions as formulated in the TOPB, this construct was excluded from the model and the potential influence of *attitudes towards the act*, *subjective norm* and *perceived behavior control* was directly established to recycling behavior. Accordingly, the first three hypotheses that are empirically tested in the study may be defined as follows:

H_1: The individual's attitude towards the act of recycling has a positive influence on recycling behavior;

H_2: The individual's subjective norm has a positive influence on recycling behavior;

H_3: The individual's perceived behavior control has a positive influence on recycling behavior.

Moreover, as in the original formulation of the TOPB, *perceived behavior control* is influenced by the individual's perceived ability to carry out the behavior (reflected by the construct *specific knowledge*) and by the external conditions on the individual that may increase or attenuate his ability to perform that behavior (represented by the latent variable *perceived convenience*). Thus, it is expected that when the individual is more aware of the specific tasks involved in recycling and more satisfied with the various components of the consumer logistics service provided by the selective-collection program, the more likely he or she will perceive the simplicity in performing the behavior and the control over that behavior. Thus, the following research hypotheses are proposed:

H_4: Specific knowledge has a positive influence on perceived behavior control;

H_5: The perceived convenience of the logistics service has a positive influence on perceived behavior control.

Generally, people look for some social support for their acts. So, the information about others' behavior, as well as the individual's beliefs concerning those referents' opinion about that behavior, may be important determinants of recycling participation. This premise is presented in the model as **H_2**. However, other than this direct influence on recycling behavior, *subjective norms* may be embraced by the individual and hence become *personal norms*, that is, internalized moral attitudes (Hopper and Nielsen, 1991;

Schwartz and Howard, 1980). As underlined above, this is a critical feature of the Schwartz's (1977) model of altruistic behavior. The suggestion that *subjective norms* are adopted by each individual, leading to *personal norms*, is, therefore, the sixth research hypothesis:

H_6: Subjective norms have a positive influence on personal norms.

Another central idea of Schwartz's (1977) model is that the effect of *social norms* on behavior is mediated by *personal norms*. This hypothesis was supported in the recycling setting by Hopper and Nielsen (1991) and, more recently, by Bratt (1999). The next research hypothesis is not indicated in the model because it has to be tested through the analysis of the indirect effect of *subjective norms* on *recycling behavior*.

H_7: The effect of subjective norms on recycling behavior is mediated by personal norms.

Schwartz's (1977) model also states that the predictive effect of *personal norms* on behavior is larger when the individual is more aware of the consequences of that behavior. Within the recycling framework, this means that those who feel morally obligated to recycle (measured by *personal norms*) are more likely to perform the act if they believe in the positive consequences of recycling (measured by *attitudes towards recycling*). The proposition that the attitude towards the act is a moderator between *personal norms* and recycling behavior was demonstrated in Hopper and Nielsen's (1991) study but not in Bratt's (1999) research. It represents the eighth research hypothesis, not depicted in the figure because its testing requires a multi-group analysis, within the context of SEM, rather than the evaluation of the statistical significance of a direct path.

H_8: The positive influence of personal norms in recycling behavior is stronger for those with higher positive attitude towards the act.

A motivation behind the current study is to investigate the potential indirect effect of *general ecological attitudes* on recycling behavior. The integration of the TOPB within the model of environmental concern proposed by Stern, Dietz and Guagnano (1995) and within the model of environmental behavior projected by Grob (1995) enables the achievement of this purpose. According to the model of environmental concern, specific attitudes regarding a pro-ecological behavior are preceded by more general attitudes towards the environment. With respect to recycling, this means that *general environmental attitudes* are a potential determinant of specific *attitudes towards* recycling. On the other hand, the model of environmental behavior establishes the relationship between *general ecological attitudes* and *perceived behavior control*. So, the following hypotheses are defined:

H_9: General environmental attitudes have a positive influence on the attitude towards recycling;

H_{10}: General environmental attitudes have a positive influence on perceived behavior control.

Another central idea of the model of environmental concern – also shared by the model of environmental behavior projected by Grob (1995) – is that personal values determine the individual's view of the world and, thus, the *general ecological attitudes*. This latter model also states that *personal values* determine *perceived behavior control*. These conceptions are the basis for the next two hypotheses:

H_{11}: Personal values have a positive influence on general environmental attitudes;

H_{12}: Personal values have a positive influence on perceived behavior control.

The remaining two hypotheses are the result of what is expected from the communication strategy followed in Portugal in the last few years to increase the recycling standards. As outlined in Chapter 1, section 1.5.4, the communication strategy has relied mainly on national advertising, with the double objective of mitigating the idea that it is difficult to participate in the selective-collection program and increasing specific knowledge about how to participate. Consequently, it is expected that those citizens that were more exposed to the communication strategy have more perceived behavior control – which measures, as referred, the difficulty to perform the behavior, besides the controllability over the performance of that behavior – and more specific knowledge about the specificities involved in recycling participation. So, there are two last research hypotheses to be investigated:

H_{13}: The communication strategy has a positive influence on perceived behavior control;

H_{14}: The communication strategy has a positive influence on specific knowledge.

5.4 Method

5.4.1 Sample procedures and participants

The data collection procedures as well as the sample description are presented in Chapter 1, section 1.5.5.

5.4.2 Instruments

This section examines the latent variables of the proposed model and justifies the items measuring each latent variable in the national survey. The measurement items (also called indicators or observed variables) are presented in Table 5.1.

TABLE 5.1
Latent variables, observed variables, and scales (*)

Latent Variables	Observed Variables and Scales
Recycling behavior	The household usually separates and disposes of recyclable materials? (scale: 0 – no; 1 – yes) Frequency of separation and disposal of recyclable materials at the "Eco-point" container (scale: 1 – never, 2 – sometimes, 3 – 1 or 2 times a week, 4 – 3 to 6 times a week, 5 – every day) Frequency of separation and disposal of recyclable materials at the glass container Adherence level to separation and disposal of recyclable materials (scale: 1 – nothing adherent, 2 – partially adherent, 3 – totally adherent)
Attitude towards recycling	Household recycling is an important way to conserve natural resources (scale: 1 – totally false, 2 – partially true, 3 – totally true) × Importance of saving natural resources and the environment (less waste/pollution) (scale: 1 – nothing important, 2 – little important, 3 – important, 4 – very important) Household recycling is an important way to conserve energy × Importance of saving natural resources and the environment (less waste/pollution) Household recycling is an important way to reduce pollution × Importance of saving natural resources and the environment (less waste/pollution) Household recycling is an important way to reduce lavishness × Importance of saving natural resources and the environment (less waste/pollution) Household recycling is an important way to reduce the amount of waste disposed at landfills × Importance of reducing the amount of waste disposed at landfills
Subjective norms	My friends expect me to recycle household materials (scale: 1 – totally false, 2 – partially true, 3 – totally true) × Importance of friends' pressure as a reason to recycle (scale: 1 – nothing important, 2 – little important, 3 – important, 4 – very important) My neighbors expect me to recycle household materials × Importance of neighbors' pressure as a reason to recycle My family expect me to recycle household materials × Importance of family's pressure as a reason to recycle
Perceived behavior control	For me, recycling household waste is a very difficult task (scale: 1 – totally true, 2 – partially true, 3 – totally false) × Recycling household waste is not up to me (scale: 1 – totally true, 2 – partially true, 3 – totally false)
Perceived convenience	Disposal conditions (mean of the items of satisfaction with: Frequency of waste collection, emptying regularity, cleaning and maintenance, local safety and number of disposal containers; scale: 1 – not satisfied, 2 – little satisfied, 3 – satisfied, 4 – very satisfied) System adequacy and information (mean of the items of satisfaction with: Information availability, support and claim service, system adequacy to lifestyle and number and type of accepted waste materials) Disposal containers location (mean of the items of satisfaction with: Distance to the disposal containers and disposal containers location) Is there any "Eco-point" container in your residence area? (scale: 0 – no; 1 – yes)
Specific knowledge	Should bottles and other glass packaging be separated and disposed for recycling? (scale: 0 – no; 1 – yes) Should paper /cardboard packaging be separated and disposed for recycling? Should cans be separated and disposed for recycling? Should plastic packaging be separated and disposed for recycling?
Personal norms	I feel a strong personal obligation to recycle a large proportion of by households' recyclables (scale: 1 – totally false, 2 – partially true, 3 – totally true) I would feel guilty if I didn't recycle regularly my households' recyclables I am willing to go blocks out of my way to recycle household materials on a regular basis
General environmental attitudes	When people interfere with nature, it often produces disastrous consequences (scale: 1 – totally disagree, 2 – disagree, 3 – agree, 4 – totally agree) People must live in harmony with nature to survive The balance of nature is very delicate and easily upset There are limits of growth beyond which our industrialized society cannot expand Humans are severely abusing the environment To maintain a healthy economy, we will have to develop a "steady-state" economy where industrial growth is controlled
Personal values	Satisfaction in increasing ways to reduce lavishness (scale: 1 – very few satisfied, 2 – somewhat satisfied, 3 – satisfied, 4 – very satisfied) Satisfaction in promoting actions able to help improving the world Satisfaction in helping others
Communication	Have you received any information about selective-collection through TV? (scale: 0 – no; 1 – yes) Have you received any information about selective-collection through billboards? Have you received any information about selective-collection through the "Eco-points"? Have you received any information about selective-collection through radio? Have you received any information about selective-collection through national newspapers?

(*) When the scale of an indicator is not presented, it is the same as was used in the previous one.

Recycling behavior (RB): Considering the impossibility of observing and reporting packaging recycling of all participants in the current study, the self reported behavior was selected as a proxy measure of the real behavior. Although the two measures are not equivalent, at least one study shows that they are quite related (Gamba and Oskamp, 1994).

Attitude towards recycling (ATT): In general terms, the attitude towards the act assesses whether the individual is in favor or against performing the behavior in question. Within the recycling research, this latent variable has been operationalized in two distinct ways: (1) using the composite measure method as originally proposed by Ajzen and Fishbein (1975), that is, the product of the individual's beliefs regarding the outcomes of the behavior by his / her evaluation of those outcomes (Cheung, Chan and Wong, 1999; Boldero, 1995); (2) as a global or direct measure, considering only the individual's positive or negative judgment of performing the behavior, that is, excluding the evaluation of the behavior's consequences (McCarty and Shrum, 2001; Cheung, Chan and Wong, 1999; Corral-Verdugo,1997; Corral-Verdugo,1996; Guagnano, Stern and Dietz, 1995; Taylor and Todd, 1995a, Taylor and Todd, 1995b; Hopper and Nielsen, 1991). While there has been much speculation concerning which approach best measures the attitude construct, Cheung, Chan and Wong (1999) show that they are strongly correlated. Since a premise of this research is that the TOPB is still promising in modeling recycling behavior, the specific attitude towards recycling was measured using the composite method, as initially suggested by Ajzen and Fishbein (1975). Accordingly, the respondent's beliefs concerning five items representative of the benefits of recycling were assessed and then multiplied by items measuring the respondents' beliefs regarding the importance of those outcomes.

Subjective norms (SN): As the previous construct, subjective norms have been measured using the composite approach as proposed by Ajzen and Fishbein (1975) or directly, as a global measure. In the study carried out by Cheung, Chan and Wong (1999) it was shown that the correlation between the two measuring methods is high and statistically significant. Social pressure may be originated by family members (internal referents) or by individuals or groups outside the family, such as friends, neighbors or social groups (external referents). Although some studies have addressed the separate influence from internal and external referents, for the sake of model parsimony, this study combined the two sources of social pressure in a single construct. Furthermore, as performed in the construct *attitudes towards recycling*, the indirect or composite method, as projected by Ajzen and Fishbein (1975), was used to measure subjective norms. Thus, items measuring the respondent's beliefs about whether his / her family, friends and neighbors think he / she should recycle were then multiplied by items measuring the corresponding importance of complying with these referents' opinion.

Perceived behavior control (PBC): Algebraically, Ajzen (1985) suggests that perceived behavior control results from the product of the beliefs regarding the difficulty to perform the behavior by the controllability over the performance of that behavior. In the first applications of the TOPB to the recycling setting, the definition of the construct perceived behavior control encompassed only the component of control, excluding any measure of perceived difficulty (Boldero, 1995; Taylor and Todd, 1995a; Taylor and Todd, 1995b). Cheung, Chan and Wong (1999) demonstrated that the product of control beliefs by the perceived power (which included situations that would facilitate or inhibit recycling) was significantly correlated with a direct measure of perceived behavior control, based on the mean of five items that are representative of both perceived control and perceived difficulty. In agreement with the procedure followed in the present study, with respect to the remaining exogenous constructs of the TOPB, *perceived behavior control* was measured by the indirect method and resulted from the product of one item measuring the perceived controllability over recycling by one item measuring the perceived difficulty in recycling.

Perceived convenience (CONV): This latent variable represents the external factors that constrain the perceived behavior control. In this study, the perceived convenience was measured by a composite of four features. The first assesses the actual availability of resources, asking if the participant possesses any "Eco-point" container in his / her area of residence. The remaining measures indicate the mean satisfaction level with the representative items of the three main logistics characteristics of the consumer-service in the selective-collection system: (1) disposal conditions, (2) system adequacy and information and (3) disposal containers location. The distribution of the items into these three dimensions resulted from an exploratory principal components analysis carried out over the initial eleven items[70].

Specific knowledge (KN): This latent variable reveals the realistic internal constraints that the individual faces in fulfilling the behavior. Since the collected materials in the Portuguese national recycling program are paper / cardboard, glass, cans and plastic packaging, specific knowledge was evaluated by asking participants whether or not they knew that these classes of materials should be previously separated and then disposed of for recycling.

[70] Cronbach's alpha for the dimension "disposal conditions": 0.9; Cronbach's alpha for the dimension "system adequacy and information": 0.82; Cronbach's alpha for the dimension "disposal containers location": 0.87.

Personal norms (PN): Personal norms reflect the beliefs held by the individual with regard to how he / she should behave. When the individual acts in accordance with these norms, he / she feels proud. On the contrary, if a personal norm is violated, the individual feels guilty. According with this general conception, personal norms were measured by two indicators of personal obligation to recycle and one item indicating the feeling of guilt experienced with non-recycling.

General environmental attitudes (GEA): As aforementioned, Stern, Dietz and Guagnano (1995) showed that broad attitudes regarding the human-environment relationship are well captured by the New Environmental Paradigm (NEP) scale. In agreement with this, the current study used six items from the NEP scale as indicators of general environmental attitudes. This set of items resulted from an exploratory principal components analysis over thirteen items related to general environmental attitudes. The six items in the first dimension yielded by the principal components analysis were chosen to measure the latent variable GEA because this dimension was the one that had presented a higher degree of internal consistency, which was assessed by the Cronbach's alpha coefficient[71].

Personal values (PV): The present study considers three indicators consistently related to social responsibility as measures of personal psychological values, for three reasons. First, social responsibility has been the personal psychological value more evaluated within the recycling framework. Second, the Portuguese national survey does not enable the measurement of most of the personal values variables suggested either by Grob (1995) or by Stern, Dietz and Guagnano (1995). Finally, the aggregation of the three

[71] This set of items resulted from an exploratory principal components analysis over thirteen items related to general environmental attitudes[71]. Eight of these items were taken from the NEP scale and most of the remaining was representative of the Dominant Social Paradigm values (Dunlap and Van Liere, 1984).

indicators was suggested by an exploratory principal components analysis over five items related to personal psychological values[72].

Communication (COM): The latent variable communication refers to the actual receptiveness to the promotional messages that make consumers aware and informed about the selective-collection issue. In this study, the reception or not of information concerning recycling and selective-collection through television, billboards, "Eco-points", radio and national newspapers was used to build the construct communication. Although other media has been used within the Portuguese communication strategy, only these were employed at a national level.

5.4.3 Statistical data analysis methodology

The application of SEM to estimate and validate the proposed model followed the methodological steps that were described in Chapter 2, section 3.4.2. Excluding $\mathbf{H_7}$ and $\mathbf{H_8}$, all the other proposed hypotheses were tested observing the statistical significance of the corresponding direct paths in the structural model. To test if the effect of *social norms* on recycling behavior was mediated by *personal norms* ($\mathbf{H_7}$), the statistical significance of the indirect path of *subjective norms* in *recycling behavior* (through *personal norms*) was evaluated.

To test $\mathbf{H_8}$, a multiple group analysis was performed. AMOS can model data from multiple groups simultaneously. This facility enabled the testing of whether there was any significant difference among those participants with stronger *attitude towards recycling* and those reporting a lower attitude level, concerning the relationship between

[72] Cronbach's alpha: 0.77.

personal norms and *recycling behavior*. To form the groups, the sum of the scores of each respondent on the five indicator variables of the construct *attitude towards recycling* was computed and the mean of this sum variable was determined. Then, those respondents with a score lower than this mean were considered as having a low attitude towards recycling and the others were classified as possessing a strong recycling attitude.

5.5 Results

The model was estimated using WLS and the values for the selected overall fit indexes are reported in Table 5.2. This Table also shows the minimum acceptance levels for fit indexes. As expected, the observed value for the Chi-square statistic is high and statistically significant, suggesting that the observed and the predicted covariance matrixes are not equal. Considering the dependence of the Chi-square test on the sample size, the evaluation of the absolute fit of the model relied on the other two adjunct measures presented in Table 5.2. The GFI is high but does not exceed the recommended level of 0.9. Thus, the model was classified as reasonable concerning this index. Inversely, the RMSEA is low and inside the recommended level, indicating a good model fit. Other than this, the proposed model exceeds the recommended acceptance levels for the remaining measures, suggesting a good incremental and parsimonious fit.

TABLE 5.2
Evaluation of the overall model fit

Goodness of Fit Criterion	Interpretation/ Recommended Acceptance levels	Observed Value	Comment
Absolute fit measures			
Chi-square of the estimated model	Tests $H_0 : S = \sum(\theta)$ against $H_a : S \neq \sum(\theta)$; p > (considered significance level)	2614.024 (p = 0.000)	The model is rejected
GFI	Ranges from 0 (no fit) to 1 (perfect fit); Values higher than 0.9 suggest a good fit	0.876	Suggest a reasonable model fit
RMSEA	Values lower than 0.08 indicate good model fit	0.055	Suggests a good model fit
Incremental fit measures			
AGFI	Ranges from 0 (no fit) to 1 (perfect fit); Values higher than 0.8 suggest a good fit	0.859	Suggests a good model fit
NFI	Ranges from 0 (no fit) to 1 (perfect fit); Values higher than 0.9 suggest a good fit	0.918	Suggests a good model fit
TLI	Ranges from 0 (no fit) to 1 (perfect fit); Values higher than 0.9 suggest a good fit	0.932	Suggests a good model fit
IFI	Ranges from 0 (no fit) to 1 (perfect fit); Values higher than 0.9 suggest a good fit	0.937	Suggests a good model fit
Parsimonious fit measures			
PNFI	Ranges from 0 (no fit) to 1 (perfect fit); Adequate to compare alternative models; The model with the higher PNFI is the best	0.845	Suggest a good model fit
Normed Chi-square	Less than 1 is a poor model fit; higher than 5 reflects a need for improvement	4.040	Suggests a good model fit

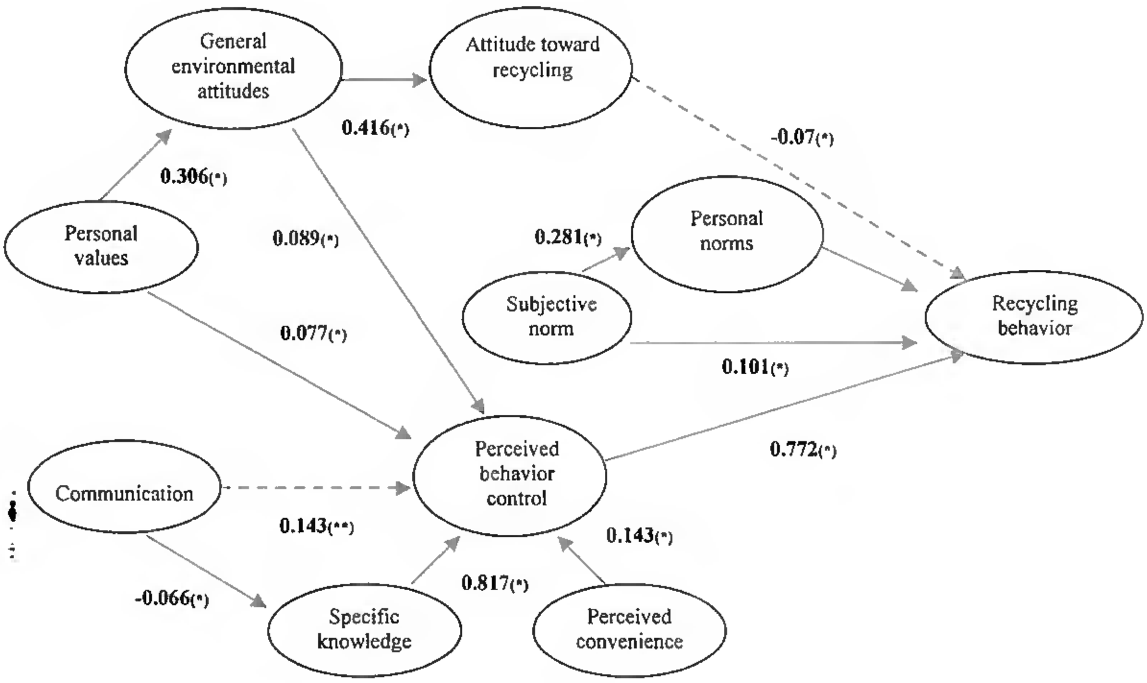
With a good overall model fit, the evaluation proceeded by analyzing the measurement model. Table 5.3 shows that all latent variables are reliable, presenting the adequate levels with respect to alpha Cronbach and composite reliability. Validity was evidenced by significant and standardized loadings of each observed variable on its construct (p = 0.000).

TABLE 5.3
Evaluation of the reliability of the latent variables

Latent Variables	Cronbach's Alpha	Composite Reliability	Comment
Recycling behavior	0.7439	0.7409	Adequate – Good
Attitude towards recycling	0.9067	0.9108	Excellent
Subjective norms	0.8155	0.8369	Very good
Perceived convenience	0.7796	0.7927	Adequate – Good
Specific knowledge	0.7386	0.7365	Adequate – Good
Personal norms	0.7124	0.7239	Adequate – Good
General environmental attitudes	0.6451	0.6473	Acceptable –Adequate
Personal values	0.7780	0.7911	Adequate – Good
Communication	0.6331	0.6425	Acceptable –Adequate

Figure 5.2 shows the estimated standardized path coefficients on the model itself. The findings show that all specified paths, except the one linking the constructs *communication* and *perceived behavior control*, are statistically significant. Additionally, the estimated coefficients representing the link, on one hand, between *attitudes towards recycling* and *recycling behavior* and, on the other hand, between *communication* and *perceived behavior control*, do not possess the hypothesized sign. In short, ten of the twelve proposed direct relationships are significant and the corresponding research hypotheses are supported (for a significance level of 5%). The broken line arrows identify the rejected hypotheses. The indirect path of *subjective norms* to *recycling behavior* (through *personal norms*) is statistically significant and so, the hypothesis that the effect of *subjective norms* on *recycling behavior* is mediated by *personal norms* (**H**$_7$) is supported by the data (p = 0.01).

FIGURE 5.2
Supported and non-supported hypotheses of the model and standardized estimates

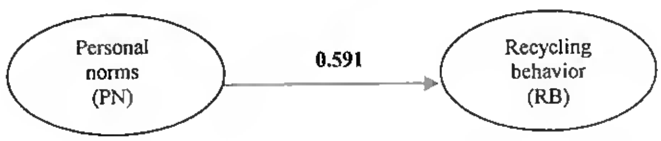


(*) p < 0.05; (**) p = 0.106

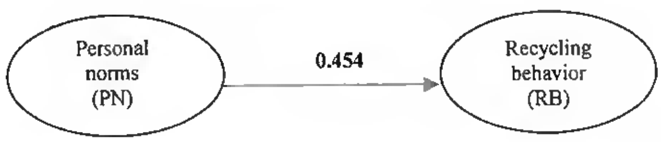
The test $\mathbf{H_8}$, the multiple group facility available in AMOS was carried out. Figure 5.3 shows the results from the simultaneous modeling of the relationship between *personal norms* and *recycling behavior* for respondents with a strong *attitude towards recycling* (group 1) and for those with a weak recycling attitude (group 2). These results were then compared with those of a restricted model, with similar form, but imposing the restrictions that both groups share the same factor loadings (i.e., the coefficients of the measurement model) and also the same regression weight of *personal norms* on *recycling behavior*. The Chi-square difference between the two models, 126.521 – 116.526 = 9.995, is not significant ($p > 0.1$). Therefore, the hypothesis of a group invariant pattern on the relationship between *personal norms* and *recycling behavior* is supported, which means that this link is not mediated by the *attitude towards recycling*. In short, $\mathbf{H_8}$ should be rejected.

FIGURE 5.3
A multiple group analysis of the relationship between personal norms and recycling behavior
Results of the unrestricted model (*)

Group 1: Participants with stronger attitude towards recycling



Group 1: Participants with weaker attitude towards recycling



(*) Chi-square = 116.526 (p = 0.000), GFI = 0.997, RMSEA = 0.059, AGFI = 0.994, NFI = 0.877, TLI = 0.838, IFI = 0.902, PNFI = 0.543; CMINDF = 4.482

The squared multiple correlation for the structural equation modeling *recycling behavior* is relatively high (0.718), suggesting that 71.8% of the variability of this latent variable is explained by the combined effects of the remaining nine latent variables. AMOS provided also the standardized and unstandardized total and indirect effects of each latent variable on recycling behavior. Considering the absolute size of standardized effects, the total influence of each latent variable on the construct *recycling behavior* may be ordered as follows: *perceived behavior control* (0.772, $p = 0.016$), *specific knowledge* (0.630, $p = 0.012$), *personal norms* (0.304, $p = 0.009$), *subjective norms* (0.186, $p = 0.005$), *perceived convenience* (0.110, $p = 0.007$), *personal values* (0.072, $p = 0.010$), *attitude towards recycling* (-0.070, $p = 0.031$), *general environmental attitudes* (0.040, $p = 0.199$) and *communication* (0.034, $p = 0.413$). Since the nature of the specified relationships among *recycling behavior* and *personal values*, *general environmental attitudes*, *perceived convenience*, *specific knowledge* or *communication* is indirect, the reported total effects of these predictor variables on the construct recycling behavior are, simultaneously, indirect effects.

5.6 Discussion

The proposed model allows the joint examination of a widely set of constructs that previous research, based on more restrict models, had suggested as being important predictors of recycling behavior. The nature of the links involving the construct *communication* relied on the objectives of the communication strategy that has been followed in Portugal to foster recycling involvement. Under the assumption that these purposes are shared by the majority of recycling programs, it is expected that the presented model may contribute to a better understanding of recycling behavior in other countries with similar selective-collection system.

It is important not to forget that any model should be regarded as an approximate description of reality. SEM enables the establishment and the estimation of multiple dependence relationships (direct and indirect) among a set of variables, and can be applied to demonstrate whether the causal hypotheses embedded in a model are consistent or not with the data (Breckler, 1990). Another key advantage of using SEM is the possibility of including latent variables in the analysis like attitudes and values. As demonstrated in this study, the data fit the proposed comprehensive structural equation model of recycling behavior. Nevertheless, the hypothesis that other models may yield a similar or even an improved global fit should not be excluded. In each concrete case, the important is to base a social marketing program that aims to improve consumers' recycling involvement in a model that describes, as thoroughly as possible, how consumers adopt that behavior (Anderson, 1995; Geller, 1989). Such a model will enable the identification of the variables in which it is more important to intervene and how they can affect, directly or indirectly, the target behavior. As it will be illustrated below, this type of information is very important in the sense that it can guide and support further decisions concerning, for instance, the communication strategy.

It should also be noted that any structural equation model of recycling participation should include all relevant variables to describe that behavior - even if their inclusion in the model seems a bit self evident – in order to avoid a misspecification bias (García and Martinez, 2000; Hair, Anderson, Tathan and Black, 1995). This is another reason why it was important to combine the constructs previously investigated in disparate models in a single framework. However, the researcher should avoid specifying relationships among the variables that are not supported by a solid theoretical background. Only in a case in which the proposed model is supported by a well founded theory, the results from its estimation and interpretation can be further understood and generalized to different settings. As Hair, Anderson, Tathan and Black (1995) state, the use of SEM "in an "exploratory" manner is invalid and misleads the researcher more often than it provides appropriate results" (Hair, Anderson, Tathan and Black, 1995: 592). This explains why other relationships that may seem intuitive were not considered in the model. As an example, it is hardly likely that *personal norms* are explained solely by *social norms*, but none of the reviewed studies and theories had permitted the justification of the inclusion of more predictors for *personal norms* that have been measured by the available data. This means that, if additional observed variables are presented in others studies, the model can be potentially improved.

A first important finding of this research is that the TOPB is actually a good starting point in modeling recycling behavior in the Portuguese case. Despite the impossibility of measuring recycling intentions as formulated by the TOPB, and hence including this construct in the model, for the most part, the research hypotheses defined with reference to this theory were supported. Thus, in accordance with $\mathbf{H_2}$, it can be stated that higher standards of recycling involvement can be found within members of households with stronger *subjective norms*, that is, those that are more concerned with the social pressure to perform the behavior and that are more motivated to comply with this pressure. Likewise, recycling compliance is superior within consumers with higher *perceived behavior control* ($\mathbf{H_3}$), that is, those giving less value to the difficulty in participating or who are more aware of their own individual contribution towards the recycling purposes.

The anticipated role of *specific knowledge* and *perceived convenience* in *perceived behavior control* (**H_4** and **H_5**, respectively) was also demonstrated, supporting, once more, the TOPB. Accordingly, consumers with higher *perceived behavior control* are those which are: (1) more aware of the materials that should be separated and disposed of for recycling, that is, more qualified to carry out the behavior (**H_4**); (2) with improved external conditions to support recycling, that is, with an "Eco-point" in their residential area and more satisfied with the overall features of the logistics consumer-service of the selective-collection program (**H_5**). However, and in opposition to **H_1**, the relationship between the *attitude towards recycling* and recycling participation, although significant, was not positive. Considering the reduced magnitude of the estimated standardized coefficient path between the corresponding constructs (-0.070), this means that consumers from non-adherent households are somehow more conscious of the multiple advantages of recycling. This is a natural consequence of the widespread awareness of the environmental issues reported in several countries (McCarty and Shrum, 2001).

A second set of comments is centered on the integration of Schwartz's (1977) model of altruistic behavior within the TOPB and on the degree of support of the three research hypotheses that derived from this model (**H_6** to **H_8**). The idea of combining these theories resulted from the observation that both shared similar constructs. Effectively, two constructs of the TOPB, *attitude towards the act* and *subjective norms*, although with different names, are also present in the model of altruistic behavior. Moreover, recognition should be given to the fact that the (justified) absence of recycling intentions in the proposed model facilitated the articulation of the two theories.

The main contribution from the Schwartz's model with respect to the TOPB relies on the introduction of *personal norms* as a mediator factor between *subjective norms* (or social norms, using the Schwartz's designation) and behavior. The conception that social norms may be internalized by the individual and thus become *personal norms* was supported by the proposed model (**H_6**).

Schwartz also claims that social norms do not have a direct influence on behavior, but rather an indirect effect through *personal norms*. The proposed model indeed proved this indirect relationship (**H_7**). However, since the direct effect of *subjective norms* on *recycling behavior* was supported (**H_2**), this premise of Schwartz's model could not be confirmed. These results underline the importance of *subjective norms* in explaining recycling behavior: they act directly and interact with *personal norms* to influence behavior.

The last hypothesis which resulted from the articulation of the model of altruistic behavior with the TOPB was that the relationship between *personal norms* and *recycling behavior* was different for participants that were more or less aware of the recycling benefits (measured by the construct *attitude towards recycling*). As demonstrated by the multiple group analysis performed within the SEM setting, this hypothesis was rejected (**H_8**). Based on this summary, it can be inferred that the principles of Schwartz's model were only partially demonstrated within the context of the proposed model.

The extension of this initial framework to global ecological attitudes brought important findings. Effectively, as hypothesized in accordance with Stern, Dietz and Guagnano

(1995), *general environmental attitudes*, as those measured by the NEP scale, were determined by *personal values* (**H_{11}**) and had, in turn, a direct positive and significant influence on the specific *attitude towards recycling* (**H_9**). Hence, the magnitude of these effects was relatively high (0.306 and 0.416, respectively). However, as pointed out earlier, the model was not well succeeded in relating, subsequently, this *specific attitude* to *recycling behavior* (**H_1**). On the other hand, despite the fact that the other hypothesis that *general environmental attitudes* may be linked to the TOPB through *perceived behavior control* had not been rejected (**H_{10}**), the total or indirect effect of *general environmental attitudes* on *recycling behavior* was not statistically significant. In short, the orientation provided by previous research that recycling behavior is not directly determined by citizens' general ideological position towards environmental issues, at least in a persistent way, is now extendable to the indirect relationship between these variables. The total standardized effect (which is also the indirect effect) of *general ecological attitudes* on *recycling behavior* is indeed very small (0.04).

The inclusion of *general ecological attitudes* in the model enabled the extension of the investigation to the potential indirect influence of *personal values* on *recycling behavior*, providing, as a consequence, a first attempt to fulfill the research gap pointed out by Stern, Dietz and Guagnano (1995) in the recycling context. Along with the statistical evidence that *personal values* explain *general environmental attitudes* (**H_{11}**), this study did not reject the hypothesis that *personal values* determine *perceived behavior control* (**H_{12}**). This means that consumers with a stronger social conscience report a significant higher awareness level towards the environmental problems, feel more responsible in participating in the selective-collection program and give less importance to the difficulty involved in the recycling tasks. Hence, this study provides statistical support for the total or indirect effect of *personal values* on *recycling behavior*.

The most surprising result from the estimated model was the absence of a significant positive relationship between the constructs *communication* and *perceived behavior control* (**H$_{13}$**). Considering that the primary objective of the communication strategy followed in Portugal in the latest years to encourage recycling practices has relied on the attempt of mitigating the general conception that "it is difficult to participate in the recycling program", the rejection of **H$_{13}$** is a clear indication of the failure of this strategy, at least, at this level. This occurrence may be the reflection of the general lack of satisfaction with the means used to transmit this message. Actually, advertising on TV has been considered the main communication channel in the Portuguese national communication campaign and it has consisted in two spots. The first shows a monkey that only needed a little over an hour to learn how to separate the recyclable materials and the second one presents the sorting and disposing of recyclable packaging as a game that a little child easily plays. Consumers, probably, consider these spots too aggressive, or even offensive, and thus tend to ignore them or act in opposition.

Increasing consumers' knowledge about how to participate in the recycling program represents the other objective of the Portuguese communication strategy. This effort has been, in some sense, recognized, as is demonstrated by the positive and significant relationship, although moderate, between the constructs *communication* and *specific knowledge* (**H$_{14}$**). Nonetheless, this finding only means that consumers that are more informed about recycling and selective-collection are, actually, those who possess more specific knowledge about these issues. The non-rejection of **H$_{14}$** is not sufficient to conclude that the SPV's purpose of increasing the Portuguese consumers' general knowledge concerning recycling has been attained. A deeply analysis of the impact of the communication strategy carried out so far represents, therefore, a topic for further investigation.

5.7 Final conclusions and implications

The main purpose of this study was to perform a more extensive analysis of recycling behavior, in which the potential predictive importance of logistics dimensions of consumer-service would be jointly examined with a larger set of intrinsic / personal variables and where the potential impact of the communication strategy could be also investigated. Thus, based on the statistical tests associated with the set of proposed research hypotheses, some management implications of the proposed model, which involves the constructs *perceived convenience* and *communication*, can now be discussed. Only these variables, indeed, may be directly targeted through social marketing interventions.

Based on the current study results, one of the conclusions is that the option of promoting *perceived behavior control* and *specific knowledge*, as main purposes of the communication strategy, should persist. In truth, the apparent failure of the communication strategy is not due to an improper choice of their objectives. As the analysis of total direct effects of the several constructs clearly showed, these two variables are the most influential motives of recycling behavior. However, this does not exclude the relevance of reflecting on the communication's messages the knowledge of the other important direct determinants of recycling behavior (as *personal norms* or *subjective norms*) or indirect predictors (like *personal values*). What seems unquestionable is the need of rethinking the means of communicating the recycling messages. The marketing strategy has relied too much on the traditional means of mass communication, such as TV, radio, billboards, magazines and newspapers. Nowadays, it is not reasonable to ignore the new marketing trends based on the information technologies. The option regarding a direct marketing approach, in a business-to-consumer perspective, seems of particular interest. It could be based on a more extensive use of curbside collection, which is already practiced in a few Portuguese municipalities. Within this collection system, the operators responsible for the collection service would provide households with all the relevant information about selective-collection and recycling and encourage non-recyclers to begin participating.

Aside from the communication effort, it is clear that entities responsible for the selective-collection (municipalities, in the Portuguese case) must facilitate recycling in order to gain widespread participation. In the current study there is ample evidence that *perceived convenience* has a degree of influence on *perceived behavior control* and, subsequently, on *recycling behavior*. Therefore, attention must be directed towards the improvement of the logistics of the recycling program. Consumer-service in the recycling framework can be improved, for instance, by shortening the distance that participants must cover to reach the collection points and by providing improved collection conditions. Once more, the option concerning the broadening of curbside collection would considerably improve the consumers' *perceived convenience*. Of course, all programs that facilitate environmental behaviors are costly to implement and manage. However, these additional expenses may be compensated by the enhancement on the quality and quantity of the recyclable materials. This is a topic for further investigation.

The current study is aimed at introducing an integrated framework that is able to contribute to the better understanding of recycling behavior. Providing that the validity of these research findings holds on different recycling programs, research devoted to the promotion of recycling behavior could more deeply explore how to change *personal norms*, *subjective norms*, *personal values* and *perceived behavior control* because, as this study shows, they can positively influence consumers' recycling involvement. In addition, future studies should seek to examine the possibility of including recycling intentions in the model and, therefore, to get a true generalization of the TOPB. A more complete definition of some constructs used in the proposed model should also be considered. For instance, *personal values* could encompass other personality features, *perceived behavior control* could be measured by additional observed variables and *specific knowledge* could include items assessing how well respondents are informed about the economic benefits of recycling and about the recycling process itself. So, despite the amount of research on predictors of recycling behavior, this research field seems far from being exhausted.

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Chapter 6

THE IMPORTANCE OF CONSUMER-SERVICE IN THE REVERSE LOGISTICS SYSTEM FOR RECYCLING

Abstract

This chapter investigates how the performance of consumer-service, in its several components, predicts consumers' adherence to the Portuguese reverse logistics system for recycling non-reusable household packaging. To accomplish this purpose, principal components analysis and discriminant analysis are applied. Results of the present research suggest important guidelines to improve this complex logistics service, in an efficient and collaborative industrial environment. Furthermore, trade-offs and challenges that arise within this reverse supply chain are also discussed.

6.1 Introduction

Reverse logistics can be defined as the continuous logistics process through which previously shipped products or parts move from the consumer back to the producer for possible reuse, recycling, remanufacturing or disposal (Johnson, 1998). It deals with the design and development of logistics systems for efficient and effective collection, sorting and transport of these materials in order to reuse them, one way or another, postponing the end of the products life cycle (Melbin, 1995). Its purpose must be to recapture or create value or simply attribute a proper disposal of the returned materials (Rogers and Tibben-Lembke, 1999).

The mission of any logistics system – forward or reverse – is always to serve and retain the customer / consumer. Consumer-service is the main driver in achieving consumers' satisfaction, loyalty and increased sales (Emerson and Grim, 1998). On the other hand, in parallel with the operational costs of reverse logistics, consumer-service is a measure of system performance (Jahre, 1995). The role of the consumer and the challenge of his customizing are particularly important in a reverse logistics system that aims to recover household packaging residues for further recycling. Actually, although the reverse logistics definition, proposed by the RevLog (2002), make reference to returns from the manufacturing and distribution sectors, in the case of household packaging, the consumer is the first and decisive link of the overall logistics chain because, without their participation (through proper sorting and disposing of recyclable materials), this system does not exist at all (Jahre, 1995). Within this framework, consumer-service (through the system's convenience) is the touchstone in creating value for consumer and, therefore, in getting their participation (Turner, Lemay and Mitchell, 1994).

Overall, this chapter explores the role of consumer-service performance in achieving consumers' involvement in the reverse logistics system for non-reusable household packaging. Specifically, using principal components and discriminant analyses, it is shown that the self-reported participation in the national recycling program is determined by the performance of the consumer-service provided. In addition, this chapter evidences the dimensions of the consumer-service that are most important as predictors of consumers' involvement, which provide guidelines for future restructuring of this reverse logistics system, regarding the collection stage.

This chapter is organized as follows. The next section summarizes the background literature within the broad areas of reverse logistics and consumer behavior in recycling programs, in order to justify the components of consumer-service, considered and analyzed in the survey, but also the research hypotheses. In the subsequent section, the research methods are described. Results are then exhibited and used as a working basis for an integrated discussion of the logistics determinants of consumers' adherence to the reverse chain, the corresponding underlying management trade-offs and the challenges that arise, inevitably, in this reverse logistics framework. Finally, the main research conclusions are presented.

6.2 Review of literature

To identify the components of consumer-service, which are able to influence the self-reported recycling behavior, the present section examines the studies in which the effect of the features and performance of the system has been investigated. Since the reverse logistics research on these subjects has been very scarce, the studies that addressed these issues in the broad field of consumer behavior in recycling programs are also reviewed.

6.2.1 The reverse logistics research

Until the 1990s, most articles on reverse logistics have been practitioners oriented, generally published in trade or transportation journals, rather than in academic or scientific publications (Dowlatshahi, 2000; Carter and Ellram, 1998). Many of these papers consisted in descriptions of how some companies are successfully dealing with reverse logistics systems, the obstacles and challenges they are facing and tips for better implementing of reverse logistics networks. The most relevant academic literature, classified in accordance with the main topics investigated and chronologically ordered, is presented in Table 6.1.

TABLE 6.1
Main topics investigated in the reverse logistics literature

Topics in Reverse Logistics Literature	Previous Studies
1. Reverse channels configuration	Fleischmann *et al.* (2000), Stock (1998), Fuller and Allen (1997), Jahre (1995), Pohlen and Farris (1992), Stock (1992), Fuller (1978), Guitinan and Nwokoye (1975), Zikmund and Stanton (1971)
2. Impact of environmental issues in logistics management	Gungor and Gupta (1999), Van Hoek (1999), Fuller and Allen (1997), Murphy, Poist and Braunschwieg (1994, 1995), Wu and Dunn (1995), Shrivastava and Hart (1994), Barry, Girard and Perras (1993), Kopicki *et al.* (1993)
3. Constraints and drivers to reverse logistics development	Rogers and Tibben-Lembke (2001), Carter and Ellram (1998)
4. Strategic and operational components/ decisions of the reverse flow	Dowlatshahi (2000), Schmidt and Wilhelm (2000), Thierry et al. (1995)
5. Environmental regulations and reverse logistics in Europe	Livingstone and Sparks (1994), Barry, Girard and Perras (1993), Cairncross (1992)
6. Market trends and opportunities for reverse logistics	Rogers and Tibben-Lembke (2001, 1999), Blumberg (1999), Byrne and Deeb (1993)
7. Application of quantitative models in reverse logistics systems	Fleischmann *et al.* (2001), Majunder and Groenevelt (2001), Klausner and Hendrickson (2000), Jayaraman, Guide and Shrivastava (1999), Barros, Dekker and Scholten. (1998), Fleichmann *et al.* (1997)
8. Transportation issues in reverse logistics	Stock (1998), Kroon and Vrijens (1995), Pohlen and Farris (1992), Stock (1992), Murphy (1986)
9. Packaging issues in reverse logistics	Stock (1998), Livingstone and Sparks (1994), Byrne and Deeb (1993), Stock (1992), Gray and Guthrie (1990), Robertson (1990)
10. Purchasing issues in reverse logistics	Johnson (1998), Drumwright (1994), Herbeling and Graham (1993), Bronstad and Evans-Correia (1992)
11. Costs/ Investments evaluation in reverse logistics	Daugherty *et al.* (2001), Guide and Wassenhove (2001), Rogers and Tibben-Lembke (2001), Goldsby and Closs (2000), Klausner (2000)
12. Determinants of reverse logistics performance	Autry *et al.* (2001), Daugherty *et al.* (2001), Ferrer (2000)
13. General management of product recovery	Guide and Wassenhove (2001), Thierry *et al.* (1995)
14. Information support for reverse logistics	Daugherty *et al.* (2002)

A few authors make reference to the importance of fulfilling the consumer-service requirements in reverse logistics (Emerson and Grimm, 1998; Marien, 1998; Byrne and Deeb, 1993; Giuntini and Andel, 1995; Kopicki *et al.*, 1993; Stock, 1992; Murphy, 1986; Fuller, 1978; Zikmund and Stanton, 1971). However, from this brief classification of the literature, it is clear that this subject has not been specifically explored in the reverse logistics research. On the other hand, only Jahre (1995) analyzed the specificities of reverse logistics for recycling household residues from the collection perspective. Jahre's main contributions were the summary of the alternative channels for recycling as well as the development of the concepts of "postponement" (commingling or separation in Material Recover Facilities) and "speculation" (source separation by consumer) within the reverse logistics context.

6.2.2 Research on consumer behavior in recycling programs

The problematic of understanding the motivations that underlie recycling behavior has been the central topic of a significant number of studies, most of them in the social-psychology area. The main conclusions of these studies are that the lack of convenience is quite often an important barrier to recycling participation as well as its removal, or at least reduction, is a good strategy for fostering this conservation practice. In general, these studies show that one way to improve the participation standards in recycling programs is to provide curbside collection (Vining and Ebreo, 1992; Folz, 1991; Folz and Hazlett, 1991; De Young, 1990). The main justification for the success of such a collection system is the physical proximity of the containers (Ludwig, Gray and Rowell, 1998; Margai, 1997).

In addition, recycling programs that imply minimal complexity in sorting and storage usually report higher levels of participation (Gamba and Oskamp, 1994). The information provided before and / or during the recycling program – about the need and importance of recycling behavior and / or about how to participate (e.g., what materials should be recycled, where to correctly dispose of these materials and how much time and space is usually involved in the waste separating process) – is also an important characteristic of the consumer-service concept (Leroux, 2000; Nyamwange, 1996; Thogersen, 1994; Austin *et al.* 1993; Folz, 1991; Folz and Hazlett, 1991; De Young, 1990). Lastly, the scheduling of collection (e.g., frequency of collection, calendar coincidence with refuse collection) is another component of consumer-service that has been investigated, although its effect in recycling participation has been somewhat more ambiguous (0'Connor, 1993; Folz, 1991; Foshay and Aitchison, 1991).

6.3 Research Hypotheses

The previous review of literature, as well as the knowledge of the main features of the Portuguese reverse logistics system (interviews were carried out on the key managers of SPV), were the bases used in identifying the specific elements of consumer-service, potentially related to household recycling behavior, that should be evaluated in the national survey. As noted earlier, the collection service is materially differentiated, based on drop-off schemes and performed by municipal undertakings. In turn, consumers are expected to sort and selectively dispose of their non-reusable packing residues, in accordance with three categories (glass, paper/cardboard and lightweight packaging), that is, the sorting process is "speculative", using Jahre's (1995) terminology.

Despite the particularities of the various pointed studies in the literature review section, they all suggest that consumer service in the reverse logistics system for recovering household packaging is potentially an important factor in getting and enhancing recycling behavior. Therefore, the following general hypotheses may be stated:

> **H_1**: Variables related to consumer-service are determinant of consumers' self-reported recycling involvement in the reverse logistics system for recycling household packaging.

In accordance with the degree of consistency of the several dimensions of consumer-service, suggested by the review of literature, as predictors of recycling behavior, these dimensions may be classified into three broad categories: *Hard*, *Medium* and *Soft* *dimensions*. The *hard dimension* includes the elements of consumer-service that all previous research shows that strongly and consistently determine recycling participation, that is, those associated with the proximity of the disposal containers. The *medium dimension* addresses the set of consumer-service elements related with the complexity of the sorting process and with the information that is provided to do so in the most proper way. The effects of these variables are usually unambiguous: a higher complexity of the sorting process as well as less information about the recycling program are generally related to lower rates of recycling engagement. However, some exceptional studies have found a non-significant relationship among these variables (Folz, 1991; Folz and Hazlett, 1991). Finally, in comparison with the other dimensions, the *soft dimension* is the least investigated and encompasses the components of consumer-service related to the disposal conditions of the packaging residues, such as the frequency of collection and the cleaning of the collection equipment. In agreement with this analysis and classification, a second research hypothesis is proposed:

> **H_2**: The self-reported recycling participation is strongly explained by the hard dimension of consumer-service, following the influence of medium dimension and, lastly, of the soft dimension.

If the previous hypotheses were statistically confirmed, the performance of consumer-service should be a major concern in the design and management of this reverse logistics system.

6.4 Method

6.4.1 Sample procedures and participants

The data collection procedures as well as the sample description are presented in Chapter 1, section 1.5.5.

6.4.2 Instruments

This chapter presents the main conclusions of the statistical analysis of three questions. The first one encompassed a list of eleven items that intended to evaluate the consumers' mean satisfaction level with the several elements of the provided logistics service, taking into account the three types of collected materials: glass, paper and lightweight packaging (plastic, metal). These items are shown in Figure 6.1 and were measured using a Likert four-point scale (1 – unsatisfied, 2 – little satisfied, 3 – satisfied, 4 – very satisfied). The second question focused on the overall satisfaction with the consumer-service and, in this case, a dichotomic scale was used (1 – satisfied, 0 – not satisfied). The last question measured the self-reported household recycling behavior, using also a dichotomic scale: 1 – separate and selectively dispose of, 0 – do not separate nor selectively dispose of.

6.4.3 Statistical data analysis methodology

After a preliminary analysis of the pointed questions, and with the main purpose of reducing data, Principal Components Analysis (PCA) was applied to the original set of eleven items that were proposed to assess the satisfaction profile with the consumer-service. The testing of the defined research hypotheses was based on the application of discriminant analysis to the main components of logistics service satisfaction, previously defined by the PCA. In the discriminant analysis, the self-reported recycling behavior was used as a dependent binary variable. Half of the cases were randomly selected and used as the analysis sample to estimate the discriminant function. The other half of the cases was used as the holdout sample to validate the discriminant analysis. These statistical methods were applied by following the methodological steps described in Chapter 3, sections 3.2.2 and 3.5.2.

6.5 Results

As expected, the hypothesis of independence between consumers' adherence to the reverse logistics system and the overall satisfaction with the consumer-service was rejected (chi-square independence test: $p = 0.000$). From those respondents who declared not adhering to the system, 68.7% were not satisfied with the consumer-service; this percentage decreased to 45.2% among those respondents who declared participating in the recycling program.

6.5.1 Principal components analysis

PCA allowed the reduction of the original eleven items into three new dimensions, together accounting for 74.7% of the total variance (KMO = 0.912; Bartlett test: $p = 0.000$). Results are summarized in Table 6.2. In accordance with the meaning of the corresponding items with higher loadings, the three logistics service dimensions were named *Disposal conditions*, *Information and system adequacy* and *Disposal containers location*. These service dimensions have a very good degree of internal consistency, as indicated by the Cronbach's alpha coefficients and, taking in account their most representative items, they correspond to the three dimensions (soft, medium and hard) previously proposed in the section *Research hypotheses*.

TABLE 6.2
Principal components of logistics service satisfaction items
(After varimax rotation)

Principal Components	Loadings	% of Explained Variance/ Cronbach α
PC1 – Disposal conditions (soft dimension)		
Frequency of waste collection	0.851	
Emptying regularity	0.815	30.4%
Cleaning and maintenance	0.814	Cronbach α = 0.90
Local safety	0.695	
Number of disposal containers	0.564	
PC2 – Information and system adequacy (medium dimension)		
Information availability	0.841	23.6%
Support and claim service	0.838	Cronbach α = 0.82
System adequacy to lifestyle	0.691	
Number and type of accepted waste materials	0.608	
PC3 – Disposal containers location (hard dimension)		
Distance to the disposal containers	0.859	20.7%
Disposal containers location	0.782	Cronbach α = 0.87

6.5.2 Discriminant analysis

Subsequently, discriminant analysis was applied by using these three dimensions as the independent or discriminating variables and the self-reported recycling behavior as the dependent variable (Box's M test: $p = 0.188$). To assess whether the discriminating function significantly distinguishes participant from non-participant households, a statistical test using the Wilks's lambda statistic was carried out. This test reveals that these groups are statistically different in what concerns the satisfaction level with the consumer-service dimensions (Wilks's lambda test: $p = 0.000$). Thus, this finding supports the first research hypothesis (**H_1**).

The predictive accuracy of the discriminant function was measured by the overall hit ratio for both the analysis and holdout samples. These ratios (68% and 66.3%, respectively) exceed the levels of the proportional chance criterion and the maximum chance criterion and are significantly higher than would be expected by chance (in both cases, Press Q statistic $> \chi^2_{(1)}$ for $\alpha = 0.05$).

The structural coefficients, which are the correlations between the discriminating variables and the discriminant function, are reported in Table 6.3. All variables are significant in discriminating the groups. However, as this table shows, of the three variables in the function, *Disposal containers location* (hard dimension) discriminates the most and the *Disposal conditions* (soft dimension) the least. In other words, **H$_2$** should not be rejected.

TABLE 6.3
Structure matrix of discriminant analysis

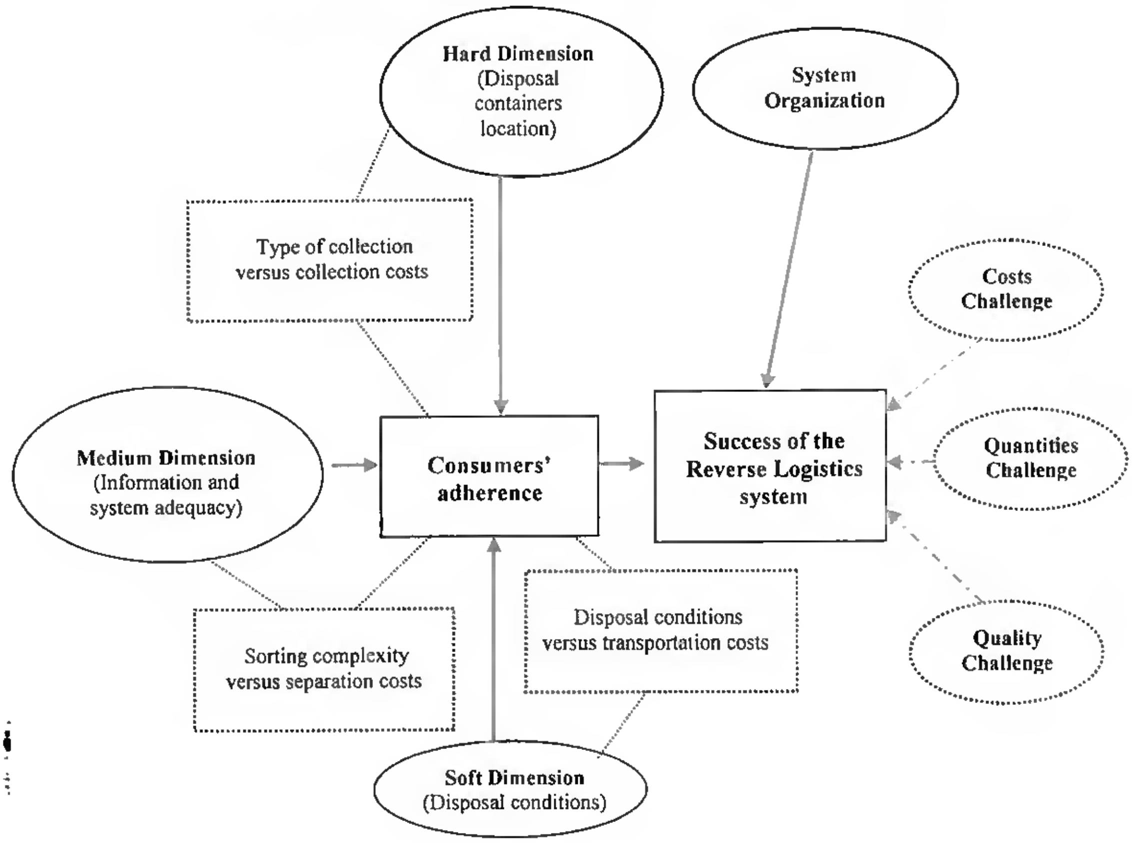
Discriminating Variables	Structural Coefficients
Disposal containers location (hard dimension)	0.726
Information and system adequacy (medium dimension)	0.638
Disposal conditions (soft dimension)	0.234

6.6 Discussion

If the non-rejection of **H$_1$** suggests the need and importance of improving the consumer-service in this reverse logistics system, the non-rejection of **H$_2$** enables the ranking of the priorities in the revision of this logistics concept. In fact, a finding of this study is that it is more important to rethink the location of the disposal containers, or even to consider a complete turnover to a different collection system, than investing in the physical conditions of these containers, although such conditions, despite the information and system adequacy, are also significant predictors of recycling participation.

Figure 6.1 depicts the predictive effect of consumer-service performance (represented by the three logistics service dimensions: *Hard*, *Soft* and *Medium*) in consumers' adherence to the reverse supply chain. However, in improving the consumer-service in these three main components, some *trade-offs*, represented by the broken line rectangles, must be managed. As the figure shows, the success of this reverse logistics system is determined not only by the *consumers' adherence* but also by the *system organization*. On the other hand, the success of this system requires that some *challenges*, also depicted in the figure by the broken line ellipses, are overcome. These elements are explained below.

FIGURE 6.1
Determinants, trade-offs and challenges in the reverse logistics system for recycling household packaging



As Figure 6.1 suggests, three major *trade-offs* must be managed in improving the collection consumer-service for non-reusable household packaging, concerning its *Hard*, *Medium* and *Soft* dimensions. Such trade-offs are described as follows:

(1) The type of collection versus the collection costs – The option concerning the type of collection that should be implemented is a crucial concern in the consumer-service design. SIGRE is essentially based on drop-off collection, more inconvenient (consumers have to transport recyclables to centrally located containers), but also less expensive than a curbside alternative. In curbside schemes, materials are residentially collected, which enhances the convenience but also the collection costs and, as a result, the total cost of the system. A less expensive collection option would be to keep the current drop-off system while increasing the care in choosing the disposal containers location or even increasing their number. However, considering the importance of the disposal containers' location, as the main logistics determinant of consumers' participation in the system, the possibility of generalizing the curbside collection, at least in residential areas with higher population density, should be carefully evaluated. As addressed by this study, shortening the distance that consumers have to go through to reach the collection points is the best way to get their participation. The additional collection costs of curbside collection could be compensated by the improvement of the quality and quantity of the collected materials;

(2) The sorting complexity versus the separation costs – As this study shows, the *medium dimension* explains the self-reported separation behavior. Drop-off systems like SIGRE, in which the sorting process is made at the source, reduce the monetary separation costs (consumers are not paid for their sorting activity), but require an additional effort from consumers that may reduce their willingness to recycle. A more convenient alternative would be to postpone the separation tasks, that is, to allow consumers to dispose of all the recyclable materials in a single container and delegate the separation process to the trial centers. Such strategy would reduce the system's perceived complexity, in the consumers' perspective, but would substantially increase the separation costs and, thus, the total cost of the system. An alternative strategy would be to maintain the current multi-material collection and use a social marketing communication campaign to increase consumers' knowledge of how to participate and also to mitigate the exaggerated expectations about the inconvenience of recycling. As in the previous challenge, the implementation on a larger scale of curbside collection is also a solution for reducing the sorting complexity, since all required information can be provided on a "one-to-one" basis;

(3) The disposal conditions versus the transportation costs – Co-collection arises when recyclables of different types are transported together. This type of collection can be used to reduce transportation costs in systems that are more demanding concerning source separation, such as the SIGRE drop-off system. A less frequent collection of recyclables reduces indeed the transportation costs but the consumer-service becomes worse, especially concerning the cleaning, the hygiene and the aesthetic of the disposal containers. The ideal would be to compensate a more efficient frequency of collection with the improvement of the remaining disposal conditions, for instance, increasing the number of disposal containers ("eco-points") and ensuring the safety of this equipment. This would imply the study of the optimal frequency of collection that would guarantee its economic viability without compromising the consumer-service performance, regarding the maintenance of proper disposal conditions. With the practice of curbside collection becoming more widespread, the main problems concerning the disposal conditions would be solved, as well.

The success of the reverse logistics system also requires the overcoming of several *challenges*, summarized as follows:

(1) The Costs Challenge – All reverse logistics systems for household packaging are cost drivers for the entities responsible for financing the system, that is, for the packers and importers that put goods in the market. This happens because the consumer-service has to be, necessarily, of high-quality, in order to achieve citizens' adherence and continuous participation. The greatest challenge that SIGRE has to overcome is to minimize the strategic costs of the collection stage of the logistics system, without compromising the performance of consumer-service. Actually, the consolidation of the system should allow the reduction of the monetary contribution paid by the system's financers, through the "green-dot value", and not the opposite. This requires the efficient use of resources, methods and technologies, and also that the performed activities, which are cost generators, represent value for consumers and for society as a whole;

(2) The Quantities Challenge – From the environmental point of view, the optimal situation is to maximize the amount of recovered and recycled materials. However, it is also essential that the market absorbs the recycled materials. Consequently, the future of SIGRE strongly relies on the development of the recyclables market. To surpass this challenge, SPV should support the investigation programs that promote the development of new products using recycled materials and also the marketing campaigns that look to increasing the acceptability of these materials among consumers;

(3) The Quality Challenge – The performance of the system is also affected by the quality of the collected packaging residues. Most of the "infected materials" either can not be further recycled (representing, as consequence, only costs) or increase the costs of the reprocessing stage. So, another challenge is continuously achieve reasonable standards of material acceptability. To successfully deal with this challenge, the consumer-service should be carefully designed and marketing campaigns should provide all relevant information to simplify the separation and disposal activities.

Other than consumers' adherence, the maintenance of the *system organization* is also crucial to the success of this reverse logistics system. Considering how the SIGRE was described in section 1.5.2, all interveners (packers and importers, distribution network, packaging manufacturers, municipalities, consumers and also SPV) have a well-defined and crucial role in this reverse supply chain. Any break in their relations would threaten the functioning of the overall system. For instance, if the municipalities that do the selective collection and trial did not deliver the collected materials to SPV, through the accredited recovers and, instead, sold the recovered packaging to other entities that pay more, even outside the country, the Portuguese recyclers embraced by the SIGRE would have significant financing losses and, in the short run, these companies would fail.

Similarly, if the distribution platforms started trading goods that did not respect the packaging legislation in force, that is, goods without the "Green-Dot" symbol, it would have an incentive for packers and importers to skirt the payment of the green-dot value. As consequence, the entire system would break down due to lack of financing. In fact, the municipalities are legally obliged to ensure the undifferentiated collection of solid waste. For municipalities to be able to provide, in a continuous way, the selective collection and trial of the packaging residues, the additional costs of these activities have to be supported by a financing entity. Thus, the best way to ensure that all objectives are accomplished and that all interests are observed is by guaranteeing global performance gains, from and to everyone, along the reverse supply network.

5.7 Final conclusions and implications

Through reverse logistics practices, businesses worldwide may become more environmentally responsible and reach competitive advantages as a result of a green reputation. In this process, the consumer has a fundamental role, which has not been sufficiently recognized and explored in the reverse logistics literature.

Consumers are the earliest and most decisive link of any return logistics chain that aims to recycle household packaging residues because, without their adherence and continuous collaboration, this system cannot exist. The major contribution of this study was to show that consumers are sensitive to the consumer-service performance and that their evaluation of the logistics system determines the present self-reported recycling behavior. The characteristics of the reverse logistics system for household packaging are controllable variables by the competent entities. Therefore, their evaluation reveals opportunities and insights to improving the effectiveness of the consumer-service concept, some of which were pointed out in this study.

An important conclusion from this research is that the tasks which require specific skills and specialization, such as the collection, trial and material preparation for recycling (the vertical dimension of the logistics system) have to be autonomously performed by the competent entities. On the other hand, the consumers' geographic dispersion requires the local establishing of some of these entities (the horizontal dimension of the logistics system). The opposite system is the one that transfers recyclables, directly, from consumers to the units of recycling (Jahre, 1995). However, the complexity of operations required from consumers in such a simple system would result in very low consumer-service which, as the present study shows, would certainly produce low rates of recycling participation, threatening the existence and the efficiency of the entire reverse supply network

The indispensability that different logistics service providers perform diverse and specialized activities at the same time in several places increases, necessarily, the complexity of the system and the need for coordination of the materials and information flows. This results in the need of integration, vertical and horizontal, within the different entities in a collaborative and extended working process (Christopher, 1998). This articulation of complementary skills requires that SPV, along with its internal administration, ensures a collaborative strategic management of the whole net of organizations. Within this framework, SIGRE, by constituting a reverse supply network on its several levels, must force reflection over its own organization in order to attain an efficient and integrated global performance. As explained, this pro-active process should regard the whole system and not only the efficiency of each individual intervenient, replacing, in this way, the old paradigm of commercial relationships of the win/lose type by collaborative partnerships, extensible to all actors in the chain, mutually profitable, of the win/win type. This is the only way that each reverse logistics chain (considering the different recyclable materials flows) may have an efficient performance and be able to overcome the three challenges aforementioned: costs, quantity and quality.

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Chapter 7

THE APPLICABILITY OF RELATIONSHIP MARKETING IN SOCIAL CONTEXTS: THE CASE OF FOSTERING RECYCLING BEHAVIOR

Abstract

The current chapter discusses the applicability of relationship marketing (RM) in social marketing contexts, by specifically exploring the need of improving the recycling standards among Portuguese consumers. In particular, this research provides some elements which are suggestive of the inefficacy of this strategy in attaining the proposed objectives. Afterwards, the potential of a renovated social marketing campaign, consistent with the main principles of individualized marketing, is discussed. As a first step, the fulfilling of the conditions for the development of RM in this concrete social marketing setting is analyzed. Then, some guidelines for a future social marketing campaign, harmonious with the principles of the current marketing trends in the commercial sector, are suggested. This analysis encompasses the definition of the global purposes of such social marketing campaign, the proposal of a few communication tools and messages and the specification of a targeting option.

7.1 Introduction

Social marketing is a process planned to influence individual behavior changes which benefit the general society (Andreasen, 1995; Kotler and Zaltam, 1971). This marketing sub-discipline has been an important impact in fostering sustainable practices in areas such as energy and water conservation, preservation of parks and forests and recycling (McKenzie-Mohr, 2000a; 2000b;1999).

SPV is responsible for the Portuguese social marketing campaign to foster consumers' participation in the recycling program. SPV has founded its marketing strategy in a mass marketing approach, providing the same communication message to all target consumers through the traditional mass communication media, as television and billboards. In this chapter, the data of the national survey on the motivations underlying the consumers' adherence to the recycling program will be used to achieve the a first purpose, which is to provide some evidence about the inefficacy of this traditional marketing option in the Portuguese case.

Hastings (2000) compares social marketing with the traditional marketing of products and services and claims that there is much in common in these marketing perspectives. As this author refers, either social marketing or commercial marketing are (1) concerned with influencing the human behavior; (2) share the purpose of retaining customers over time; (3) accept that human behavior is shaped by the surrounding social context; and (4) recognize that any attempt of changing behavior must be persuasive, not coercive, and offer a valuable return for the consumer. The only fundamental difference between social marketing and commercial marketing rests, therefore, in its ultimate purpose: whereas commercial marketing focuses on maximizing profits, social marketing is motivated by the altruistic value of fostering socially beneficial behavior changes (Smith, 2000; Hastings, 2000; Kotler and Andreasen, 1996; Corson, 1995).

In the second half of the 1990s, several marketing publications in the commercial setting announced relationship marketing (RM) as the new marketing paradigm (Brodie *et al.*, 1997; Coviello, Brodie and Brookes, 1996). The underlying principles of this emerging approach to marketing, sometimes named as individualized marketing or one-to-one marketing, are to maintain and enhance customer relationships in order to gain their loyalty (Berry, 1983).

RM was initially developed for the transactions among companies, that is, in a business-to-business perspective (Ford, 1997; Berry, 1983) The use of RM in business-to-consumer frameworks is indeed a relatively new phenomenon and there is still little research about the contexts in which this new marketing approach may be successfully implemented or even if it should be extended to all individual consumers. Moreover, all the discussions on these issues in consumer markets have been centered on the commercial setting. A second purpose of this chapter is to discuss the applicability of RM in the social marketing framework of encouraging recycling practices.

The current chapter is organized as follows. The next section is a literature review of the RM field. Afterwards, the research hypotheses are defined and the research methods are described. The provision of some indicators that SPV is not accomplishing its communication goals is the main purpose of the following empirical analysis. Then, since these empirical findings suggest the need for change in the communication strategy, this chapter discusses the opportunity and the applicability of a new marketing approach, based on the RM principles, in this social marketing context. Finally, the last section contains the conclusions.

7.2 Review of literature

The key premise of RM is the belief that establishing and maintaining long-term relationships with individual customers is the best form to gain their loyalty, which, as a consequence, has a decisive influence on corporate success (Bauer, Grether and Leach, 2002; Turnbull and Wilson, 1989; Pine, Peppers and Rogers, 1995). RM is, therefore, customer-centered marketing. In this new marketing perspective, the company's most important resource is no longer its market share but, instead, the value of the actual and potential relationships with their present customers (Seybold, 2000). The advantages for companies in this new business model were summarized by O'Malley and Tynan (2000). As these authors point out, the benefits of a stable and long-term relationship with customers clearly exceed the value of each isolated sale. Instead, benefits are translated into efficiency and efficacy gains that result from "reducing marketing costs, particularly those relating to mass communications, facilitating the targeting of high-profit customers; enhancing customer loyalty; reducing price sensitivity among relationship customers; creating opportunities for up-selling and cross-selling; erecting exit barriers; and facilitating database development" (O'Malley and Tynan, 2000: 783).

Peppers and Rogers (1999) propose four basic stages to implement individualized marketing, embedded in an integrated process named "learning relationship". In a first step, each customer should be carefully identified in order to enable a future contact. Second, customers should be ordered, in accordance to their value for the company and, after that, in agreement with their needs. Then, the company should interact with the customer, in an effective and efficient way. Finally, the company must adapt its offering to each different customer. In the new marketing paradigm, companies no longer offer products or services. Instead, they provide global solutions, customized to the wants and needs of their clients (Moutinho, 2000). Through this process of long term relationship and mass customizing, companies are investing in the retention of their customers, which will determine business success.

Database marketing, as the more visible result of the application of the new information technologies in the marketing discipline, has a central role in the four stages of RM (Copulsky and Wolf, 1990). In fact, to be effective in the one-to-one marketing, companies must know their customers well. This requires complete, high quality and reliable databases. In this case, the new technologies allow storing information about how to contact each customer and, as importantly, about their preferences and individual demands (Petrison and Wang, 1993; Blattberg and Deighton, 1991). Besides, database marketing enables the identifying and profiling of the most important consumers, to personalize the interaction with them and to show the customized products or services (Blattberg and Deighton, 1991).

RM was initially conceived for business-to-business contexts and services markets (Ford, 1997; Wilson, 1995; Hunt and Morgan, 1994). The interest in extending the RM principles to consumer markets was first defended by Dwyer, Schurr and Oh (1987) in the 1980s. However, the technological conditions for its application were only available a few years later, with the impressive decrease of costs of computing hardware and the subsequent extensive use of direct and database marketing. The studies of Sheth and Parvatiyar (1995a, 1995b) are crucial references in the move of RM to consumer markets. In their first research, these authors proposed that the paradigmatic change from transactions to relationships depends on a more direct interaction, which makes sense and has applicability potential either in business-to-business situations or in business-to-consumer settings. In their second study, Sheth and Parvatiyar merge insights from the literature in four broad areas (consumer behavior, RM, direct and database marketing), providing the conceptual background for the implementation of RM in consumer markets.

After the emblematic studies of Sheth and Parvatiyar (1995a, 1995b), the extension of RM to mass consumer markets was faced with enthusiasm by several authors (Bennet, 1996; Christy, Oliver and Penn, 1996; Gruen, 1995; Palmer, 1995). However, other studies are still critical in what concerns this issue and discuss some conceptual and empirical issues that arise from this broadening of the RM's domain (Pressey and Mathews, 2000; O'Malley and Tynan, 2000, 1998; Iacobucci and Ostrom, 1996; O'Malley, Patterson and Evans, 1997).

O'Malley and Tynan (2000) identify ten critical issues that remain unsolved in the application of RM in consumer markets. With particular interest for the current study is the lack of research about the contexts with propensity to develop RM. Concerning this topic, O'Malley and Tynan (2000) refer that it can be speculated that there is opportunity to develop RM whenever the consumers' involvement with the product category is high and the interaction with consumers is possible. This is also the position defended by Emmelhainz and Kavan (1999) and by Voss and Voss (1997). As Emmelhainz and Kavan point out, "as valuable as relationship marketing is, it is not appropriate for all industries and firms. It is most appropriate for companies that offer complex services, stress personalized customer interaction, and attempt to develop social bonds with customers" (Emmelhainz and Kavan, 1999: 163). Pressey and Mathews (2000) provide a summary of seven dimensions that are important in fulfilling the purposes of RM: "a high level of trust between both parties"; "a high level of commitment between both parties"; "a long time horizon", "open communication channels between both parties, with information exchanged between both parties"; "having the customers' best interest at heart"; "a commitment to quality for both parts" and "an attempt to favorably lock-in or retain the customer".

Still concerning the applicability of RM, other subject that O'Malley and Tynan (2000) propose for further investigation is whether all consumers are important enough to deserve an individual treatment by marketers..

7.3 Research hypotheses

In chapter 5, a structural equation model of recycling participation was advanced. Besides establishing causal relationships among various potential predictors of this socially desirable behavior, this model enabled the establishment of two research hypotheses which directly involved a "communication" construct. This construct was measured by items reflecting the exposure (or not) to some media used in the Portuguese communication campaign (TV, billboards, "Eco-points", radio and national newspapers).

Based on the two main objectives of the SPV's national communication campaign – (1) to oppose the attitude that "it is difficult to participate in the recycling program" and (2) to enhance consumers' knowledge about the materials that should be separated and in which containers they should be placed in order to be properly disposed of – it was hypothesized that the construct "communication" would have a significant positive effect on consumers' perceived control about how to participate (by decreasing the perceived difficulty in participating) and also on consumers' knowledge about how to do it. The first research hypothesis was rejected, which was quite unexpected considering the notable effort of SPV, mainly through the two television spots mentioned above, in increasing consumers' self confidence in adopting household recycling practices. The general lack of satisfaction with the marketing messages used in the two spots – too aggressive, maybe – was proposed as a possible explanation for this surprising result, which was considered as a first sign of the inefficacy of the SPV's communication strategy in achieving its first and main objective.

The second research hypothesis, on the contrary, was not rejected, suggesting that consumers who are more informed about recycling and selective-collection are, actually, those who possess more specific knowledge about these issues. As also reported in this earlier study, the non-rejection of this hypothesis, however, was not sufficient to conclude that the SPV's purpose of increasing the Portuguese consumers' general knowledge concerning recycling has been attained. Moreover, due to the rejection of the first hypothesis involving the construct "communication", the (indirect) relationship between this construct and the construct "recycling behavior", although positive, was not statistically significant ($p = 0.413$), suggesting that more information would not be a significant determinant of recycling behavior.

Based on these findings, a more detailed analysis of the impact of the communication strategy implemented so far was considered, as a result, a topic for further investigation. In this chapter it is intended to analyze the general level of knowledge of the Portuguese population about selective-collection and recycling, the satisfaction level with the provided specific information and also the receptiveness to an increased effort in the communication domain. If results of these analyses evidence a still great lack of knowledge about how to participate in the recycling program, little satisfaction with the information provided so far, and willingness to receive more information, so there will be evidence of the inefficacy of the SPV's communication strategy in attaining its second communication objective. This type of findings, in addition to those yielded in Chapter 5, would be indicative of the need of a review in the communication strategy carried out so far. Therefore, a first research hypothesis may be stated:

> **H_1**: There is a need for change in the communication strategy that has been followed in Portugal to foster recycling behavior.

A second purpose of this study is to discuss whether or not it is possible to base a renovated social marketing strategy to encourage recycling practices in Portugal in the principles of relationship marketing. The research premise is that if there are some very common features between commercial and social marketing, as those stressed by Hastings (2000), the domain of this emerging marketing approach may be potentially extended to foster individual sustainable behaviors, like recycling. So, a second research hypothesis is proposed:

H_2: There is potential to implement a communication strategy that would be compatible with the principles of relationship marketing.

7.4 Method

7.4.1 Sample procedures and participants

The data collection procedures as well as the sample description are presented in Chapter 1, section 1.5.5.

7.4.2 Instruments

The current chapter presents the main conclusions of the statistical analysis of three questions. The first one intended to evaluate the consumers' knowledge about how to participate in the recycling program. It encompassed a list of materials and asks consumers to identify which ones should be separated and disposed of for further recycling. The second question comprised of the set of sources of recycling information used in the communication plan implemented by SPV. It enabled the identification of the media through which consumers had received recycling information (measured by a binary answers scale: received / did not receive), which media are perceived as being the most important (measured by the Likert four-point scale: 1 – not important, 2 – of little importance, 3 – importance, 4 – very important), the satisfaction level with each of the media (in this case, the answers scale is 1 – unsatisfied, 2 – little satisfied, 3 –

satisfied, 4 – very satisfied) and also the willingness to receive recycling information through each one (evaluated by a binary scale: yes / no). A last question measured the self-reported household adherence level to recycling behavior. This question was measured in a three-point scale: (1 – totally adherent, 2 – partially adherent 3 – nothing adherent).

7.4.3 Statistical data analysis methodology

The first research hypothesis was assessed by applying quantitative methods. In a first step, a preliminary descriptive analysis of the first two questions was carried out, essentially supported by graphical displays. In a second step, the interrelations among the media exposure and the adoption of recycling practices were analyzed. In this step, it was intended to complement the analysis on the relationship between the constructs "communication" and "recycling behavior", based on a dependence model, which was initiated in chapter 5. This evaluation started with the performance of chi-square tests to show the non-independence between the reception of recycling information through each media and the consumers' adherence to the selective-collection program. Subsequently, the nature of these interrelations was identified and described through the application of HOMALS. The application of this statistical method followed the methodological steps that were described in Chapter 2, section 3.6.2.

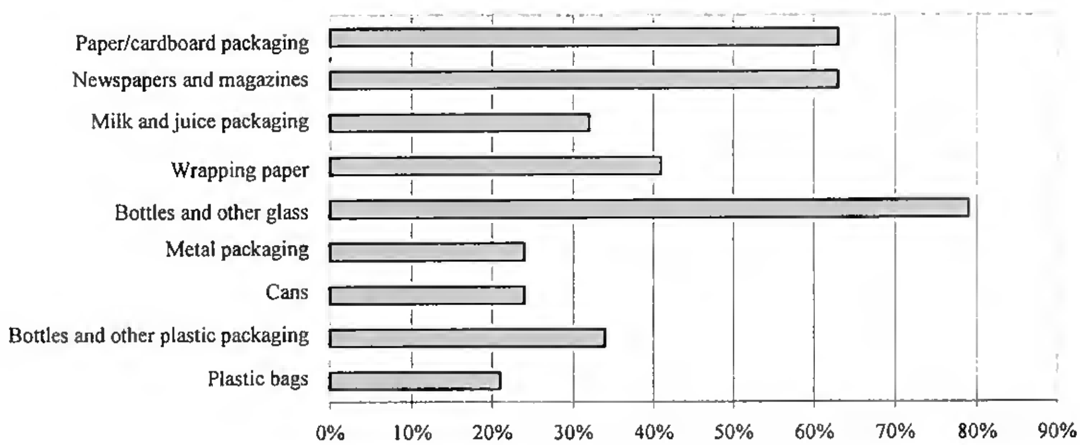
The second research hypothesis was qualitatively analyzed, taking into account the conditions advanced by O'Malley and Tynan (2000) concerning the applicability of relationship marketing in consumer markets.

7.5 Results

7.5.1 Preliminary analyses

Figure 7.1 depicts the materials that should be recycled and disposed of in each "Eco-point" container (paper, glass and lightweight packaging containers, respectively) and also the proportion of consumers that correctly identify these materials. The lack of knowledge is less notorious regarding glass (around 80% of respondents declared that bottles and other glass packaging should be separated for recycling and disposed selectively in the "Eco-point" glass container), but particularly serious regarding the lightweight packaging materials (plastic and metal).

FIGURE 7.1
Knowledge about recyclable materials to dispose of at the "Eco-points"



Although television has been classified as the main communication channel of the mass marketing strategy followed by SPV, other means, as referred, were used, as well. Figure 7.2 represents the percentage of consumers that declared to have received information about recycling through each of the nine media used by SPV in its social marketing communication strategy. Almost 80% of Portuguese consumers said to have received some information about selective-collection through television. The advertising on the radio and also the information placed on the "Eco-point" collectors follow television as sources of recycling information. However, with the exception of these media (primarily television), the general level of received information may be considered low.

FIGURE 7.2
Percentage of consumers that received recycling information through the media

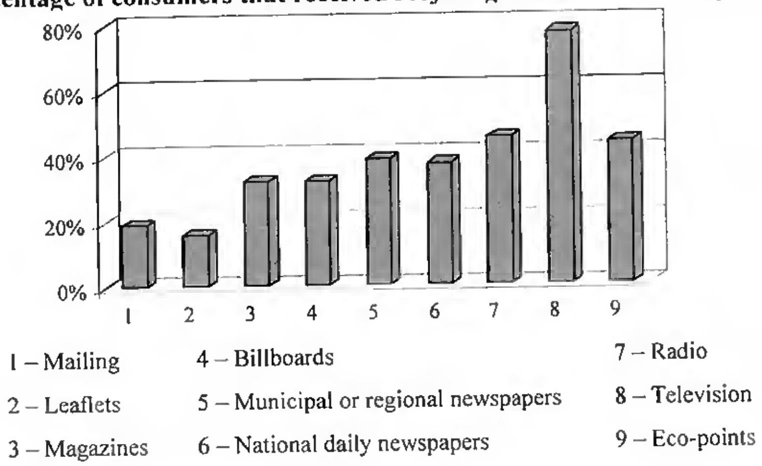
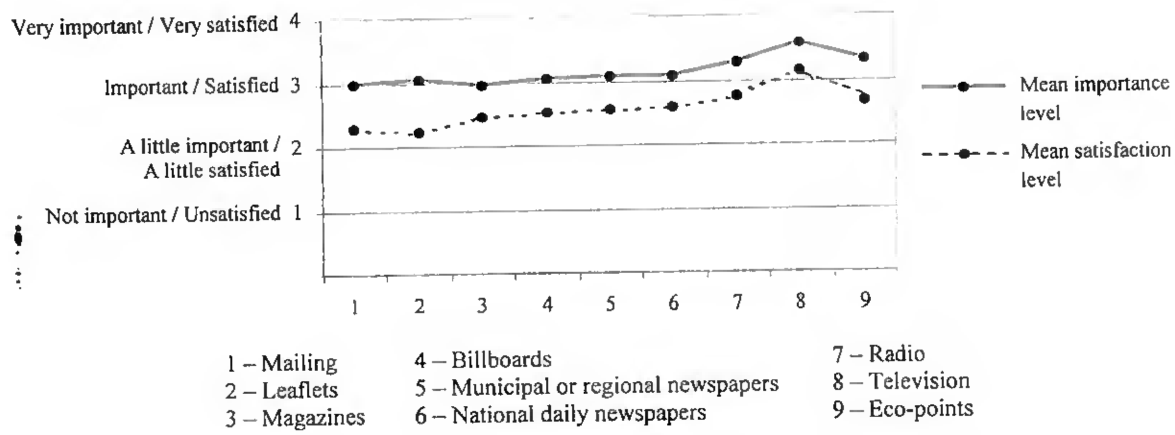


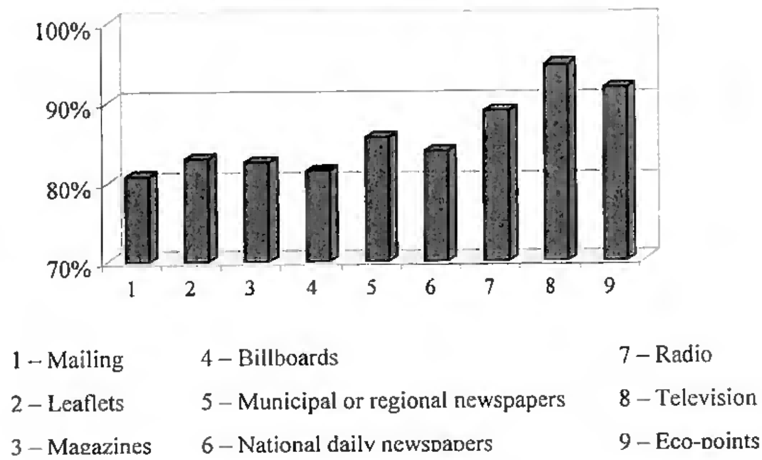
Figure 7.3 illustrates the consumers' satisfaction level with the information provided by each of the media. Excluding television, the mean satisfaction level is low (ranges between 2 – a little satisfied and 3 – satisfied). Moreover, Figure 7.3 enables to analyze the level of importance that consumers ascribed to each of the media. Television stands out as the most important media. Mean importance level ranges between 3 (important) and 4 (very important).

FIGURE 7.3
Mean satisfaction level and mean importance level concerning each media



The importance conferred to information is also notorious in Figure 7.4 which represents the willingness to receive information about recycling through each of the media. More than 90% of consumers would like to receive information about selective-collection through television and are receptive to more information on the "Eco-points". The motivation to receive information by means of the remaining media is also quite considerable.

FIGURE 7.4
Percentage of consumers that would like to receive recycling information through the media



7.5.2 HOMALS

A HOMALS was undertaken to relate the set of variables measuring the reception of recycling information through the media with the consumers' adherence level. In this analysis, the variable related to the reception of information through TV was not considered because a previous Pearson's Chi-square independence test had shown its independence with the adherence level to the recycling program (Chi-square independence test: $p > 0.05$).

Table 7.1 presents the discriminating measures for the variables included in the HOMALS, as well as the corresponding eigenvalues, in the first two retained dimensions[73]. The first dimension (which will be represented in the horizontal axis) discriminates significantly most of the media (at bold). On the contrary, the second dimension, clearly with less discriminating ability, discriminates significantly the variables *Leaflets* and *Mailing*. In this HOMALS, the variable "Eco-points" has a discriminating measure lower than any eigenvalue associated with each dimension. The same happens with the variable "adherence level". However, since in both cases these discriminating measures are very close to the eigenvalue of at least one dimension, it was decided not to exclude them from the analysis.

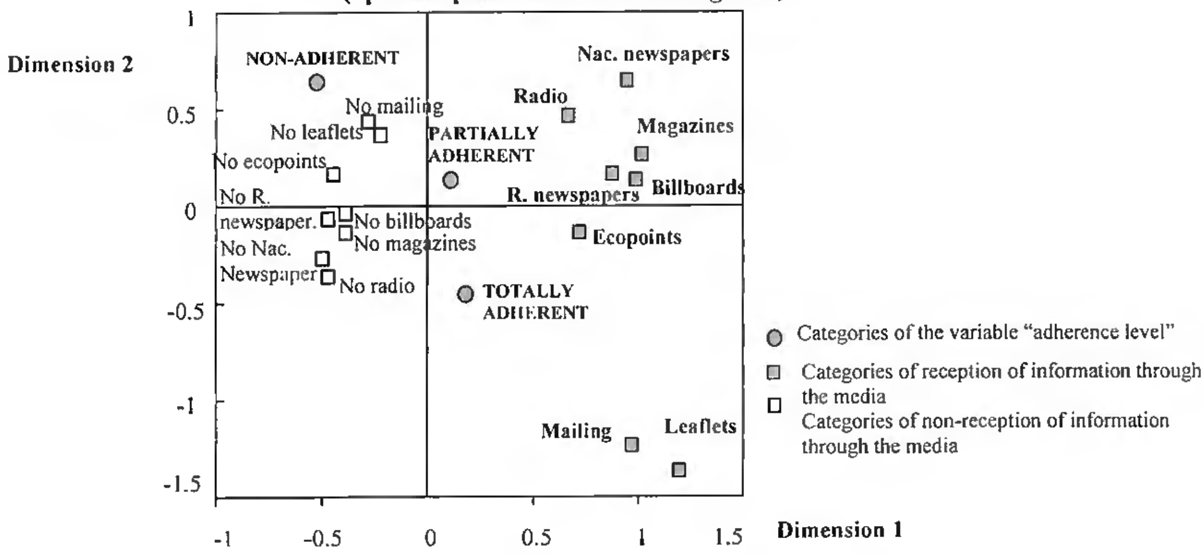
TABLE 7.1
Discriminating measures and eigenvalues

Variables	Dimensions	
	1	2
Mailing	0.200	**0.348**
Leaflets	0.227	**0.327**
Magazines	**0.398**	0.022
Billboards	**0.390**	0.001
Municipal or regional newspapers	**0.412**	0.007
National daily newspapers	**0.446**	**0.178**
Radio	**0.332**	**0.157**
Ecopoints	0.290	0.021
Adherence level	0.044	0.129
Eigenvalue	0.305	0.132

The perceptual map of HOMALS, which represents the optimal categories quantifications in the two dimensions, is presented in Figure 7.5.

[73] Each eigenvalue can be interpreted as a measure of the importance of the corresponding dimension in explaining the variance of the input data (Carvalho, 1998). It can be easily attested that each eigenvalue is the arithmetic mean of the discriminating measures in each dimension. Authors like Carvalho (1998), propose that it should be given a greater relevance to the variables with discriminating measure, in each dimension, at least equal to the respective eigenvalue.

FIGURE 7.5
Perceptual map for categories of the media and adherence level variables (optimal quantifications for categories)



From the observation of Figure 7.5, some conclusions can be addressed:

(1) The categories representing the absence of information and the non-adherence category are placed close together, which means that they are associated. This suggests that the lack of information through the media is relatively more frequent within the non-adherent consumers. The aspect is confirmed by observing the "raw" data. In effect, 78.3% of non-adherent consumers declared not having received information about recycling through mailing. This percentage was 67.8% among the partially adherent consumers and 64.9% among the most adherent. Similar trends characterize most of the remaining media;

(2) The relative positions of the set of points regarding the reception of information through the media (excluding mailing and leaflets) and the "partially adherent" point indicate that they are related. This suggests that the reception of information through these media is relatively more frequent within the partially adherent consumers. Once again, the "raw" data attest this relationship. Actually, 41.6% of partially adherent consumers declared having received information about recycling through regional newspapers. This percentage was only 24.5% among the non-adherent consumers and 39.5% among the most adherent. Similar trends typify all the remaining media, excluding mailing and leaflets;

(3) The categories representing the reception of information through mailing and leaflets are closer to the "totally adherent" category, which denotes that the reception of information through these media is relatively more frequent within the totally adherent consumers. In this case, the "raw" data shows that 20.9% of totally adherent consumers declared having received information about recycling through leaflets. This percentage was 8.2% among the non-adherent consumers and 14.4% among the partially adherent ones. The same pattern characterizes the reception of information through mailing;

(4) The categories "partially adherent" and "totally adherent" are also close to the overall categories of absence of information. This suggests that the general lack of information is widespread even in the most adherent groups. The "raw" data that was pointed out above is suggestive of this generalized lack of reception of information through the media (excluding TV).

Overall, the HOMALS is indicative of some interdependence between the media exposure and the participation in the recycling program. In truth, despite the general lack of information, which is evident within the three groups of consumers (totally adherent, partially adherent and non-adherent), the lower levels of knowledge about selective-collection can be found among the non-adherent consumers. However, as the point **(4)** suggests, the three groups are not completely homogeneous. This last finding is in accordance with the previous analysis, based on structural equation modeling, which demonstrated a positive but non-statistically significant relationship between "communication" and "recycling behavior".

7.6 Discussion

Despite the high investment of SPV in the communication field, it is clear from this study, and also from Chapter 5, that the option regarding an undifferentiated marketing approach, to foster recycling in Portugal, is not allowing SPV to attend its objectives. On one hand, Chapter 5 had demonstrated that the communication strategy is not increasing consumers' feeling of confidence on how to participate. On the other hand, excluding glass materials and some types of paper residues, the lack of specific knowledge about which materials should be recycled is still very high (Figure 7.1). Moreover, despite the diversity of communication means used by SPV in its communication policy, the consumers' (reduced) knowledge about the recycling program proceeds, in most cases, from the TV spots. The reception of information through the remaining media – including billboards, classified by SPV as the main complement to the TV spots – is quite low (Figure 7.2). The reduced level of satisfaction concerning the information provided by the several media (Figure 7.3) also reinforces the weak performance of SPV in its communication campaign.

The modest level of knowledge and reception of information through the media (excluding TV), stressed by these first illustrations, contrast, however, with the high receptivity to a communication strategy on this topic, illustrated in the remaining displays of the preliminary data analysis. On the other hand, the multivariate data analysis, by means of application of HOMALS, shows some interdependence between the media exposure and recycling behavior: the higher levels of reception of information can be found among the totally or partially adherent consumers to the selective-collection program. However, this analysis also evidences a great and generalized lack of information about recycling. These results and also the non-significant relationship between the constructs "communication" and "recycling behavior", demonstrated in Chapter 5, put forward the need of a conversion in the communication policy. In other words, the first research hypothesis should be supported (**H_1**).

Three main causes can be suggested for the lack of success of the SPV's communication strategy in attaining its purposes. First, SPV seems to have ignored that social marketing goes beyond communication. Communication may have an important contribute in solving problems as lack of knowledge or lack of motivation. However, as stressed by McKenzie-Mohr (2000a; 2000b), several other barriers, besides these, usually dissuade individuals from adopting pro-environmental behaviors. In the Portuguese case, the lack of convenience of the recycling program, based essentially on drop-off systems, represents, indeed, an important external barrier that has deterred several consumers from participating (Menezes, Reis and Valle, 2002).

Secondly, this campaign forgot the crucial role of market research in the social marketing scope (Andreasen, 1995). Actually, the studies that enabled the understanding of the main determinants of recycling participation in the Portuguese case were made after the communication strategy had been implemented (Valle *et al.*, 2003; 2002). Because a social marketing program should always be centered on the consumer, it would have been essential to understand, at the start of the program, what motivates the adoption of recycling behaviors (incentives), as well as the factors that discourage consumers from engaging in such sustainable practices (barriers) (Macstravic, 2000; Shrum, Lowrey and McCarty, 1994).

Finally, at the same time as the need of more personalized marketing strategies was being extensively discussed and encouraged in consumer markets, SPV ignored the new marketing trends and based its social marketing campaign on a mass marketing approach. Such a strategy has imposed a great distance between the service providers (the municipalities) and consumers, ignoring their needs, wants and perceptions. Since the market research was already carried out and the problems in the consumer-service of the logistics system are now entirely known, the next challenge is to analyze the potential of extending the underlying principles of RM to this particular context of social marketing. Despite the data of this study does not provide evidence of the potential success of this renovate marketing strategy, the importance of changing the existing marketing approach justifies this reflection effort.

In his comprehensive study on the use of marketing to social change, Andreasen points out the interest of one-to-one marketing. As this author stresses,

> "the more closely tailored a marketing program is to the needs and wants of a given individual, the more likely an individual will respond positively. Ideally, this would mean one-on-one contact with each customer so as to learn about the customer's unique needs, to present alternatives, and to receive feedback to adjust the individualized campaign to reach the desired goal" (Andreasen, 1995: 52).

The use of a personalized marketing approach, like RM, in social marketing contexts is, in truth, conceptually defensible. In the commercial sector, the key purpose of RM is to get the customers' loyalty. This is also a purpose that social marketing intends to achieve. Using recycling as an example, social marketing aims that not only citizens begin separating and properly disposing their recyclable waste but, also, that these sustainable behaviors go on for life. On the other hand, RM is customer-centered marketing. The same happens with social marketing. This view of social marketing, as customer-centered marketing, has been underlined on several occasions (Andreasen 2000, 1995; Weinreich, 1999). Concerning a social marketing program, Andreasen adds that "the customer is always the figure who drives the program – not vice versa" (Andreasen, 1995: 49). This means that the challenge of social marketing must be to realize how to adapt the program to the consumer's objectives, needs, perceptions and attitudes.

Nevertheless, in order to deeply investigate the potentiality of RM in social marketing contexts, it is important to evaluate whether the conditions proposed by O'Malley and Tynan (2000), concerning the applicability of the RM's principles, are satisfied. As previously referred, these authors suggest that there is an opportunity to develop RM whenever (1) the consumers' involvement with the product category is high and (2) the interaction with customers is possible.

When limiting the type of behaviors encompassed by his study, Andreasen (1995) distinguishes between high and low-involvement decisions. This author defines low-involvement decisions as those that are less important. In this case, consumers do not look for much information before taking them and, after they have decided, they do not think about the issue any more. For instance, the buying of most daily products requires low-involvement decisions. As this author points out, since these decisions do not require central cognitive processing, they may be easily influenced by "minor environmental factors such as package design, commercial jingles or chance comments by friends" (Andreasen, 1995, 142). High-involvement decisions, instead, are those considered very important by consumers. As a consequence, they gather much information before making their choices. In theses cases, the decision process is difficult, time-consuming and requires emotional involvement.

Andreasen (1995) defends that behaviors which social marketing intends to change involve high-involvement decisions. In the case of recycling, several reasons support such proposition. Firstly, whereas in choosing to buy a specific product, the consumer is self-interested in that purchase and, thus, he compares the direct benefits of that product, to him or to his family, with its costs, in adopting ecologically compatible behaviors, such as recycling, only the costs, financial and behavioral (nuisance and inconvenience), are promptly realized. Effectively, the environmental benefits that accrue from recycling are not immediately visible, will probably not benefit the person that has the behavior directly or may even never be realized.

Second, recycling is often considered as an instrumental activity, in the sense that it is not a purpose in itself but just a way to attain a greater objective: to protect the natural environment (Thogersen, 1994). Nevertheless, there are other alternatives, less inconvenient, to contribute for the environmental preservation, for instance, reusing or buying environmentally friendly products. Finally, because the environment is a public or collective good (it can be consumed without being purchased and can be produced only in cooperation), it provides the opportunity for *free-riding* (Uusitalo, 2000). Actually, even those consumers who do not participate in a recycling program will benefit from the expected collective benefits of recycling, for example, a better environment.

If it seems undeniable that all these factors may leave consumers to question the relative importance of their individual participation in a recycling program and, thus, that their decision to participate requires a high involvement decision, the next step is to analyze the opportunity of interacting with customers in such social marketing framework. At the present time, and taking into account how the Portuguese selective-collection system is designed, this interaction is really impossible. As referred, the national recycling program has relied, essentially, on drop-off systems, the "Eco-points", which do not allow for any personal contact between the service provider and the consumer. Moreover, the communication strategy has been based on impersonal channels, as TV advertisements and billboards.

In order to eliminate the distance between the service providers and the consumers, the selective-collection system would have to be globally reinvented, which would imply a change from drop-off collection to curbside collection – under certain circumstances, as will be discussed below – as well as the selection of communication channels based on personal contact. The interest in using personal behavioral changing tools, in community-based social marketing programs, is underscored by McKenzie-Mohr (1999). As this author refers, personal contact is emphasized because social science research indicates that we are most likely to change our behavior in response to direct appeals from others.

In short, although personal contact in the current recycling program is inexistent, it can be achieved by changing the selective-collection system and by modifying the communication means. These topics will be further discussed in the following point.

Overall, since to begin recycling requires a high-involvement decision and because there is potential for establishing interactions with consumers – by modifying the current recycling program, of course – the two conditions proposed by O'Malley and Tynan (2000), for the applicability of RM, can be satisfied. The same is to say that $\mathbf{H_2}$ should be supported.

7.7 Final conclusions and implications

This research provides some elements that suggest the lack of success of SPV in attaining the communication objectives it had proposed. It should be emphasized that this empirical assessment does not offer any evidence that a social marketing campaign based on a mass approach will be condemned to failure. Firstly, what happened in Portugal, until the survey's date, was not a really social marketing experience in the recycling context, but rather the development of a communication strategy to foster consumers' recycling participation. Secondly, whether a campaign is a success or a failure can only be assessed by comparing the campaign's outcomes to a control and the available data does not allow such an analysis. This aspect deserves, therefore, further investigation.

Nevertheless, the presented empirical results came to reinforce some previous research of the idea that SPV is having problems in accomplishing its communication objectives and that something should be done to invert this trend. The current study aims, therefore, to be a first contribution to the discussion about the applicability of the new marketing paradigm, the RM, in social marketing contexts, exploring specifically the need to improving the recycling standards among the Portuguese consumers.

The next critical step is to discuss how this renovate marketing approach, compatible with the principles of RM, may be effectively implemented to change behaviors towards recycling, in the Portuguese case. This analysis, which integrates the planning stage of strategic social marketing, requires the definition of the broad and more specific objectives of the social marketing program, the selection of the behavior change tools, the design of the messages and the specification of the target audience to be reached

(Andreasen, 1995). This section proceeds by suggesting some guidelines, in a non-exhaustive way, considering each of these topics.

Main characteristics of a future social marketing campaign

As referred, the recycling goals that Portugal is obliged to accomplish are quite demanding. To attain the established recycling targets, it is necessary to maximize the number of citizens that participate in the selective-collection program. Considering that consumers who presently participate in the selective-collection program have already integrated this behavior in their daily tasks and, therefore, will continue recycling, the broad purposes of the Portuguese social marketing campaign to foster this sustainable behavior should be: (1) to motivate non-adherent consumers for the importance of adopting recycling practices; (2) to change non-adherent consumers' behavior, that is, to convince them to begin participating; and (3) to retain these consumers, that is, to make them continue recycling for life. This third objective is in agreement with the ultimate purpose of any RM approach.

In opposition to the impersonal mass communication means used in the past, a social marketing campaign compatible with the RM principles should rely, essentially, on personal communication channels. As Kotler defines, "personal communication channels involve two or more persons communicating directly with each other. They might communicate face-to-face, person to audience, over the telephone, or through the mail" (Kotler, 2000: 616). Eight main communication channels are suggested to change behaviors towards recycling: (1) Block-leaders intervention through curbside collection; (2) leaflets and brochures; (3) the SPV's Magazine; (4) "Green-Dot" line; (5) proximity campaigns; (6) seminars; (7) web page/ e-mail and (8) packages.

Most proposed channels involve personalized and interactive communication and may be considered as direct marketing tools[74]. On the whole, all of them attempt to inform, motivate and persuade consumers to the recycling problematic but, more importantly, to correspond to the consumers' needs of information and motivation.

The first communication tool that is proposed requires a reorganization of the current logistics system, presently based on drop-off collectors (the "Eco-points"). It is crucial to eliminate the distance that separates consumers from the service providers and the best form to attain this objective is to provide *curbside or door-to-door collection.* This would be the most important element of a new social marketing campaign to foster recycling behavior. As is known, the primary external barrier that discourages consumers to participate in the recycling program is the lack of convenience of the collection-system.

In this new collection system, it would be interesting to introduce a recompense system for the consumers' loyalty, as used in the practice of RM in the commercial sector. Such support technique could be the offering of a points-coupon, depending on the amount of materials delivered for recycling, which could be accumulated, for instance, to a customer's gasoline loyalty card or exchangeable for discounts in specific retail store. On the other hand, the operators responsible for the collection of the recyclable materials would act also as active community block-leaders of a one-to-one communication effort. Besides distributing special bins (with different colors) for the

[74] The communication strategy in the RM is based, essentially, on direct marketing. As Shimp (1997) defines, direct marketing is an interactive system of marketing which apply one or more advertising media to influence a measurable response and / or transaction at any location. As this author underlines, this definition encompasses four special features of direct marketing: (1) it involves personalized and interactive communication between the marketer and the prospect; (2) it uses a diversity of communication tools, such as direct mail, personal selling, telemarketing and direct response advertising; (3) it permits a superior measurability of communication response in comparison with the indirect media; and (4) it can occur at a variety of locations, for instance, through personal visits, by mail (traditional or electronic) or by telephone.

recyclables collection, they should be prepared to provide all relevant information about the recycling program and to encourage consumers to begin or go on participating. Considering the current study's results, a special focus should be given on the information about the separation of lightweight (plastic and metal) and paper packaging materials. In addition, this personal contact would provide the opportunity for modeling, that is, for exemplifying, in practice, how to prepare the materials for recycling.

This effort on the information field should be supported by the distribution of leaflets and brochures on the recycling problematic and, eventually, a SPV's magazine. In agreement with the RM principles, these informative elements would be personally delivered to consumers by the curbside operators. Ideally, two types of short *leaflets* should be distributed. The first one should contain tips to make the domestic separation easier, clearly identifying the materials that should be separated. On the other hand, the second leaflet should be a "feedback leaflet", informing about the national and local evolution in the amount of packaging residues recovered and delivered for recycling to SPV and also about the number of households that are involved in the campaign. This leaflet should be regularly updated and establish the future recycling goals for the household and for the municipality. On the other hand, the *brochure* could be a little bit longer and focus on the benefits of recycling.

The creation of the *SPV's magazine*, to divulge the relevant annual reports, may also be thought as a complement to the leaflets and brochures. Additionally, all these written informative elements should make reference to a *"Green-Dot" line*, through which consumers may contact by phone with a specialized operator to clear out any remaining doubt or question about the participation in the social marketing program.

The *proximity campaigns* that are proposed to SPV by the municipalities embraced by the selective-collection system represent another communication tool that should be privileged and supported in a more personalized social marketing approach to foster recycling behavior. The same happens regarding the performance of small *seminars* on the recycling problematic, at schools or in other institutions. During these local communication actions, some awards and gifts (made of recycled materials, for example) may be offered to the participant consumers and the brochures, leaflets, referred above, should be distributed, as well.

Considering the fundamental role and the growing use of the new information technologies, the investment of SPV on the regular updating of its *Web Site* should be a priority. It would provide all relevant information about selective-collection and recycling. The information access would have to be easy and fast and the information should be presented in a pleasant, vivid and organized form. Visitors must have also the possibility of making questions and to put their doubts and expectations. The Web site should also permit to collect information about their visitors, who must be motivated to fulfill a small questionnaire. This questionnaire would enable the conception of a relational database, supporting the SPV database marketing, in a business-to-consumer perspective. The appliance of a similar questionnaire would well precede the proximity campaigns – as a pre-requisite for participation, for instance – to be distributed and collected by the curbside collection operators or even and to be conducted after the seminars. The option regarding a database marketing approach in this social marketing context is quite interesting. It enables the identification of the participant and / or motivated consumers for the selective-collection problematic, to characterize them and, afterwards, to establish personal contact platforms, through *e-mail*, for the participation in new proximity campaigns or seminars, attendance of the satisfaction level with the provided logistics service and testing the receptiveness to the current or new communication tools.

Finally, also with the purpose of getting a narrower relationship between consumers and SPV, it would be useful to consider the possibility of including in the *package* of any recyclable product, along with the "Green-Dot" symbol, some indication about the suitable container for disposing the corresponding packaging residue. This indication could be a small icon with the color of the proper container: blue, yellow or green. Such tool would enable a better response to consumers' needs and wants regarding more specific information about recycling.

The targeting of a future social marketing campaign

Despite supporting the conceptual principles of one-to-one marketing, Andreasen questions its efficiency and, so, its practical application. Instead, this author suggests that the proper targeting in a social marketing campaign should rely on market segmentation, rather than on an individualized marketing perspective. He argues that

> "marketers know that resources are limited and that individualized approaches are often not cost efficient. On the other hand, they recognize that mass approaches are also often ineffective because they must inevitably be too broad to speak to anyone in any great specificity. Wise marketers therefore choose a middle ground for focusing on market segments" (Andreasen,1995: 52).

This author adds that "segmentation is one of the most powerful contributions that commercial sector marketing has to make to the solution of social problems" (Andreasen, 1995: 176). The importance of segmentation in the present times is underlined in recent studies on the commercial marketing field, as well. As Neal and

Wurst state, "in today's competitive marketplace, locating and effectively targeting unique market segments is both a reality and a necessity" (Neal and Wurst, 2001: 15).

As Andreasen (1995) addresses this issue, it leaves the idea that individualized marketing and market segmentation are not compatible targeting options. Other authors, however, stress the pertinence of using a RM approach only in some specific market segments. For instance, Emmelhainz and Kavan point out that relationship marketing is not appropriate for all customers. As these authors stress,

> "not all customers are the "right" customers; therefore, it is important to identify the type of customers with whom an organization wants to have a relationship (Zeithaml and Bitner 1996). The foundation for developing an effective customer relationship strategy is market segmentation because through market segmentation a firm can identify the best target markets for long-term relationships" (Emmelhainz and Kavan, 1999: 162).

O'Malley and Tynan share a similar position, saying that "it is neither possible nor profitable to create close, personal and long-term relationships with all customers in all product markets" (O'Malley and Tynan, 2000: 808).

The conviction that individualized marketing and marketing segmentation are not competitive targeting alternatives is also the position defended in the present study. In truth, it is believed that for being cost-effective, the proposed curbside collection – which represents the main vehicle of a one-to-one marketing intervention in the social marketing framework under discussion – should rely on previous market segmentation.

In agreement with the broad objectives of the Portuguese social marketing campaign, the ideal would be to reach only those consumers who, despite not being effectively adhering to the national recycling program, are motivated to participate. Then, the consumers within this market segment would be personally targeted by the one-to-one marketing approach. However, such targeting option raises, at least, two types of problems. The first problem is how to identify these consumers. The second problem is a question of costs.

In fact, the most common segmentation variables used in social marketing contexts are socio-demographics. However, the previous research on the determinants of recycling behavior shows a weak or inconsistent relationship between these variables and consumers' involvement in recycling programs. Furthermore, a recent study on the predictors of recycling participation, in the Portuguese case, clearly evidences a non-significant link among such sustainable behavior and gender, age, education or household income level (Valle *et al.*, 2002). In alternative, it is known that some psychographic factors, like attitudes and values, are related to the adoption of recycling practices (Valle *et al.*, 2003; 2002). From a theoretical point of view, these factors could be used as a basis for segmentation. The problem is that, in practice, it is not possible, at least in the short term, to geographically locate these consumers whose psychographic profile would be indicative of non-involvement in the recycling program.

Within this framework, a proposal for identifying the less adherent households would be to use the current amount of collected packaging residues for recycling, per-capita and by municipality, as a segmentation variable. Accordingly, those municipalities reporting lower adherence levels to the selective-collection program (above a pre-determined value of the segmentation variable) would be classified as a priority in the one-to-one marketing approach. In these municipalities, an increased effort would be carried out not only in the curbside collection but also in the other communication tools that involve personal contact and interactivity, like the proximity campaigns. Inversely, in the municipalities with an adherence level equal or higher than the specified value of the segmentation variable, the selective-collection would go on being based on the current "Eco-points".

The problem in considering this segmentation variable is that, probably, the quantity of recovered materials for recycling in these municipalities would not compensate the increased costs of their curbside collection. A recent study on the economic viability of door-to-door collection in Portugal shows that the generalized implementation of such a selective-collection system is not economically viable (GIESTA, 2003). A finding of this study is that curbside collection is only cost efficient in the municipalities with a minimum population density of 2000 ha/ km^2, where the potential of consumption and, consequently, the production of residues, is higher. As a consequence, a preferable segmentation variable for the implementation of the one-to-one marketing could be the mix of the two variables previously referred, that is, to provide door-to-door collection just in the municipalities with, at least, 2000 ha/ km2, with high consumption potential and that report a low level of recycling participation.

Since it is not economically reasonable to mass-customize RM in this social marketing context, what is proposed is a marketing campaign founded on three major stages. Table 7.2 summarizes these stages (in line) and also their relationship with the broad purposes of the social marketing program (in column). The center of the table contains the main communication channels that may be used to reach the proposed objectives in each defined stage.

TABLE 7.2
Stages, purposes and communication channels in a social marketing campaign to foster recycling behavior

		Purposes		
		(1) To motivate non-adherent consumers	(2) To change non-adherent consumers' behavior	(3) To maintain recycling behavior
Stage 1	Mass-marketing	• Television • Leaflets and brochures • Packages • "Eco-points"	--------	--------
Stage 2	RM in some market segments	--------	• Block-leaders intervention through curbside collection • Proximity-campaigns • Seminars • Leaflets and brochures	--------
Stage 3	Mass-marketing and RM	--------	--------	• "Eco-points" • Web Page/ e-mail • "Green-Dot" line

The first challenge of the social marketing campaign would be to create awareness among the non-adherent consumers about the interest in participating in the recycling program. This should be done through a mass-marketing approach, using television as the main communication channel. At this first stage, the presence of an icon on each recyclable package, indicating in what "Eco-point" container it should be disposed, should already be a reality that could be informed, also, on the television spots. Still in this stage, it would be of crucial importance an increased investment on the cleaning, maintenance and safety of the "Eco-points", and even to rethink their location, in order to improve the global consumer service. This study also shows that despite consumers considering the information placed on these selective-collection containers as one of the most important, they report, on average, a low satisfaction level with it (see Figure 7.3). Thus, an investment in the local information, by means of billboards placed near the "Eco-point" containers and also the improvement of the information that presently appears on each one, would certainly be relevant.

The second stage of the proposed social marketing campaign would rely on the application of RM in the specified market segments. The purpose of a personalized marketing intervention is to introduce the routine of household separation of recyclable materials, that is, to lock-in consumers to the social marketing program. At this stage, the intervention of block-leaders, through the curbside collection, would be the main communication tool. The proximity campaigns should also be a priority in the chosen target segments. The personal distribution of the written informative elements, as the leaflets and brochures, would be an important contribution for increasing the impact of both the curbside collection and proximity campaigns.

Once the recycling practices have been internalized, the progressive replacement of the door-to-door collection for a centralized drop-off system may be considered. As suggested in Table 7.2, this does not imply a renunciation of the RM's principles. At this stage, the relational database should be sufficiently developed to keep allowing a straight and long term relationship with the consumers, through the exchange of information between them and SPV. The internet, as the main open communication channel of the current time, but also the use of the "Green-dot" line, would have a key role on this exchange of information. This personalized contact would function as the support technique of RM, acting as a recompense for loyalty. Consumers, in turn, must already have a high level of commitment and trust in the system, based on the recognition of the quality of the provided logistics service and the merit of the ultimate purpose of all this effort: to contribute for a more sustainable future. In brief, the seven indicators of RM, as summarized by Pressey and Mathews (2000) and described at the end of the literature review section, would be accomplished.

Final remarks

At this stage, a legitimate question is whether or not a social marketing campaign with the projected features in this study is cost efficient. Naturally, the answer to this question would require a detailed cost-benefit analysis of the proposed social marketing campaign, which represents a topic for subsequent research. In this necessary detailed study, it would be of great value to estimate the long term economic value of getting a citizen to recycle on a regular basis. If these long term customer value exceed the costs of a personalized recycling intervention, it will have economic evidence about the applicability of RM in social contexts.

However, it should be noticed that some of the more personalized marketing interventions that are proposed in this study are already in practice, in Portugal. For instance, since the summer of 2002, SPV has financed numerous local proximity campaigns that it titled as "The recycling adventure". These campaigns have been carried out, in an undifferentiated way, all over the country and without special focus on some target areas, as defended in this study.

On the other hand, despite the Portuguese selective-collection system having relied, mainly, on drop-off collection, curbside recycling is already practiced with relative success in a few municipalities (SPV, 2003). This collection system has also been used in several other countries for years. Therefore, what is proposed in this study is not a totally new experience in the recycling field. The only truly innovative element, in what is suggested, is that the operators responsible for the door-to-door collection should now also act as active partners on the RM strategy, providing all the required information and inciting consumers to participate. Moreover, as already referred, curbside collection can be economically viable considering that it is implemented only in the municipalities with more than 2000 ha/ km^2.

Such a collection method would require, obviously, an additional investment in formative and education actions and a reorganization of the overall logistics of the selective-collection system. Nevertheless, these extra costs could be compensated with the reduction or even with the elimination of mass communication, at this stage, which has been revealed as having little effect and that is also quite expensive. Considering that most consumers are aware and concerned with environmental problems, the possibility of increasing, in such municipalities, the current tax for solid waste treatment, in agreement with the "user-pays" principle should not be neglected. On the other hand, the personalized marketing intervention, through the curbside collection, would be a transitory strategy to change non-adherent consumers' behavior. Once the separation and selective disposal of packaging residues has become a routine task among Portuguese consumers, the selective collection could once again revert to a drop-off system, based on safe, clean and well located disposal containers.

Nowadays, as in the commercial sector, social marketing should not make the mistake of using a marketing approach that ignores the personal needs and wants of its most relevant customers. An option regarding a personal marketing intervention, compatible with the philosophy of RM, seems of particular interest in the social marketing challenge of changing behaviors towards recycling, which deserves, however, further empirical confirmation. As several studies underscore, strategies involving personal contact are associated with a higher level of recycling involvement. The economic advantages of such growth, translated into increased business for the recycling industry and creation of employment, should not be ignored. However, from this enhance in the recycling standards, the environment and the well-being of the general society would be, in truth, the really big winners. This is what all social marketing is about, isn't it?

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Chapter 8

GENERAL CONCLUSIONS

8.1 Introduction

As a result of today's consumerism society, the amount of solid waste has ubiquitously increased. At the same time, the public opinion has revealed a growing resistance concerning many of the technical solutions for this problem, like waste incineration and landfill disposing, due to their potentially negative consequences on the environment and health. As many other countries, Portugal has legislation which confers higher priority to the behavioral solutions for the waste problem, such as recycling, in relation to the technical alternatives. Increasingly, recycling is perceived as an attractive industrial activity that generates economic, social and environmental benefits and, therefore, as a sustainable activity sector.

Even though the selective-collection for recycling in Portugal had preceded the foundation of SPV and the conception of the SIGRE, much of the national positive results concerning the recent evolution of recovered packaging residues for recycling are a response to the unquestionable effort and determination of this private company in accomplishing the recycling targets defined by European Directive 94/62/CE. Despite the delay in the full implementation of selective-collection infrastructures, SPV had accomplished the recovery of 25.3% of the declared packaging weight and the recycling of 14 % of this material, by the end of 2002. Nevertheless, these numbers are still rather distant from the corresponding target percentages of 50% and 25% that Portugal has to attain in 2005. This concern assumes a greater relevance because the European Directive is presently being reviewed and much more ambitious targets of recovering and recycling, for each State Member, are expected for the future. The achievement of the current and of the forthcoming recycling goals will require an increased financial effort as well as a more efficient partnership among all SIGRE's interveners.

"Recycling" and "source separation of residues" are inseparable terms. Consumers' behavior of separating domestic residues and the disposing of these materials in the appropriate containers are necessary conditions for the existence and for the economic viability of the recycling industry. Therefore, the problem of increasing the recycling rates in Portugal, or elsewhere, is basically a problem of changing consumers' behavior towards the recycling problematic.

The challenge of making consumers adopt recycling practices is a classic and particular application of social marketing in the domain of environmental preservation. To be well succeeded, however, a social marketing campaign should be based in the application of a sequence of stages. The first of these stages, very likely the most important, implies *listening* to the consumers, which means, as earlier referred, "identifying and understanding the determinants (motivations and barriers) of the behavior to be changed". It is based on the findings of this market research that the remaining stages should be oriented, especially the *planning* of the strategy itself. This was not, however, what was followed in the Portuguese case. Instead, a selective-collection service, centered on drop-off collection, was implemented in several municipalities and a communication strategy was used to encourage citizens to adhere to this service.

Nonetheless, this fact should not be understood as a criticism to the SPV behavior in the early years of its activity. In effect, how could this company ask citizens about its motivations and barriers concerning recycling if this subject was, at that time, totally unknown for the great majority of the population and if the physical infrastructures for the selective-collection were rarely available? Taking into account the short deadline SPV had to quickly enhance the recycling rates in Portugal, it is reasonable to accept that this organization followed its only possible roads: (1) to provide some physical conditions so that the selective-collection could be widespread and (2) to use a communication strategy to create awareness of the need and importance of citizens' participating in the recycling program.

By adjudicating to the GIESTA the carrying out of a national survey on the attitudes and motivations of the Portuguese population towards selective-collection, with the aim of supporting "the definition of a strategy that permits increasing the take back of household packaging residues" (GIESTA, 2000: 4), SPV revealed it shared a social marketing view on the recycling problematic. The availability of the data set, yielded by this survey, supported this thesis in the carrying out of a quantitative formative research on the predictors of recycling behavior in Portugal. On the other hand, the results of this market research were the basis for the definition of a few orientations for planning a future social marketing strategy, in what concerns some restructurings at the logistics and at the communication levels. Actually, most of the suggested guidelines were evidenced by the quantitative formative research. Even though the division of these purposes by the four central chapters of this thesis would not be rigid, it is evident that the quantitative formative research was primarily pursued in Chapters 4 and 5 and that their logistics and communication implications were more soundly discussed in Chapters 6 and 7.

It is undeniable that the opportunity of offering some contribution for the planning stage of a new social marketing campaign, conceived to encourage such pro-ecological behavior, strongly motivated the carrying out of this thesis. While it seems unlikely to deter the consumption culture of the modern world, it becomes particularly encouraging to develop a study whose management implications can help, in some degree, to minimize the deterioration of the natural environment, which is the result of sustaining the current high quality-of-life patterns. In addition to this general driver, some breaches in the literature approaching the recycling thematic have oriented the specific topics explored in Chapters 4 to 7 of this thesis:

(1) The identification of the main direct determinants of recycling behavior, in the Portuguese case, through the adjustment and thorough misspecification analysis of a logistic regression model (Chapter 4);

(2) The specification and testing of a comprehensive structural equation model of recycling participation, by combining a superior number of potential personal and situational determinants of this sustainable behavior, in comparison to the previous studies on the field, which had also used the same statistical analysis instrument (Chapter 5);

(3) The quantitative analysis of the relevance of consumer-service performance in determining consumers' involvement in the selective-collection system for recycling and the discussion of its implications (Chapter 6);

(4) The analysis of the potential application of relationship marketing in social marketing frameworks, specifically focusing on the case of encouraging recycling behavior (Chapter 7).

The overcoming of these literature gaps constitutes the theoretical contribution of this thesis. This chapter continues by summarizing the management contributions of this thesis. The following section synthesizes the main findings of the formative quantitative research that was carried out all along the thesis and the subsequent sections are dedicated to their implications on planning a new social marketing strategy, in what regards logistics and communication aspects. The nine research questions that were formulated in Chapter 1 serve as the framework for these discussions. Lastly, this chapter ends by proposing some directions for future research.

8.2 General conclusions of the quantitative formative research

As noted above, Chapter 4 was explicitly motivated by the attempt to identify the principal direct determinants of recycling behavior in the Portuguese case, that is, to provide some response to the first research question that was advanced:

> **(1)** What are the main direct determinants of Portuguese consumers' involvement in the national selective-collection program?

In this chapter, a set of four potential determinants of consumers' involvement in the national recycling program were analyzed: general environmental attitudes, specific attitudes towards recycling, the satisfaction with the logistics concept of the recycling program, the existence of some space at home to temporarily store the recyclable materials and a few socio-demographic variables (gender, age, education and family income). The items measuring the first three types of predictors were captured by eleven principal components: (1) *Balance and limits of nature*, *incapability and lack of knowledge*, *importance of life style change* and *man over nature* (in what concerns general environmental attitudes); (2) *Social norms*, *awareness of recycling benefits*, *personal norms* and *difficulty and indifference* (in what respects specific attitudes towards recycling); and (3) *disposal conditions*, *system adequacy and information* and *disposal containers location* (in what regards the logistics service satisfaction).

These principal components and also some dummy variables representing the socio-demographic attributes entered as independent variables in a logistic regression model, in which the dependent variable was the self-reported behavior in separating and disposing of recyclable material, measured by a binary scale (1 – yes; 0 – no). After estimating and testing the model, as well as a set of research hypothesis related with the potential effect of these independent variables in the household propensity to participate in the recycling program, it was concluded that general environmental attitudes and socio-demographic characteristics were not significant direct determinants of recycling behavior. Instead, the propensity to participate in the selective collection program was significantly and directly determined, first, by specific attitudes towards recycling – in the following decreasing order of importance: *Difficulty and indifference*, *personal norms* and *social norms* – and, then, by variables of logistics nature – in the following decreasing order of importance: *Space to store*, *disposal containers location* and *system adequacy and Information*.

This aspect of the direct determinants of recycling behavior was also addressed in Chapters 5 and 6 by using different statistical data analysis instruments (SEM in Chapter 5 and discriminant analysis in Chapter 6), even though without the explicit and detailed approach followed in Chapter 4.

In Chapter 5, it was hypothesized that the latent variables *attitude towards recycling*, *personal norms*, *subjective norms* and *perceived behavior control* would have a significant direct effect on recycling behavior. The conclusions concerning the importance of these variables, as determinants of recycling participation, supported the findings reported in Chapter 4, not only in what regards the identification of the statistically significant variables but also in what respects their order of importance. Actually, as in Chapter 4, the hypothesis that recyclers were significantly more aware of the benefits of recycling (measured by the latent variable *attitude towards recycling*) than non-recyclers was rejected. On the other hand, and similarly to what happened in Chapter 4, recycling behavior was strongly determined by *perceived behavior control* (measured by an item representing the perceived difficulty in participating and by another item indicating indifference towards recycling), afterwards by *personal norms* and, lastly, by *subjective norms* (essentially the same as social norms).

Chapter 6, instead, confirmed Chapter 4 in what respects the importance of variables related with the logistics consumer-service performance as direct determinants of recycling participation. Besides attesting the general importance of this sort of variables, Chapter 6 conducted to similar findings that those evidenced in Chapter 4, that is, that "the current recycling behavior is mainly explained by the *disposal containers location,* followed by the decreasing influence of *information and system adequacy* and, finally, by the *disposal conditions*.

This summary of results allows the advance of a profile of the consumer that is more likely to adopt recycling practices. In brief, higher levels of recycling involvement are expected among those consumers who have the following characteristics: (1) do not value the difficulty in participating in the recycling program too much and recognize the importance of their individual action so that the recycling process can exist and their benefits can happen; (2) feel proud in practicing such a sustainable activity, guilty if they do not carrying it out and are willing to make some sacrifices to go on participating (such as walking a few blocks to the nearest "Eco-point" or managing some space at home to temporarily store the recyclable materials); (3) believe that their participation in the recycling program is expected by the others (family, friends and neighbors) and have also expectations concerning these referents' behavior; (4) are more satisfied with the logistics component of the selective collection system, primarily with the location of the disposal containers / distance from these infrastructures but also with the information provided and the general adequacy of the system to their lifestyle.

The analysis of the comprehensive structural equation model of recycling behavior proposed in Chapter 5 provided the needed elements to answer to the second and to the third research questions that were formulated in Chapter 1:

(2) Is it possible to identify the indirect significant determinants of recycling behavior?

(3) Given an affirmative answer to the previous question, how would these variables interact with the direct determinants in order to improve the understanding of this phenomenon?

As Figure 5.1 evidences, there were specified indirect relationships among recycling behavior and six latent variables: *subjective norms*, *general environmental attitudes*, *personal values*, *specific knowledge*, *perceived convenience* and *communication*. By observing the statistical significance of the regression weights of the structural model[75], as well as the statistical significance of the indirect paths presented at the end of section 3.5[76], some conclusions can be pointed out.

[75] See Figure 5.2, p. 251.

[76] See p. 252.

Firstly, Figure 5.2 shows a significant positive indirect relationship between *subjective norms* and recycling behavior, through personal norms, as was hypothesized. This means that the individual's belief concerning others' opinion or expectation about how he / she must behave will positively influence his / her own moral attitudes (*personal norms*) that, as a consequence, will determine recycling behavior. This finding is in accordance with the Schwartz's (1977) model of altruistic behavior. Moreover, this result reinforces the importance of *subjective norms* as a predictor of recycling behavior. As referred and demonstrated in Chapters 4 and 5, these norms are also direct determinants of recycling participation.

Another significant positive indirect relationship was detected between *personal values* and recycling behavior, which implies that higher levels of recycling participation are expected among those consumers with superior social conscience, that is, those who are more likely to feel satisfied in promoting actions able to help change the world, in developing responsible environmental behaviors and in helping the others. As indicated in Figure 5.1, this variable affects recycling behavior by increasing consumers' *perceived* behavior control or, in other words, by enhancing consumers' self confidence in their ability to participate.

Additional significant positive indirect relationships were found between *specific knowledge* and recycling behavior, on one hand, and between *perceived convenience* and recycling behavior, on the other hand. Both *specific knowledge* and *perceived convenience* influence recycling behavior by means of enhancing consumers' *perceived behavior control,* as it was expected considering the TOPB (Ajzen, 1985). The interpretation of these findings is that the consumers that are better informed about the materials that should be recycled and more satisfied with the provided logistics service are those who feel more confident in their ability to recycle, which, in turn, conducts to a superior involvement in the national recycling program.

In opposition to what was proposed, no indirect significant relationship was demonstrated between *general environmental attitudes* and recycling behavior. The lecture of this result is that recyclers and non-recyclers are equally aware of the recycling problems and share similar feelings concerning the need for improving the quality of the natural environment. This result is in agreement with the previous studies on the recycling behavior problematic that shows a weak or non-statistically significant relationship between general environmental beliefs and sustainable behaviors. In effect, the perception that environmental quality is being degraded and posing a direct threat to human health and well-being is increasing worldwide. In Portugal, the most recent national survey about environmental conceptions and practices indicated that Portuguese consumers reveal a high degree of concern and awareness about environmental problems and that the great majority (72.9%) shared, even moderately, pro-ecological values (Observa, 2001). This non-significant relationship was not, therefore, a surprising result.

The occurrence of a non-statistically significant indirect relationship between the latent variable *communication* and the adoption of recycling behavior was, actually, an unexpected result. In accordance with the objectives of the most recent and striking communication campaign carried out by SPV during 2000, it was projected that a superior media exposure would be reflected in an increased knowledge about the recyclable materials as well as in an enhanced self-confidence in the consumers' ability to participate in the selective-collection program (measured by the latent variable *perceived behavior control*). This second hypothesized relationship was rejected.

Moreover, the regression weight representing this relationship presented a negative sign, suggesting that the communication messages that were being used were yielding an opposite result in relation to the desired one. This finding and the absence of a statistically significant indirect relationship between the constructs *communication* and recycling behavior were interpreted as indicators that the communication strategy should be reformulated.

8.3 General implications in logistics

The formative quantitative research that was carried out is clear about the importance of the logistics of the selective collection-system in determining Portuguese consumers' adherence to the reverse system for recycling household packaging. The performance of this analysis, in the reverse logistics perspective, was the central focus of Chapter 6, even though, as aforementioned, variables related to system convenience have also been analyzed in Chapters 4 and 5, in articulation with other types of predictor variables. The research questions **(4)** to **(6)** provide a guide for a summary of the implications on the logistics scope of the results of these analyses. Question **(4)** will first be considered:

> **(4)** What is the relative importance of consumer-service components as determinants of consumers' adherence to the reverse logistics system for recycling?

Up to now, the role of consumers in the reverse channels has been ignored and overlooked by the reverse logistics researchers. Chapter 6 underlined the importance of consumers' motivation to participate in the SIGRE by initiating the system and by ensuring that the needed supplies of recyclable materials are available for the recycling industries. Moreover, by using a combination of multivariate statistical methods (PCA plus discriminant analysis), this chapter shown the importance of high levels of convenience in getting consumers' participation in the recycling program. Chapter 6 also evidenced that the proposed hypothesis that the current recycling behavior was principally determined by the *disposal containers location* (hard dimension), then by the *information and system adequacy* (medium dimension) and, lastly, by the *disposal conditions* (soft dimension), should not be rejected. By ordering these variables of logistics nature, taking into account their relative importance in fostering recycling participation, it becomes easier to establish a ranking of the priorities in a revision of the logistics concept of the selective-collection system.

A conclusion of this thesis is that the organization and the performance of the Portuguese reverse logistics system for recycling have to be improved. It should not be ignored that non-adherent consumers are significantly more unsatisfied with all individual items used to measure the performance of the logistics consumer-service in the SIGRE. On the other hand, Chapter 5 shown that the *perceived convenience* of the system has a positive and significant effect on *perceived behavior control*, that is, on consumers' self confidence in their ability to participate in the recycling program, which is the strongest personal determinant of recycling behavior.

Considering the results about the relative importance of each consumer-service dimension, offered by Chapter 6, another conclusion is that this need for improvement should focus on, as a first priority, in the location of the "Eco-points", more specifically, in how close they are of the populations. Taking into account the relative importance of this dimension, the possibility of changing to a different collection-system, mainly based on curbside collection (or door-to-door collection) – at least provisionally and in a few municipalities – which allows personal contact between consumers and the service providers, was also suggested. When this consumer-service problem is solved, it is worth to intervene in the remaining logistics variables, such as the existence of a support and claim service, more information availability and in the general disposal conditions (cleaning, maintenance, safety, etc). Restructurings at these levels, however, cannot be overlooked.

Research questions **(5)** and **(6)** were specifically answered and developed in Chapter 6. These questions are:

(5) What are the main trade-offs that arise when intervening in the logistics determinants of consumers' behavior in this reverse logistics system?

(6) Besides the consumers' adherence to the reverse logistics system for recycling, what other factors can affect the success of the Integrated Recovery System in the medium / long term?

Concerning question **(5)**, the general conclusion is that the improvement of consumer-service at the collection stage easily represents an increase in the total costs of the reverse logistics system. As explained, a strategy to minimize the problem of the (improper) *disposal containers location* (hard dimension) is to comprise more municipalities with more and better located "Eco-points" or even to consider a change to a different type of collection system, essentially based on curbside collection. Any of these changes towards a more convenient system would increase the recovered rate of recyclable materials. However, the collection costs and, as a consequence, the total costs of the system, would increase as well.

A similar problem would incur if the improvement of consumer-service would imply a dramatic change to a commingled collection system (in opposition to multi-material collection) or to the implementation of a much more frequent collection system (and transportation to the trial centers). Both of these latter strategies would improve the consumer-service in what respects its medium and soft dimensions: the "perceived sorting complexity" problem would be eliminated and the cleaning and the aesthetic of the disposal containers would be significantly improved. Nevertheless, the separation and transportation costs would significantly increase too.

To solve these trade-offs is a challenge that SIGRE needs to overtake. In Chapter 6 some suggestions were made to attend this purpose, that is, for balancing the need of increasing consumers' adherence to this reverse logistics system without compromising its economic viability. These suggestions encompass, for instance, (1) the provision of curbside collection in a larger number of municipalities, considering that they fulfill a minimum value of population density (so that the additional collection costs could be compensated by the extra amount of collected material); (2) the conception of a communication strategy that effectively could enhance consumers' knowledge about how to participate and help to attenuate the overstated expectations about the inconvenience of recycling; and (3) the provision of co-collection and transportation of the recyclable materials, naturally in vehicles with some compartments (three, at least), one for each sort of recyclable material.

Besides consumers' adherence to the system, other factors are also determinants in the development and future success of SIGRE. By identifying these factors, research question **(6)** is being answered. All of these aspects were explained in detail in Chapter 6. In summary, it is important to overcome the *costs challenge*, by efficiently using the available resources, methods and technologies and by investing in actions that represent value for consumers, that is, those which can effectively change consumers' behavior towards recycling. It is also required to surpass the *quantities challenge*, which implies the development of the recyclables market and, likewise, the *quality challenge* that can be done by reviewing the communication strategy. Another fundamental aspect is concerned with the *maintenance of the SIGRE organization*. Effectively, in this reverse logistics system, each intervenient has a well defined role that has to necessarily be done or, otherwise, the functioning of the overall system will be threatened.

8.4 General implications in communication

The previous sub-section emphasizes the need of restructuring the logistics consumers-service in order to increase the rates of consumers' adherence to the recycling program. Besides the importance of these changes at the logistics level, a management intervention within this context should also be centered on the communication strategy.

Besides providing a quantitative formative research on the determinants of recycling behavior in the Portuguese case, Chapters 4 and 5 also discussed some implications of their quantitative findings in planning a future social marketing communication plan. Nevertheless, the question of the importance of the communication strategy and how it should be reoriented to foster recycling participation was soundly explored and marked the central point of debate of Chapter 7. In particular, this chapter provided answers to the research questions **(7)** and **(8)**:

(7) Is it possible to plan a social marketing strategy that would be compatible with the principles of relationship marketing, which is considered nowadays as the new marketing paradigm in the commercial sector?

(8) If yes, what would the objectives, the communication means and the targets of this new marketing strategy be?

Actually, just as the marketing focus gradually moved from mass marketing to segmented marketing during the 20th century, several recent studies herald that segmentation is increasingly losing importance in favor of a more personalized marketing approach: the relationship marketing. As explained in Chapter 7, RM is much the result of the merge of the new information economy, based on the fast advances of the information technologies, with the parallel change in customers' profile (Liechty, Ramaswamy and Cohen, 2001). The "new" customers require products and services designed to their individual wants and needs. In spite of the applicability of this marketing perspective in consumer markets has already been focused on in a few studies, no research was encountered that had analyzed its potential use in social marketing contexts. This finding, as referred, motivated the performance of Chapter 7.

Data analysis in this chapter and also the previous market research that was carried out in the previous chapters are indicative that the mass communication strategy, which has been used in Portugal, is not being effective in attaining its purposes. Despite the amount invested in the communication domain, Chapter 5 shown that the media exposure is not allowing the increasing of consumers' self-confidence in their ability to participate in the national recycling program, the first objective of the communication policy. On the other hand, data analysis in Chapter 7 evidenced a still great lack of specific knowledge about how to participate, low satisfaction level with the information provided by most media and a great willingness to receive more information, independently from the media selected by SPV. Moreover, the HOMALS conducted in this last chapter have shown some interdependence between the media exposure and the consumers' adherence level to the recycling program. However, this multivariate method also underscored a great lack of knowledge, even among the most adherent consumers.

Although these findings are not enough to conclude that, nowadays, mass marketing interventions in social marketing contexts will inevitably failure, they are indicative that something has to be changed in the communication scope, at least in the Portuguese case. Taking this premise as a reference, Chapter 7 discussed whether a personalized marketing approach, like the one defended in the RM, was theoretically defensible. This analysis is a direct answer to the research question **(7)**. In short, Chapter 7 concluded that a RM intervention is conceptually justified because the adoption of recycling practices, due to various pointed reasons, requires a high-involvement decision, which is considered by O'Malley and Tynan (2000) as the first condition for the applicability of RM. On the other hand, it was discussed that there is the potential of interacting with consumers (the second condition for the applicability of RM), obviously in a renovated communication intervention, which would imply some changes in the selective-collection system and in the communication means that have been used by SPV so far.

Chapter 7 intended, afterwards, to discuss how such a communication strategy could be structured by proposing some guidelines for its broad purposes, communication means, and targeting options. This discussion constitutes an explicit answer to the research question **(8)**. Basically, an intervention based on three stages was suggested, each of these with a broad purpose, centered on a different target and by using a particular combination of communication means. In summary, Stage 1 should look for motivating non-adherent consumers to the need and interest in participating in the recycling program. This purpose can be achieved through a mass-marketing intervention that uses television, leaflets, brochures, packages and the "Eco-points" as communication means. The details about these communication means and communication messages are presented in Chapter 7.

Concerning Stage 2, in turn, the use of RM is defended in a few market segments with the purpose of changing non-adherent consumers' behavior. Specifically, it was proposed that this type of marketing intervention, in what involves direct marketing through the door-to-door collection, should be restricted to the municipalities with, at least, 2000 ha / km^2 that report a low level of recycling participation as well as a high consumption potential. Also in these municipalities, an increased effort in what concerns the occurring of proximity campaigns was recommended. Lastly, Stage 3 should seek to maintain recycling behavior. At this stage, it is expected that household recycling practices have already become a habit. In this case, a turnover to a centralized drop-off system, based on well located and clean "Eco-points" should be reconsidered. As explained in Chapter 7, this decision does not mean a denial of the RM's principles. At that time, the internet as well as the "Green-Dot line" would allow the maintaining of individualized contacts and exchange of information between consumers and SPV.

Besides the evident need of rethinking the logistics consumer-service in order to increase the system convenience, a renovated social marketing strategy that intends to foster recycling in Portugal should use media and communication messages that are able to intervene in the other significant predictors of recycling behavior, which were mainly identified in Chapters 4 and 5. On the other hand, the definition of the specific objectives of such a social marketing campaign should be based on the insights of the market research carried out recently on this issue. As already pointed out, social marketing, like RM, is customer-centered and, as a consequence, it should be adapted to the consumers' needs, perceptions and attitudes. In other words, a last question, which was not specifically treated in the previous chapters, must be analyzed:

(9) How would this marketing strategy interfere in the main determinants of recycling participation, previously identified, in order to foster this socially desirable behavior?

Chapter 4 proposes the need to use communication messages that are able to "demystify negative attitudes towards recycling and reinforce more positive ones". Naturally, these positive and negative attitudes are those which were identified as significant determinants of recycling participation, such as *difficulty and indifference* or *lack of perceived behavior control* (negative attitudes), on one hand, or *personal norms* and *social norms* (positive attitudes), on the other hand. Furthermore, it is important to take advantage of the other significant positive personal determinant of recycling behavior, the *personal values / social conscience*, and act to eliminate the other personal barrier to recycling participation, that is, the lack of *specific knowledge* of how to participate in the program. In the *Discussion* section of Chapters 4 and 5, although mainly in Chapter 4, a few concrete guidelines were proposed to attain some of these purposes.

In summary, a future social marketing communication campaign should pursue two specific objectives: (1) to minimize the personal barriers to recycling like the lack of specific knowledge and unsupportive attitudes (indifference, excessive perceived difficulty); and (2) to explore the factors that have a positive significant effect on recycling behavior like some supportive attitudes (personal norms and social norms) and personal values / social conscience. Table 8.1 depicts the connection between these specific objectives and the communication means that were proposed.

TABLE 8.1
Correspondence between the specific objectives of the communication strategy and the communication means

Communication Channels	Specific Objectives	
	(1) To minimize personal barriers	**(2) To reinforce personal incentives**
1 – Block-leaders intervention trough curbside collection	×	
2 – Leaflet 1 (Recycling tips)	×	
3 – Leaflet 2 (Feedback and goal setting)	×	×
4 – Brochure (Benefits of recycling)		×
5 – SPV magazine	×	×
6 – Green-Dot line	×	
7 – Proximity campaigns	×	×
8 – Seminars	×	×
9 – Web Page/ e-mail	×	
10 – Packages	×	
11 – "Eco-points"	×	
12 – Television	×	×

As was shown, the primary external barrier that discourages consumers to participate in the recycling program is the lack of convenience of the collection-system. The implementation of *curbside collection*, temporarily and in a few municipalities, would allow the attenuation of an important situational barrier that dissuades many consumers from participating in the recycling program, that is, the lack of convenience of the collection-system. In addition, and as proposed in Chapter 7, the operators responsible for the door-to-door collection should intervene as community block-leaders, by providing all the requested information about the recycling program and also encouraging consumers to begin or go on participating. Besides the verbal information, the personal contact offered by this communication channel would enable the opportunity for modeling, that is, for exemplifying how to separate and prepare the materials for recycling.

To improve consumers' knowledge level about how to participate in the recycling program is, indeed, of crucial importance. As Chapter 5 demonstrates, the lack of knowledge of the population concerning the selective-collection issue is a problem that SPV and the municipalities still have to solve. This chapter also proves that *specific knowledge* is the second most influential motive of recycling behavior, right after the *perceived behavior control*. Also in this chapter, it was shown that a higher level of *specific knowledge* is significantly and positively related with a stronger *perceived behavior control*, the main determinant of recycling participation in the Portuguese case. Therefore, the block-leaders intervention through curbside collection would enable the accomplishment of the first specific objective defined to the social marketing communication campaign, that is, to reduce the internal barriers that deter consumers from participating: the lack of knowledge and the lack of confidence in the ability to carry out such behavior.

Chapter 7 also suggests that this investment in the information domain should be complemented by the conception of two types of leaflets and a brochure. The *first type of leaflet* should clearly identify the materials that should be separated and disposed of. Consequently, its specific purpose clearly is to minimize the personal barriers hampering recycling by increasing specific knowledge about how to participate. The same purpose is pursuit by many of the other communication means that appears in Table 8.1, like the "*Green-dot*" *line*, the icons in the recyclable *packaging* (identifying the suitable container for its dispose of), the *web site* and the placement of improved and more informative billboards near the "*Eco-points*".

The *second sort of leaflet*, however, should be a goal-setting and feedback leaflet. As the literature review in the consumer behavior field evidenced, goal setting and feedback are important determinants of recycling involvement. This second leaflet would allow showing that the participation in the recycling program is not an isolated action, only performed by a few more environmentally friendly consumers. Information of this kind is very important to mitigate the idea that "almost no one recycles any household material", which contributes to form an (negative) attitude of indifference towards recycling. In this sense, this leaflet may contribute to achieve the first specific objective of the communication strategy, as is shown in Table 8.1.

On the other hand, this type of information is also relevant to reinforce *social norms*, another significant predictor of recycling behavior in the Portuguese case, evidenced in Chapters 4 and 5. As explained in this thesis, consumer's contribution to environmental protection is often threatened by social dilemmas. As long as the desired behavior has costs to the individual and the expected environmental benefits are not immediately visible, it is rational for him / her not to have that behavior. As referred by Bratt, "contributions to a common aim may well depend on the individual's assumptions about how other parties will behave" (Bratt, 1999: 631). Within this context, by publicizing that some selective-collection targets are being attained by the municipality where the individual lives, a clear message is being sent regarding the perceived importance of recycling to others. The expectation that others are also participating may directly activate the social norms that, in turn and as shown in Chapter 5, may indirectly influence the *personal norms*. This means that, consumers tend to act in accordance to what they feel to be the others' expectation and perceive the behavior that the social norm prescribes (and that "others" are practicing) as the "right" behavior, which they should carry out too. In summary, a specific purpose of the second type leaflet is also, as reported in Table 8.1, to reinforce the personal determinants of recycling behavior, in particular, *social* and *personal norms*.

Concerning the brochure, it was suggested that it should focus on the benefits of recycling. Considering that Chapters 4 and 5 show that recyclers and non-recycler are equally sensitive to the environmental problems and equally aware of the benefits of recycling, the focus of this brochure should go beyond the gravity of the excessive production of solid waste residues and the potential of recycling in attenuating such a serious environmental problem. Instead, the brochure could explore the important role that the recycled materials perform in everyone's day to day life. This implies putting in evidence the intrinsic value of the recyclable packaging, underlying the role of recycled materials as a secondary factor of production that, in combination with some raw materials, enables the production of infinity of goods that everyone recognizes and uses in the daily life.

Moreover, this brochure could evidence the benefits of recycling to the national economy, pointing out some numbers about the energy and other natural resources savings that it allows. Exploring the benefits of recycling (which means indirectly emphasizing the serious consequences of the passivity) is a worthily way to promote the more positive attitudes towards recycling. In particular, it would directly strengthen the *personal norms*, that is, the feeling of pride in being involved in a project with beneficial environmental and economic impacts and some guilt and sense of responsibility for doing nothing. Additionally, such evidence of the recycling potential would appeal to the *social conscience*, which is also a significant determinant of consumers' recycling involvement evidenced by Chapter 5. Briefly, the distribution of this type of brochures is a potentially important means of achieving the second specific objective proposed to the social marketing communication campaign, that is, to activate the internal incentives that may encourage consumers to recycle: *personal norms* and *personal values* (*social conscience*). The *SPV's Magazine* was proposed as a complement to the leaflets and brochure and, consequently, it looks for similar specific purposes.

Other important elements of the social marketing communication strategy are the *proximity campaigns* that are proposed to SPV by the municipalities embraced by the selective-collection system. The same applies to the performance of *seminaries* on the recycling problematic at schools or in other institutions. Chapter 7 explains how the SPV's Web site can be used in favor of the proximity campaigns. Since environmental issues are all the fashion, these local communication actions may attract several participants. They have a fundamental importance for various reasons. First, they act as local awareness campaigns towards the relevance of packaging recycling and the crucial importance of the household separation in this process. Accordingly, besides the evident role of these initiatives in reinforcing *social norms*, they also have a potential positive impact on the remaining personal determinants of recycling behavior like *personal norms*. Secondly, these local campaigns enable the provision, individually if required, of all relevant information about recycling (and, inclusively, to exemplify the separation behavior) and, particularly in the case of the proximity campaigns, this can be done in an environment of leisure and amusement, through games and contests. Finally, the entertainment nature of these activities facilitates the perception of the household separation of recyclables as an easy and even amusing activity. These campaigns are, therefore, a valuable contribution to increase consumers' knowledge about selective-collection and also to strengthen their self-confidence in their perceived ability to participate. The same is to say that these local campaigns can contribute for both specific objectives of the communication strategy, as indicated in Table 8.1.

A last reference concerns the use of television as the main communication means of a mass marketing intervention, in agreement to what was suggested to Stage 1 of the communication strategy. Considering the results of Chapter 5, one conclusion that stands out is that the option of continuing promoting *perceived behavior control* and *specific knowledge* as the objectives mass advertising would not be wrong because, as was demonstrated in this chapter, these two variables are the most important determinants of recycling behavior. However, what seems unquestionable is that for attaining these objectives, different communicating messages have to be used. As also reported in Chapter 5, this does not exclude the interest of reflecting on the communication's messages the knowledge of the other important positive determinants of recycling behavior, like *personal norms, subjective norms* or *personal values.* Although some of the aforementioned ideas could be developed with this purpose, this is a challenge that would be better surpassed by the creative department of an advertising company.

8.5 Limitation and Directions for future research

In the domain of understanding Portuguese consumers' behavior towards recycling, a comprehensive model that includes both personal and situational determinants was proposed and tested in Chapter 5. Despite the generally positive findings of this model, the study carried out in this chapter also has a few limitations, whose overcoming provides directions for additional research.

In particular, future studies based on a general structural equation model of recycling behavior should seek to include the latent variable *recycling intentions* in the model and, therefore, to get a true generalization of the TOPB. A more complete definition of some constructs used in the proposed model should also be considered. For instance, the construct *personal values* could embrace other personality features, besides social conscience, and the latent variable *perceived behavior control* should be measured by additional observed variables. The use of a single indicator to measure the construct *perceived behavior control* in the model has required the fixing of the reliability of this latent variable. Although the two items chosen to form the single indicator were in accordance with the TOPB and, as a result, it is expected that they reflect the nature of the latent variable to a substantial degree, it would be preferable to measure this construct by using two or more indicators. Actually, when at least two observed variables are used to measure a latent variable, the reliability of the construct can be estimated through the application of SEM, rather than fixed. In subsequent surveys to evaluate household recycling participation, additional measurement items for this construct should, thus, be included.

Any model should be regarded as an approximate description of reality. SEM enables the establishment and the estimation of multiple dependence relationships among a set of variables and can be applied to demonstrate whether the causal hypotheses embedded in a model are consistent or not with the data (Breckler, 1990). As demonstrated in Chapter 5, the data fit the proposed comprehensive structural equation model of recycling behavior. Nevertheless, the hypothesis that other models may yield a similar or even an improved global fit should not be excluded. So, for the environmental preservation, research on what motivates individual sustainable behaviors, like recycling, should go on being encouraged.

The measurement of recycling behavior, in this thesis, was made through self-reports, which is another limitation of this study. Actually, due to the impracticability of observing the actual recycling behavior of the participants in the study, the self reported behavior was chosen as a proxy measure of the true behavior. This approach is unavoidable in studies analyzing, at a national level, the consumers' compliance in recycling programs based on drop-off systems, as those used in Portugal. Since at least one study had demonstrated that self-reports and observed measures are significantly strongly correlated (Gamba and Oskamp, 1994), it is expected that the presented findings in the current thesis do not differ, in a substantial degree, from those that would be obtained if observed recycling had been considered.

As noted in the literature review on the social marketing field, the process of social marketing is continuous and centered on the consumer. An implication of these aspects is that market research should be regularly updated in order to attend consumers' changing features and needs. Consequently, it would be important to repeat the national survey on motivations and attitudes towards household packaging recycling soon, perhaps based on a shorter and more focused questionnaire. Besides including items that could measure, more accurately, some of the aforementioned latent variables, a new questionnaire should include questions that can evaluate the receptiveness to the communication means which were proposed in this thesis, mainly in Chapter 7. On the other hand, this questionnaire also should evaluate consumers' opinion towards the communication messages that have been used by SPV and try to get information about their openness and level of conferred importance to alternative communication messages, such as those which are being used nowadays.

Some questions in this new questionnaire could be used as the foundation for consumers' receptivity to a RM approach in this social marketing context. Another aspect that requires further research concerns the costs involved in a more personalized marketing approach. Therefore, future studies on household recycling practices may extend beyond the motivations and their implications settings and examine the costs that are involved in the proposed strategies.

As a last note, SPV is presently negotiating its license to manage packaging residues in Portugal for the years 2006-2011. A question that arises is whether is possible to make SIGRE a less complex system in this forthcoming management period. This kind of analysis is, therefore, a last proposal for future research.

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