Marina Bouzon

# EVALUATING DRIVERS AND BARRIERS FOR REVERSE LOGISTICS IMPLEMENTATION UNDER A MULTIPLE STAKEHOLDERS' PERSPECTIVE ANALYSIS USING GREY-DEMATEL APPROACH

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Esta Tese foi julgada adequada para obtenção do Título de "Doutor em Engenharia de Produção" e aprovada em sua forma final pelo Programa de Pós-Graduação em Engenharia de Produção.

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This work is dedicated to my parents and my beloved grandmother, Laurita.

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“Choose a job you love, and you will never have
to work a day in your life.”
(Confucius)

## RESUMO

Nas últimas décadas, a quantidade de resíduos aumentou drasticamente enquanto a produção industrial e a demanda dos consumidores cresceu. Isto é, mais matérias-primas são usadas e a capacidade dos aterros sanitários está se extinguindo. A fim de resolver este problema crescente, recentemente, o interesse em recuperação de produtos, logística reversa (LR) e cadeia de suprimentos de circuito fechado tem atraído a atenção não somente das empresas, mas também de pesquisadores. Adicionalmente, o surgimento de leis ambientais mais rigorosas e a consciência ambiental dos clientes impulsionaram as empresas a pensar em gestão ambiental por meio da implementação da LR de produtos em fim de vida útil. Entretanto, enquanto a LR está se tornando um componente obrigatório nas cadeias de suprimento dos países desenvolvidos especialmente por causa de questões legislativas, a LR ainda está imatura nas economias emergentes, como o Brasil. Mais ainda, a LR pode ser considerada como a iniciativa mais difícil de implementar da Gestão de Cadeia de Suprimentos Verde, quando comparada com compras verde e *eco-design*. Nesse sentido, fatores de influência, como direcionadores e barreiras, devem ser considerados e analisados previamente, assim como as várias perspectivas dos *stakeholders* chave para o desenvolvimento da LR. Para lidar com esse problema, o principal objetivo desta pesquisa é avaliar as interrelações entre os direcionadores e barreiras da LR sob as perspectivas dos *stakeholders* mais importantes no contexto Brasileiro. Para tal, primeiramente, um plano de pesquisa é proposto, apresentando cada passo adotado no decorrer deste estudo. Posteriormente, este trabalho começa por uma descrição geral da LR e suas práticas, algumas percepções de LR em países em desenvolvimento, e um retrato detalhado da LR no contexto brasileiro por meio de um processo sistemático de revisão de literatura. Em seguida, dois estudos de caso diferentes realizados no Brasil são apresentados – uma empresa de manufatura e um operador de logística reversa – a fim de obter conhecimento prático em LR no Brasil. Na sequência, este manuscrito transfere seu foco para uma detalhada revisão de literatura em direcionadores, barreiras e *stakeholders* da LR. Para isso, é feito o uso de duas teorias – *Stakeholder* e *resource-based view theories* – que servem de lentes teóricas para o trabalho, criando-se uma estrutura de múltiplas perspectivas para direcionadores e barreiras da LR. O passo seguinte é a avaliação destes fatores de influência da estrutura de múltiplas perspectivas com experts por meio de uma ferramenta multicritério de apoio à decisão chamada *grey-based* DEMATEL (*Decision Making Trial*

*and Evaluation Laboratory*). Um expert de cada *stakeholder* foi consultado para se obter as comparações par-a-par dos direcionadores e barreiras da LR. Portanto, o efeito de rede e o nível de importância de cada fator é fornecido, assim como as similaridades e diferenças das opiniões dos *stakeholders*. Com relação às contribuições deste trabalho, a maior parte das barreiras chave da estrutura de múltiplas perspectivas da LR vem da organização. Isto é, pressões externas podem prejudicar a implementação da LR, mas as empresas podem primeiramente focar em superar as barreiras internas, como a baixa importância dada a LR em relação a outras atividades e as políticas da empresa que vão contra à LR. Os direcionadores mais proeminentes vem da organização em si, sendo eles: *Eco-design* e projeto para técnicas de recuperação (remanufatura, reciclagem, etc.), Sustentabilidade a longo prazo, Viabilidade econômica da LR e Redução do consumo de matérias-primas e custos de despejo de resíduos. De um ângulo prático e gerencial, esta pesquisa mostra-se relevante, uma vez que uma análise crítica dos fatores de influência da LR – assim como conhecer os atores que os causam ou são afetados por eles – pode ser uma fonte de informação valiosa para tomadores de decisão. O conhecimento sobre os fatores de influência no ambiente da LR pode auxiliar as indústrias a melhor implementar e gerenciar fluxos reversos e a cobrir a lacuna entre as soluções ambientais existentes e futuras para a LR.

**Palavras-chave**: Logística Reversa, Tomada de decisão; Direcionadores, Barreiras, *Stakeholders*, DEMATEL, *Grey Theory*.

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## ABBREVIATIONS

3PRL – Third Party Reverse Logistics
CIF – Cost, Freight and Insurance
CLSC – Closed Loop Supply Chain
DEMATEL – Decision Making Trial and Evaluation Laboratory
EOL – End-Of-Life
FOB – Free On Board
GDP – Gross Domestic Product
GSCM – Green Supply Chain Management
LT – Lead Time
MCDM – Multi-Criteria Decision Making
NGO – Non-Governmental Organizations
NPSW – National Policy on Solid Waste (Política Nacional dos Resíduos Sólidos)
RBV – Resource-Based View
RL – Reverse Logistics
RSC – Reverse Supply Chain
SC – Supply Chain
SMEs – Smaller and Medium sized Enterprises
SO – Specific Objective

## SUMMARY

# 1. INTRODUCTION

Technological development, mass consumption, and a decrease in product lifecycles have augmented worldwide production. As a consequence, more raw materials are used and available landfills are filling up (WASSENHOVE; BESIOU, 2013). In order to solve this increasing problem, in the past decades, an interest in product recovery, reverse logistics, and closed-loop supply chains has attracted not only the attention of companies and professionals but also has become the subject of interest for researchers (FLAPPER; GAYON; VERCRAENE, 2012; NIKOLAOU; EVANGELINOS; ALLAN, 2013; GOVINDAN; SOLEIMANI; KANNAN, 2015).

In this context, Green Supply Chain Management (GSCM) is considered one of the major efforts aimed at integrating environmental requirements with the supply chain (SC) systems (GOVINDAN *et al.*, 2014). According to Zhu; Sarkis and Lai (2008) and Diabat and Govindan (2011), GSCM goes from green purchasing to integrated life-cycle management supply chains flowing from supplier, to manufacturer, customer, and closing the loop with Reverse Logistics (RL).

However, RL might be considered as the most difficult initiative of GSCM to implement, when compared to green purchasing or eco-design (HSU *et al.*, 2013). RL is the process of moving goods from their typical final destination for the purpose of capturing value or proper disposal. Reverse logistics comprises all of the activities involved in managing, processing, reducing, and disposing of hazardous or nonhazardous waste from production, packaging, and use of products, including the processes of reverse distribution (ROGERS; TIBBEN-LEMBKE, 1999; ROGERS; TIBBEN-LEMBKE, 2001; GOVINDAN; SARKIS; PALANIAPPAN, 2013). Effective RL focuses on the backward flow of materials from customer to supplier (or alternate disposition) with the goals either of maximizing value from the returned item or minimizing the total RL cost (SASIKUMAR; KANNAN, 2008).

In a broad sense, RL is the joint responsibility of producers and consumers to minimize waste generation by means of reuse, remanufacturing, recycle, and safe disposal of unwanted items in order to enhance the absorptive and regenerative capacity of the planet, all of which contributes to circular economy issues. In this matter,

resource depletion, environmental concerns, increasing costs of landfills, and the substantial return policies of retailers have led to the growing importance given to RL by academicians, producers, and their stakeholders worldwide.

Nevertheless, reverse supply chains have not been broadly researched or developed (KUMAR; PUTNAM, 2008), and little research has been conducted on reverse supply chain subjects (VAN DER WIEL; BOSSINK; MASUREL, 2012). Many authors have recognized RL's strategic value (ROGERS; TIBBEN-LEMBKE, 1999; SHEAR; SPEH; STOCK, 2002; GUIDE JR; VAN WASSENHOVE, 2009). Although RL is strategically important (ALVAREZ-GIL *et al.*, 2007) and the RL concept is gaining popularity in practice, the available literature and theory on the strategic sphere are limited (SUBRAMONIAM; HUISINGH; CHINNAM, 2009; SUBRAMONIAM *et al.*, 2013).

As a result, this research primarily intends to deepen insight into the RL area and to build innovative knowledge in the field. To introduce this manuscript, this first Chapter is organized as follows. Section 1.1 presents a brief context on which this work is grounded. Section 1.2 highlights the research gaps and elaborates the research problem, while Section 1.3 and Section 1.4 present the research objectives. Section 1.5 discusses the delimitation of this work as well as its originality. Finally, the last Section, 1.6, provides the organization of this piece of work and the logic behind it.

## 1.1 RESEARCH CONTEXT AND JUSTIFICATION

Although products gradually are being recycled and reused in developed countries, the most common practices in emerging economies continue to be sending used products to landfills, causing considerable costs and harm to the environment (HSU *et al.*, 2013). Reverse logistics and product take back activities are ways of reducing this harm to the environment by managing the end-of-life (EOL) of products. Generally, in the most economically developed countries, a more mature and widespread perception of environmental problems exists (NUNES; MAHLER; VALLE, 2009). By contrast, in developing countries RL seems to be an immature practice in most industry sectors (LAU; WANG, 2009).

Among the Brazil-Russia-India-China (BRIC) countries, Brazil is fifth in the world both in size and in population, with about

200 million inhabitants. Brazil is the largest economy in Latin America and the seventh largest world economy (UNITED_NATIONS, 2012). In this country, Paulo Roberto Leite, the president of the Brazilian Council of Reverse Logistics (*Conselho de Logística Reversa do Brasil – CLRB*), highlights the growing amount of unwanted products with short life-cycles; he recognizes the problem of an unbalanced state between discarded and recovered products (LEITE, 2009). According to a survey Leite performed on RL with 71 Brazilian companies, the author posits that only 12% of firms consider themselves prepared for implementing and managing RL processes for EOL products (LEITE, 2011). This lack of industry commitment may arise at least partially from the fact that while RL is a mandatory component of the SC in developed countries, particularly due to legislation issues, RL is still in a state of infancy in emerging economies.

Nevertheless, although Brazil is a country with lower environmental standards, RL is gaining importance due to several factors: the recent implementation of new environmental policies because of the National Policy on Solid Waste issued in 2010; the recognition that recovering used products creates value and provides economic sense; the development of green marketing; and an improvement in social conditions. At the same time, Brazilian companies face the challenge of a deficient logistics infrastructure (DA ROCHA; DIB, 2002). Flaws in logistics infrastructure may act against the expansion of efficiency and effectiveness in the Brazilian business environment (ARKADER; FERREIRA, 2004). Thereby, an expansion of knowledge through scientific research to better understand the factors that either hinder or motivate Brazil's RL development seems necessary. With this in mind, the following Section highlights the research gaps and the research problem.

## 1.2 RESEARCH GAPS AND RESEARCH PROBLEM

In prior international research on the field, many motivational factors (or drivers) have been proposed to understand why companies engage in green activities (ANDIÇ; YURT; BALTACIOĞLU, 2012), such as RL. Pressures appear from employees, from the firm's strategy to reduce cost or guarantee the intellectual property, from government, community, clients, and even from the media. However, companies

commonly encounter RL implementation challenges from different stakeholders (ABDULRAHMAN; GUNASEKARAN; SUBRAMANIAN, 2014). RL is not a symmetric picture of forward distribution (FLEISCHMANN *et al.*, 1997; SRIVASTAVA, SAMIR K., 2008). Many industries face difficulties implementing RL due to the lack of interest from Supply Chain (SC) members (BERNON, M. *et al.*, 2013). Furthermore, in general, RL is considered by firms as an undervalued part of the SC (ABDULRAHMAN; GUNASEKARAN; SUBRAMANIAN, 2014).

Moreover, some authors (SARKIS; ZHU; LAI, 2011) state that it is still unclear how external and internal factors interactively promote green initiatives, and how different are the multiple perspectives regarding these drivers and barriers from the many stakeholders involved in the implementation process. Some authors (CRANE; RUEBOTTOM, 2011) state that firms might benefit from stakeholder management, either through trusting and cooperative relationships, risk reduction, reputation, or other material gains. Beyond that, the failure to address the interests of multiple stakeholders may harm company performance (AVKIRAN; MORITA, 2010).

Given the complexity of influential factors under different perspectives from the many stakeholders involved in the RL processes, this work intends to tackle the following research problem:

*What are the main RL drivers and barriers, and what is the interrelationship among them under the perspectives of the most important RL stakeholders in the Brazilian context?*

Concerning RL and stakeholder issues, few previous works have been developed that combine these fields. Some papers recognize the importance of analyzing the relationship between stakeholders' pressures and RL implementation (GONZÁLEZ-BENITO; GONZÁLEZ-BENITO, 2006; ALVAREZ-GIL *et al.*, 2007; ABRAHAM, 2011; ABDULLAH; YAAKUB; ABDULLAH, 2012). Still, as far as we know, no paper has examined the multiple perspectives of stakeholders to analyze drivers and barriers for RL implementation in this international scenario. In addition, as further discussed in this manuscript, to the best of our knowledge, no previous work has dealt systematically with RL drivers and barriers in the Brazilian context. In this way, research in Brazil on factors promoting or hindering RL implementation – drivers and barriers – as well as on the stakeholders'

influence becomes crucial. Based on the aforementioned research problem, the following two Sections depict the main objective and the specific objectives, respectively.

## 1.3 MAIN OBJECTIVE

The primary objective of this research is to evaluate the interrelationship among RL drivers and barriers under the perspectives of the most important reverse logistics stakeholders in the Brazilian context.

## 1.4 SPECIFIC OBJECTIVES

In order to achieve this research objective, a summary of the research sub-objectives (SO) is given:

- SO1: Provide a synthesis of the state-of-the-art of RL in Brazil;
- SO2: Explore RL practices in Brazil in order to gather practical knowledge on the field in this country;
- SO3: Identify the most relevant RL drivers, barriers, and stakeholders, and classify them into a framework;
- SO4: Provide a multiple stakeholders' perspective analysis for RL drivers and barriers in Brazil and a research agenda based on the research gaps found during this study.

## 1.5 RESEARCH DELIMITATION AND ORIGINALITY

With the purpose to better stablish the delimitation of this research, Figure 1 presents a classification of research fields in Green Supply Chain Management (GSCM).

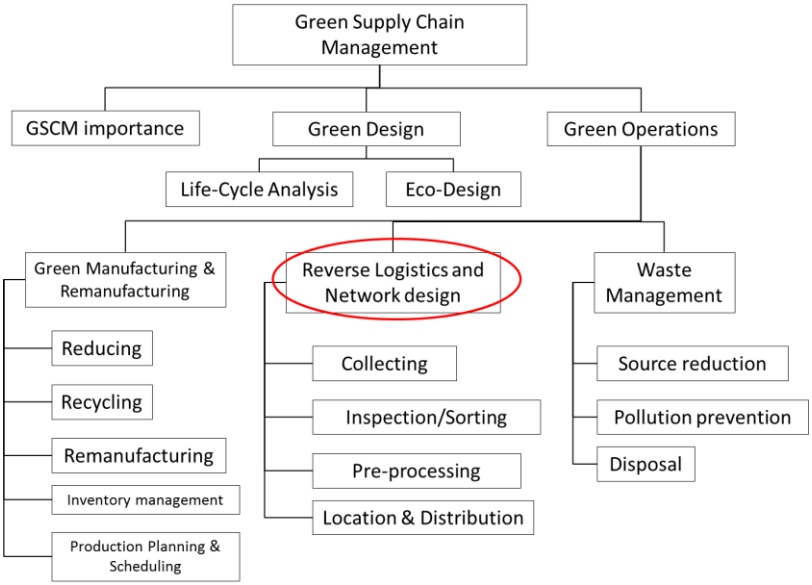


Figure 1 – Reverse Logistics in the domain of GSCM.
Adapted from Srivastava, Samir K (2007).

Among the different fields exposed in Figure 1, the focus of this work is related to green operations and, more specifically, to reverse logistics. Beyond that, this research has its purposes on:

- Reverse Logistics. Prior publications focusing on sustainable supply chain management or green supply chain management were not considered, since the focus of this research is on reverse logistics and not the broad areas it is inserted in.
- EOL products. After sales returns were not considered in this research for two main reasons: first, the return process is more similar to forward logistics thus influential factors might be different; second, the focus of this research is related to green supply chain initiatives, as the product EOL management.

Regarding its originality, this research differs from the existing literature in the following aspects. First, this research focuses on the field of RL and stakeholders' influence where concerns have

rapidly increased but in which little research has been exhibited. Second, the chosen approach combines resource-based view theory and stakeholder theory, with the concepts of barriers and drivers, offering a solid theoretical framework on which future research can be developed. Third, the originality of this work relies on the fact that no previous study was found in the domain of multiple stakeholders' perspective for drivers and barriers for RL. To the best of our knowledge, formal research for analyzing barriers and drivers for implementing RL from a multiple stakeholder perspective is limited. Some previous studies (RAVI; SHANKAR, 2005; RAHIMIFARD *et al.*, 2009; GONZÁLEZ-TORRE *et al.*, 2010; KAPETANOPOULOU; TAGARAS, 2011; SHARMA *et al.*, 2011; HO *et al.*, 2012; STAROSTKA-PATYK *et al.*, 2013; KANNAN; DIABAT; SHANKAR, 2014; SHAHARUDIN; ZAILANI; TAN, 2014) have tried to identify either drivers or barriers for RL by, mostly, one stakeholder perspective. This work attempts to bridge this gap by considering multiple stakeholders' perspectives, as the same RL drivers and barriers can be interpreted differently. Beyond that, this research provides an innovative RL multi-perspective framework for drivers and barriers, which served as basis for an evaluation of their interrelationship under the different views from stakeholders. For that, a Multi-Criteria Decision Making (MCDM) tool is used named DEMATEL, in association with grey theory. No previous work has dealt with RL and this solution methodology in Brazil (this issue is further discussed in Section **Error! Reference source not found.**). Before presenting the adopted esearch design (Chapter 2) to attain these contributions, next Section addresses the organization of this manuscript and its logic.

## 1.6 MANUSCRIPT ORGANIZATION AND LOGIC

When planning and organizing this manuscript, two important considerations were taken into account. First, this piece of work should show the progress over time of the research performed and second, at the same time, the text should be written in the best way to clearly outline the research contributions and the achievement of the research objectives.

For these reasons, this manuscript is chronologically organized, that is, the main Chapters are placed in a time order

according to the development of the research during the four years of the author's doctorate program. Moreover, the Chapters are arranged in accordance with the specific objectives of this research, as detailed in Table 1.

Table 1 – Specific objectives and related Chapters.

| Specific objective | Chapter number and description |
|---|---|
| **SO1**: Provide a synthesis of the state-of-the-art of RL in Brazil; | **Chapter 3 – Comprehensive Theoretical Background** Chapter 3 intends to clarify RL definition and offer a relevant background for the reading of this manuscript. It presents a general description of RL and its practices, some insights on RL in developing countries, and a thorough picture of RL in the Brazilian context through a systematic literature review process. |
| **SO2**: Explore RL practices in Brazil in order to gather practical knowledge on the field in this country; | **Chapter 4 – Exploratory Field Research** This Chapter presents two different exploratory case-based studies performed in Brazil: a manufacturing company and a third party reverse logistics service provider (3PRL). |
| **SO3**: Identify the most relevant RL drivers, barriers, and stakeholders, and classify them into a framework; | **Chapter 5 – Specific Theoretical Background** It provides a thorough literature review on RL drivers, barriers and stakeholders. It also defines the theoretical lenses used in this research, and provides the multi-perspective framework for RL. |
| **SO4**: Provide a multiple stakeholders' perspective analysis for RL drivers and barriers in Brazil and a research agenda based on the research gaps found during this study. | **Chapter 6 – Evaluation of RL Drivers and Barriers under a Multiple Stakeholders' Perspective Analysis** This Chapter is the core of this research presenting and discussing original data from the analysis on the evaluation of RL influential factors in the Brazilian context. For that, it provides the adopted solution methodology and the research gaps found in this study. |

It is important to highlight that the accomplishment of these four specific objectives has as a result the attainment of the main objective of this research.

In the following Chapter, the research design adopted for the present research is provided. Chapters 3 to 6 are already described in Table 1. In Chapters 3 to 6, a prior discussion of results is already provided inside these topics. However, Chapter 7 closes this manuscript with a further discussion of results, tacking together the outcomes from all previous Chapters. Chapter 7 also provides some concluding remarks, managerial implications, and emergent and outstanding topics in this field that are fertile areas for further development and investigation.

## 2. RESEARCH DESIGN

This research is explanatory as it intends to explain, rather than simply to describe, the phenomena studied. This type of research attempts to connect ideas to understand cause and effect. Nevertheless, the initial part of this research is exploratory, as described in the sequence.

The nature of data is qualitative and quantitative. It is classified as a theoretical-empirical research, since the main objective is to evaluate the interrelationship among RL drivers and barriers under the perspectives of key RL stakeholders in the Brazilian context. Figure 2 sums up the main steps of this research and the achievement of each specific objective provided by each step in the research design. The next Sections depict in detail each step adopted.

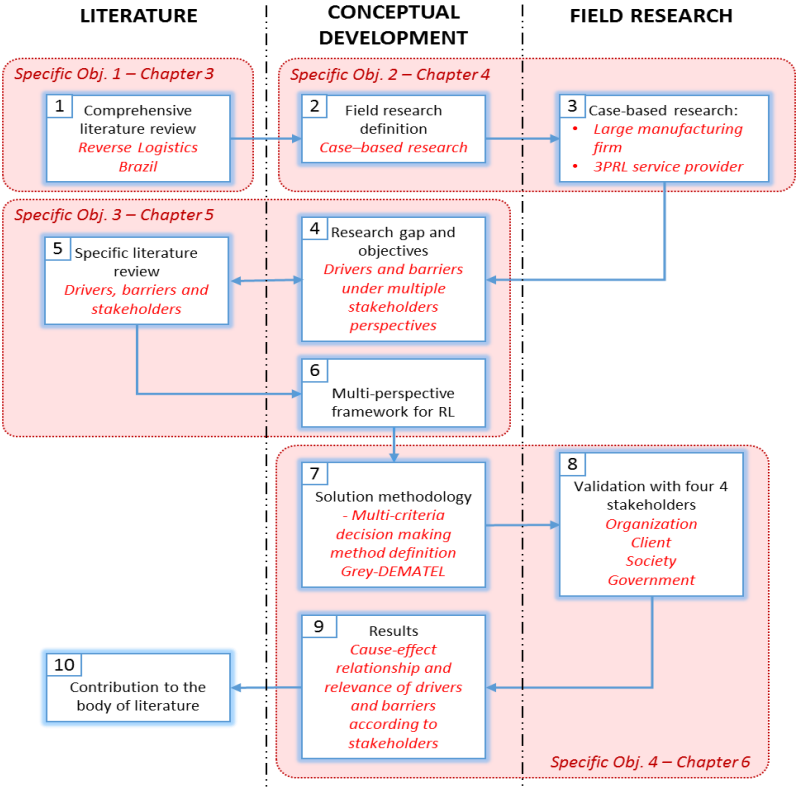

Figure 2 – Research design.

## 2.1 STEP 1 AND STEP 2

As shown in Figure 2, firstly a comprehensive literature review took place on Reverse Logistics (RL) and on RL in Brazil (Step 1). The purpose of this initial research is to provide a general understanding of the topic, highlight the possible areas of research, and provide a current panorama of RL in Brazil, comparing to international RL body of literature as well. It also seeks to provide a systematic literature review procedure and a classification framework for RL literature categorization.

A descriptive and content analysis approach was adopted. First, a topic delimitation phase was aimed at defining the main research areas and related keywords. Second, a material collection phase focused on a selection of peer-reviewed Brazilian and international journals. Third, a total of 34 papers were assessed by quantitative indicators, and a classification framework was employed to classify them. Finally, papers were evaluated using content analysis. Further details on the methods of this main step are described in Chapter 3, Section 3.3.1.

The theoretical research performed in step 1 motivated an exploratory field research in order to gain more practical knowledge on RL related topics in Brazil. Thus, step 2 consisted of defining how to gather practical insights. Case-based research method was selected.

## 2.2 STEP 3 AND STEP 4

Step 3 comprises an exploratory and descriptive field research. Case-based research was chosen as the research method. Two cases were selected: in-depth study in a large machinery manufacturing company in Santa Catarina State and in a third party reverse logistics service provider (3PRL) in Paraná State.

Case-based research is an appropriate method for theory building, extension or refining in emerging subjects (such as RL), where a well-developed set of theories are scarce (EISENHARDT, 1989; KAPETANOPOULOU; TAGARAS, 2009). Guidelines from the existing literature were considered (VOSS; TSIKRIKTSIS; FROHLICH, 2002; YIN, 2009). As descriptive case study, it did not postulate a causal

relationship between the variables because those are still not well-established in the literature. The data gathered were predominantly qualitative and were obtained from many sources, as is described further ahead in Section 4.1.

The exploratory case study research helped to better design the main objective of this study (Step 4), since drivers and barriers emerged as relevant factors for implementing RL during field data analysis. Additionally, a multiple stakeholder perspective analysis also seemed to be necessary to obtain a broader picture of the RL scenario and to understand the complex relationship between drivers and barriers.

## 2.3 STEP 5 AND STEP 6

In order to build a RL multiple stakeholders' perspective framework, a structured literature review process was used (Step 5). This second theoretical research intended to deepen and narrow down the first comprehensive literature review by focusing on RL influential factors related issues.

Literature reviews are defined as primarily qualitative synthesis (SEURING; GOLD, 2012). Fink (2013) defines literature review as "a systematic, explicit, comprehensive, and reproducible method for identifying, evaluating, and interpreting the existing body of original work produced by researchers and scholars". In this sense, literature reviews are the backbone of almost every academic piece of writing (SEURING; GOLD, 2012).

Forty-nine papers concerning RL drivers, barriers and stakeholders' influence were thoroughly assessed and classified according to structural dimensions and analytical categories. Two extensive lists of 37 drivers and 36 barriers, categorized and analyzed against the dimensions and categories, served as basis for the development of the referred framework. The RL multiple stakeholders' perspective framework was developed based upon this structured literature review process (Step 6) using the lens of resource-based view (RBV) and stakeholder organizational theories. The main steps adopted in the construction of this specific theoretical background and framework are described in details in Section 5.1.

## 2.4 STEP 7, STEP 8, STEP 9 AND STEP 10

Influential factors (drivers and barriers) were evaluated through a multi-criteria decision making (MCDM) tool (Step 7) named Decision Making Trial and Evaluation Laboratory (DEMATEL). DEMATEL was first developed in the mid-1970s (ZHU; SARKIS; GENG, 2011). Batelle Memorial Institute first conducted DEMATEL project through its Geneva research center (GABUS; FONTELA, 1972; WU; LEE, 2007; XIA; GOVINDAN; ZHU, 2014). This method is best appropriate for analyzing structural models with causal relationship between complex factors with matrices or diagraphs (WU; LEE, 2007) based on experts' opinions. The matrices (or digraphs) represent relationships between system components, with strengths of relationships amongst these relationships quantitatively portrayed (ZHU; SARKIS; GENG, 2011). Respondents should complete survey matrices by fulfilling paired comparisons. With this approach, drivers and barriers can be classified in two groups: the cause group and the effect group. This analysis helps decision makers to have a better understanding of the structural relationship between system elements (ZHU; SARKIS; GENG, 2011).

In sum, DEMATEL method can convert the relationship between the causes and effects of factors into an intelligible structural model of the system (SHAIK, MOHAMMED NAJEEB; ABDUL-KADER, 2014). With the purpose to deal with conflict resolution among experts and lack of information, a grey-based approach is associated with DEMATEL. Details on Grey-DEMATEL procedures are described in Section 6.2.

Four RL experts - each one representing a stakeholder - were consulted (Step 8). Respondents completed survey matrices by fulfilling paired comparisons for all influential factors from the RL multi-perspective framework. With this approach, drivers and barriers can be classified into two groups: the cause group and the effect group. This analysis helps decision makers to have a better understanding of the structural relationship between system elements (Step 9). Finally, results are discussed and presented in order to contribute to the body of knowledge in the RL area (Step 10).

The next Chapter addresses the comprehensive literature review methods and results, attaining the first specific objective of this research.

# 3. COMPREHENSIVE THEORETICAL BACKGROUND

Logistics is defined as the "process of planning, implementing and controlling the efficient flow and storage of raw materials, work in process, finished products and related information from the point of origin to the point of consumption, with the objective of meeting customer demands" by the Brazilian Association of Logistics and many relevant authors in the field, e.g. Bowersox and Closs (2001) and Ballou (2006).

In general terms, reverse logistics embraces all the processes described above, but in a reverse flow. This Chapter intends to clarify this definition and offer a relevant background for the reading of this manuscript. To do so, it begins by presenting a general description of RL and its practices, some insights on RL in developing countries, and a thorough picture of RL in the Brazilian context through a systematic literature review process.

## 3.1. RL DEFINITION AND PRACTICES

While RL has received a lot of attention over the past years, it remains a relatively novel concept (VAN DER WIEL; BOSSINK; MASUREL, 2012). RL is the process of moving products from their typical final destination for the purpose of capturing value or proper disposal. In this sense, RL comprises all the activities involved in processing, managing, reducing, and disposing of hazardous or nonhazardous waste from production, packaging, and use of products (ROGERS; TIBBEN-LEMBKE, 1999; ROGERS; TIBBEN-LEMBKE, 2001; GOVINDAN; SARKIS; PALANIAPPAN, 2013).

RL plays an important role in the reverse flow of closed-loop supply chains, focusing on product take-back and value recovery by reusing the whole product or parts or modules of the product (GUIDE JR; VAN WASSENHOVE, 2009). RL involves all the activities required for the collection and recovery or disposal of end-of-life (EOL) products (ILGIN; ONDEMIR; GUPTA, 2014). For this reason, RL is mostly related to environmental issues.

Terms such as Reverse Channels or Reverse Flow were already used in the scientific literature of the 1970s but were consistently related to recycling (DE BRITO; DEKKER, 2004). The Council of Logistics Management (CLM, which is currently known as the Council of

Supply Chain Management Professionals or CSCMP) published its first definition of RL at the beginning of the 1990s. This definition and others are shown in

Table 2. The many definitions found in prior publications reveal that the RL concept is evolving, along with the growing academic and industrial interest in the field (LEITE, 2009).

Table 2 – RL definitions over the years.
Source: adapted from De Brito and Dekker (2004).

| **Author/Organization and Year** | **Reverse Logistics Definition** |
|---|---|
| Council of Logistics Management (CLM); early 1990s | "…the term often used to refer to the role of logistics in recycling, waste disposal, and management of hazardous materials; a broader perspective includes all relating to logistics activities carried out in source reduction, recycling, substitution, reuse of materials and disposal." |
| Pohlen and Farris (1992) | "… the movement of goods from a consumer towards a producer in a channel of distribution." |
| Kopicky et al. (1993); Stock (1992) | "RL is a broad term referring to the logistics management and disposing of hazardous or non-hazardous waste from packaging and products. It includes reverse distribution which causes goods and information to flow in the opposite direction of normal logistics activities." |
| European Working Group on Reverse Logistics – RevLog (1998) | "The process of planning, implementing and controlling flows of raw materials, in process inventory, and finished goods, from a manufacturing distribution or use point, to a point of recovery or point of proper disposal." |

| | |
|---|---|
| Rogers and Tibben-Lembke (1999); El Saadany; Jaber and Bonney (2011); Govindan *et al.* (2012) | "Reverse logistics is the process of planning, implementing, and controlling the efficient, cost effective flow 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." |

In summary, RL is concerned with issues such as reclaiming, recycling, remanufacturing, reuse, take back, and disposal needs to be available for adequate service requirements (GOVINDAN *et al.*, 2012). The many RL definitions and citations thus far show that the concept is still evolving and that interest from business and academia has been growing over the last decade.

Due to the diversity of products in the reverse flow, there are various alternatives of RL activities namely as: reutilization, repair, renovation, reprocessing, cannibalization or recycling (THIERRY *et al.*, 1995). The majority of returned products undergoes practices such as resell "as is", remanufacturing/refurbishment, recycling, send to landfills, or repacking and sell as new. Rogers and Tibben-Lembke (2001) suggest further options: donations, sent to central processing facilities, sold to brokers or outlet stores.

When a product reaches its end of life (EOL), there are a number of recovery options available and selecting a suitable strategy is mainly based on the quality of the parts and components and also the economic considerations (MANSOUR; ZAREI, 2008). RL consists of a series of activities such as disassembly of products, inspection, recycling, repair, refurbishing, remanufacturing or final disposal during various stages in the SC (CHAN; CHAN; JAIN, 2012).

RL practices can be classified as follows (AKDOĞAN; COŞKUN, 2012):

- Direct reuse: product reuse without involving in production process instead with slight cleaning and limited repair.
- Repair: products are returned to have it back in working order, requiring limited effort and, therefore, less quality than a new product.

- Refurbishing: returned products are brought up to specified quality level.
- Remanufacturing: returned products are carefully inspected, disassembled and broken or outdated parts are replaced with new ones in order to increase quality standards up to new products quality.
- Cannibalization: the purpose is to recover limited parts of used products that are reused in other RL activities (e.g. repair, refurbish, remanufacture).
- Recycling: recycling is concerned about reusing the materials in production of new parts, thus the identity of product is lost.
- Incineration and landfilling: the last alternative is to incinerate or landfill the returned products because of the limited capacity of waste yards.

Figure 3 presents the many flows in RL operations, as well as the RL practices.

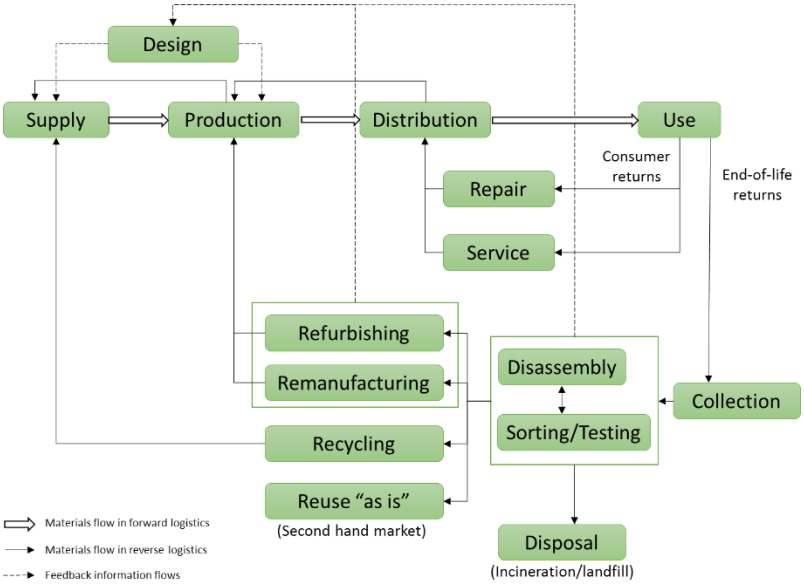


Figure 3 – Activities and flows in reverse logistics.
Adapted from Kannan *et al.* (2012) and Lau and Wang (2009).

## 3.2. RL IN DEVELOPING COUNTRIES

Most existing research on factors to RL implementation has focused on developed countries, with relatively little attention being paid to developing nations (ABDULRAHMAN; GUNASEKARAN; SUBRAMANIAN, 2014). Researchers (SARKIS; ZHU; LAI, 2011; ZHANG *et al.*, 2011) have stated that the scarcity of RL studies for developing countries is hardly surprising because while RL is a mandatory component of the SC in developed countries, RL is still in a state of infancy in emerging economies. Thereby, more research is needed on the factors for RL adoption in developing nations, such as BRIC countries.

Among the emerging economies, the on-going rapid industrialization and presence of 22% of the world population in China has led to enormous production and consumption in the Chinese economy (ABDULRAHMAN; GUNASEKARAN; SUBRAMANIAN, 2014). China has become a new global manufacturing center, contributing to economic growth but, at the same time, bringing resource scarcity and serious environmental burden (ZHU; GENG, 2013). The disadvantage of this economic growth has been extremely high resource consumption and serious environmental pollution (SUBRAMANIAN *et al.*, 2014), as China occupies the second position in the world, after the USA, in incineration and landfilling of e-waste residues (ABDULRAHMAN; GUNASEKARAN; SUBRAMANIAN, 2014). In this matter, Chinese manufacturers, as the main resource consumers and polluters, have been experiencing higher legal pressures as they have to comply with regulations (ZHU; GENG, 2013). Still, RL is not a discipline that has attracted sufficient attention in this country yet. In addition, top Chinese managers are reluctant to implement product return systems and do not believe that doing so is justified from a cost–benefit perspective (YE *et al.*, 2013). Chinese RL implementation requires government monitoring mechanism and incentives, top management commitment within companies, technology and human capabilities support (SUBRAMANIAN *et al.*, 2014).

Besides China, India, another significant BRIC country, has one of the largest populations and, consequently, is one of the greatest producers of waste. Therefore, Indian industries are particularly pressured regarding issues of environmental adoption, e.g. reducing

wastage from industries and consumption of less energy (AL ZAABI; AL DHAHERI; DIABAT, 2013). However, whereas Indian industries are aware of the environmental impact of their business, they are still at the initial stages of GSCM implementation (GOVINDAN *et al.*, 2014), which includes activities such as RL. A key barrier of RL in India is the lack of awareness about the benefits of RL (GOVINDAN *et al.*, 2014). In a real sense, the benefits of RL implementation are not yet fully realized in these emerging economies (ABDULRAHMAN; GUNASEKARAN; SUBRAMANIAN, 2014).

Among the BRIC countries, Brazil is in a stage of green awakening. Brazil is a developing country that is fifth in the world both in size and in population, with about 200 million inhabitants. Brazil is the largest economy in Latin America and the seventh largest world economy with a Gross Domestic Product (GDP) of about US$ 2.2 trillion (UNITED_NATIONS, 2012). However, the country's geographical and economical magnitude also has its drawbacks for the environment. In Brazil, environmental degradation is a major issue that has been discussed by society, the Government, and businesses (DE SOUSA JABBOUR *et al.*, 2013). A significant area of environmental degradation stems from the generation of solid waste, which remains an urgent global problem (MALLAWARACHCHI; KARUNASENA, 2012). In 2011, Brazil's population generated almost 62 million tons of solid waste (JABBOUR *et al.*, 2014). However, RL is recently gaining importance in this country due to some factors: economic issues as the recovery of the value of used products, green marketing, improving social conditions and the implementation of new environmental policies as found in the National Policy on Solid Waste – NPSW (*Política Nacional de Resíduos Sólidos*).

From those cited benefits, the national policy seems to be an important driver for RL in Brazil. Brazilian regulators enacted the NPSW in 2010. The expressed purpose of this regulatory policy is to internalize costs and liabilities to manufacturers and consumers while establishing and promoting RL and product or material stewardship (JABBOUR *et al.*, 2014). To achieve this goal, supply chains (SC) must develop processing systems for a broad variety of consumer materials, such as: tires, pesticide packaging, batteries, lubricants and their respective packaging, light bulbs and electrical–electronic equipment rejected by consumers. This effort requires developing RL systems which must include capacities for return of these solid wastes back

into the original production SC (JABBOUR *et al.*, 2014). According to the NPSW, Brazilian companies and municipalities might have implemented the remediation and preventing actions by August 2014, which did not actually happened in practice by this month. Companies, organizations and government agencies still struggle in this country to implement RL due to a variety of reasons.

Brazilian companies face the challenge of a deficient logistics infrastructure (DA ROCHA; DIB, 2002) to cope with the NPSW. Flaws in logistics infrastructure may act against the expansion of efficiency and effectiveness in the Brazilian business environment (ARKADER; FERREIRA, 2004). For example, transport infrastructure is deficient: poor conditions of publicly operated highways lead to high vehicle maintenance costs and cargo loss in Brazil (MARTINS *et al.*, 2012). Thereby, more effort from industrial and academia is needed to understand RL adoption in developing countries such as Brazil. Few studies have been presented so far to understand RL implementation in the Brazilian context. Next section discusses RL prior research in Brazilian scenario.

## 3.3. RL IN BRAZIL

This section proposes to identify, evaluate, and interpret the existing body of documents on RL produced by researchers in the Brazilian context. Thus, a bibliographic search was conducted aimed at gathering and analyzing relevant papers in RL in the Brazilian context by means of a structured literature review. The content provided in this Section 3.3 has been already scientifically validated and accepted by a peer-review process in the *Management of Environmental Quality: An International Journal*, as can be seen in the Appendix A of this manuscript.

This section is organized as follows. Section 3.3.1 presents the research methods and section 3.3.2 shows the descriptive analysis. In Section 3.3.3, results of the content analysis are presented, and Section 3.3.4 discusses the distinctive features of Brazilian RL.

### 3.3.1. Research methods

Descriptive and content analysis methods have been adopted for this research. Content analysis is an observational research method

that is used to systematically evaluate the symbolic content of all forms of recorded communication (KOLBE; BURNETT, 1991).

This research is driven by theoretical pre-considerations and follows a comprehensive process, as this allows conclusions to be drawn on the reviewed literature. The review procedure is based on Seuring and Müller (2008) with some modifications. As such, this review has adopted the following work process:

(i) Topic delimitation;

Since this research focuses on the return flow of products, sustainable logistics and green logistics, as subjects, were not specifically included in this review. However, papers addressing to these issues were examined in order to check if their content would be of interest. The following keywords were used in our research approach: reverse logistics, reverse channel, reverse supply chain, product return, product take back, and closed-loop supply chain. These were the terms used for searching in title, keywords and abstract for retrieving the papers during the material collection phase.

(ii) Material collection;

The literature review focused on papers in peer-reviewed Brazilian and international journals. Since the objective of this research was to identify and analyze the Brazilian RL scenario, journals in English were also considered when publishing works developed in the Brazilian context. In Brazil, SciELO (www.scielo.br) database was used and additional Brazilian journals were chosen from a list of main scientific publication journals of the Brazilian Association of Industrial Engineering (ABEPRO). After a sorting process, abstracts were analyzed to assure that their main subject was suitable for the research scope. This resulted in a total of 20 papers. For publications in international journals, keywords in English were combined with the word "Brazil" and its variations. Papers were also retrieved from the following major international databases: ISI Web of Knowledge, JSTOR, Elsevier, Emerald, and Wiley, or library services (e.g. Ebsco, Scopus and Compendex). This search added 14 more papers in the article portfolio, after a sorting process as well. Thereby, the final article portfolio comprises 34 peer-reviewed publications, shown in the Appendix B of this dissertation thesis.

(iii) Descriptive analysis;

In this phase, generally quantitative indicators of the article portfolio are assessed. These include the number of publications per

year, the number of publications per journal, most used keywords, and so forth. This process helps to provide a background for subsequent theoretical analysis.

(iv) Category selection;

Next, structural dimensions and related analytic categories were selected. Structural dimensions are the major topics of analysis, which are composed by single analytic categories. The conceptual framework used for article classification, which is shown in Figure 4, was adapted from Bernon, Michael; Rossi and Cullen (2011). Three dimensions were considered: operational performance, organizational integration and managing and reporting control.

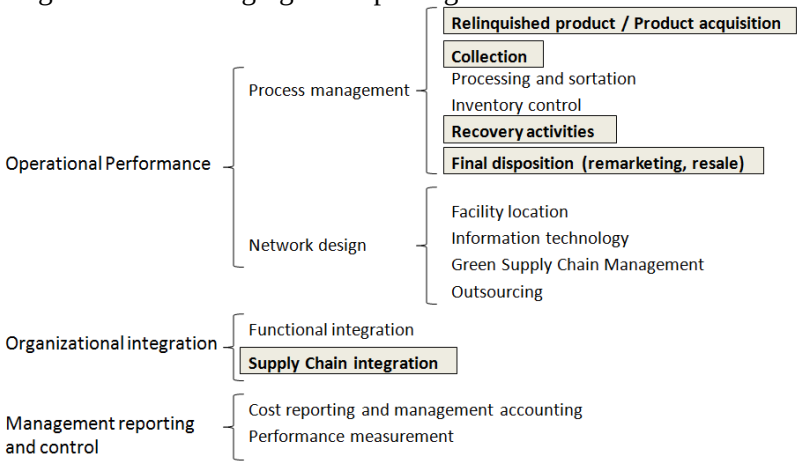


Figure 4 – Classification framework.
Adapted from: Bernon et al. (2011).
Note: Terms in bold and inside the boxes are the main changes made in the conceptual framework in the original publication by Bernon et al. (2011).

(v) Material evaluation.

Papers were fully read and classified according to the dimensions and categories in Figure 4. The contents of the papers were assessed by applying the following queries:

a. What research methods are applied? Five research methodologies were differentiated: theoretical and conceptual approach, literature review, case study, survey, and modelling, as in Seuring and Müller (2008).

b. What kind of goods does the paper address? The categories used to classify the papers were: after sale product, end-of-life product, end-of-use product, packaging, and process waste.

c. In what industrial sector is the paper placed? The economic activities addressed in the papers were classified according to the North American Industry Classification System (NAICS). A three-digit code was chosen to designate the industry subsector.

d. Which dimensions of RL are addressed? The contents of the papers were coded for each category and structural dimension described in Figure 4.

e. What is the main RL purpose? Five final scenarios were taken into account: reuse "as is", remanufacturing, refurbishment, recycling and landfilling.

### 3.3.2. Descriptive analysis

The allocation of the 34 publications across the time period is shown in Figure 5.

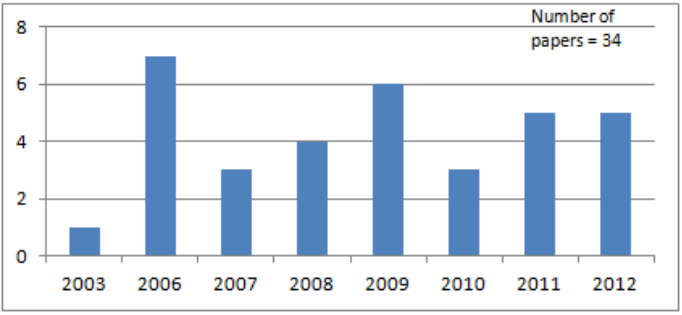


Figure 5 – Distribution of publications per year.

As seen in Figure 5, 2003 was considered the first year of publication of RL in the Brazilian scenario. A growing number of publications were found starting from 2006. Moreover, it is important to emphasize that even considering only 2012 publications until May, five papers were identified in that. Based on this trend, this may represent the highest rate of publications per year in this subject area.

Authors' keywords were identified and quantified as well. The number of occurrences of the top five most used keywords is presented in

Table 3. As expected, RL is the most common term. The second most used keyword is "recycle" or "recycling". This indicates a strong connection between this keyword and the top one (RL).

Table 3 – Authors' most used keywords.

| **Keyword** | **Events** |
|---|---|
| Reverse logistics | 24 |
| Recycle or Recycling | 12 |
| Environment or environmental impact / management | 8 |
| PET bottles/packaging | 3 |
| Sustainability | 3 |

Regarding the research methods, most papers (47%) were carried out using a case-based research approach. Theoretical research appears as the second most employed method (20%), followed by the survey research approach (7%). However, most of the papers in the portfolio classified as case study by the authors were not, in fact, carried out using rigorous case-based research guidelines. Besides, more than 90% of case study papers were single-case and exploratory research.

Regarding product type analysis, Brazilian RL research most commonly focuses on packaging. Almost half of the papers (44%) deal with packaging returns, such as recycling of PET (polyethylene terephthalate) bottles.

In the NAICS industrial sector classification, as can be seen in Table 4, six papers address the transportation equipment manufacturing sector, out of which two address automotive tire recycling. The number of papers that report on automotive tires may be a consequence of a specific Brazilian law CONAMA number 258/99, which was implemented in 1999. Another relevant sub-set of papers was identified in the plastics and rubber products industrial sector. Among the six papers addressing this sector, four of them are concerned mainly with PET bottle recycling. The quantity of papers about PET bottles is a consequence of the high consumption of this type of packaging in Brazil. The country is one of the largest

consumers of PET bottles and one of the fastest growing consumer markets. Moreover, Brazil has secured second place worldwide in PET recycling based on post-consumer PET recycling (54.8%), just after Japan (69.2%).

Table 4 – NAICS industrial sector classification of papers.

| Industrial Sector | Number of Papers |
|---|---|
| Plastics and Rubber Products Manufacturing | 6 |
| Transportation Equipment Manufacturing | 6 |
| Paper manufacturing | 2 |
| Beverage and Tobacco Product Manufacturing | 2 |
| Waste Management and Remediation Services | 2 |
| Primary Metal Manufacturing | 1 |
| Computer and Electronic Product Manufacturing | 1 |
| Chemical Manufacturing | 1 |
| Health and Personal Care Stores | 1 |
| Agriculture | 1 |
| Electrical Equipment, Appliance, and Component Manufacturing | 1 |
| Food and Beverage Stores | 1 |
| Specialty Trade Contractors | 1 |
| Construction | 1 |

### 3.3.3. Content analysis

Content in the research portfolio was classified according to the RL dimensions previously discussed (see Figure 4). For this analysis, four papers were excluded from the research portfolio because the main scope of the papers was not RL. Thus, 30 papers remained for the content analysis.

The articles were divided into three dimensions related to RL. Some papers were classified into more than one dimension when their content covered more than one category. Table 5 shows the dimensions and categories used for the analysis and the occurrences

of them in the article portfolio. This classification was based on the conceptual framework presented in Figure 4.

Table 5 – Analysis of the article portfolio with regard to RL dimensions.
Note: cell with grey background represents the least encompassed categories.

| DIMENSIONS AND CATEGORIES USED IN PAPERS | | | OCCURRENCES |
|---|---|---|---|
| **Operational performance** | Process management | Relinquished product | 10 |
| | | Collection | 8 |
| | | Processing and sortation | 4 |
| | | Inventory control | 2 |
| | | Recovery activities | 9 |
| | | Final disposition | 5 |
| | Network design | Facility location | 1 |
| | | Information technology | 1 |
| | | Green SCM | 7 |
| | | Outsourcing | 0 |
| **Organizational integration** | Functional | | 0 |
| | SC Integration | | 4 |
| **Managing and reporting control** | Cost reporting and management accounting | | 6 |
| | Performance measurement | | 1 |

As seen in Table 5, many publications are concentrated on the "operational performance" dimension. Most papers in this dimension

report on “relinquished product or product acquisition”, “collection” and “recovery activities”. The quantity of publications found in “recovery activities” category is directly related to the high number of papers that deal with recycling, as stated earlier. Similarly, a significant number of papers address “network design”, particularly in “Green Supply Chain Management” subject. Six papers are focused on “Managing and reporting control”, which involves “cost reporting and management accounting”. For the “organizational integration” dimension, papers only focused on the supply chain perspective. None of the papers addresses the integration of functions in a company in order to pursue RL activities.

Very few papers addressed inventory control or facility location in terms of reverse supply chain, information technologies in RL, functional integration for returns, or performance measurement in RL. Most papers classified in the “operational performance” dimension and in the “process management” category only discussed these issues superficially. Most papers focused on describing the RL process in general, especially those within a single case. The findings of those papers were directed to a specific problem of a single case study to reach a specific solution, but with no theoretical or empirical contribution.

Based on our keyword study, recycling, as noted before, seems to be the main focus of most RL papers evaluated. Table 6 shows this result. Twenty-five papers were classified in this analysis. Papers that were not included in this classification did not address a specific RL purpose, such as literature review or general theoretical papers. Moreover, some of the 25 papers address more than one RL purpose.

Table 6 – Analysis of main purpose of RL in 25 Brazilian publications.

| **RL main purpose** | **Number of Papers** |
|---|---|
| Recycling | 23 |
| Reuse "as is" | 4 |
| Landfill (including incineration and composting) | 4 |
| Remanufacturing | 0 |

| | |
|---|---|
| Refurbishment/Repair | 0 |

As seen in Table 6, most RL papers in Brazil address recycling operations (92%). In other words, the main objective of performing RL in Brazil is to recycle products or packaging. Few papers report on landfill and reuse of the product "as is". No publication was identified as reporting on remanufacturing or refurbishment issues.

### 3.3.4. Further discussion and concluding remarks on RL research in Brazil

RL literature in Brazil mainly appears to report on recycling. No publication was identified related to remanufacturing, refurbishment, or repair issues, contrasting from RL international literature. Scopus data base was used to perform a comparison between Brazilian and International publications. This data base was chosen because of its relevance in the operations management field. For this search, the keyword "reverse logistics" was used in the paper title field. A total of 252 papers were identified. The authors' keywords were analyzed by a co-occurrence network with the view to identifying the most used subject in RL international publications. This analysis was performed using the software Sci2 Tool. Based on the keywords of all papers, the top ten nodes were selected, as shown in Figure 6.

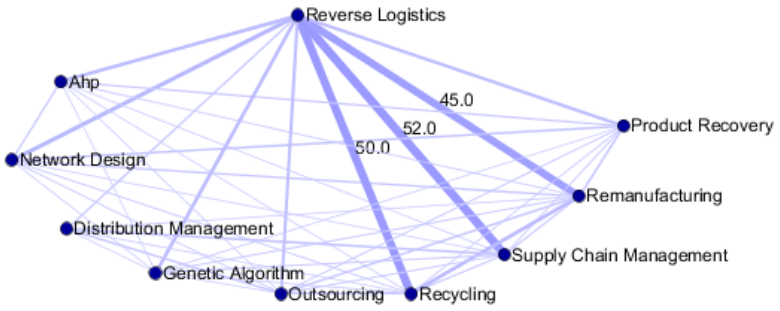


Figure 6 – Top ten keyword co-occurrence in international RL papers.

As can be seen in Figure 6, the top keyword co-occurrences are “reverse logistics” and “supply chain management” or “recycling” or “remanufacturing”. “Remanufacturing” appears frequently in RL papers in the international arena. Possibly, these contrasts with Brazilian publications occur for the following reasons:

*The Brazilian Social Condition*: High unemployment and low education in Brazil have led to the emergence of survival activities, such as those of rag or waste pickers. Sometimes, these activities are organized into scavenger cooperatives, which provide a scale pattern to these jobs, turning recycling into an economically attractive activity. Most of these cooperatives do not emerge from environmental or legislative concerns, but from social and economic conditions confronted by a portion of the population (DE SOUZA; DE PAULA; DE SOUZA-PINTO, 2012). To illustrate the point, Coelho; Castro and Gobbo Jr (2011) state that “the Brazilian reality of post-consumer PET bottles can be summarized by the individual collection performed by scavengers who survive from the economic activity provided by the trash”. In addition, Kumar and Putnam (2008) argue that “Brazil and India are leading recyclers of aluminium because of the poverty”.

*The Brazilian Economic Condition*: The Brazilian economic condition can also explain the absence of RL publications related to remanufacturing. Brazil is an emerging economy with an undeveloped industrial base when compared to developed countries. Remanufacturing is an economic activity and the value of a returned product is a determining factor for remanufacturing (SUBRAMONIAM; HUISINGH; CHINNAM, 2009). That is, high-value products are more suitable for remanufacturing activities. Thereby, products are not as suitable for remanufacturing in Brazil as in developed countries.

In short, the increase of environmental image in the market and the environmental consciousness of customers day by day seem to push industries around the world to think about environmental quality by means of RL operation. However, in emerging economies, such as Brazil, RL is also driven by other issues. RL in Brazil is directly linked to recycling activities and the social and economic conditions. RL practice is driven by survival activities, as rag or waste pickers, and economic opportunities in some specific industrial sectors (e.g. PET bottles and automotive parts). On the other hand, legislative concerns also influence the RL of some particular products

in Brazil, such as automotive tires and batteries. Even so, environmental legislation in Brazil is still limited when compared to European directives and laws. However, in 2010, a National Policy on Solid Waste was granted, bringing many innovations to the Extended Product Responsibility principle. Such innovations may require changes in corporate behavior regarding product return, encouraging RL practice and, consequently, RL research in Brazil. Publications are lacking in quantity and content, as shown by the results. Generally, the theoretical foundations are also missing from these papers, as well as poor research methods, thus threatening the quality and reliability of results.

In these connections, after analyzing prior RL publications about the Brazilian scenario, it seems necessary to perform a research on factors that drive or hinder RL implementation in Brazil. Moreover, well-structured empirical research on RL is lacking in order to explore the RL practice in Brazil to gather practical insights from industries in this country. With the purpose of attaining these issues and better draw the research gap of this work, two exploratory case-based researches were performed in Brazil. Next chapter presents these cases, the used methods and results.

# 4. EXPLORATORY FIELD RESEARCH

This Chapter presents two different case-based studies: a Brazilian-based multinational corporation from the machinery manufacturing industry sector focusing on RL drivers; and a third party reverse logistics service provider (3PRL) focusing on RL barriers. It begins with the description and explanation of the steps adopted in case-based research.

## 4.1. CASE-BASED RESEARCH DESIGN

The literature, e.g. Abdulrahman; Gunasekaran and Subramanian (2014), reveals that there are not many rich descriptive case-based research on RL concentrating on influential factors, particularly considering the context and needs of a developing country. In this matter, case-based research was adopted for gathering and analyzing field data. It is an appropriate method for theory building, extension or refining in emerging subjects (such as RL), where a well-developed set of theories are scarce (EISENHARDT, 1989; KAPETANOPOULOU; TAGARAS, 2009).

Guidelines from the existing literature were considered (e.g. Voss; Tsikriktsis and Frohlich (2002) and Yin (2009)). As a descriptive and exploratory case study, it did not postulate a causal relationship between the variables because those are still not well-established in the literature. The data gathered were predominantly qualitative and were obtained from many sources, as is described further ahead. The main steps adopted for this research design are depicted in Figure 7 and summarized as follows.

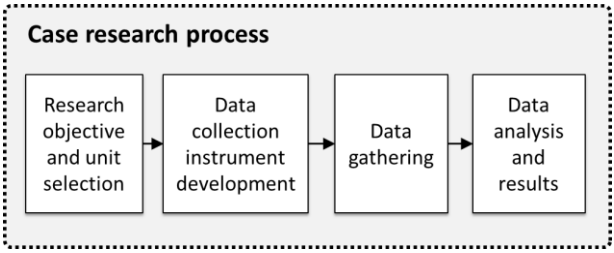


Figure 7 – Case research process.
Adapted from Stuart *et al.* (2002).

### 4.1.1. Research objective and unit selection

The main objective of this empirical phase of this dissertation thesis is to investigate specific issues related to RL application in practice in Brazil. In order to obtain polar information from the empirical research, two different companies were chosen for collecting practical data. One is a large machinery manufacturing company in Santa Catarina State, and the second is a 3PRL service provider in Paraná State. For confidentiality, the first is called 'Company A', and the second 'Company B'.

These units of analysis were selected based on criteria for improving the quality of data, reliability, and internal validity, as follows: (i) the plants should be located in the region of interest and access (Brazil); (ii) due to resources available, medium to large manufacturing companies should be selected; (iii) companies with a RL program older than 15 years (corresponding to a mature RL practice) should be chosen, and (iv) the company representatives should agree to participate in the study and provide data access. Factors that drive the implementation of RL (drivers) were analyzed in Company A, and factors that hinders the RL implementation (barriers) were examined in Company B.

### 4.1.2.Data collection instrument

A structured interview protocol was developed to each company prior to starting the site visits, as recommended by Yin (2009). The protocols were created to ensure reliability and internal validity of this research as well to assure gathering relevant data for follow-up research activities. The research protocols comprised interview questions, people and institutions involved in addition to other field procedures.

### 4.1.3. Data gathering

The prime data were gathered through semi-structured interviews, which were backed up by personal observations, non-formal (spontaneous) conversations with companies' representatives,

and an analysis of the companies' archival sources (internal documents such as: historical production, sales, recovery data, and others). The sources of evidence were identified as part of a research protocol. Factors that impede or enable RL practice may have different interpretations or viewpoints, so multiple respondents were used in each company to mitigate bias. The interviews lasted between 30 minutes and 2 hours each.

For Company A, seven key informant participants from different company functional areas were involved in this investigation, namely: order management technician, sales specialist, sales manager, product return area operator, costs and budget specialist, sustainability specialist, and environmental specialist. In Company B, three informants were selected. The prime informants were: sales specialist, costs and budget specialist and reverse manufacture technician.

### 4.1.4. Data analysis and results

Qualitative data were examined using content analysis. The prime interview data served as the major source of information but secondary sources of evidence were also used, as mentioned earlier. The validity of the data analysis was enhanced by using data from the various sources of evidence (field observation, interviews, company documents, and so on). The use of a number of respondents also support the internal validity of collected data for subsequent analysis.

## 4.2. COMPANY A – ANALYSIS OF RL DRIVERS

This section describes the context of the Company A case study and its results concerning RL drivers. The content presented in Sections 4.1 and 4.2 has been submitted as an article to the Journal named *Production Planning and Control*, in which is currently accepted with major revision, as can be seen in the Appendix C.

### 4.2.1. Case description

The company is a Brazilian-based multinational corporation that has operated in the manufacturing sector for more than 30 years, offering cooling solutions. Company production capacity are over 30

million products per year, which have been sold in more than 80 countries. The company currently directly employs approximately 9,600 people in Brazil and in five other countries.

The Company began RL processes in Brazil in the late 1980s prior to environmental legislation on product take-back. The RL practice began by collecting used products from the Brazilian market to extract the residual material value of these products. This reverse process was established as a Company RL program in 2000, including EOL returns.

The returned products are disassembled and the materials are used in recycling processes. Some materials are sold as scrap (such as copper, steel and aluminum) and others (e.g. ferrous metals) are internally recycled in the foundry process. Moreover, some materials are reused by other industries without passing through a chemical process for recycling, such as in product lubricating oil, which is reused by the petrochemical industry as a high quality oil.

Considering all the product components, 99.94% of the weight of an EOL product is recycled. This high rate of material recovery for a product results from its metal constitution (i.e. the products contain high market value materials). Thus, the residual value of the material drives the recovery process.

The Company operates the RL program in partnership with 20 resellers and outsources the transportation of the EOL products back to the industrial plant. The resellers are service organizations, one of which represents 80% of the Company's return market. The resellers are located in the primary industrial center of the country (São Paulo). Direct business customers are responsible for 11.7% of product return.

To encourage product return, the Company offers a conversion rate: "n" EOL returned products are equivalent to a new product shipped to a reseller. The current conversion rate depends on the three major families of products as follows:

- Product X (large size AB products): 8 to 1;
- Product Y (medium size AB products): 12 to 1; and
- Product Z (small size AB products): 16 to 1.

The reverse flow steps are summarized in Figure 8: (i) the reseller calls Company A and offers a mix of EOL products; (ii) the Company A authorizes the shipping; (iii) the EOL products arrive at the Company A; (iv) the EOL products are stored for approximately 40 days; (v) the products are sent to the treatment line (disassembling

and sorting operations), (vi) the materials are sent to the recycling process. The six-step process results in a lead-time of approximately 2.5 months.

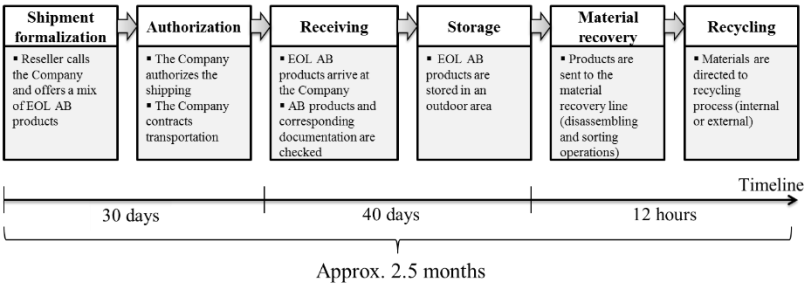


Figure 8 – Reverse logistics steps and timeline.
Source: Constructed by the authors based on collected data.

### 4.2.2.Findings and prior discussion for Company A

A RL environment framework was used to analyze the drivers for the RL program of the Company A. The drivers and stakeholders that were identified for the Company's RL program are shown in Figure 9. This figure shows that Company A performs RL of its products to meet several interests, both internal and external.

Figure 9 – RL environment for the Company A.
Adapted from Certo and Peter (1993).

Each driver is further discussed in addition to the claims of each stakeholder and the Company's responses to the RL program. The drivers are classified into three levels showed in Figure 9: organization (internal drivers), operational environment (external and direct relationship) and general environment (external drivers).

#### 4.2.2.1. Organization level

Shareholders/Financial issues

Clearly, there is a claim for profit from shareholders, as in Alvarez-Gil *et al.* (2007). In this sense, Company A meets the profit shareholder requirements (financial goals) because the material extracted from the products has market value. Currently, the Company's RL program is economically self-sustaining. Thus, the main claim of the shareholders is profit and the company's response is the revenue from scrap metal sales and the green image associated with the RL program. Several authors - e.g. Kapetanopoulou and Tagaras (2011), Subramoniam *et al.* (2013), and Kannan; Diabat and Shankar (2014) - have stated that RL is a means of obtaining valuable spare parts, recapturing value and recovering assets.

Corporate Citizenship

Also known as social responsibility, corporate citizenship encompasses a range of values or principles that stimulate an industry or organization to practice RL. Sustainability is one of the Company's values. One of the interviewees stated that in business management, the concept of sustainability for the company is related to reducing the environmental impacts of the production process and of the products, encouraging best practices in the supply chain and developing communities. One of the policies of the Company A is ISO 14001 compliance, despite the limitations imposed by this international standard. The RL program contributes to these policies, closing the materials life cycle. Previously, some authors - e.g. Aitken and Harrison (2013) and Jindal and Sangwan (2013) - have also confirmed the presence of corporate citizenship pressure to implement RL.

#### 4.2.2.2. Operational environment level

Suppliers

The Company's relationship with the suppliers appears to be based on a commitment to share responsibility for the product life cycle and, in some cases, the sale of scrap metal. However, in contradiction with this result, some authors - e.g. Abdulrahman; Gunasekaran and Subramanian (2014) and Bernon, M. *et al.* (2013) - have stated that there is poor coordination and support in the supply chain for the implementation and management of RL, such as lack of supplier commitment.

Customer/Consumer

The Company is leading an initiative with its major industrial customers to share responsibility for the waste. Moreover, by collecting used products, the Company A reduces the amount of refurbished products on the market that present risk to the end user. In addition, the RL program helps to create a "green image", which is valued especially by European customers. In this sense, some authors - e.g. Abdullah; Yaakub and Abdullah (2012) and Mathiyazhagan and Haq (2013) - uncovered the customer satisfaction issues related to RL. The cited authors posit that the goodwill developed through RL and proper disposal of products can create customer loyalty.

Market/Aftermarket/Refurbishers

By closing product and materials cycles through its RL program and other sustainable initiatives, the Company A has gained market share in Europe because of the growth of environmental concerns in the European market. Another important driver for the RL program was identified as the refurbishers who informally repair EOL products without complying with quality and safety requirements, thus cannibalizing sales of new products and harming the Company's image.

#### 4.2.2.3. General environment level

Physical environment

Environmental concerns were mentioned during the interviews. However, it is noteworthy that this concern was related to

sustainable policies and the green image provided by the RL program. In this matter, marketing objectives such as having a green image is a growing concern among industries (KAPETANOPOULOU; TAGARAS, 2011; JINDAL; SANGWAN, 2013).

## 4.3. COMPANY B - ANALYSIS OF RL BARRIERS

This section describes the context of the Company B case study and its results concerning RL barriers. The content presented in Sections 4.1 and 4.3 has been submitted, accepted and presented in the 22th International Conference on Production Research, as can be seen in the Appendix D.

### 4.3.1. Case description

The Company B is a Brazilian reverse logistics service provider which has offered environmental solutions since 1994. The Company works mainly with end of life (EOL) products, such as: electronic devices in general, refrigerators, air conditioners and printers. The Company B also receives production rejects from industries as well. The Company is certificated by the norms OHSAS 18001, ISO 9001 and ISO 14001. It operates in different areas, such as: treatment and destination; reverse manufacturing; engineering and consultancy; recovering and "revalorization"; and gas and oil. For the purpose of this study, the investigation was performed in the reverse manufacturing unit of the Company B. The case study focused on the reverse flow of EOL refrigerators as well as on the reverse flow of production rejects, which are the most significant flows for the company in terms of return volume. These flows can be divided in three stages: product disposal by the consumer/client, reverse logistics and reverse manufacturing. The reverse process is described in full in the sequence.

The Company receives 15 to 18 tons per month of non-serviceable refrigerators (EOL and production rejects). As already mentioned, there are two main product return flows: (i) some refrigerators return from industries that have established a partnership with the Company B for the final destination of non-serviceable refrigerators. These products are not proper for retail sale and, therefore suited for dismantling and material recovery in the Company

B. Usual problems found in these products are: the production batch did not attain the expected quality or the shipment suffered some kind of damage during transportation. (ii) The second type of return flow is related to a Brazilian energy efficiency project (EEP). The main objective of this project is to reduce the energy consumption in a specific area in Rio de Janeiro, named "Favela da Rocinha", the largest Favela community in Brazil. At the same time, this project aims at reducing the amount of illegal energy connections. For this purpose, the Brazilian government has created a partnership with the Company B. Houses in the "favela" are visited in order to replace the used and high energy consumption refrigerators with new low energy ones. Simultaneously, illegal energy connections are undone. The Company collects those used refrigerators and transports them to its reverse manufacturing plant. The Company outsources the transportation of all the returned refrigerators. For the specific case of non-serviceable refrigerators from industries, the producer is responsible for sending those products to the Company.

The process stages for each type of returned refrigerator are different. Products brought from industries go directly to shredder processing and segregation. Products brought from the EEP need to pass through the primary manual dismantling, in order to remove the compressor. The final stock, after trituration and segregation, is divided in: plastic, ferrous metal, copper and aluminum. All these scrap materials are sold to recycling companies.

The process lead time of the treatment line (shredder and segregation of materials) is approximately five minutes. This line operates in one shift and handles, in average, 2,500 refrigerators per month. The Company usually works in batches for this treatment line, although the batch size is not fixed. The batch size mostly depends on the volume of products that arrives for reverse operations. This is why reverse production systems are commonly classified as "supply-driven flows", rather than "demand-driven flows" as seen in the forward production system, as already stated by some authors (JAYARAMAN; GUIDE JR; SRIVASTAVA, 1999; ASSAVAPOKEE; WONGTHATSANEKORN, 2012).

Figure 10 summarizes the complete reverse process for production reject and EOL refrigerators as well.

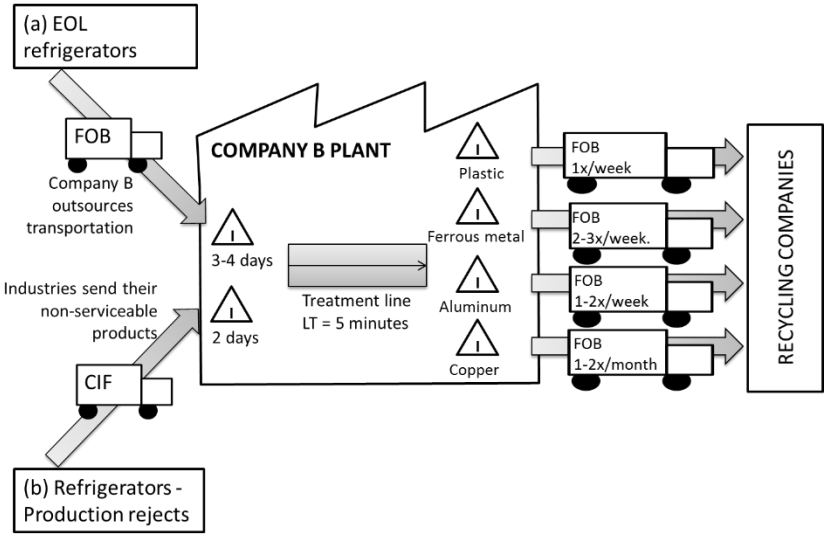


Figure 10 – Return flow for Company B.

### 4.3.2. Findings and prior discussion for Company B

Even considering that the company studied is specialized in product return solutions, it faces some particular barriers when implementing or operating RL activities. These barriers and the RL stakeholders identified during the investigation are presented in Figure 11.

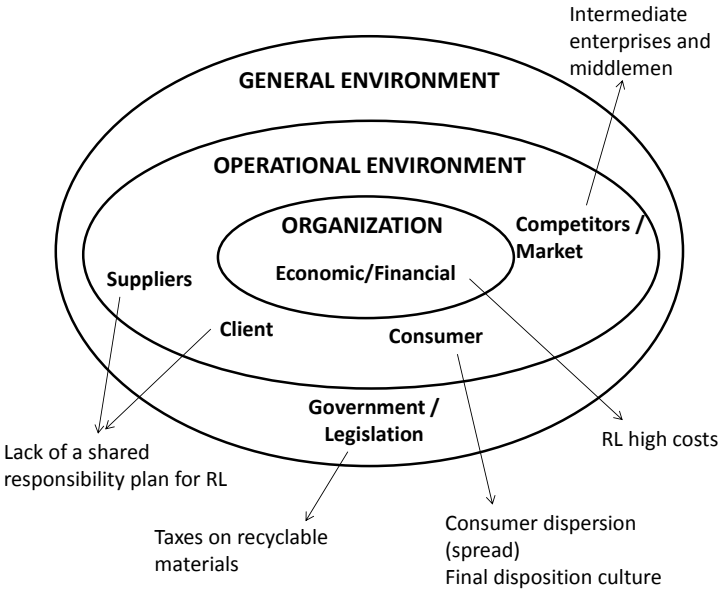


Figure 11 – RL barriers for Company B.

According to data gathered during investigation, the most relevant barriers for the operation of RL for the Company B are described and classified (organization, operational and general environment levels) as follows.

#### 4.3.2.1. Organization level

Economic/Financial

There is an impact on the RL costs due to barriers such as lack of shared responsibility in the reverse supply chain (RSC), and high taxation on recyclable materials.

#### 4.3.2.2. Operational environment level

Consumer

The collection of EOL product is a hindrance inherent to RL operations because of the dispersion of the points of collection (consumer houses, for example). Furthermore, Brazilian consumers

are not yet broadly conscious of the environmentally appropriate final disposal options.

Suppliers and Clients

It was also mentioned during the investigation the lack of shared responsibility in the RSC for the RL planning and operation. This barrier generates a misbalanced cost distribution in the reverse channel, hindering RL development.

Competitors and Market

The presence of many parties in the return flow increases costs of the reverse process. Each party in the reverse chain places a profit margin on products, increasing RL overall operation cost.

#### 4.3.2.3. General environment level

Government/Laws

At last but not least, in Brazil, the taxation on recyclable materials is equivalent to taxation on brand new materials. In some developed countries (UE countries or USA, for example), there are incentives for recyclable materials, reducing taxation on reusable materials or products.

## 4.4. FURTHER DISCUSSION OF RESULTS – COMPANIES A AND B

From the general environment perspective, even though environmental concerns are mentioned by companies, usually it is related to sustainable policies and the green image provided by green activities such as RL. On the barrier side, environmental legislation is still limited in Brazil (SAAVEDRA *et al.*, 2013) and does not provide incentives to increase materials recycling (GIANNETTI; BONILLA; ALMEIDA, 2013).

At the operational environment level, suppliers and customers' compliance for RL implementation and management appears to be an important issue. While in Company A the RL process is well-functioning due to the reverse supply chain structure with resellers and suppliers, for Company B, there is a struggle when implementing RL due to the difficulty of sharing the responsibility among the reverse supply chain partners.

At last, in the organization level, it can be seen that financial related issues may drive or hinder RL activities. On one hand, RL is a means of obtaining valuable spare parts, recapturing value and recovering assets, as seen in Company A case. In the manufacturing industry context, a factor related to materials value recovery drives the reverse flow. This revalorization makes RL programs doubly important for the shareholders: a "green image" is created or enhanced and the related gain in the market share may be economically self-sustaining or even profitable. On the other hand, there might be a negative impact from RL activities due to barriers such as lack of shared responsibility and high taxation on recyclable materials, as mentioned by Company B.

Similarly to other exploratory studies, this part of the research has some limitations. The drivers and barriers are pointed out and analyzed directly from field analysis. That is, no research framework was previously developed to gather from literature a comprehensive list of factors affecting RL implementation. This step is necessary to deepen into driver and barrier analysis and enable a discussion on the possible solutions for dealing with RL influential factors. Moreover, this exploratory part of the research showed that RL is influenced by factors from many different stakeholders. Thus, a thorough literature review process on drivers and barriers under the different

stakeholders' perspectives appears to be essential for continuing this research. In this sense, with the purpose of building a RL multiple stakeholders' perspective framework including these influential factors, next Chapter presents the second theoretical research.

## 5. SPECIFIC THEORETICAL BACKGROUND

In the literature, numerous drivers, such as legislation, economic concerns, social responsibility, ethics, and stakeholder pressures have been proposed to account for the motivational factors that lead companies to engage in green activities (ANDIÇ; YURT; BALTACIOĞLU, 2012), such as RL. Internal pressures arise from employees (feel-good factors related to environmental practices), from the firm's strategy to reduce cost risks or to guarantee the intellectual property of EOL products. At the same time, external pressures from government, non-governmental organizations (NGOs), community, clients, and even the media emerge in order to make industries cope with environmental regulations.

On the other hand, companies encounter RL implementation challenges from different stakeholders, both internally and externally (ABDULRAHMAN; GUNASEKARAN; SUBRAMANIAN, 2014). Most industry sectors still struggle to implement RL strategies due to a lack of interest of their SC members (BERNON, M. *et al.*, 2013). In addition, some firms consider RL an undervalued part of the SC for a variety of reasons, such as its uncertain profitability, its lack of personnel technical skills, and its difficulties with supply chain members (ABDULRAHMAN; GUNASEKARAN; SUBRAMANIAN, 2014).

Given this, it is still unclear how external and internal factors interactively promote green initiatives (SARKIS; ZHU; LAI, 2011), and how different are the multiple perspectives regarding these drivers and barriers from the many stakeholders involved in the implementation process.

With the aforementioned in mind, the aim of this Chapter is to provide further insight into the domain of multiple stakeholders' perspectives for RL drivers and barriers. To accomplish this task, this Chapter attempts to answer the question "what are the drivers and barriers according to each key stakeholder perspective?" To answer this question, this Chapter intends to:

- identify the most relevant papers related to RL, its barriers, drivers, and stakeholders;
- classify these articles in terms of methodology, industry sector, the specific country of interest, stakeholders, drivers and barriers addressed in the paper;

- provide a multiple stakeholders' perspective analysis for RL drivers and barriers.

The chosen approach combines Resource-Based View (RBV) theory and stakeholder theory, with the concepts of barriers and drivers, offering a solid theoretical framework. Thereby, this Chapter unfolds as follows. In the following section, literature review research methods are provided. In the sequence, a brief overview of the theoretical lens used in the research is presented (Section 5.2). Section 5.3 provides a descriptive analysis of the literature review. The Chapter then shifts focus to the content analysis and the multi-perspective framework, in Section 5.4. Finally, Section 5.5 discusses the results by relating them to previous publications and to the theoretical basis, i.e., stakeholder and RBV theories.

## 5.1. RESEARCH METHODS

Literature reviews typically aim at three purposes: firstly, it summarizes existing research by identifying subjects, issues, and patterns; secondly, it offers an overview and a critical evaluation of a body of bibliography relating to a given research topic or a research problem; and finally, it helps to identify the conceptual content of the field (MEREDITH, 1993) as well as contributing to theory development, as discussed elsewhere (HARLAND *et al.*, 2006).

Just as with any other research approach, literature reviews are subject to threats of validity in the study. Controlling and minimizing such threats makes the study more robust and legitimate. Therefore, the systematic approach taken for this research is based on a structured process to ensure the objectivity of the research. In order to assure validity, the following aspects were taken into account. We considered databases and peer-reviewed journals; we created a search strategy, and we evaluated the body of the literature retrieved in order to determine its quality and relevance.

The review procedure is based on a work process from Govindan *et al.* (2014), Lage Junior and Godinho Filho (2010), Seuring and Gold (2012), Brandenburg *et al.* (2014) and Govindan; Soleimani and Kannan (2015) with some adaptations. The main steps adopted in this literature review are illustrated in Figure 12. Each of the steps presented in Figure 12 is detailed in the sequence.

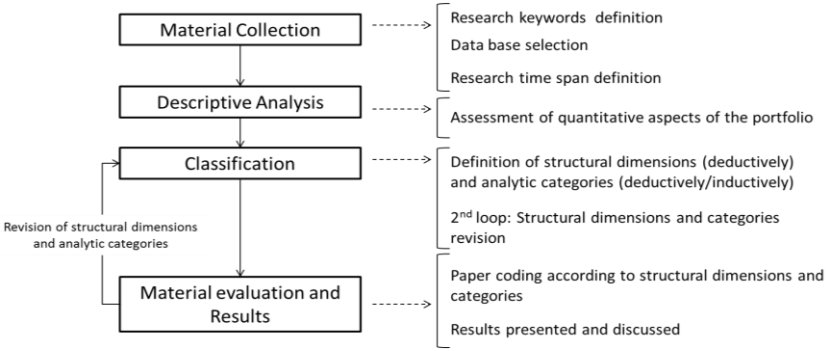


Figure 12 – Research process.
Source: elaborated by the author based on Seuring and Gold (2012), Brandenburg et al. (2014) and Govindan et al. (2015).

### 5.1.1. Material collection

In the phase of material collection, two main decisions to be taken are the definition and delimitation of the material and the definition of the unit of analysis (SEURING; GOLD, 2012). Therefore, the selection process used the following filtering criteria:

- The literature review focuses upon previous works published in English from the last 11 years (from January 2004 to August 2014).
- The scientific-technical bibliographic databases used to search for articles were: Science Direct, Springer, Emerald, Taylor & Francis, Wiley, ISI Web of Science, Inderscience, Google Scholar, and Scopus.
- The keywords contained in the title and abstract used for retrieving the papers during the material collection step are ‘reverse logistics,’ ‘reverse supply chain,’ or ‘closed-loop supply chain,’ and ‘drivers’ or ‘barriers’ or ‘stakeholders.’ Terms such as ‘reuse,’ ‘remanufacturing,’ and ‘recycling’ were also accepted during the publication gathering process.
- Papers focusing on sustainable supply chain management or green supply chain management were not considered, because the focus of this thesis is on RL, not on the broad areas in which it is commonly inserted.

This search resulted in more than 150 articles from more than 50 journals. After eliminating duplicate papers with the aid of the software EndNote®, a sorting process was performed in which titles and abstracts were analyzed to assure that their main subject was suitable for this research scope. As stated before, the aim was to analyze articles that directly related to stakeholders' perspectives, drivers and barriers for RL. This narrowing resulted in a set of 48 papers. Then, a backward search was performed in the references (a cross-referencing), and that process added one more relevant paper to our portfolio. Hence, careful research procedures were followed, resulting in a final set of 49 articles from 30 different journals.

We did not consider literature and practices related to green purchasing, corporate environmental behavior, green logistics, and industrial ecology, unless the article explicitly deals with RL issues. The aim of this review is to focus on RL from multiple stakeholder and resource-based viewpoints. Papers focusing on after sales returns were not considered in the review for two reasons: the return process is more similar to forward logistics, and this research focus pertains to green supply chain initiatives such as product EOL management.

### 5.1.2. Descriptive analysis

Because there is a lack of systematized knowledge and valuable guidelines regarding RL research, a quantitative content analysis was used to examine the literature from different bodies of studies. In this step, information about the distribution of the papers across various journals is assessed, as well as the distribution across the years. Additionally, the descriptive analysis provides information on the country specifically focused on in the paper, the industrial sector analyzed, and the method used. These results are presented in Section 5.3.

### 5.1.3. Classification

Structural dimensions constitute the major topics of analysis, which are formed by single analytic categories. The structural dimensions of this study and major topics of analysis including detailed classifications are categorized in Table 7. Structural dimensions were established in a deductive approach, i.e., they were

assessed before the material was analyzed, based on existing theory (SEURING; GOLD, 2012). For the analytical categories, some were derived deductively while others were determined inductively. The latter means that "categories are derived from the material under examination itself, employing an iterative process of category building, testing and revising by constantly comparing categories and data" (SEURING; GOLD, 2012). This information is given in the right-hand column of Table 7.

Table 7 – Structural dimensions, analytic categories and definitions.

| **Structural Dimensions (deductive)** | **Definition** | **Analytical categories** | **Inductive/ Deductive** |
|---|---|---|---|
| Method used | Reported tools/procedure for identifying, gathering, and analyzing the data for attaining the paper's objective. | Survey, Case Study, Mathematical modelling, Focus Group, Theoretical, Literature Review. | Deductive/ Inductive |
| Industry sector | Describes the specific industry sector in which the research was performed. | North American Industry Classification System (NAICS) industrial sector classification was used.[1] | Deductive |
| Country specific | Describes the specific country in which the research was developed. | Worldwide countries. | Deductive |

[1] NAICS was used in this research due to its broad international use, which was considered for the revision process of other important international classifications such as the International Standard Industrial Classification of All Economic Activities.

| | | | |
|---|---|---|---|
| Stakeholders | Stakeholders' perspectives used in the manuscript. | Stakeholders were taken from previous literature and defined in Section 5.4.1. | Inductive |
| Drivers | Influential factors cited in the paper. | Drivers were taken from the studied literature and defined in Section 5.4.2. | Inductive |
| Barriers | Impediments cited in the paper. | Barriers were taken from the studied literature and defined in Section 5.4.3. | Inductive |

Structural dimensions were established according to the objectives of this review ('drivers,' 'barriers,' and 'stakeholders'). In addition, other structural dimensions used included 'method used,' 'industry sector,' and 'country specific,' as based on previous literature reviews (BRANDENBURG *et al.*, 2014; GOVINDAN; SOLEIMANI; KANNAN, 2015). This approach allowed us to find not only the main streams of publications in the topic but also the research gaps.

To facilitate an exhaustive categorization of each article, the analytic categories are complemented with ''many/other'' and ''not applicable/not specified'' categories.

### 5.1.4.Material evaluation and results

Content analysis is a useful means for assessing the symbolic content of published articles in a systematic manner to unearth research opportunities drawn from the diverse literature base (SHAHARUDIN; ZAILANI; TAN, 2014). After the article selection process and the definition of the major topics of analysis and its categories, a classification was performed to sort the articles by their main focus. In other words, the portfolio of collected papers on RL-related issues has been analyzed according to the structural dimensions and analytic categories detailed in the previous Section.

For that, a spreadsheet software was used to minimize errors and to evaluate different aspects of the analyses (GOVINDAN; SOLEIMANI; KANNAN, 2015).

The results are presented and discussed, aiming to provide some practical guidance for RL researchers and practitioners. The theoretically-based categorization scheme with predefined categories and clear definitions improves reliability of the coding and internal validity of the findings (SEURING; GOLD, 2012). Lastly, an analysis of the review is performed to provide insights into the researched topic, pointing out research gaps in the RL area.

## 5.2. THEORETICAL BASIS

Organizational theory is the study of formal social organizations and their interrelationship with the environment in which they operate. It is "a management insight that can help explain or describe organizational behaviors, designs, or structures" (SARKIS; ZHU; LAI, 2011). The primary focus with organizational theory for this research is at the interrelationship with the environment in which the business organizations operate. We consider that RL implementation and management is dependent: (i) on the support and participation of the key stakeholders; (ii) on the shared responsibility through the reverse supply chain to bring back the EOL products; and (iii) on the resources committed to RL operations. For these reasons, this work is grounded in two theoretical foundations: resource-based view (RBV) and stakeholder theories. In this sense, this research contributes to the green supply chain literature, the broad field where RL is typically inserted, by applying the RBV and stakeholder theory to develop a RL framework. This framework shows the interactions among different perceptions from the multiple RL stakeholders on a common set of drivers and barriers. This section proceeds by detailing the theoretical rationale of this research.

### 5.2.1. Resource-based view

Some authors (CLEMENS; DOUGLAS, 2006) affirm that both external drivers and internal resources drive environmental management practices. However, it has been recognized that it is difficult to adopt green supply chain initiatives, such as RL, without

proper managerial support and designated resources (ROGERS; TIBBEN-LEMBKE, 2001; SHAHARUDIN; ZAILANI; TAN, 2014).

In this matter, the resource-based view (RBV) posits that a company's inimitable competitive advantage is derived from its exclusive bundle of resources (SHAHARUDIN; ZAILANI; TAN, 2014). Firms' resources are defined as all assets, capabilities, firm attributes, organizational processes, knowledge, and information controlled by an enterprise that enable the firm to conceive of and to implement strategies with the purpose of improving its competitiveness (BARNEY, 1991; SARKIS; ZHU; LAI, 2011).

The development of resources and capabilities may be exemplified through improvements in various organizational performance metrics (SARKIS; ZHU; LAI, 2011). Moreover, having the capabilities and knowledge for the whole supply chain to implement green initiatives is a resource that falls well within the RBV dimensions (LAI; CHENG; TANG, 2010). Inter-organizational learning is meant to greatly enhance the resources of organizations throughout the supply chain (SARKIS; ZHU; LAI, 2011).

In GSCM, eco-design and product recovery are typical organizational resources requiring supply chain partnership to attain performance benefits (ZHU; SARKIS, 2004; SHANG; LU; LI, 2010; SARKIS; ZHU; LAI, 2011). The interdependency of supply chain members, as well as the effectiveness and quality of their collaboration, determines the success of implementing green initiatives and should not be ignored (SARKIS; ZHU; LAI, 2011).

The use of the RBV theory may facilitate the identification of resources that are constrained, as already stated by previous research (SHAHARUDIN; ZAILANI; TAN, 2014). Such constraints serve as a main obstacle for product return. The lack of capabilities and resources make the implementation of RL practices difficult (GONZÁLEZ-TORRE *et al.*, 2010), since successful product returns management requires both resources and capabilities (SHAHARUDIN; ZAILANI; TAN, 2014). Thereby, it is important to use the lens of RBV for this research, since it has emerged as a dominant tool to explain manufacturing firms' green supply chain management (SHAHARUDIN; ZAILANI; TAN, 2014). Additionally, the lack of resource commitment is pointed out as a main obstacle for RL operations (an issue discussed further in this Chapter). Finally, RBV is closely related to stakeholder theory (FREEMAN, 1984), which is discussed next.

### 5.2.2. Stakeholder theory, classification and multiple perspectives

In addition to the RBV, we also consider the stakeholder theory as a main theoretical foundation of this research. Stakeholder theory has been used extensively in green research (SHAHARUDIN; ZAILANI; TAN, 2014). The stakeholder theory suggests that "companies produce externalities that affect many parties (stakeholders) which are both internal and external to the firm" (SARKIS; ZHU; LAI, 2011).

There are many definitions of stakeholders (MITCHELL; AGLE; WOOD, 1997), but all share their roots in the definition from Freeman (1984, p. 46): "any group or individual who can affect or is affected by the achievement of the organization's objectives." (CRANE; RUEBOTTOM, 2011; SARKIS; ZHU; LAI, 2011; KIM; LEE, 2012). ''Stakeholder theory is concerned with who has input in decision making as well as with who benefits from the outcomes of such decisions'' (PHILLIPS; FREEMAN; WICKS, 2003; CRANE; RUEBOTTOM, 2011). Persons, groups, neighborhoods, organizations, institutions, societies, and even the natural environment are generally thought to qualify as actual or potential stakeholders (MITCHELL; AGLE; WOOD, 1997).

Mitchell; Agle and Wood (1997) developed a classification which groups stakeholders based on three attributes: (1) the stakeholder's power to influence the firm, (2) the legitimacy of the stakeholder's relationship with the firm, and (3) the urgency of the stakeholder's claim on the firm. The authors combined these attributes, generating a stakeholder typology consisting of latent stakeholders, expectant stakeholders, and definitive stakeholders (KIM; LEE, 2012). Latent stakeholders are those who possess only one of the three stakeholder attributes. Expectant stakeholders and definitive stakeholders are those who possess two or three stakeholder attributes, respectively. Given this classification, this research considers mostly the influence of expectant and definitive stakeholders, as "corporate managers must pay attention to the interests of these two last stakeholders" (KIM; LEE, 2012).

The supply chain, as an entity, has a multiplicity of stakeholders, even more than individual companies with an extension

of these stakeholder groups when environmental issues are introduced (DE BRITO; CARBONE; BLANQUART, 2008). A stakeholder analysis for the reverse supply chain is particularly relevant as there are understandings that not all reverse logistics practices are beneficial for generating competitive advantages for companies but, at the same time, are necessary due to pressures from stakeholders.

Stakeholder pressure has been found to be an important motivational element for green initiatives (ANDIÇ; YURT; BALTACIOĞLU, 2012). The requirements of different stakeholders such as customers, suppliers, governmental agencies, NGOs, and shareholders can be seen as instigators of RL implementation. In other words, stakeholders have various claims which the firm may satisfy through RL activities (ALVAREZ-GIL *et al.*, 2007). Because most organizations recognize the multi-dimensional and dynamic nature of doing business, uncovering the perceptions of several stakeholders can inform managerial decision-making in an exercise of peer benchmarking (AVKIRAN; MORITA, 2010). Furthermore, recently, companies are increasingly accountable not only to their typical stakeholders such as shareholders, or state regulatory authorities, but also to new ones such as NGOs for their social and environmental profiles and to consumers (for example, through social media communications) (WASSENHOVE; BESIOU, 2013). In this sense, companies understand the importance of responding to pressure from stakeholders (FREEMAN, 1984) to help improve their competitiveness.

Nevertheless, different stakeholders may exhibit different perspectives on the desirability of characteristics (AVKIRAN; MORITA, 2010). The goals and objectives of these various groups are not necessarily the same as the companies' and many times, they may be quite different (WASSENHOVE; BESIOU, 2013). In fact, it is possible that stakeholders may have views that conflict with those of management (AVKIRAN; MORITA, 2010). The conflicting objectives of the stakeholders are many. Shareholders focus mostly on the company's profitability. Employees support their own interests and oppose, for example, a factory closure, even if this step would increase a company's profitability (WASSENHOVE; BESIOU, 2013). Government and regulators intensify legislation, which usually raises the cost of products or services. NGOs might criticize and expose publicly companies for not being environmentally friendly. The media can publish negative news about companies, harming company's

sales. In summary, companies need to manage the various perspectives and conflicting interests of their stakeholders, which requires them to develop specific capabilities to manage these pressures (SARKIS; GONZALEZ-TORRE; ADENSO-DIAZ, 2010). These examples confirm the suitability of stakeholder theory for capturing how external forces influence RL (ALVAREZ-GIL *et al.*, 2007).

In this sense, Wassenhove and Besiou (2013) identified common characteristics of the multiple-stakeholder problems, such as: uncertainty, problems tend to change dynamically through time, and problems tend to be much broader involving many stakeholders with conflicting goals. In order to better draw the research gap of this work, Table 8 lists previous research relating RL to stakeholder theory and/or stakeholder analysis.

Table 8 – Previous papers on RL and stakeholders issues.

| **Source** | **Paper objective** | **Main contribution** |
|---|---|---|
| (GONZÁLEZ-BENITO; GONZÁLEZ-BENITO, 2006) | The article identifies the factors determining the implementation of environmental logistics practices by studying two variables: the environmental pressure of the stakeholders as perceived by the firm and the values and beliefs of its managers. | Two dimensions of pressure can be distinguished, governmental and non-governmental, and that only the latter is able to explain the implementation of environmental practices in logistics. |
| (KOVÁCS; SPENS; KORKEILA, 2006) | The study proposes an evaluation framework for reverse supply chains and indicates how stakeholder theory can be applied from a supply chain perspective. | How the stakeholders of the glass recycling supply chain in Finland respond to legislation changes is explored and described in different scenarios. |

| | | |
|---|---|---|
| (ALVAREZ-GIL *et al.*, 2007) | The paper develops a model that proposes external, internal, and individual factors that affect the implementation of RL programs. | The study finds that customers, employees, and the government prominence in terms of RL activities and a manager's progressive posture have a significant influence on the final decision of implementing RL programs. Shareholder salience negatively impacts the decision. |
| (ABRAHAM, 2011) | The paper aims to map RL systems in the apparel aftermarket in India and identify the collaboration between stakeholders. | Benefits accrued by collaboration in the RL chain are increased market knowledge, more predictable business and better margins. |
| (KIM; LEE, 2012) | The article investigates the role of eco-oriented culture in the relationship between stakeholder pressure and the adoption of environmental logistics practices. | There are significant relationships between stakeholder pressure and environmental logistics practices. Corporate eco-oriented culture fully mediates the relationship between perceived stakeholder pressure and the adoption of environmental logistics practices. |

| | | |
|---|---|---|
| (ABDULLAH; YAAKUB; ABDULLAH, 2012) | The research aims to look at the current level of RL adoption among manufacturers in Malaysia and to identify the influence of customer/stakeholder pressure, regulatory pressure, financial and competitive pressure, and corporate citizenship pressure on RL adoption. | The regulatory pressure has a significantly strong influence on the level of RL adoption, while customer/stakeholder pressure has moderate influence. |
| (YUSUF; RAOUF, 2013) | The paper presents a framework of RL optimizing the stakeholders', social, economic and environmental gains. | The research proposed the Social, Stakeholder, Economic & Environmental sustained gain model optimizing the benefits of stakeholders and highlights the variety of waste and its operational methodology in Pakistani industry. |

As Table 8 shows, few works have dealt with RL issues using the lens of stakeholder theory. Some papers recognize the importance of analyzing the relationship between stakeholders' pressures and RL implementation (GONZÁLEZ-BENITO; GONZÁLEZ-BENITO, 2006; ALVAREZ-GIL *et al.*, 2007; ABRAHAM, 2011; ABDULLAH; YAAKUB; ABDULLAH, 2012). Still, as far as we know, no paper has researched the multiple perspectives of stakeholders for the analysis of drivers and barriers for RL implementation.

## 5.3. DESCRIPTIVE ANALYSIS

From the 49 studied pieces of work, 44 are from journal articles, four from conference proceedings, and one book chapter. An overview of the journals used can be seen in Table 9. The largest

number of publications per journal was found in the *Journal of Cleaner Production*, followed by the *International Journal of Production Economics* and *The International Journal of Advanced Manufacturing Technology*. It is important to mention that the first eight journals represent more than 50% of the journal references identified.

Table 9 – References divided by journals.

| **Journal title** | **Number of articles** |
|---|---|
| Journal of Cleaner Production | 5 |
| International Journal of Production Economics | 4 |
| The International Journal of Advanced Manufacturing Technology | 4 |
| International Journal of Operations & Production Management | 3 |
| International Journal of Physical Distribution & Logistics Management | 2 |
| Resources, Conservation and Recycling | 2 |
| Supply Chain Management: An International Journal | 2 |
| Academy of Management Perspectives | 1 |
| Acta Universitatis Agriculturae et Silviculturae Mendelianae Brunensis | 1 |
| Applied Sciences | 1 |
| British Journal of Management | 1 |
| Clean Technologies and Environmental Policy | 1 |
| Computers & Industrial Engineering | 1 |
| Global Journal of Flexible Systems Management | 1 |

| | |
|---|---|
| International Journal of Business Performance and Supply Chain Modelling | 1 |
| International Journal of Modeling and Optimization | 1 |
| International Journal of Production Research | 1 |
| International Journal of Sustainable Engineering | 1 |
| International Journal of Technology Management | 1 |
| Journal of Business Research | 1 |
| Journal of Fashion Marketing and Management | 1 |
| Journal of Operations Management | 1 |
| Journal of Purchasing and Supply Management | 1 |
| Management Decision | 1 |
| Measuring Business Excellence | 1 |
| Omega | 1 |
| Proceedings of the Pakistan Academy of Sciences | 1 |
| Production Planning & Control | 1 |
| Technological Forecasting and Social Change | 1 |

The distribution of all papers along the years is presented in Figure 13. As can be seen, 2005 was the first year of publication of RL related to the topics 'influential factors' and 'stakeholders.' A growing number of publications was found starting from 2011/2012. This increase shows a growing interest in RL related to topics such as influential factors and stakeholder analysis. It is relevant to mention that publications were considered up to August 2014.

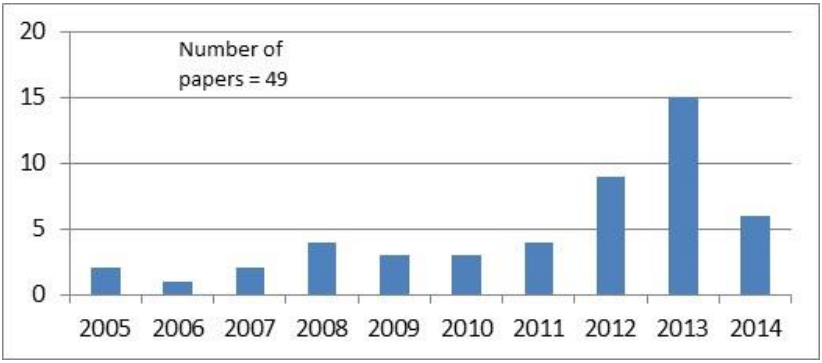

Figure 13 – Distribution of publications through the years.

Table 10 shows the economic activities addressed in the articles. To determine this distribution, we used the classification of the North American Industry Classification System (NAICS). As can be seen, the majority of papers address the 'transportation equipment manufacturing' and the 'electrical equipment, appliance, and component manufacturing' industry sectors. This result is hardly surprising, because RL practice in these sectors is strongly driven by legislation issues and direct economic benefits, such as the recovery of the remaining value of products.

Table 10 – Distribution according to industry sector.

| **Industry Sector** | **Papers** |
|---|---|
| Many (more than 2 sectors) | 12 |
| Transportation Equipment Manufacturing | 12 |
| Electrical Equipment, Appliance, and Component Manufacturing | 11 |
| Apparel Manufacturing | 1 |
| Chemical Manufacturing | 1 |
| Paper Manufacturing | 1 |
| Primary Metal Manufacturing | 1 |
| Not specified | 10 |

Regarding the specific country addressed in the papers, Table 11 shows that the majority of publications analyzed refer to India, followed by China, and the United Kingdom. Some authors (ABDULRAHMAN; GUNASEKARAN; SUBRAMANIAN, 2014) have stated that most of prior research on RL issues is focused on developed nations, but this scenario seems to be changing. As can be noted in Table 11, studies focused on the BRIC countries are emerging in the body of knowledge.

Table 11 – Country specific.

| **Country** | **Papers** |
|---|---|
| India | 10 |
| China | 4 |
| UK | 4 |

| | |
|---|---|
| Malaysia | 3 |
| Many (more than 2) | 3 |
| Spain | 3 |
| Brazil | 2 |
| Hong Kong | 2 |
| Turkey | 2 |
| Czech Republic | 1 |
| Greece | 1 |
| Holland | 1 |
| Pakistan | 1 |
| Poland | 1 |
| Taiwan | 1 |
| USA | 1 |
| None | 9 |

Finally, we also analyzed the methods used in the papers. The results from this descriptive analysis can be observed in Table 12. Case-based research and surveys are the most common methods applied by papers from the portfolio. The category "others" includes mainly articles that employed multi-criteria decision making (MCDM) tools, such as analytic hierarchical process (AHP) and interpretive structural modelling (ISM). None of the literature reviews analyzed in this research dealt with influential factors and multiple perspectives from stakeholders for RL implementation.

Table 12 – Methods used in papers.

| **Method** | **Papers** |
|---|---|
| Case study | 16 |
| Survey | 14 |
| Theoretical | 7 |
| Other | 5 |
| Mathematical Modelling | 4 |
| Literature review | 3 |

The next section discusses the issues concerning the content of the articles and develops the RL multiple perspectives framework.

## 5.4. CONTENT ANALYSIS AND FRAMEWORK DEVELOPMENT

Content analysis offers one sound methodological frame for conducting rigorous, systematic, and reproducible literature reviews (SEURING; GOLD, 2012). It is defined as any kind of methodological measurement applied to text for social science purposes (SHAPIRO; MARKOFF, 1997). Content analysis was applied for reviewing the 49 papers in our portfolio. The content analysis is performed on the basis of the specific pattern of structural dimensions and analytic categories derived inductively and deductively, as already described.

In the process of content analysis, the first level analyzes the manifest content of texts and documents by statistical methods (SEURING; GOLD, 2012). This step is provided in Sections 5.4.1, 5.4.2, and 5.4.3, where the stakeholders, drivers, and barriers are listed, defined, and quantified. Some quantitative analyses are also given. On a second level, a latent content of the text is excavated, which requires an interpretation of the underlying meaning of terms and arguments (SEURING; GOLD, 2012). This step is also present in some classifications in Sections 5.4.1, 5.4.2, and 5.4.3, but it is mainly attained in Section 5.4.4 with the purpose of developing the multi-perspective framework.

### 5.4.1. Identification of stakeholders

Given Mitchell's *et al.* (1997) classification (discussed in Section 5.2.2) and the fact that a firm never satisfies every stakeholder's interest, managers are strategically required to pay attention to the more influential stakeholders (expectant stakeholders or definitive stakeholders) than to others (KIM; LEE, 2012). Thereby, before determining the drivers and barriers for RL, this topic intends to define the stakeholders for RL. The encountered stakeholders are presented in Table 13.

Besides the stakeholders gathered from the analyzed papers from our portfolio, some additional papers were included in this analysis in order to guarantee that this work comprises all relevant stakeholders for RL. Considering that RL is seen as part of environmental logistics practice (GONZÁLEZ-BENITO; GONZÁLEZ-BENITO, 2006) and part of green supply chain initiatives

(SRIVASTAVA, SAMIR K, 2007; DIABAT; GOVINDAN, 2011; GOVINDAN; KHODAVERDI; JAFARIAN, 2013; MUDULI *et al.*, 2013), previous works on stakeholders for environmental logistics were also considered, namely studies by Avkiran and Morita (2010), Crane and Ruebottom (2011), Kim and Lee (2012), and Wassenhove and Besiou (2013).

Table 13 – List of stakeholders by reference.

| **Stakeholder** | **Description** | **Sources** |
|---|---|---|
| Government | Government, legislation agencies. | (Abdullah et al., 2012; Aitken & Harrison, 2013; Alvarez-Gil et al., 2007; Avkiran & Morita, 2010; Crane & Ruebottom, 2011; González-Torre et al., 2010; Hsu et al., 2013; Kannan et al., 2014; Kim & Lee, 2012; Mathiyazhagan & Haq, 2013; Sarkis et al., 2010; M. N. Shaik & Abdul-Kader, 2013; R. Subramoniam et al., 2009; Wassenhove & Besiou, 2013; Ye et al., 2013) |
| Customers | Clients and consumers. | (Abdullah et al., 2012; Alvarez-Gil et al., 2007; Avkiran & Morita, 2010; Crane & Ruebottom, 2011; González-Torre et al., 2010; Hsu et al., 2013; Kannan et al., 2014; Kim & Lee, 2012; Mathiyazhagan & Haq, 2013; Rahimifard et al., 2009; Sarkis et al., 2010; M. N. Shaik & Abdul-Kader, 2013; Wassenhove & Besiou, 2013; Ye et al., 2013) |
| Society/NGOs | Society, community and non-governmental organization representing the | (Abdullah et al., 2012; Alvarez-Gil et al., 2007; Crane & Ruebottom, 2011; González-Torre et al., 2010; Hsu et al., 2013; Kim & Lee, 2012; Mathiyazhagan & Haq, 2013; Sarkis et al., 2010; R. |

| | | |
|---|---|---|
| | societal interests. | Subramoniam et al., 2009; Van Der Wiel et al., 2012; Wassenhove & Besiou, 2013) |
| Market/ Competitors | Market and competitors. | (Abdullah et al., 2012; Crane & Ruebottom, 2011; González-Torre et al., 2010; Ye et al., 2013) |
| Suppliers | Upstream side of the supply chain. | (Alvarez-Gil et al., 2007; Crane & Ruebottom, 2011; Hsu et al., 2013; Kannan et al., 2014; Rahimifard et al., 2009; Van Der Wiel et al., 2012) |
| Organization | Focal company including interest of shareholders. | (Alvarez-Gil et al., 2007; Avkiran & Morita, 2010; Crane & Ruebottom, 2011; Kim & Lee, 2012; Rahimifard et al., 2009; Sarkis et al., 2010; M. N. Shaik & Abdul-Kader, 2013; R. Subramoniam et al., 2009; Van Der Wiel et al., 2012; Wassenhove & Besiou, 2013) |
| Employees | Manpower from the focal company. | (Avkiran & Morita, 2010; Crane & Ruebottom, 2011; Hsu et al., 2013; Kannan et al., 2014; Kim & Lee, 2012; Sarkis et al., 2010; M. N. Shaik & Abdul-Kader, 2013; Wassenhove & Besiou, 2013) |
| Media | Including traditional media and social media. | (Crane & Ruebottom, 2011; Mathiyazhagan & Haq, 2013; Sarkis et al., 2010; Wassenhove & Besiou, 2013) |

By means of an inductive analysis, eight types of stakeholders were identified exerting influence on RL activities: Government, Customer, Society/Community, Market/Competitors, Suppliers, Organization (focal company/shareholders), Employees, and Media. These encountered stakeholders shown in Table 13 serve as analytical categories for classifying each of the drivers and barriers, to be described in the following Sections.

### 5.4.2. RL Drivers

An efficient and effective RL implementation and management has become a crucial weapon for a firm to defeat its rivals in the same industry (LAU; WANG, 2009). In this sense, identifying and understanding the motivational factors, namely drivers, for RL implementation is a major step to gain competitiveness. Drivers are considered motivational elements that lead companies to engage in some sort of activity. The main drivers of RL activities are not well understood yet (AKDOĞAN; COŞKUN, 2012). In the literature, many drivers have been suggested to understand the motivational elements that lead companies to perform RL, as shown in Table 14. By means of the thorough literature review process adopted and the papers classified in the spreadsheet already described in Section 5.1.4, 37 drivers have been identified and categorized based on their meaning and similarities. We classified the drivers by internal and external, and we related each of them to one or more stakeholders defined previously in Table 13. The selected drivers were then classified into eight clusters. These clusters were inspired by previous classification schemes found in literature, namely by Abdulrahman; Gunasekaran and Subramanian (2014) and by Govindan *et al.* (2014). The clusters are:

- Policy related issues (P): this cluster includes issues on regulations and laws concerning product take back and RL.
- Governance and supply chain process related issues (G&SC): this cluster refers to reverse supply chain drivers, co-operation issues, and business partners.
- Management related issues (M): this cluster includes issues such as employee satisfaction, human resources support, and department integration for RL practice.
- Market and competitors related issues (M&C): this cluster includes customer satisfaction, competitive advantage potential, green market issues, and competitive pressures.
- Technology and infrastructure related issues (T&I): this cluster includes information technology drivers,

availability of eco-design and design for ‘X’ techniques and recovery technologies.

- Economic related issues (E): this cluster includes financial and economic drivers related to RL.
- Knowledge related issues (K): this cluster refers to information flows and RL awareness in companies.
- Social related issues (S): this cluster refers to RL drivers related to societal pressures, such as higher public awareness on environmental conservation and corporate citizenship pressure.

Table 14 – List of RL drivers, classification and sources.

| Driver | Description | Internal/ External | Stakeholders Involved | Sources |
|---|---|---|---|---|
| **Cluster - Policy related issues** | | | | |
| D1. Regulatory pressure for product return/recovery | Many countries have introduced legislation or directives to ensure effective disposal of manufactured products or may make it mandatory for the companies to recover used products. | External | Government | (Abdullah et al., 2012; Aitken & Harrison, 2013; Akdoğan & Coşkun, 2012; Alvarez-Gil et al., 2007; Andiç et al., 2012; Chan & Chan, 2008; Chan et al., 2012; Chiou et al., 2012; de Sousa Jabbour et al., 2013; Hsu et al., 2013; Jayaraman & Luo, 2007; Jindal & Sangwan, 2013; Kannan et al., 2014; Kapetanopoulou & Tagaras, 2011; Krikke et al., 2013; Kumar & Putnam, 2008; Lau & Wang, 2009; Mathiyazhagan & Haq, 2013; Saavedra et al., 2013; M. N. Shaik & Abdul-Kader, 2013; Mohammed Najeeb Shaik & Abdul-Kader, 2014; Samir K. Srivastava, 2008; Samir K Srivastava, 2013; Subramoniam et al., 2013; Van Der Wiel et al., 2012; Wang & Sun, 2005) |
| D2. License to operate | Firms are increasingly adopting RL practices in their business schedule in order to get license to operate. | External | Government | (Andiç et al., 2012) |
| D3. End-of-life levies for the consumer at point of sale | Tax revenues at point of sales drives customers to return their EOL products. | Internal | Organization | (Rahimifard et al., 2009) |
| D4. Motivation laws | Take-back levies from manufacturers drives industries to take back their products. For example special tax exemption for ISO 14001 certified firms. | External | Government | (Mathiyazhagan & Haq, 2013; Rahimifard et al., 2009; Samir K Srivastava, 2013) |
| **Cluster – Governance and SC process related issues** | | | | |
| D5. Qualification and support of business partners | Well-trained SC partners may assist RL implementation and management. | External | Suppliers, Customers | (Aitken & Harrison, 2013; Ho et al., 2012) |
| D6. Cooperation and integration with partners in the SC | Cooperation and relation with business partners in the SC can help the RL implementation. | External | Suppliers, Customers | (Ho et al., 2012; Janse et al., 2010; Saavedra et al., 2013; M. N. Shaik & Abdul-Kader, 2013; R. Subramoniam et al., 2009; Subramoniam et al., 2013; Xie & Breen, 2012) |
| **Cluster - Management related issues** | | | | |
| D7. Employee satisfaction | Feel-good factors, employee morale, individual satisfaction obtained by environmental practices in the company. | Internal | Employees | (Andiç et al., 2012) |
| D8. Number of staff | Number of staff is positively related to the implementation of RL of a company. | Internal | Employees | (Ho et al., 2012) |
| D9. Human resources support | Company's human resources support boosts RL activities. | Internal | Employees | (Ho et al., 2012) |
| D10. Top management awareness and commitment | RL implementation is facilitated when top managers are conscious about its relevance and committed to RL implementation. | Internal | Employees | (Janse et al., 2010; Xie & Breen, 2012) (Samir K Srivastava, 2013) |
| D11. Department integration | A well-integrated physical and non-physical organizational structure with the manufacturing divisions has a positive impact on the decision to perform RL. | Internal | Organization | (R. Subramoniam et al., 2009) |
| **Cluster – Market and Competitors related issues** | | | | |
| D12. Customer satisfaction | Better after sales services increase customer satisfaction and customer trust.<br>The goodwill developed through reverse logistics and proper disposal of products can create customer loyalty. | External | Customer | (Abdullah et al., 2012; Andiç et al., 2012; Jayaraman & Luo, 2007; Jindal & Sangwan, 2013; Kapetanopoulou & Tagaras, 2011; Mathiyazhagan & Haq, 2013; M. N. Shaik & Abdul-Kader, 2013; Samir K Srivastava, 2013) |

| | | | | |
|---|---|---|---|---|
| D13 .Competitive advantage | RL can be a differentiator by means of gaining market and competitive advantage as a strategic weapon (higher profits, process intensification, larger market share, lower costs, differentiation, higher share price, rent-earning resources and capabilities). | External | Market/ Competitors | (Abdullah et al., 2012; Akdoğan & Coşkun, 2012; Andiç et al., 2012; Chan & Chan, 2008; Chiou et al., 2012; Jayaraman & Luo, 2007; Kapetanopoulou & Tagaras, 2011; Lau & Wang, 2009; Mathiyazhagan & Haq, 2013) |
| D14. Green consumerism / consumers environmental awareness | Customer pressure is a growing concern for environmental protection among consumers. | External | Customer | (Abdullah et al., 2012; Andiç et al., 2012; Chan et al., 2012; Chiou et al., 2012; Hsu et al., 2013; Jindal & Sangwan, 2013; Kapetanopoulou & Tagaras, 2011; Lau & Wang, 2009; Mathiyazhagan & Haq, 2013; M. N. Shaik & Abdul-Kader, 2013; Mohammed Najeeb Shaik & Abdul-Kader, 2014; Samir K. Srivastava, 2008; Subramoniam et al., 2013) |
| D15. Green marketing | Marketing objectives such as having a green image is a growing concern among industries. Negative media attention by environmental action groups. | External | Society, Media | (Akdoğan & Coşkun, 2012; Chiou et al., 2012; Jindal & Sangwan, 2013; Kapetanopoulou & Tagaras, 2011; Lau & Wang, 2009; Mathiyazhagan & Haq, 2013; M. N. Shaik & Abdul-Kader, 2013; Samir K Srivastava, 2013; Van Der Wiel et al., 2012; Wang & Sun, 2005) |
| D16. Long-term sustainability | Firms are concerned about their survival in the long run in the market, considering, for example, the increasing shortage of raw materials and the green consumerism. | Internal | Organization | (Andiç et al., 2012; Jindal & Sangwan, 2013; Kannan et al., 2014; Kumar & Putnam, 2008; Mathiyazhagan & Haq, 2013) |
| D17. Competitors pressures to adopt green initiatives | Many organizations work in an environment that includes pressures from their competitors that induce organizations to adopt green initiatives to combat competition. | External | Market/ Competitors | (Hsu et al., 2013; Mathiyazhagan & Haq, 2013; Mohammed Najeeb Shaik & Abdul-Kader, 2014) |
| D18. Brand protection | The outside RL competition and the resulting brand erosion may influence the decision to perform RL. | Internal | Organization | (Jindal & Sangwan, 2013; Subramoniam et al., 2013) |
| **Cluster – Technology and infrastructure related issues** | | | | |
| D19. RL management information system | The availability of specific IT for RL is a success factor for RL development | Internal | Organization | (Chiou et al., 2012) |
| D20. Recycling management system | The availability of good recycling management system and recycling service drives RL practice. | Internal | Organization | (Chiou et al., 2012; Lau & Wang, 2009) |
| D21. Technological innovations | Rapid innovations, quicker obsolescence and shortening product lifecycle propels RL activities. | Internal | Organization | (Lau & Wang, 2009; Mohammed Najeeb Shaik & Abdul-Kader, 2014) |
| D22. Eco-design and Design for X techniques | Design for remanufacturing, or recycle, or disassemble are techniques that can enhance the chance of getting an EOL product back because RL costs are reduced. | Internal | Organization | (Kannan et al., 2014; R. Subramoniam et al., 2009; Subramoniam et al., 2013; Xie & Breen, 2012) |
| D23. Recycling and remanufacturing technologies | Many recycling and remanufacturing strategies are evolving towards continuous improvement by the researchers. | Internal | Organization | (Kannan et al., 2014; M. N. Shaik & Abdul-Kader, 2013) |
| **Cluster - Economic related issues** | | | | |
| D24. Benefits of recycling | Economic benefits of recycling places more pressure on firms to create a better RL strategy. | Internal | Organization | (Abdullah et al., 2012) |
| D25. Reduction on raw material consumption and waste disposal cost | Decreasing the use of raw materials by replacing them by recovered ones as well as reduction of final disposal costs. | Internal | Organization | (Akdoğan & Coşkun, 2012; Mathiyazhagan & Haq, 2013; Rahimifard et al., 2009; Samir K Srivastava, 2013; Subramoniam et al., 2013) |

| | | | | |
|---|---|---|---|---|
| D26. Value recovery | Obtaining valuable spare parts, recapturing value and recovering assets. | Internal | Organization | (Akdoğan & Coşkun, 2012; Chan & Chan, 2008; Chan et al., 2012; Janse et al., 2010; Kannan et al., 2014; Kapetanopoulou & Tagaras, 2011; Mathiyazhagan & Haq, 2013; Rahimifard et al., 2009; Subramoniam et al., 2013) |
| D27. Second hand market | Other financial opportunities as entering in the second hand market. | Internal | Organization | (Akdoğan & Coşkun, 2012; Chan et al., 2012) |
| D28. Reduction of cost risks | Companies implement RL in order to avoid fines and penalties, lessening risks.<br>Example: Carbon tax force fuel cost reduction. | Internal | Organization | (Andiç et al., 2012; Mathiyazhagan & Haq, 2013) |
| D29. Economic viability | RL can improve economic efficiency. | Internal | Organization | (Chan et al., 2012; Jindal & Sangwan, 2013; Kannan et al., 2014; Krikke et al., 2013; Lau & Wang, 2009; M. N. Shaik & Abdul-Kader, 2013; Mohammed Najeeb Shaik & Abdul-Kader, 2014; Samir K. Srivastava, 2008; Subramoniam et al., 2013; Wang & Sun, 2005) |
| D30. Financial support | Availability of initial capital for investment in RL operations | Internal | Organization | (Ho et al., 2012) |
| **Cluster - Knowledge related issues** | | | | |
| D31. Knowledge on sustainable issues and perception of RL benefits | Awareness of manager and industries in general on environmental issues, sustainable development, corporate citizenship. | Internal | Organization, Employees | (Abdullah et al., 2012; Ho et al., 2012) |
| D32. Cost and performance knowledge | Detailed insight in cost and performance of RL operations. | Internal | Organization, Employees | (Janse et al., 2010; Mathiyazhagan & Haq, 2013) |
| D33. Intellectual property | The need to protect the Intellectual Property of the product influence the decision to perform RL. | Internal | Organization | (Subramoniam et al., 2013) |
| **Cluster – Social related issues** | | | | |
| D34. Higher public awareness | Greater concern of environment by the population drives RL operations and claim for environmental behavior by NGOs. | External | Society, Customer | (Alvarez-Gil et al., 2007; Lau & Wang, 2009) |
| D35. Corporate citizenship pressure | Firms are under pressure to behave in a socially responsible manner, by meeting legal, ethical and economic responsibilities placed on them. | External | Society, Media | (Abdullah et al., 2012; Akdoğan & Coşkun, 2012; Chan & Chan, 2008; Hsu et al., 2013; Jayaraman & Luo, 2007; Mohammed Najeeb Shaik & Abdul-Kader, 2014; Van Der Wiel et al., 2012)<br>(Aitken & Harrison, 2013; Chan et al., 2012; Jindal & Sangwan, 2013; Mathiyazhagan & Haq, 2013; M. N. Shaik & Abdul-Kader, 2013) |
| D36. Increasing landfill | Illegal landfills became a major threat and RL is a solution to give a proper disposal to EOL products.<br>Scarcity of landfill. | External | Society | (Jindal & Sangwan, 2013; Kannan et al., 2014) |
| D37. Environmental conservations | Hazardous substances can be released from EOL products that are dangerous for the environment. | External | Society | (Kannan et al., 2014) |

From the 37 drivers, 23 were classified as internal to the organization, and 14 classified as external. Internal drivers are those factors that exist in the firm itself that promote the adoption of RL, whereas external drivers involve motivational factors from outside the companies that dispel the adoption of RL. We also classified the drivers according to the stakeholders involved, either as creating the motivational factor or, conversely, as being influenced by the driver.

This research also analyzed the popularity of RL drivers according to the number of times the driver appeared in the article portfolio. The result of this analysis is presented in Figure 14.

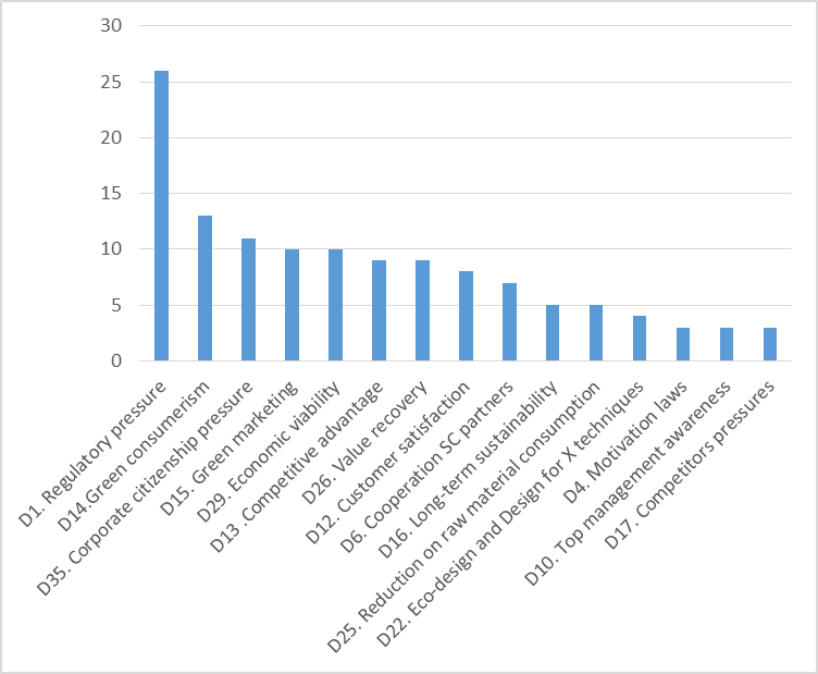


Figure 14 – Most widely used drivers according to appearance in previous literature.

Regulatory pressure for the adoption of environmental initiatives is by far the leading driver according to the studied papers; more than half of the articles cited this driver. The next most common motivational factor is green consumerism, which appeared in 13 papers and clearly demonstrates that customer pressure is a growing

concern for environmental protection among consumers. Corporate citizenship pressures, appearing 11 times, attained third place, which shows that companies are progressively under pressure to behave in a socially responsible manner.

### 5.4.3. RL Barriers

Although there might be environmental, social, and economic reasons to get involved in product return and recovery activities, at the same time, many barriers can withhold firms from implementing RL (KAPETANOPOULOU; TAGARAS, 2011; SRIVASTAVA, SAMIR K, 2013). From the literature, it emerges that RL is not a symmetric picture of forward distribution, as previously mentioned. Thus, an analysis of barriers hindering the successful implementation of RL is a crucial issue (SHARMA *et al.*, 2011).

The barriers can be both internal or external (SRIVASTAVA, SAMIR K, 2013). Internal barriers are the obstacles that exist in the firm itself that impede the adoption of environmental efforts, whereas external barriers involve hindrances from outside of companies that disrupt the adoption of green practices (HILLARY, 2004). Different authors have discussed the multiple barriers for RL implementation. Similar to the drivers' classification, Table 15 depicts each encountered barrier, its description, classification as internal or external, the stakeholders involved, and sources. The 36 selected barriers were classified into seven clusters, following the same approach used for the drivers' classification. The encountered clusters are:

- Technology and infrastructure related issues (T&I): this cluster includes information technology barriers, technical skills issues and barriers related to lack of infrastructure for RL development.
- Governance and supply chain process related issues (G&SC): this cluster refers to reverse SC barriers, co-operation issues and performance measurement.
- Economic related issues (E): this cluster includes financial and economic barriers related to RL.
- Knowledge related issues (K): this cluster refers to information flows and RL awareness in companies.

- Policy related issues (P): this cluster includes issues on regulations and laws concerning product take back and RL.
- Market and competitors related issues (M&C): this cluster includes competition advantage reasons and recovery market issues.
- Management related issues (M): this cluster includes issues such as managers' posture concerning RL and the relative importance of RL compared to other activities.

Table 15 – RL barriers, classification and sources.

| Barrier Name | Description | Internal/ External | Stakeholders Involved | Sources |
|---|---|---|---|---|
| **Cluster - Technology and infrastructure related issues (T&I)** | | | | |
| B1. Lack of personnel technical skills | There is a lack of skilled manpower and lack of capabilities to perform RL activities. | Internal | Employees, Organization | (Abdulrahman et al., 2014; Aitken & Harrison, 2013; Chan & Chan, 2008; Daily & Huang, 2001; González-Torre et al., 2010; Govindan, Kaliyan, et al., 2013; Hillary, 2004; Kapetanopoulou & Tagaras, 2011; Geneviève M Perron & Student, 2005; Ravi & Shankar, 2005; Rogers & Tibben-Lembke, 2001; Sarkis et al., 2010; Shaharudin et al., 2014; Sharma et al., 2011; Škapa, 2011; Starostka-Patyk et al., 2013; Van Der Wiel et al., 2012; Walker et al., 2008; Wang & Sun, 2005; Yusuf & Raouf, 2013) |
| B2. Lack of IT systems standards | IT connectivity issues, including: lack of information and technological systems, incompatibility of IT systems and inadequate information technology support. | Internal | Organization | (Abdulrahman et al., 2014; Aitken & Harrison, 2013; Bernon et al., 2013; Chan & Chan, 2008; González-Torre et al., 2010; Janse et al., 2010; Ravi & Shankar, 2005; Rogers et al., 1999; Sharma et al., 2011; Škapa, 2011; Starostka-Patyk et al., 2013; Wang & Sun, 2005; Yusuf & Raouf, 2013) |
| B3. Lack of latest technologies | Lack of latest available technologies for performing product/material recycling. | External | Organization | (Abdulrahman et al., 2014; Chan et al., 2012; Lau & Wang, 2009; Shaharudin et al., 2014; Samir K Srivastava, 2013) |
| B4. Lack of in-house facilities | Deficient industrial infrastructure.<br>Lack of infrastructure such as storage, handling equipment and vehicles for the movement of EOL products. | Internal | Organization | (Abdulrahman et al., 2014; González-Torre et al., 2010; Shaharudin et al., 2014) |
| B5. Technology and the R&D issues related to product recovery | There is a complexity of design to reuse/recycle used products and manufacturers resist improving design for EOL recovery. Recycling technologies or design for 'X' techniques are mostly not in practice, especially in developing countries. | Internal | Organization | (Andiç et al., 2012; Beamon, 1999; Govindan, Kaliyan, et al., 2013; Rahimifard et al., 2009; Shaharudin et al., 2014) |
| B6. Complexity in operation | There is more uncertainty and complexity in RL system than in forward SC because the recovery processes and options of RL system are complicated and vary in view of life cycles and characteristics of products, resources required, and capacity of facilities. | Internal/ External | Organization | (Kapetanopoulou & Tagaras, 2011; Wang & Sun, 2005) |
| **Cluster – Governance and supply chain process related issues (G&SC)** | | | | |
| B7. Difficulties with supply chain members | Poor coordination and support in the supply chain for the implementation and management of RL, such as lack of supplier commitment; lack of the retailers' willingness to share costing information; reluctance of the support of the dealers, distributors, and retailers towards the RL activities. | External | Suppliers, Customer | (Abdulrahman et al., 2014; Bernon et al., 2013; González-Torre et al., 2010; Mangla et al., 2012; Ravi & Shankar, 2005; Sharma et al., 2011; Starostka-Patyk et al., 2013; Walker et al., 2008; Wang & Sun, 2005) |
| B8. Limited forecasting and planning | Many companies experience difficulties in forecasting and planning the reverse chain due to the degree of diversity of goods and flows.<br>Unpredictability of supply or demand for recycled products (stochastic return and demand).<br>Unpredictability of the mix of returned products (variable product mix). | Internal | Customer, Organization | (Abdulrahman et al., 2014; Abraham, 2011; Chan et al., 2012; Janse et al., 2010; Lau & Wang, 2009; Shaharudin et al., 2014; Sharma et al., 2011; Samir K Srivastava, 2013; Starostka-Patyk et al., 2013; Yusuf & Raouf, 2013) |
| B9. Inconsistent quality | The product quality is not uniform in RL compared to the forward logistics where the product quality is uniform. | External | Organization | (Abraham, 2011; Ravi & Shankar, 2005; Shaharudin et al., 2014; Sharma et al., 2011; Yusuf & Raouf, 2013) |
| B10. Complexity for finding third party for RL | Identifying third parties to recollect used products not easy for industries.<br>Missing consultancy for the field of reverse flows. | External | Organization | (Govindan, Kaliyan, et al., 2013; Shaharudin et al., 2014; Škapa, 2011) |
| B11. Lack of appropriate performance management system | Lack of appropriate performance metrics and a performance management system for RL. | Internal | Organization | (Abdulrahman et al., 2014; Janse et al., 2010; Ravi & Shankar, 2005; Shaharudin et al., 2014; Sharma et al., 2011; Starostka-Patyk et al., 2013; Yusuf & Raouf, 2013) |

| | | | | |
|---|---|---|---|---|
| B12. Inappropriate organizational co-operation | Lack of inter-departmental co-operation in communication, causing restrictions in information flow across organization hierarchy. | Internal | Organization | (González-Torre et al., 2010; Govindan, Kaliyan, et al., 2013; Ravi & Shankar, 2005; Shaharudin et al., 2014) |
| **Cluster - Economic related issues (E)** | | | | |
| B13. Lack of initial capital | Companies require allocation of funds and other resources for the implementation of RL.<br>High cost of the process of environmental adaptation (new machinery, certification).<br>Making an investment or undergoing a restructuring process generates high set-up and operating cost. | Internal | Organization | (Abdulrahman et al., 2014; AlKhidir & Zailani, 2009; Andiç et al., 2012; Carter & Ellram, 1998; Chan & Chan, 2008; González-Torre et al., 2010; Govindan, Kaliyan, et al., 2013; Hervani et al., 2005; Lau & Wang, 2009; Mangla et al., 2012; Mudgal et al., 2010; Ravi & Shankar, 2005; Rogers & Tibben-Lembke, 2001; Sharma et al., 2011; Škapa, 2011; Starostka-Patyk et al., 2013; Van Der Wiel et al., 2012; Wang & Sun, 2005; Yusuf & Raouf, 2013) |
| B14. Funds for training | Lack of funding for training human resources for RL operations. | Internal | Organization | (Abdulrahman et al., 2014) |
| B15. Return monitoring system/storage and handling | Lack of financial support for investments in return monitoring systems, storage and handling operations. Investing in product recovery activities is not justifiable in economic terms. | Internal | Organization | (Abdulrahman et al., 2014; Kapetanopoulou & Tagaras, 2011) |
| B16. Financial burden of tax | Complex flows of goods as well as the diverse bought-in services engrained in the reverse chain create a high degree of tax complexity and lead to unexpected tax exposures and costs. | Internal | Organization | (Abdulrahman et al., 2014; Lau & Wang, 2009; Sharma et al., 2011; Starostka-Patyk et al., 2013) |
| B17. Uncertainty related to economic issues | There is a claim for profit from shareholders and the establishment of product recovery activities constitutes a highly uncertain investment, which is hard to see the economic benefits. | Internal | Organization | (Alvarez-Gil et al., 2007; González-Torre et al., 2010; Kapetanopoulou & Tagaras, 2011; Shaharudin et al., 2014; Starostka-Patyk et al., 2013) |
| B18. Lack of economy of scale | Compared to forward flows, RL might be uncertain regarding the volume of returned products, creating a difficulty on attaining economy of scale. | Internal | Organization | (Starostka-Patyk et al., 2013) |
| **Cluster – Knowledge related issues (K)** | | | | |
| B19. Lack of knowledge on RL practices | Difficulty in obtaining information about the best practices in RL. | Internal | Organization | (Abdulrahman et al., 2014; Samir K Srivastava, 2013) |
| B20. Lack of information on take back channels | No proper dissemination of information regarding take back channels available for customers to return their products. | External | Organization | (Abdulrahman et al., 2014; Govindan, Kaliyan, et al., 2013; Shen & Tam, 2002) |
| B21. Lack of awareness concerning RL and its benefits | Lack of publicity and knowledge of RL.<br>Lack of awareness regarding the benefits of RL and EOL product return. | Internal | Organization, Employees | (Abdulrahman et al., 2014; Aitken & Harrison, 2013; Shaharudin et al., 2014) |
| B22. Lack of taxation knowledge on returned products | Companies can face a cost burden due to unawareness of customs procedures and planning, cash flow risks, and funding for value-added tax (VAT) payments. | Internal | Organization, Employees | (González-Torre et al., 2010; Govindan, Kaliyan, et al., 2013; Lau & Wang, 2009; Meade et al., 2007; Mudgal et al., 2010; Rahimifard et al., 2009; Ravi & Shankar, 2005; Rogers & Tibben-Lembke, 2001; Sharma et al., 2011; Starostka-Patyk et al., 2013; Van Der Wiel et al., 2012; Yusuf & Raouf, 2013) |
| B23. Lack environmental regulations awareness | Lack of awareness of environmental legislation and ignorant of environmental impact on the organization's activities and benefits of adopting RL. | Internal | Organization, Employees | (Janse et al., 2010) |
| **Cluster – Policy related issues (P)** | | | | |
| B24. Lack of specific laws | Lack of supportive policies: a lack of legislation or appropriate laws is seen as a major barrier for companies to be involved in EOL returns. | External | Government | (Abdulrahman et al., 2014; Carter & Ellram, 1998; Chan & Chan, 2008; Krikke et al., 2013; Lau & Wang, 2009; Mangla et al., 2012; Shaharudin et al., 2014; Sharma et al., 2011; Starostka-Patyk et al., 2013; Walker et al., 2008) |
| B25. Lack of waste management practices | In many countries, waste management practices are not implemented due to a lack of clear return policies or not fully regulated waste management. | External | Government | (Abdulrahman et al., 2014; Janse et al., 2010; Starostka-Patyk et al., 2013) |
| B26. Lack of inter-ministerial communication | Lack of inter-ministerial communication could provide conflicting laws. | External | Government | (Abdulrahman et al., 2014) |

| | | | | |
|---|---|---|---|---|
| B27. Lack of motivation laws | Lack of regulations or directives to motivate manufacturers' to perform RL and maintain a green environment and also motivate customers to buy green products | External | Government | (Abdulrahman et al., 2014; AlKhidir & Zailani, 2009; Govindan, Kaliyan, et al., 2013; Geneviève M Perron & Student, 2005; Shaharudin et al., 2014; Samir K Srivastava, 2013; Zhu et al., 2012) |
| B28. Misuse of environmental regulations | Some environmental laws are not well implemented, for example non-deterrent penal sanctions and loop holes in WEEE regulations. | External | Government | (Abdulrahman et al., 2014; Andiç et al., 2012; González-Torre et al., 2010) |
| B29. Difficulties in extended producer responsibility across countries | Complexity created by the globalization of the supply chains, hindering the implementation of the extended producer responsibility. | External | Government | (Abdulrahman et al., 2014) |
| B30. Company polices against RL | Companies do not want to see their "junk" cannibalizing their first quality or "A" channel, so they often develop policies that make it very difficult to handle returns efficiently. | Internal | Organization | (Abdulrahman et al., 2014; Aitken & Harrison, 2013; Chan & Chan, 2008; Ravi & Shankar, 2005; Rogers et al., 1999; Sharma et al., 2011; Škapa, 2011; Starostka-Patyk et al., 2013) |
| **Cluster - Market and competitors related issues (M&C)** | | | | |
| B31. Perception of a poorer quality product | Customers might think recovered products or the use of recycled material as a lower quality standard. | External | Customer | (Carter & Ellram, 1998; González-Torre et al., 2010; Rahimifard et al., 2009; Shaharudin et al., 2014) |
| B32. Undeveloped recovery marketplaces | Difficulty on establishing end-of-life recycled material markets and on establishing remanufactured products markets. | External | Market/ Competitors | (Abraham, 2011; Rahimifard et al., 2009; Shaharudin et al., 2014; Starostka-Patyk et al., 2013) |
| B33. Little recognition of competitive advantage | Little recognition of RL as a factor in creating competitive advantage | Internal | Organization | (Abdulrahman et al., 2014; Janse et al., 2010; Rogers et al., 1999; Shaharudin et al., 2014; Škapa, 2011) |
| **Cluster - Management related issues** | | | | |
| B34. Low importance of RL relative to other issues | Product recovery activities are perceived as inconsistent with the company's main operations (extremely low priority compared to other activities). | Internal | Organization | (Abdulrahman et al., 2014; Chan & Chan, 2008; Kapetanopoulou & Tagaras, 2011; Rogers et al., 1999; Shaharudin et al., 2014; Škapa, 2011; Walker et al., 2008; Wang & Sun, 2005) |
| B35. Low involvement of top management and strategic planning | Resistance of top management to change to RL due to organizational culture. Resistance to change existing investments, information systems and habits.<br>Lack of strategic planning and structure for RL. | Internal | Organization | (Abdulrahman et al., 2014; Bernon et al., 2013; González-Torre et al., 2010; Govindan, Kaliyan, et al., 2013; Hillary, 2004; Lin & Ho, 2008; Genevieve M Perron et al., 2006; Ravi & Shankar, 2005; Rogers et al., 1999; Rogers & Tibben-Lembke, 2001; Sarkis et al., 2010; Shaharudin et al., 2014; Sharma et al., 2011; Škapa, 2011; Starostka-Patyk et al., 2013; Van Der Wiel et al., 2012; Walker et al., 2008; Yusuf & Raouf, 2013; Zhu et al., 2007) |
| B36. Limited approval of disposal licenses | A system does not allow one company to hold several products' disposal permissions simultaneously. | Internal | Organization | (Andiç et al., 2012) |

From the 36 barriers, 23 were classified as internal to the organization, and 14 classified as external (one barrier was sorted as both internal and external). As well as the analysis performed for the drivers, we analyzed the popularity of RL barriers according to the number of times the obstacle appeared in the article portfolio. The result of this analysis is presented in Figure 15.

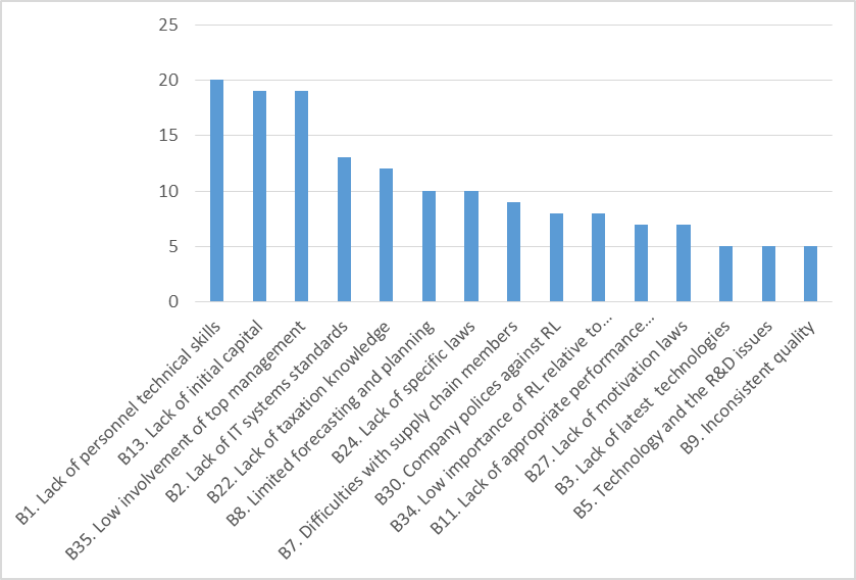


Figure 15 – Most widely used barriers according to appearance in previous literature.

The lack of personnel technical skills appears as the leading barrier according to the number of times this impediment is stated in the literature. Many authors (KAPETANOPOULOU; TAGARAS, 2011; ŠKAPA, 2011; AITKEN; HARRISON, 2013; ABDULRAHMAN; GUNASEKARAN; SUBRAMANIAN, 2014) have recognized personnel resources issues, such as lack of training and poor level of technical knowledge. The lack of initial capital and low involvement of top management barriers come next, cited by 19 articles each. The lack of IT systems standards barrier occupies fourth place, followed by the lack of taxation knowledge on returned products.

### 5.4.4.Towards a RL multi-perspective framework

Pressures from stakeholders are considered one of the most important determinants influencing a firm's environmental initiative (KIM; LEE, 2012). In this sense, we know very little about how a firm deals with the factors affecting its return operations when considering multiple stakeholders' perspectives, where the same variables may be interpreted differently. Orienting toward the many interests of stakeholders is central to strategic planning, and failure to address the interests of multiple stakeholders may harm company performance (AVKIRAN; MORITA, 2010).

A primary motivation for the construction of this framework is to show the interactions among different perceptions from the multiple RL stakeholders on a common set of drivers and barriers. To do so, we focus on the definitive stakeholders for RL implementation. According to the already discussed classification of stakeholders based on power, legitimacy, and urgency, the definitive stakeholders for RL implementation are: government, society, and customers. The chosen stakeholders are in line with the suggestion from Fineman and Clarke (1996) for the "green stakeholders."

From the regulatory perspective, government can have a huge impact on companies' strategic decisions by providing regulatory schemes (KIM; LEE, 2012). Businesses must comply with return and environmental regulations and policies to avoid regulators' legal actions (SARKIS; GONZALEZ-TORRE; ADENSO-DIAZ, 2010). Society and NGOs play a critical role in encouraging unethical firms to become more socially responsible organizations (KIM; LEE, 2012), mobilizing public opinion in favor of or against an organization's activities. Finally, some business customers often require their supply chain partners to follow the environmental standards that they have set for themselves (KIM; LEE, 2012), and these demands may include EOL strategies.

The perspectives of each definitive stakeholder are shown in the following tables (Table 16, Table 17, and Table 18) and the multiple perspective framework involving RL influential factors is presented in Figure 16. Information used to build the aforementioned tables was gathered from the massive literature compilation presented in Table 14 and Table 15.

Table 16 – Customers' perspective.

| **Drivers** | **Barriers** |
|---|---|
| D5. Qualification and support of business partners | B7. Difficulties with supply chain members |
| D6. Cooperation and integration with partners in the SC | B8. Limited forecasting and planning |
| D12. Customer satisfaction | B31. Perception of a poorer quality product |
| D14. Green consumerism / consumers environmental awareness | |
| D34. Higher public awareness | |

Table 17 – Governmental perspective.

| **Drivers** | **Barriers** |
|---|---|
| D1. Regulatory pressure for product return/recovery | B24. Lack of specific laws |
| D2. License to operate | B25. Lack of waste management practices |
| D4. Motivation laws | B26. Lack of inter-ministerial communication |
| | B27. Lack of motivation laws |
| | B28. Misuse of environmental regulations |
| | B29. Difficulties in extended producer responsibility across countries |

Table 18 – Societal perspective.

| **Drivers** | **Barriers** |
|---|---|
| D15. Green marketing | - |
| D34. Higher public awareness | |

| | |
|---|---|
| D35. Corporate citizenship pressure | |
| D36. Increasing landfill | |
| D37. Environmental conservations | |

Considering these external perspectives, Figure 16 presents the multiple perspectives of definitive stakeholders who exert pressures and place obstacles for RL development. Due to the huge number of barriers and drivers from the organizational perspective, for this framework, we considered only the most widely used drivers and barriers from the organizational point of view, extracted from Figure 14 and Figure 15.

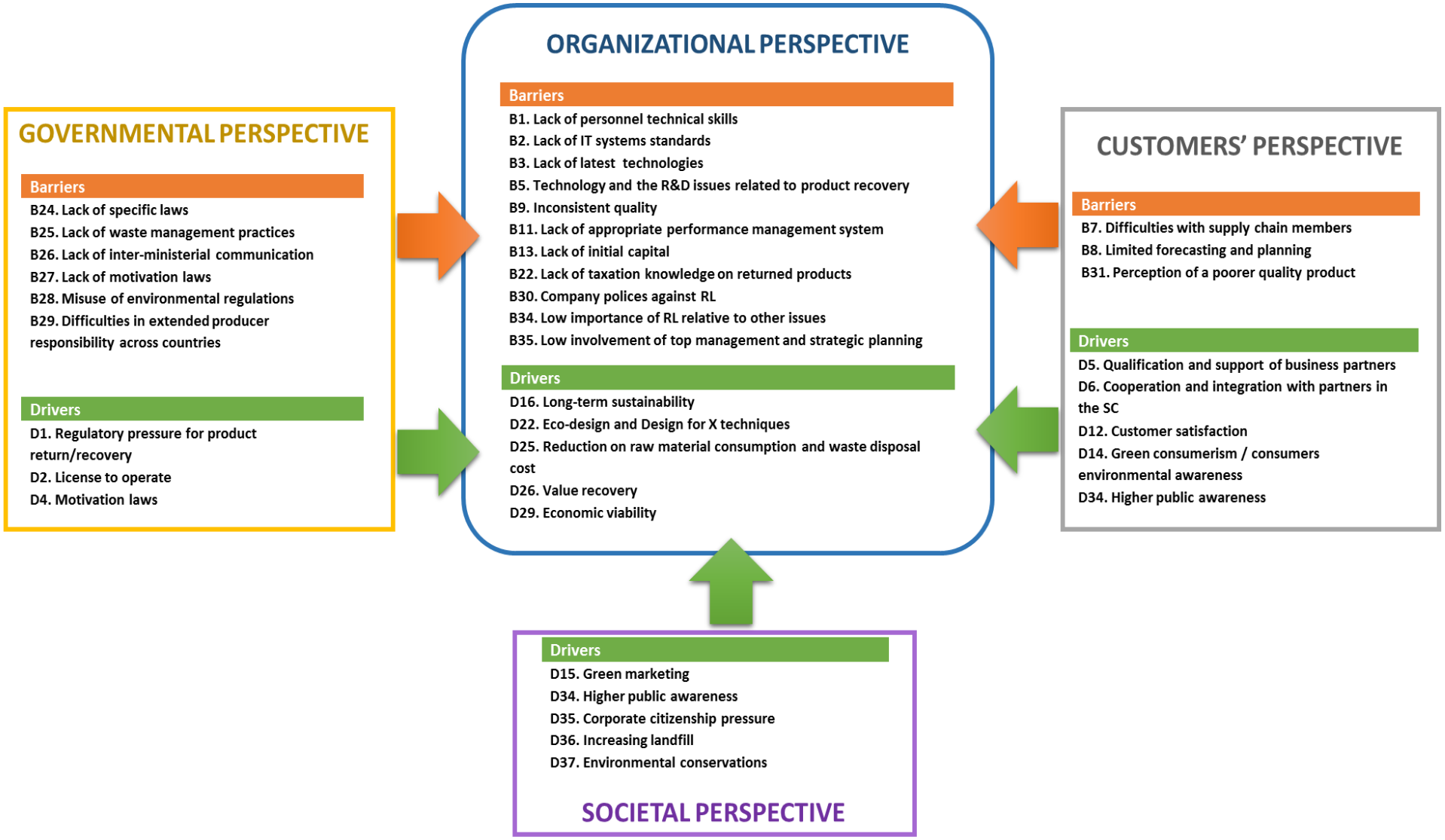


Figure 16 – Multi-perspective framework for RL drivers and barriers.

# 6. EVALUATION OF REVERSE LOGISTICS DRIVERS AND BARRIERS UNDER A MULTIPLE STAKEHOLDERS' PERSPECTIVE ANALYSIS

Along with Chapter 5, this Chapter is the core of this dissertation thesis, and presents further original data and analysis on the evaluation of RL influential factors in the Brazilian context. For this purpose, the Chapter is organized as follows: Section 6.1 shows the proposed structure for identifying and analyzing the causal drivers and causal barriers for RL implementation in Brazil. Then, the solution methodology (grey-DEMATEL) is depicted in Section 6.2, including research results. Finally, Section 6.3 discusses the research findings.

## 6.1. PROPOSED STRUCTURE FOR ANALYZING RL INFLUENTIAL FACTORS

As already thoroughly discussed in this work, more effort from industrial and academia is needed to analyze the factors influencing RL adoption in developing countries such as Brazil. To tackle this issue, a research structure is proposed, and it is validated through its application helped by various stakeholders' perspectives from Brazil. Influential factors (drivers and barriers) gathered from existing literature were selected and depicted in Chapter 5. These factors are evaluated using the grey-based DEMATEL method (to be further explained and justified). Figure 17 shows the proposed structure.

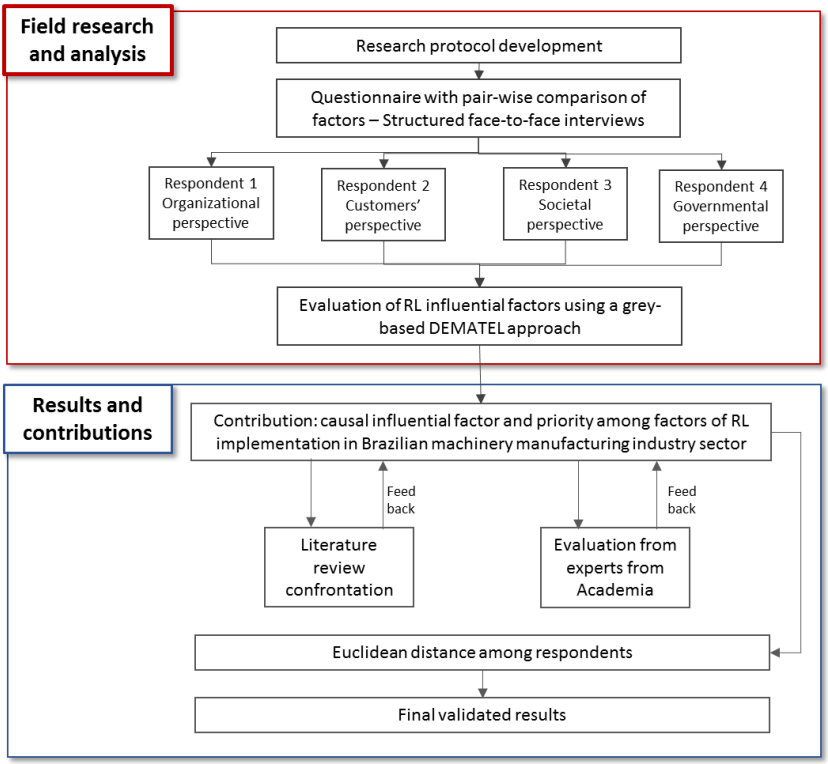


Figure 17 – Proposed research structure for grey-based DEMATEL approach.

The research structure begins with field research and data analysis. In this phase, the relationship between influential factors from Table 14 and Table 15 is analyzed from the perspectives of the organization, customers, society, and government with the assistance of grey-based DEMATEL. A research protocol was developed including a questionnaire with pair-wise comparison of factors. From the replies, an initial direct relationship matrix is formed. In the sequence, grey-based DEMATEL steps take place to evaluate the causal factors to RL implementation in the Brazilian context. At last, results are then compared to prior publications and validated by academic experts. Field procedure details are presented in the sequence.

## 6.2. SOLUTION METHODOLOGY – GREY-BASED DEMATEL

### 6.2.1. Grey system theory approach

Ju-Long (1982) first proposed the mathematical theory called a "grey" theory from a grey set. The grey number is a number with an unknown position within a clear boundary with upper and lower limits. In this sense, there are a set of candidate numbers within that boundary, and this is called a grey set (YANG; JOHN, 2003). A grey number denotes the assortment of the possible variance of the underlying number; hence, it infers that there is uncertainty surrounding the number itself.

The use of a grey system can bring satisfactory outcomes even with incomplete and relatively limited data or with great variability in factors (LI; TAN; LEE, 1997). The major advantage of the grey system over other systems is that it can generate possible outcomes with a small amount of data (XIA; GOVINDAN; ZHU, 2014). The application scope of the grey system theory has extended to industry, social affairs, agriculture, economy, energy, water conservancy, ecology, environment, and other fields, and it has resolved a great number of practical problems in production, life sciences, and scientific research successfully (NAIMING XIE; DR CHUANMIN MI; HUANG, 2014). In recent years, grey system theory has been an effective methodology that deals with uncertain and indeterminate problems (BAI; SARKIS, 2013).

Some general notation and operations for grey systems used in this research are hereby presented. A grey number $\otimes x$ is defined as an interval with known upper and lower bounds but unknown distribution information for x (DENG, 1989). That means:

$$\otimes x = [\underline{\otimes} x; \overline{\otimes} x] = [x' \in x | \underline{\otimes} x \leq x' \leq \overline{\otimes} x]$$

where $\underline{\otimes} x$ and $\overline{\otimes} x$ are the lower and upper bounds of $\otimes x$, respectively.

The basic grey number mathematical operations are represented by the following relationships (BAI; SARKIS, 2013):

$$\otimes x_1 + \otimes x_2 = \underline{x}_1 + \underline{x}_2, \overline{x}_1 + \overline{x}_2$$
(Eq. 1)

$$\otimes x_1 - \otimes x_2 = \underline{x}_1 - \overline{x}_2, \overline{x}_1 - \underline{x}_2$$
(Eq. 2)

$$\otimes x_1 \times \otimes x_2 = [\min(\underline{x}_1\underline{x}_2, \underline{x}_1\overline{x}_2, \overline{x}_1\underline{x}_2, \overline{x}_1\overline{x}_2), \max(\underline{x}_1\underline{x}_2, \underline{x}_1\overline{x}_2, \overline{x}_1\underline{x}_2, \overline{x}_1\overline{x}_2)]$$
(Eq. 3)

$$\otimes x_1 \div \otimes x_2 = [\underline{x}_1, \overline{x}_1] \times \left[\frac{1}{\underline{x}_2}, \frac{1}{\overline{x}_2}\right]$$
(Eq. 4)

For the present study, let us define $\otimes x_{ij}^k$ as the grey number for an evaluator k who evaluates the influence of factor i on factor j. Additionally, $\underline{\otimes} x_{ij}^k$ and $\overline{\otimes} x_{ij}^k$ are respectively the lower and upper grey values by the evaluator k for the relationship between factors i and j.

That is: $\otimes x_{ij}^k = [\underline{\otimes} x_{ij}^k, \overline{\otimes} x_{ij}^k]$

The grey numbers can be converted into crisp numbers by using the modified-CFCS method, which involves a three-step procedure as described in Zhu; Sarkis and Geng (2011):

(i) Normalization

$$\underline{\otimes} \overline{x}_{ij}^k = \left(\underline{\otimes} x_{ij}^k - \min_j \underline{\otimes} x_{ij}^k\right) / \Delta_{min}^{max} \quad \text{(Eq. 5)}$$

$$\overline{\otimes} \overline{x}_{ij}^k = \left(\overline{\otimes} x_{ij}^k - \min_j \overline{\otimes} x_{ij}^k\right) / \Delta_{min}^{max} \quad \text{(Eq. 6)}$$

Where

$$\Delta_{min}^{max} = \max_j \overline{\otimes} x_{ij}^k - \min_j \underline{\otimes} x_{ij}^k$$
(Eq. 7)

(ii) Determination of a total normalized crisp value

$$Y_{ij}^{k} = \frac{\underline{\otimes} \overline{x}_{ij}^{k} - \left(1 - \underline{\otimes} \overline{x}_{ij}^{k}\right) + \overline{\otimes} \overline{x}_{ij}^{k} \times \overline{\otimes} \overline{x}_{ij}^{k}}{1 - \underline{\otimes} \overline{x}_{ij}^{k} + \overline{\otimes} \overline{x}_{ij}^{k}}$$

(Eq. 8)

(iii) Computation of final crisp values

$$z_{ij}^{k} = \min_{j} \underline{\otimes} \, x_{ij}^{k} + Y_{ij}^{k} \Delta_{min}^{max}$$

(Eq. 9)

### 6.2.2. Grey-based DEMATEL steps

Grey-based DEMATEL has been used to evaluate drivers and barriers for RL implementation amongst four entities from the multi-perspective framework. The grey-based DEMATEL method comprises the following major stages and steps (adapted from Zhu; Sarkis and Geng (2011) and Xia; Govindan and Zhu (2014)).

Stage 1

Develop a crisp direct-relation matrix for each stakeholder. This first stage in the process is divided into three steps:

*Step 1a*: Define a comparison scale for the variables representing grey pair-wise influence. For this research, a 5-level scale was used with the following scale items: 0 - no influence, 1 - very low influence, 2 - low influence, 3 - high influence, and 4 - very high influence. The grey scales for these linguistic values are defined in Table 19.

Table 19 – The grey linguistic scale for the respondents' evaluation. Adopted from Xia; Govindan and Zhu (2014).

| **Linguistic terms** | **Grey numbers** | **Normal values** |
|---|---|---|
| No influence (N) | [0, 0] | 0 |
| Very low influence (VL) | [0, 0.25] | 1 |
| Low influence (L) | [0.25, 0.5] | 2 |
| High influence (H) | [0.5, 0.75] | 3 |
| Very high influence (VH) | [0.75, 1] | 4 |

*Step 1b*: Create the grey direct-relation matrix X from evaluators' answers. In order to measure the relationship between the criteria $c = \{c_i | i = 1, 2, \ldots, n\}$, a group of decision makers *k* from the key stakeholders from the research framework were asked to develop sets of pair-wise comparisons in linguistic terms for the selected RL drivers and barriers, separately. This means that each of the respondents should introduce the grey pair-wise influence relationships ($\otimes x_{ij}^{k}$ ) between the drivers and barriers in separated matrices. That is, $X^{d}$ represents the drivers matrix (17 x 17) and $X^{b}$ represents the barriers matrix (20 x 20). Hence, $\otimes x_{ij}^{dk}$ represents the grey number for the driver analysis from an evaluator *k* who evaluates the influence of driver *i* on driver *j* and $\otimes x_{ij}^{bk}$ represents the grey number for the barrier analysis from an evaluator *k* who evaluates the influence of barrier *i* on barrier *j*. All the principal diagonal elements are initially equaled to a crisp value of zero (0 - no influence). Two pair-wise influence matrices are answered by the respondents, one corresponding to the drivers comparison and the other concerning the barriers. As already described, four respondents were consulted, each representing one stakeholder. Hence, eight grey matrices ($X^{d1}$; $X^{d2}$; $X^{d3}$; $X^{d4}$ and $X^{b1}$; $X^{b2}$; $X^{b3}$; $X^{b4}$), each corresponding to a respondent on either driver or barrier and with grey numbers as its elements, were obtained. The grey matrices $X^{dk}$ and $X^{bk}$ are called the initial direct-relation grey matrices. For simplicity, denote $X^{k}$ (either for drivers or barriers) as:

$$X^{k} = \begin{matrix} c_1 \\ c_2 \\ \vdots \\ c_n \end{matrix} \begin{bmatrix} [0,0] & \otimes x_{12}^{k} & \cdots & \otimes x_{1n}^{k} \\ \otimes x_{21}^{k} & [0,0] & \cdots & \otimes x_{2n}^{k} \\ \vdots & \vdots & \ddots & \vdots \\ \otimes x_{n1}^{k} & \otimes x_{n2}^{k} & \cdots & [0,0] \end{bmatrix}$$

An example of a specific pair-wise influence question posed to respondents would be "How much influence does 'License to operate' (D2) have on 'Motivation laws' (D4)?" The direct-relation matrix for RL drivers for respondent k=1 from organizational perspective ($X^{d1}$) is shown in

Table 20, with the corresponding normal values obtained from Table 19.

Table 20 – Direct-relation matrix for RL drivers for respondent k=1 from organizational perspective ($X^{d1}$).

| Drivers | D1 | D2 | D4 | D5 | D6 | D12 | D14 | D15 | D16 | D22 | D25 | D26 | D29 | D34 | D35 | D36 | D37 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| D1. Regulatory pressure for product return/recovery | 0 | 4 | 4 | 0 | 1 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 1 | 0 | 1 | 2 |
| D2. License to operate | 4 | 0 | 4 | 4 | 3 | 0 | 0 | 0 | 1 | 0 | 1 | 0 | 0 | 1 | 2 | 3 | 3 |
| D4. Motivation laws | 4 | 4 | 0 | 3 | 4 | 1 | 0 | 0 | 2 | 0 | 2 | 4 | 4 | 2 | 3 | 4 | 3 |
| D5. Qualification and support of business partners | 0 | 0 | 0 | 0 | 4 | 4 | 3 | 3 | 3 | 4 | 4 | 3 | 3 | 1 | 0 | 2 | 4 |
| D6. Cooperation and integration with partners in the SC | 2 | 2 | 2 | 3 | 0 | 3 | 3 | 3 | 4 | 2 | 3 | 4 | 3 | 3 | 3 | 3 | 4 |
| D12. Customer satisfaction | 0 | 0 | 0 | 3 | 4 | 0 | 4 | 4 | 4 | 4 | 3 | 3 | 3 | 3 | 4 | 3 | 3 |
| D14. Green consumerism / consumers environmental awareness | 1 | 0 | 1 | 3 | 4 | 4 | 0 | 4 | 3 | 4 | 3 | 3 | 3 | 4 | 4 | 2 | 4 |
| D15. Green marketing | 0 | 0 | 0 | 3 | 3 | 4 | 4 | 0 | 3 | 4 | 2 | 2 | 2 | 4 | 4 | 2 | 4 |
| D16. Long-term sustainability | 2 | 2 | 2 | 3 | 3 | 3 | 3 | 3 | 0 | 3 | 4 | 4 | 4 | 2 | 3 | 4 | 4 |
| D22. Eco-design and Design for X techniques | 0 | 0 | 0 | 4 | 4 | 4 | 4 | 4 | 3 | 0 | 4 | 3 | 3 | 3 | 3 | 3 | 4 |
| D25. Reduction on raw material consumption and waste disposal cost | 0 | 0 | 0 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 0 | 4 | 4 | 2 | 2 | 4 | 4 |
| D26. Value recovery | 0 | 0 | 3 | 4 | 3 | 4 | 1 | 1 | 4 | 3 | 4 | 0 | 4 | 2 | 1 | 3 | 1 |
| D29. Economic viability | 0 | 0 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 3 | 4 | 0 | 2 | 0 | 1 | 0 |
| D34. Higher public awareness | 0 | 0 | 0 | 0 | 1 | 4 | 4 | 4 | 2 | 3 | 0 | 1 | 1 | 0 | 4 | 0 | 4 |
| D35. Corporate citizenship pressure | 3 | 0 | 3 | 1 | 1 | 3 | 3 | 3 | 2 | 4 | 0 | 0 | 1 | 3 | 0 | 0 | 4 |
| D36. Increasing landfill | 3 | 4 | 3 | 1 | 2 | 1 | 3 | 3 | 3 | 3 | 4 | 2 | 3 | 1 | 3 | 0 | 4 |
| D37. Environmental conservations | 4 | 4 | 4 | 3 | 3 | 3 | 4 | 3 | 2 | 4 | 3 | 2 | 2 | 4 | 3 | 4 | 0 |

Note: 0 – no influence; 1 – very low influence; 2 – low influence; 3 – high influence; 4 – very high influence.

*Step 1c*: Transform the grey direct-relation matrices $X^{dk}$ and $X^{bk}$ into the crisp matrices $Z^{dk}$ and $Z^{bk}$ using the modified-CFCS process as already described in Section 6.2.1 (Equations 5-9). The process needs to be completed for each of the respondents' direct-relation matrices.

Stage 2

On the basis of the crisp direct-relation matrices $Z^{dk}$ and $Z^{bk}$, the normalized direct-relation matrices $N^{dk}$ and $N^{bk}$ can be obtained through expressions:

$$s = \frac{1}{\max\limits_{1 \le i \le n} \sum_{j=1}^{n} z_{ij}}, \; i, j = 1,2, \dots, n. \qquad \text{(Eq. 10)}$$

$$N = s.Z \qquad \text{(Eq. 11)}$$

Stage 3

In this stage, a total relation matrix T needs to be set up. The normalized matrices (for each stakeholder for drivers and barriers) are processed by the following formula in which I denotes the identity matrix.

$$T = N(N - I)^{-1} \qquad \text{(Eq. 12)}$$

The total relation matrix for drivers obtained from answers of respondent k=1 (organizational perspective) $T^{d1}$ is shown in

Table 21. The remaining total relation matrices ($T^{d2}$, $T^{d3}$, $T^{d4}$, $T^{b1}$, $T^{b2}$, $T^{b3}$ and $T^{b4}$) are depicted in Tables G1 to G7 in Appendix G.

Table 21 – Total relation matrix for drivers from respondent k=1 (organizational perspective) - $T^{d1}$.

| Drivers | D1 | D2 | D4 | D5 | D6 | D12 | D14 | D15 | D16 | D22 | D25 | D26 | D29 | D34 | D35 | D36 | D37 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **D1** | 0.0407 | 0.1095 | 0.1189 | 0.06 | 0.0839 | 0.058 | 0.0565 | 0.0546 | 0.0767 | 0.0577 | 0.0545 | 0.0538 | 0.0547 | 0.0701 | 0.0558 | 0.0761 | 0.1073 |
| **D2** | 0.1391 | 0.0611 | 0.1523 | 0.1799 | 0.1766 | 0.1181 | 0.1157 | 0.1123 | 0.134 | 0.1198 | 0.1249 | 0.1041 | 0.1062 | 0.1174 | 0.137 | 0.1578 | 0.19 |
| **D4** | 0.1658 | 0.1554 | 0.1238 | 0.2278 | 0.2631 | 0.2078 | 0.184 | 0.1794 | 0.2214 | 0.1921 | 0.2045 | 0.2339 | 0.237 | 0.1908 | 0.209 | 0.2303 | 0.2584 |
| **D5** | 0.0891 | 0.0781 | 0.1201 | 0.2019 | 0.2943 | 0.2997 | 0.2761 | 0.2706 | 0.2701 | 0.3008 | 0.2709 | 0.247 | 0.249 | 0.2029 | 0.186 | 0.2185 | 0.3055 |
| **D6** | 0.1442 | 0.1296 | 0.1782 | 0.2747 | 0.2437 | 0.3025 | 0.2944 | 0.2885 | 0.3071 | 0.2872 | 0.2691 | 0.2797 | 0.2666 | 0.2567 | 0.2588 | 0.254 | 0.3334 |
| **D12** | 0.103 | 0.0867 | 0.1364 | 0.2763 | 0.3173 | 0.2563 | 0.3209 | 0.3152 | 0.3116 | 0.33 | 0.2729 | 0.2658 | 0.2696 | 0.2617 | 0.2809 | 0.2525 | 0.3205 |
| **D14** | 0.1236 | 0.0902 | 0.1575 | 0.28 | 0.322 | 0.3324 | 0.2534 | 0.3187 | 0.2983 | 0.3337 | 0.2748 | 0.2689 | 0.2725 | 0.2838 | 0.2852 | 0.2391 | 0.3425 |
| **D15** | 0.0943 | 0.0786 | 0.1229 | 0.2545 | 0.2772 | 0.3053 | 0.2997 | 0.2226 | 0.2711 | 0.3074 | 0.2338 | 0.2272 | 0.2308 | 0.262 | 0.2642 | 0.2161 | 0.3148 |
| **D16** | 0.1488 | 0.134 | 0.1855 | 0.2873 | 0.3118 | 0.3149 | 0.3071 | 0.3009 | 0.2483 | 0.3174 | 0.2988 | 0.2913 | 0.2955 | 0.2489 | 0.2676 | 0.2818 | 0.3456 |
| **D22** | 0.105 | 0.0894 | 0.1393 | 0.3004 | 0.3254 | 0.3353 | 0.3283 | 0.3222 | 0.3017 | 0.2662 | 0.2969 | 0.2725 | 0.2761 | 0.2672 | 0.2686 | 0.2592 | 0.3446 |
| **D25** | 0.1102 | 0.0953 | 0.1483 | 0.3139 | 0.3396 | 0.3479 | 0.3401 | 0.3337 | 0.3323 | 0.3505 | 0.2401 | 0.3027 | 0.3064 | 0.2593 | 0.2605 | 0.2886 | 0.3564 |
| **D26** | 0.0878 | 0.0774 | 0.1701 | 0.2652 | 0.2691 | 0.2887 | 0.2299 | 0.2255 | 0.2797 | 0.272 | 0.2631 | 0.1875 | 0.2617 | 0.2087 | 0.1937 | 0.2289 | 0.2445 |
| **D29** | 0.0936 | 0.0814 | 0.195 | 0.2868 | 0.31 | 0.3139 | 0.3024 | 0.2979 | 0.3013 | 0.3114 | 0.2653 | 0.2793 | 0.2096 | 0.2304 | 0.198 | 0.2119 | 0.2519 |
| **D34** | 0.067 | 0.0539 | 0.0859 | 0.1409 | 0.174 | 0.2351 | 0.2319 | 0.2276 | 0.1864 | 0.2201 | 0.136 | 0.149 | 0.1519 | 0.1371 | 0.2107 | 0.1253 | 0.2417 |
| **D35** | 0.1266 | 0.0641 | 0.1451 | 0.1614 | 0.1794 | 0.2175 | 0.2139 | 0.2095 | 0.1885 | 0.2353 | 0.1389 | 0.1362 | 0.1557 | 0.1925 | 0.1395 | 0.1313 | 0.2467 |
| **D36** | 0.1572 | 0.1608 | 0.1864 | 0.2189 | 0.2565 | 0.2372 | 0.2657 | 0.2602 | 0.2626 | 0.2736 | 0.2617 | 0.2215 | 0.2423 | 0.2002 | 0.2369 | 0.1809 | 0.3069 |
| **D37** | 0.1895 | 0.1743 | 0.2214 | 0.2838 | 0.3104 | 0.31 | 0.3203 | 0.2975 | 0.2812 | 0.3286 | 0.2759 | 0.252 | 0.2564 | 0.2836 | 0.2712 | 0.2808 | 0.2785 |

Stage 4

Determine row ($R_i$) and column ($D_j$) sums for each row *i* and column *j* from the total relation matrix (T). This should be calculated through equations:

$$R_i = \sum_{j=1}^{n} t_{ij} \ \forall i \quad \text{(Eq. 13)}$$

$$D_j = \sum_{i=1}^{n} t_{ij} \ \forall j \quad \text{(Eq. 14)}$$

The row values $R_i$ represent the overall direct and indirect effect of a factor *i* on other factor, while the column values $D_j$ stand for the overall direct and indirect effects of all the factors on factor *j*. We have separately determined these results for each of the four stakeholders on RL drivers first and then on RL barriers.

Stage 5

Determine the overall importance or prominence ($P_i$) of factor *i* and net effect ($E_i$) of factor *i* using the following expressions:

$$P_i = \{R_i + D_j | i = j\} \quad \text{(Eq. 15)}$$

$$E_i = \{R_i - D_j | i = j\} \quad \text{(Eq. 16)}$$

The larger the value of $P_i$, the greater the overall importance or influence of factor *i* in terms of overall relationships with other factors (ZHU; SARKIS; GENG, 2011). If $E_i > 0$, it means that factor *i* is a foundation or net cause for other factors. On the other hand, if $E_i < 0$, then factor *i* is net effect of other factors. These values are then used onto a two-dimensional axis for each factor.

Stage 6

Develop the overall DEMATEL prominence-causal graphs for aggregation of the four key RL stakeholders. This stage intends to obtain an overall cause-effect analysis of RL drivers and barriers considering an unique perspective based on all studied stakeholders. This stage can be separated into two steps.

*Step 6a*: Through a simple averaging method for the pair-comparison values from crisp direct-relationships, two direct-relation matrices were developed for all four stakeholders in aggregation: one for drivers and another one for barriers. In order to determine the aggregated overall structures (prominence and net cause) for the drivers and barriers, we used the same five DEMATEL stages above. The overall total-relation matrices $T^d$ (drivers) and $T^b$ (barriers) for the aggregation of the four stakeholders are shown in Table 22 and Table 23, respectively.

Table 22 – The overall total-relation matrix for RL drivers ($T^d$).

| Drivers | D1 | D2 | D4 | D5 | D6 | D12 | D14 | D15 | D16 | D22 | D25 | D26 | D29 | D34 | D35 | D36 | D37 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **D1** | 0.0684 | 0.1286 | 0.1549 | 0.1609 | 0.2139 | 0.1443 | 0.1549 | 0.185 | 0.1815 | 0.1912 | 0.1721 | 0.1663 | 0.171 | 0.1138 | 0.1202 | 0.0459 | 0.1256 |
| **D2** | 0.0918 | 0.0466 | 0.1028 | 0.1408 | 0.1503 | 0.1093 | 0.1015 | 0.1399 | 0.1427 | 0.14 | 0.1349 | 0.1286 | 0.1306 | 0.0816 | 0.0987 | 0.0473 | 0.1075 |
| **D4** | 0.1378 | 0.1254 | 0.0941 | 0.2069 | **0.2485** | 0.1735 | 0.1502 | 0.2002 | 0.2086 | 0.2143 | 0.1989 | 0.204 | **0.2408** | 0.1254 | 0.1256 | 0.068 | 0.1493 |
| **D5** | 0.0616 | 0.0542 | 0.0776 | 0.1255 | **0.2197** | 0.1749 | 0.1451 | 0.1857 | 0.1887 | **0.2146** | 0.2015 | 0.2068 | 0.2111 | 0.0965 | 0.1 | 0.0511 | 0.1336 |
| **D6** | 0.0914 | 0.0918 | 0.1209 | **0.2176** | 0.1904 | 0.2144 | 0.1782 | **0.2312** | **0.2428** | **0.2459** | **0.238** | **0.2483** | **0.2552** | 0.1502 | 0.1444 | 0.0661 | 0.1584 |
| **D12** | 0.0856 | 0.0606 | 0.0886 | 0.159 | 0.1953 | 0.1177 | 0.1474 | 0.1914 | 0.1858 | 0.2082 | 0.161 | 0.1548 | 0.1797 | 0.1167 | 0.1329 | 0.0542 | 0.1266 |
| **D14** | 0.1326 | 0.1114 | 0.152 | **0.222** | **0.2682** | 0.2126 | 0.1477 | **0.2637** | **0.2363** | **0.267** | **0.2361** | **0.2247** | **0.2482** | 0.1584 | 0.1639 | 0.069 | 0.1779 |
| **D15** | 0.0679 | 0.0694 | 0.096 | 0.1596 | 0.1891 | 0.1746 | 0.1595 | 0.1302 | 0.1645 | 0.1923 | 0.1445 | 0.1438 | 0.1687 | 0.13 | 0.1205 | 0.0474 | 0.1237 |
| **D16** | 0.1076 | 0.0932 | 0.1268 | 0.2067 | **0.2566** | 0.2081 | 0.1775 | **0.2301** | 0.1704 | **0.2548** | **0.243** | **0.2423** | **0.2494** | 0.1336 | 0.1327 | 0.0716 | 0.1629 |
| **D22** | 0.097 | 0.0752 | 0.1224 | **0.2232** | **0.2706** | **0.2422** | **0.2159** | **0.2659** | **0.2548** | 0.1985 | **0.2598** | **0.254** | **0.2677** | 0.1589 | 0.1476 | 0.0697 | 0.1778 |
| **D25** | 0.0805 | 0.0716 | 0.1093 | 0.2039 | **0.2569** | 0.1962 | 0.1814 | **0.2321** | **0.2283** | **0.241** | 0.1576 | **0.2241** | **0.246** | 0.1287 | 0.122 | 0.0689 | 0.1515 |
| **D26** | 0.0785 | 0.0764 | 0.1164 | 0.1908 | **0.2412** | 0.1767 | 0.1466 | 0.1948 | 0.214 | 0.2089 | 0.2104 | 0.1442 | **0.2316** | 0.113 | 0.1063 | 0.0593 | 0.1245 |
| **D29** | 0.0875 | 0.0794 | 0.1262 | 0.2044 | **0.2514** | 0.1914 | 0.1706 | **0.2208** | **0.2234** | **0.24** | 0.209 | **0.2251** | 0.1645 | 0.1247 | 0.1075 | 0.051 | 0.1261 |
| **D34** | 0.0925 | 0.062 | 0.0923 | 0.1126 | 0.1446 | 0.1271 | 0.1587 | 0.1711 | 0.1363 | 0.1691 | 0.1165 | 0.1201 | 0.123 | 0.0711 | 0.1451 | 0.0371 | 0.1302 |
| **D35** | 0.1245 | 0.0839 | 0.1385 | 0.1704 | 0.2027 | 0.162 | 0.1521 | 0.2024 | 0.17 | 0.2031 | 0.16 | 0.1596 | 0.1696 | 0.1315 | 0.0871 | 0.0396 | 0.1423 |
| **D36** | 0.1368 | 0.1295 | 0.1516 | 0.1782 | 0.206 | 0.1382 | 0.1621 | 0.1817 | 0.1882 | 0.1938 | 0.1955 | 0.1561 | 0.1823 | 0.1237 | 0.1307 | 0.0417 | 0.1481 |
| **D37** | 0.1634 | 0.1497 | 0.1804 | 0.2037 | **0.2358** | 0.1906 | 0.1902 | **0.2203** | 0.2049 | **0.228** | 0.2052 | 0.1925 | 0.205 | 0.1375 | 0.145 | 0.0766 | 0.1176 |

Table 23 – The overall total-relation matrix for RL barriers ($T^b$).

| Barrier | B1 | B2 | B3 | B5 | B7 | B8 | B9 | B11 | B13 | B22 | B24 | B25 | B26 | B27 | B28 | B29 | B30 | B31 | B34 | B35 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **B1** | 0.0753 | **0.1322** | **0.133** | **0.1533** | **0.1549** | **0.1456** | **0.1278** | **0.1332** | 0.0921 | 0.0486 | 0.0421 | 0.0879 | 0.018 | 0.0344 | 0.0478 | 0.0658 | 0.1074 | 0.1091 | 0.1162 | 0.1098 |
| **B2** | 0.1036 | 0.0642 | 0.1212 | 0.1216 | **0.14** | **0.1379** | 0.0984 | **0.1274** | 0.0826 | 0.0508 | 0.038 | 0.0748 | 0.0285 | 0.049 | 0.0492 | 0.0599 | 0.0847 | 0.0745 | 0.0875 | 0.0875 |
| **B3** | 0.0823 | 0.0937 | 0.0609 | **0.1363** | **0.1287** | **0.1269** | 0.0812 | 0.111 | 0.1045 | 0.0422 | 0.0291 | 0.0773 | 0.0265 | 0.0469 | 0.0339 | 0.0439 | 0.0804 | 0.0779 | 0.1003 | 0.0836 |
| **B5** | 0.1249 | 0.1119 | **0.13** | 0.088 | **0.1683** | **0.1534** | 0.0991 | 0.1057 | 0.1213 | 0.0413 | 0.0405 | 0.0743 | 0.0286 | 0.0525 | 0.059 | 0.0522 | 0.1162 | 0.087 | 0.1133 | 0.1017 |
| **B7** | **0.1424** | **0.1295** | 0.1094 | **0.1451** | 0.1161 | **0.1848** | **0.1345** | **0.1489** | **0.1314** | 0.0479 | 0.0404 | 0.1009 | 0.0324 | 0.0514 | 0.0733 | 0.0917 | 0.117 | 0.0774 | **0.1527** | **0.1328** |
| **B8** | **0.1704** | **0.1692** | **0.1563** | **0.1843** | **0.2263** | **0.1308** | **0.1542** | **0.1617** | **0.1655** | 0.1077 | 0.0554 | **0.1345** | 0.0243 | 0.0677 | 0.0852 | 0.1052 | **0.1685** | 0.1126 | **0.1946** | **0.1865** |
| **B9** | 0.1224 | 0.1206 | 0.1201 | **0.1566** | **0.1948** | **0.1717** | 0.0763 | 0.1107 | 0.1178 | 0.0405 | 0.0527 | 0.0761 | 0.0387 | 0.0531 | 0.0666 | 0.0908 | **0.1459** | 0.1073 | **0.1504** | 0.1249 |
| **B11** | 0.1034 | 0.1086 | 0.0954 | 0.1106 | **0.1525** | **0.1365** | 0.0901 | 0.0773 | 0.1128 | 0.0469 | 0.0412 | 0.0717 | 0.0282 | 0.0461 | 0.0659 | 0.0642 | 0.1213 | 0.0788 | **0.143** | 0.1252 |
| **B13** | 0.1186 | 0.1244 | 0.1186 | **0.1552** | **0.1419** | **0.128** | 0.075 | 0.1241 | 0.0638 | 0.0377 | 0.0252 | 0.0746 | 0.0154 | 0.0425 | 0.0422 | 0.0592 | 0.0844 | 0.0697 | 0.0928 | 0.0995 |
| **B22** | 0.0322 | 0.0318 | 0.0317 | 0.0437 | 0.0468 | 0.0427 | 0.0226 | 0.0346 | 0.057 | 0.0116 | 0.017 | 0.0245 | 0.0054 | 0.0122 | 0.0209 | 0.0289 | 0.0442 | 0.0187 | 0.0539 | 0.0649 |
| **B24** | 0.0908 | 0.089 | 0.088 | 0.1136 | 0.1266 | 0.104 | 0.078 | 0.0898 | 0.0739 | 0.046 | 0.0277 | 0.1203 | 0.0422 | 0.077 | 0.0858 | 0.0813 | 0.1108 | 0.0614 | 0.1137 | 0.1078 |
| **B25** | **0.131** | **0.1301** | 0.1168 | 0.1209 | **0.1782** | **0.1552** | 0.1139 | **0.133** | 0.0962 | 0.0775 | 0.0522 | 0.0598 | 0.0317 | 0.0371 | 0.0843 | 0.0837 | 0.119 | 0.0987 | **0.1361** | **0.1416** |
| **B26** | 0.0171 | 0.0159 | 0.0159 | 0.0326 | 0.0353 | 0.0196 | 0.0146 | 0.018 | 0.0168 | 0.015 | 0.0276 | 0.0202 | 0.0039 | 0.0423 | 0.0382 | 0.0185 | 0.0377 | 0.0119 | 0.034 | 0.0384 |
| **B27** | 0.0824 | 0.069 | 0.0688 | 0.0856 | 0.0928 | 0.0791 | 0.0448 | 0.075 | 0.0868 | 0.0438 | 0.0204 | 0.0623 | 0.0103 | 0.0226 | 0.061 | 0.0508 | 0.0879 | 0.0443 | 0.1137 | 0.0974 |
| **B28** | 0.0363 | 0.0293 | 0.0283 | 0.0478 | 0.0543 | 0.0366 | 0.0459 | 0.0457 | 0.0404 | 0.0218 | 0.0336 | 0.0551 | 0.0082 | 0.0154 | 0.019 | 0.0526 | 0.0628 | 0.0232 | 0.0731 | 0.0513 |
| **B29** | 0.0704 | 0.0685 | 0.0538 | 0.0854 | 0.1233 | 0.1013 | 0.0896 | 0.1121 | 0.0552 | 0.0684 | 0.0702 | 0.0908 | 0.0671 | 0.0742 | 0.0766 | 0.0388 | 0.0808 | 0.0613 | 0.1143 | 0.0775 |
| **B30** | 0.1164 | 0.1145 | 0.1148 | **0.1432** | **0.1614** | **0.1446** | 0.0908 | 0.1234 | 0.1075 | 0.0696 | 0.0694 | 0.0727 | 0.018 | 0.0819 | 0.0771 | 0.0813 | 0.0777 | 0.1021 | **0.1336** | **0.139** |
| **B31** | 0.0665 | 0.0597 | 0.0787 | 0.0877 | 0.0845 | 0.0841 | 0.0942 | 0.095 | 0.0588 | 0.0348 | 0.0186 | 0.0653 | 0.0107 | 0.0273 | 0.0326 | 0.0358 | 0.0737 | 0.036 | 0.073 | 0.0814 |
| **B34** | 0.1156 | 0.1143 | 0.1143 | **0.1478** | **0.1604** | **0.1382** | 0.0898 | **0.141** | 0.1187 | 0.062 | 0.0428 | 0.0884 | 0.0169 | 0.0541 | 0.0685 | 0.0668 | 0.1206 | 0.102 | 0.0854 | **0.1309** |
| **B35** | 0.12 | 0.1132 | 0.1259 | **0.1426** | **0.1475** | 0.1192 | 0.1248 | **0.1331** | **0.1295** | 0.0344 | 0.0555 | 0.0564 | 0.0177 | 0.0553 | 0.0676 | 0.0727 | 0.126 | 0.0834 | **0.1412** | 0.0765 |

*Step 6b*: With the purpose of observing general patterns and relationships amongst all the drivers and barriers both simultaneously and in pairs, an overall prominence-causal relationship diagram was developed. To build this diagram, a threshold θ was calculated as the number of relationships may include all the possibilities. Only the relationships over the threshold θ were mapped. A high value for the driver ($\theta^d$) and barrier ($\theta^b$) threshold was chosen owing to the large number of factors. These values were calculated by taking the mean and standard deviation of the values $t_{ij}$ from the $T^d$ and $T^b$ matrices, and adding one standard deviation to the mean. Therefore, $\theta^d = 0.1579 + 0.0565 = 0.2145$ and $\theta^b = 0.0835 + 0.0434 = 0.1268$. All the relationships in Table 22 meeting or exceeding the threshold 0.2145 are underlined, and the same for the barriers matrix in Table 23 and the threshold 0.1268. These strongest dyadic relationships are plotted in Figure 18 (drivers) and Figure 19 (barriers). One-way relationships are represented by dashed lines, whereas two-way significant relationships are represented by solid lines.

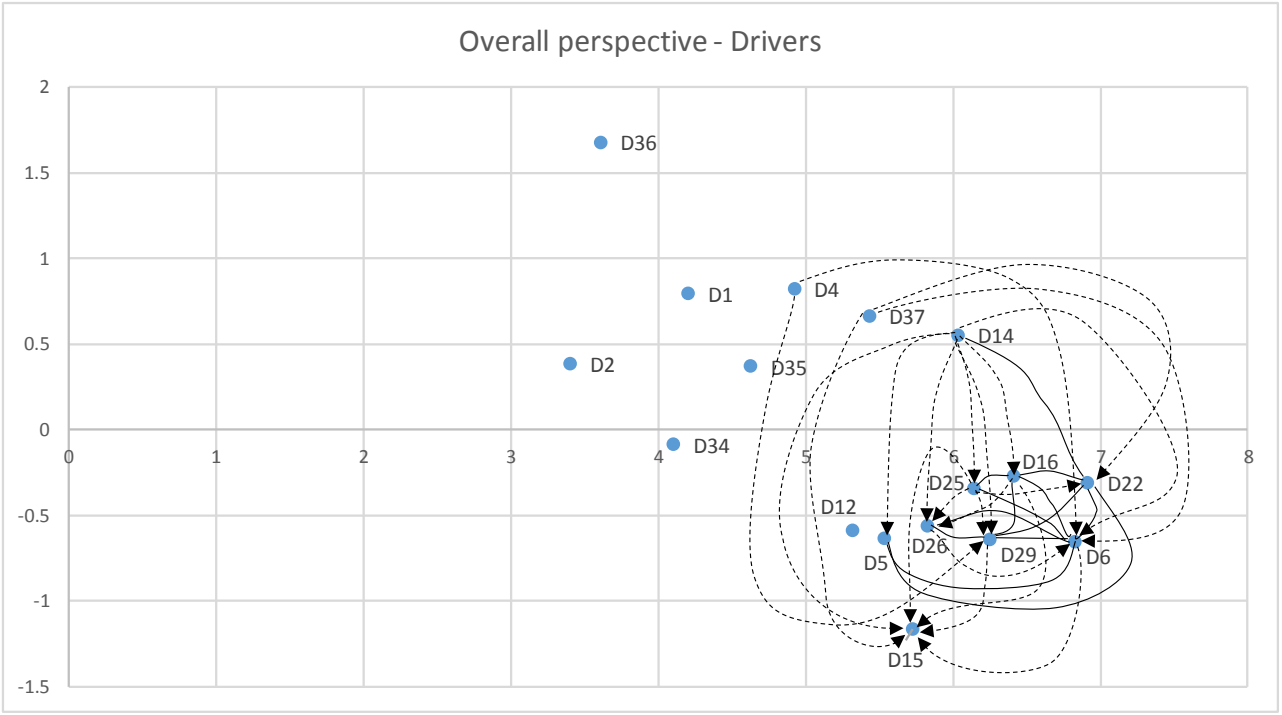


Figure 18 – Overall DEMATEL prominence–causal relationship diagram for RL drivers.
Note: X-axis represents the prominence (P) value and Y-axis represents net effect (E) value.

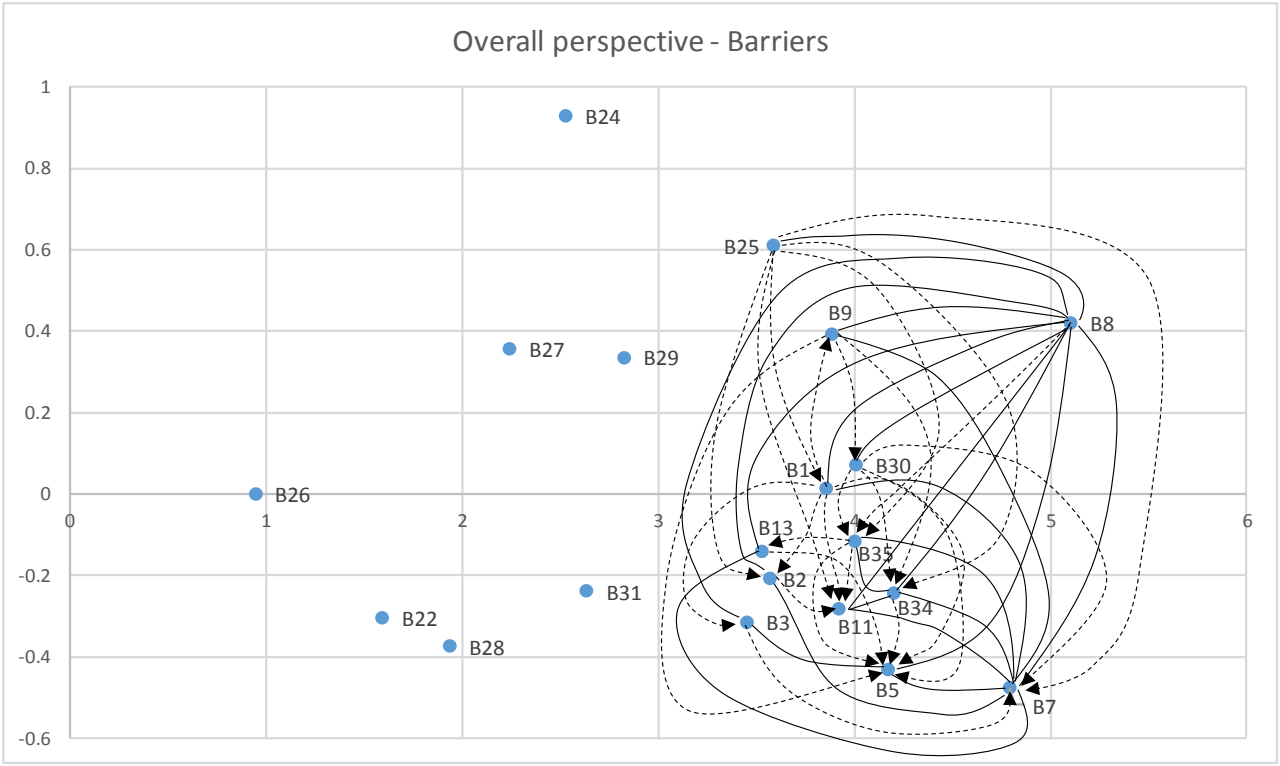


Figure 19 – Overall DEMATEL prominence–causal relationship diagram for RL barriers.
Note: X-axis represents the prominence (P) value and Y-axis represents net effect (E) value.

## 6.3. DISCUSSION

This discussion has been divided into three topics to better present the detailed treatment of results. First, it begins with a general discussion of major results. A determination of clusters of cause and effect groups and the importance level of factors are given. The stakeholders' similarities are discussed in the sequence. At last, stakeholders' differences are also provided.

### 6.3.1. General evaluation

The results allow us to determine the cause and effect groups of factors from the different stakeholders' points of view. The factors in the cause group are denoted as influencing criteria, and factors in the effect group are denoted as influenced criteria. We focused this discussion on factors with the greater influencing power (E value) and prominence (importance – P value) according to the research results.

#### 6.3.1.1. Drivers: net effect and importance

Due to the amount of drivers and perspectives, this Section presents and discusses the drivers with greater influence (E value) and greater relevance or importance (P value) for each stakeholder and the overall perspective.

Organizational perspective

From the organizational point of view, the influencing drivers can be sorted as follows: D4 > D25 > D2 > D16 > D29 > D16 > D14. In this causal cluster, Motivation laws (D4) is on the top of the cause group, which denotes that D4 is the primary causal factor. This result confirms the aforementioned underdeveloped situation of RL practices in Brazil, due to the lack of legislation encouraging product return or offering tax discounts on recycled material as an example. For the industrial expert, as the National Policy on Solid Waste (NPSW) has been already implemented, legislation agencies should now focus on motivation laws to promote RL practices. The effect cluster for the organizational expert includes the following drivers: D22, D26, D6, D12, D5, D37, D15, D1, D35, D34. These ten drivers

are influenced by causal drivers which motivates the development of RL in the Brazilian context.

However, we also consider the prominence or importance level of the drivers, which denotes the correlation with other drivers. Hence, the list of the top five drivers is as follows: D37 > D22 > D12 > D16 > D6. Environmental conservations (D37), an effect factor, reached the highest correlation with other drivers. That is, from the organizational expert point of view, closing the supply chain loop by enabling a proper final destination to EOL products is the most important effect driver for RL. Eco-design and Design for X techniques (D22) reached second place after D37. This driver almost reached null net effect, which means that it is an important linkage element in the system, acting either as a cause or as an effect factor. For the organization, this result means that the inclusion of environmental issues during the design phase of a product helps to put RL in practice. Driver 22 is followed by Customer satisfaction (D12), Long-term sustainability (D16), and Cooperation and integration with partners in the SC (D6), respectively.

Customer perspective

From the customer opinion, the influencing drivers are arranged as follows: D36 > D37 > D1 > D35 > D4 > D14 > D34 > D2. From this list, Increasing landfill (D36) is the most influencing driver. Thus, RL seems to be a solution for the problem of scarcity of landfills as it gives a proper final disposal to EOL products. Concerning the effect group, the cluster includes the following drivers: D29, D12, D26, D15, D6, D16, D5, D25, and D22.

According to the customer expert, the importance of factors is sorted as follows for the top five drivers: D22 > D25 > D14 > D16 > D6. Eco-design and Design for X techniques (D22) achieved the first level of importance, while in the previous analysis for organizational perspective D22 got the first place. This driver is an effect factor in the system, that is, eco-design is influenced by other drivers of the system, such as Regulatory pressure for product return/recovery (D1) and Green consumerism / consumers' environmental awareness (D14). The second, third, fourth, and fifth positions in the importance scale are: Reduction on raw material consumption and waste disposal cost (D25), Green consumerism / consumers' environmental

awareness (D14), Long-term sustainability (D16) and Cooperation and integration with partners in the SC (D6), respectively.

Societal perspective

From the society expert standpoint, the influencing drivers are sorted as follows: D36 > D2 > D14 > D29 > D12 > D1 > D26. The most influencing driver is Increasing landfill (D36), which is in accordance with the customer perspective. The NGO member believes that used products should have a proper final destination in order to decrease the use of landfills and this issue becomes the primary driver in the system. The group of effect drivers is composed of D4, D6, D16, D22, D34, D35, D25, D15, D5 and D37.

The importance order for the societal perspective is D22 > D16 > D37 > D4 > D14. The most relevant driver is again Eco-design and Design for X techniques (D22), as for the customer expert. The society representative understands that RL is mostly driven by economic issues, and that investments in eco-design techniques are essential for reducing EOL and RL costs. Long-term sustainability (D16), Environmental conservations (D37), Motivation laws (D4) and Green consumerism / consumers' environmental awareness (D14), respectively follow this driver.

Governmental perspective

The Government expert, through the factor pair-wise comparisons, selected as influencing drivers D4 > D1 > D35 > D37 > D14 > D34 > D36 > D5. Motivation laws (D4) reached the greatest influence in the system. This result is somehow expected from this perspective, because this driver originated from the Government. The report of Govindan; Kannan and Shankar (2014) provided similar outcomes, stating that "government regulations get high priority because in modern business, firms concentrate only on economic profit; they don't practice these types of sustainable practices voluntarily." The list of effect drivers from this perspective includes: D16, D2, D12, D25, D22, D26, D6, D29, D15.

According to the Government respondent, the top five drivers concerning their importance are: D6 > D29 > D22 > D15 > D26. The highest prioritized driver is Cooperation and integration with partners

in the SC (D6). The expert from the Government believes that implementing the NPSW, which includes RL, depends mostly on the shared responsibility on product returns throughout the reverse supply chain. Firms must cooperate to implement product return initiatives. This driver is followed by Economic viability (D29), Eco-design and Design for X techniques (D22), Green marketing (D15) and Value recovery (D26).

Overall perspective

Finally, yet importantly, an overall perspective for drivers evaluation is provided in Figure 18 (diagram). From the aggregated point of view, the following drivers are placed in the cause group: D36 > D4 > D1 > D37 > D14 > D2 > D35. Thus, Increasing landfill (D36) reached the highest cause value, although it does not represent an important driver (low P value). D36 has the second lowest importance level in the system. This means that the scarcity of landfills drives RL implementation, but it does not have a strong relation with other drivers in the system. The effect cluster contemplates D34, D16, D22, D25, D26, D12, D5, D29, D6, and D15.

Concerning the importance level of the drivers, the aggregated perception points out the following most relevant factors: D22 > D6 > D16 > D29 > D25. Eco-design and Design for X techniques (D22) reached the highest importance level. This driver is followed by Cooperation and integration with partners in the SC (D6), Long-term sustainability (D16), Economic viability (D29), and Reduction on raw material consumption and waste disposal cost (D25), respectively.

Furthermore, analyzing the strongest dyadic relationships in Figure 18, it is evident that D14 (Green consumerism / consumers environmental awareness) plays a relevant role in the drivers system. In this diagram, it can be seen that D14 influences other eight factors, including the three most relevant ones (D22, D6, and D16). Consumers' environmental awareness is an increasing tendency, pressuring companies to cope with environmental standards and legislation. Also in the causal cluster, Environmental conservations (D37) is noteworthy, influencing three other drivers: Cooperation and integration with partners in the SC (D6), Green marketing (D15) and Eco-design and Design for X techniques (D22). Lastly, Motivation laws (D4) stands out in the causal group, having effect on Cooperation

and integration with partners in the SC (D6) and Economic viability (D29).

With the purpose to clarify the results from Figure 18, the most important dyadic relationships from this graph are placed in a diagram (Figure 20). The relationship between the drivers *i* and *j* is shown by an arrow pointing from *i* to *j*. Drivers on the bottom (level I) denote causal influence, while the other drivers (levels II, III and IV) denote the effect cluster. Levels of cause-effect influence were determined based on E values of each driver.

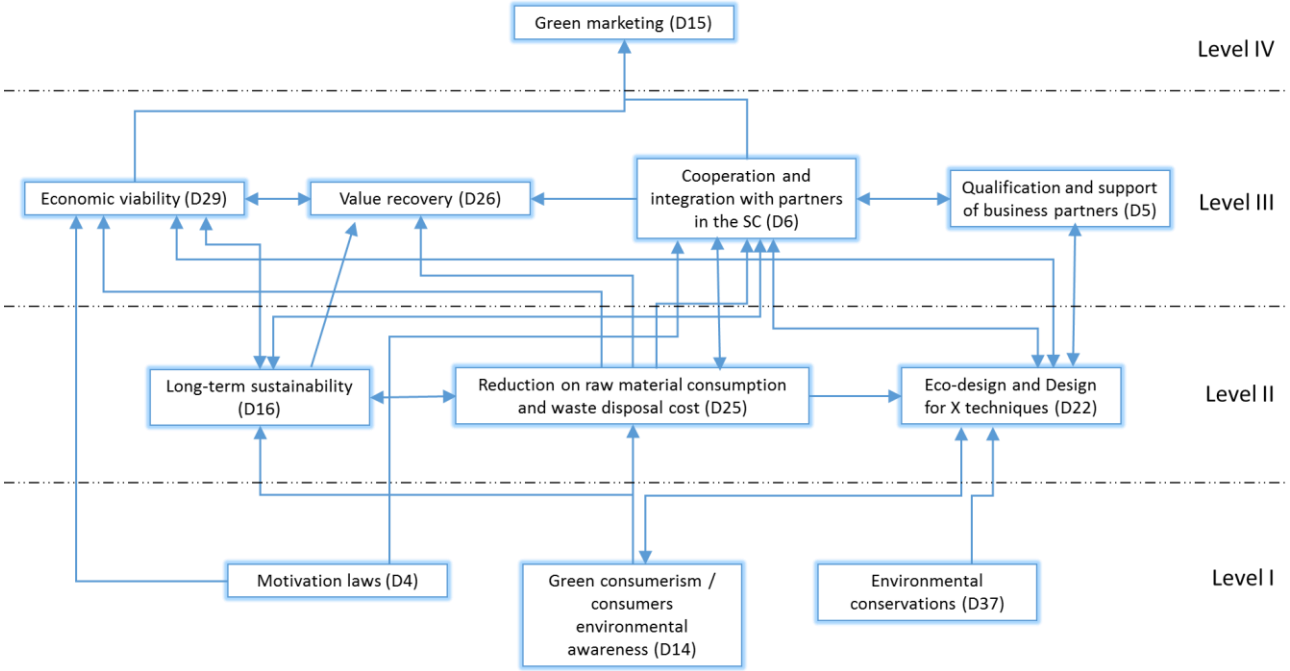


Figure 20 – Drivers interrelationship digraph according to overall perspective.

#### 6.3.1.2. Barriers: net effect and correlation

Considering the plurality of barriers in the system and the multiple perspectives, this Section focuses on the discussion on barriers with greater influence (E value) and greater relevance or importance (P value) for each stakeholder and the overall perspective.

Organizational perspective

The causal barriers can be sorted as follows: B24 > B27 > B26 > B30 > B35 > B8 > B13 > B25 > B31 > B29 > B34. The organization expert sees Lack of specific laws (B24) as the primary causal barrier for RL development. The following barrier, Lack of motivation laws (B27), confirms the causal influence of laws in this complex system. In this matter, many prior studies (SHARMA *et al.*, 2011; ABDULRAHMAN; GUNASEKARAN; SUBRAMANIAN, 2014; SHAHARUDIN; ZAILANI; TAN, 2014) state that the lack of appropriate laws is seen as a major barrier for companies to be involved in EOL returns. The effect group is composed by: B9, B22, B1, B11, B3, B28, B5, B7, and B2.

With regards to the importance level of barriers, the top five barriers according to the organizational point of view are B30 > B8 > B34 > B7 > B35. Interestingly, Company polices against RL (B30) got the first position. From the expert opinion, the company does not want to cannibalize sales of their brand new products by recovering and selling their used products. This barrier is followed by Limited forecasting and planning (B8), Low importance of RL relative to other issues (B34), Difficulties with supply chain members (B7), and Low involvement of top management and strategic planning (B35).

Customer perspective

The causal cluster of barriers for the customer expert is B8 > B25 > B29 > B24 > B2 > B1 > B7 > B9 > B28. In these causal factors, B8 (Limited forecasting and planning) is on the top of the cause group, which indicates that B8 is the primary causal factor. The same barrier attained the second place for the organizational perspective. In this matter, many companies have trouble in forecasting and planning the reverse chain due to the degree of diversity of products and flows. The effect group consists of B26, B27, B13, B11, B22, B3, B30, B5, B34, B35, and B31.

Concerning the importance level of factors, the most prominent barriers are B8 > B7 > B1 > B5 > B9. Thus, for the customer respondent, B8 (Limited forecasting and planning) is the most important barrier and has the greatest influence in the system. The subsequent barriers in order of importance are Difficulties with supply chain members (B7), Lack of personnel technical skills (B1), Technology and the R&D issues related to product recovery (B5), and Inconsistent quality (B9).

Societal perspective

From this standpoint, causal barriers can be sorted as follows: B30 > B5 > B9 > B1 > B2 > B29 > B25 > B11 > B3 > B8 > B7. Company polices against RL (B30) achieved the first place. This barrier attained the first position concerning the level of importance from the organizational perspective. The effect group of barriers for the societal member is B31, B13, B28, B35, B34, B24, B22, B26, and B27. These nine barriers are influenced by causal factors which restricts development of RL.

For the society expert, the most relevant barriers are B9 > B30 > B25 > B8 > B1. The most important barrier from this perspective is Inconsistent quality (B9). The product quality is not uniform in RL when compared to the forward logistics. This fact hinders the standardization of recovery activities and, consequently, increases RL costs. The subsequent barriers are Company polices against RL (B30), Lack of waste management practices (B25), Limited forecasting and planning (B8), and Lack of personnel technical skills (B1).

Governmental perspective

Regarding the cause-effect results, the Government expert elected as causal barriers the following factors: B27 > B9 > B22 > B24 > B25 > B34 > B35 > B2. Similar to results from the organizational perspective, legislation issues appear to play an important cause role in the barrier system, since Lack of motivation laws (B27) got the first place. The effect cluster comprises B8, B31, B29, B3, B1, B11, B7, B5, B13, and B30.

According to prominence results, the most important factors are B34 > B35 > B7 > B8 > B13. Low importance of RL relative to other issues (B34) reached number one. The governmental representative believes that companies give an extremely low priority

to RL activities when compared to other issues. This barrier is followed by Low involvement of top management and strategic planning (B35), Difficulties with supply chain members (B7), Limited forecasting and planning (B8), and Lack of initial capital (B13). At last, it is noteworthy that Lack of inter-ministerial communication (B26) and Misuse of environmental regulations (B28) reached null as both importance (P value) and net effect (E value). That is, according to the government expert, neither of these barriers exist in the Brazilian context.

Overall perspective

The aggregation of the stakeholders' opinions comprises the following barriers regarding the causal cluster: B24 > B25 > B8 > B9 > B27 > B29 > B30 > B1 > B26. Lack of specific laws (B24) is the primary influence in the barrier system. The subsequent barrier is also from Policy related issues cluster: Lack of waste management practices (B25). These two barriers are clearly related to each other since waste management practices usually are not implemented due to a lack of clear return policies or not fully regulated waste management (STAROSTKA-PATYK *et al.*, 2013). The influenced barriers in the system are: B35, B13, B2, B31, B34, B11, B22, B3, B28, B5, and B7.

Concerning the prominence, the five most important factors are B8 > B7 > B34 > B5 > B30. Limited forecasting and planning (B8) is the most correlated barrier in the system. As already mentioned, many firms encounter difficulties in forecasting and planning the reverse flow due to the degree of diversity of products (mix) and the many flows. This fact brings instability to the RL operations, consequently increasing RL costs. The subsequent barriers in order of importance are Difficulties with supply chain members (B7), Low importance of RL relative to other issues (B34), Technology and the R&D issues related to product recovery (B5), and Company polices against RL (B30).

At last but not least, relevant insights arise from the dyadic relationships presented in Figure 19. It is evident the causal influence and importance of Limited forecasting and planning (B8) in the system. This barrier has an effect on 12 other barriers. Many authors (ROGERS; TIBBEN-LEMBKE, 2001; CHAN; CHAN; JAIN, 2012; ABDULRAHMAN; GUNASEKARAN; SUBRAMANIAN, 2014) have discussed and mentioned the difficulties in planning for reverse

logistics as opposed to forward logistics since RL involves a higher degree of uncertainty. This limitation has many consequences. According to the aggregated results, the most important consequence is the emergence of the Difficulties with supply chain members barrier (B7). As previously discussed, Limited forecasting and planning (B8) increases RL costs, hindering the interest of SC members in investing in RL activities.

With the view to elucidate the most important dyadic relationships from Figure 19, a diagram was developed representing the most important connections among barriers (Figure 21). The relationship between the barriers i and j is shown by an arrow pointing from i to j. Barriers placed on levels I and II denote causal influence, while the other drivers (levels III, IV and V) denote the effect cluster. Levels of cause-effect influence were determined based on E values of each barrier.

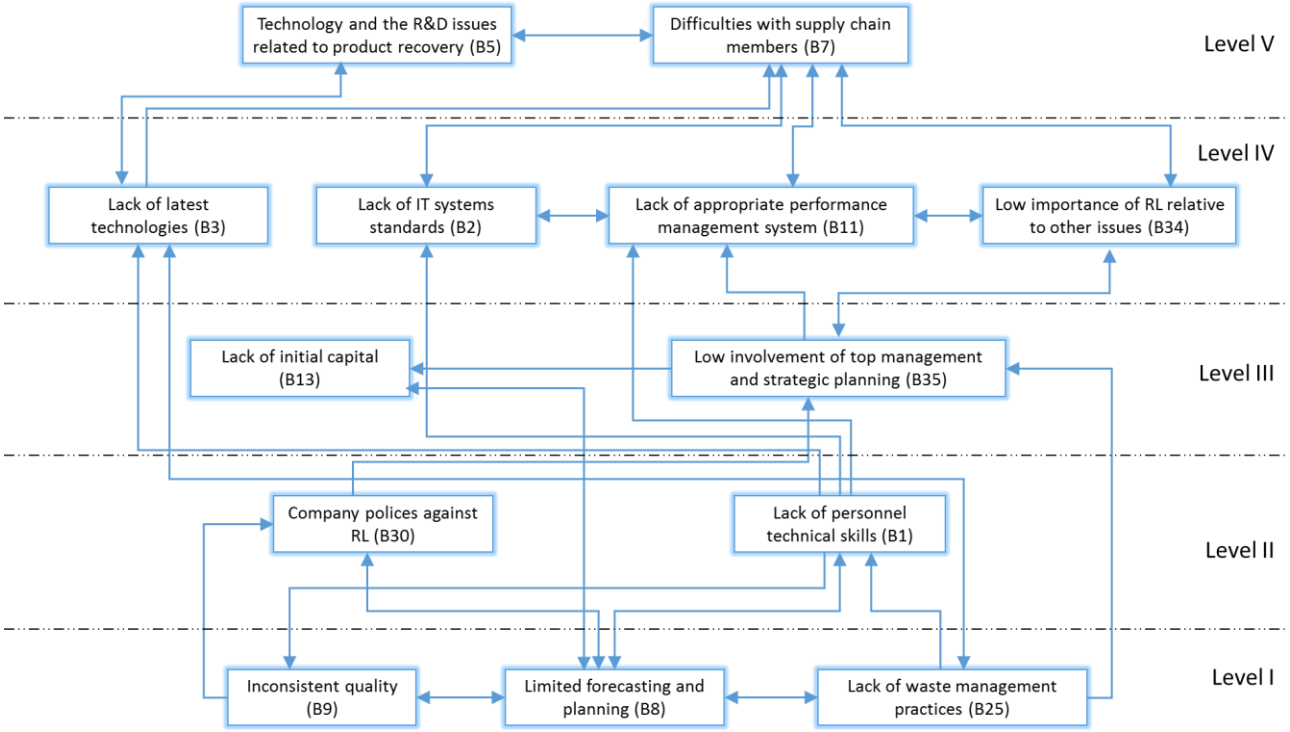


Figure 21 – Barriers interrelationship digraph according to overall perspective.

# 7. FURTHER DISCUSSION AND CONCLUDING REMARKS

The aim of this last Chapter is to gather the outcomes from all spheres of this research, to present a further discussion of results, and to offer concluding remarks. This objective will be attained by the following organization. Section 7.1 develops the overall discussion of this manuscript. Completing this research, Section 7.2 presents the concluding topics, including the accomplishment of the research objectives, its limitations, and future paths for subsequent works in the field.

## 7.1. Overall Discussion

This topic intends to coordinate results from Chapters 3, 4, 5 and 6 and to highlight the most relevant findings in order to discuss them in parallel.

From the comprehensive literature review in Chapter 3, it is noteworthy that RL literature in Brazil mainly appears to report on recycling. This finding contrasts from international literature on RL, which many times includes remanufacturing, refurbishment, or repair issues. In this matter, the high unemployment and low education rates in Brazil have led to the emergence of survival activities. Sometimes, these activities are organized into scavenger cooperatives, which provide a scale pattern to these jobs, turning recycling into an economically attractive activity. That is, most of these cooperatives do not emerge from environmental or legislative concerns, but from social and economic conditions confronted by a portion of the population.

Regarding prior publications in Brazil, scientific articles are lacking in quantity and content, as shown in Section 3.3. Generally, the theoretical foundations are also missing from these papers, as well as poor research methods, thus threatening the quality and reliability of results. After analyzing prior RL publications about the Brazilian scenario, it seemed necessary to perform a research on factors that drive or hinder RL practice in Brazil. Furthermore, it was noticed that well-structured empirical research on RL in this country was lacking.

Thereby, from the empirical results provided by the case studies (Chapter 4), some practical insights emerged. Suppliers and

customers' compliance for RL implementation and management is an important issue. Sharing the responsibility among the reverse supply chain partners is essential for product return implementation. Similarly, during case studies, it was noticed that financial related issues may drive or hinder RL activities. That is, while RL is a means of obtaining valuable spare parts and recapturing value, there might be a negative impact from RL activities due to barriers such as lack of shared responsibility and high taxation on recyclable materials.

A further look into the influential factors and stakeholders for RL implementation worldwide (Chapter 5) reveals that the choice of stakeholders for our framework was successful. The multiple company–society–government-customer association perspective was satisfactory since 12 from the 15 most widely used drivers (Figure 14) are considered in the framework as well as 14 from the 15 most widely used barriers (Figure 15). Regarding the internal and external sides of the framework, 15 factors were classified as internal (inside the firm's perspective), and 22 factors were identified as external. From the cluster of internal influential factors, 10 are barriers hindering RL implementation and five are driving forces. On the other hand, from the external perspective, we found nine barriers and 13 drivers.

It is also relevant to mention that most of the key barriers from the RL multiple perspective framework are from the organizational standpoint. That is, external pressures may harm RL implementation, but firms may first focus on overcoming the internal barriers. Another relevant outcome is that, as this study reveals, the society perspective does not directly present any barrier towards RL practice. Mostly, this stakeholder presents some drivers, which impel industries to cope with environmental causes such as product return initiatives.

Bringing together results from Chapter 5 and Chapter 6, Figure 22 presents the selected drivers from the multi-perspective framework (Figure 16) according to the most prominent drivers in the overall perspective. In this picture, the order of importance achieved by each key driver is also provided. From this graphic representation, it is clear that most of the key drivers come from the organizational and customer's perspective. All organizational drivers from the framework were confirmed by the DEMATEL method. Moreover, four from the top five most important drivers are from this stakeholder, namely: Eco-design and Design for X techniques (D22); Long-term sustainability (D16), Economic viability (D29), and

Reduction on raw material consumption and waste disposal cost (D25).

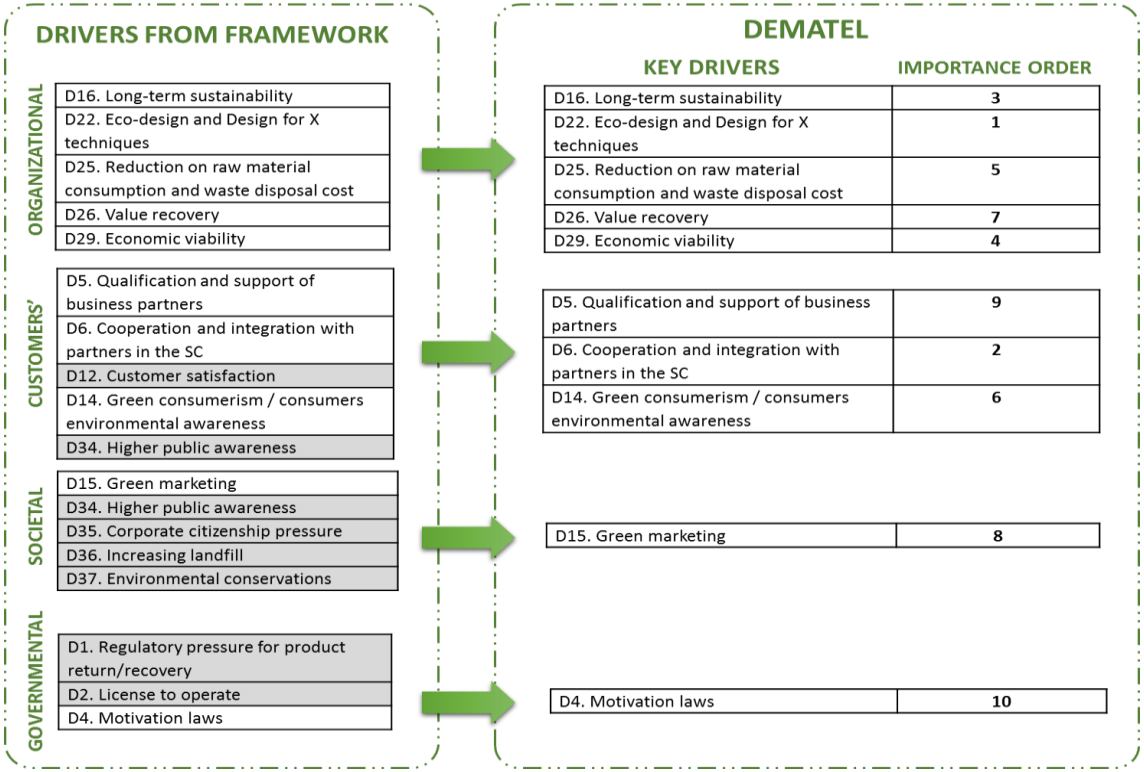


Figure 22 – Selected drivers using grey-DEMATEL approach based on the overall perspective.

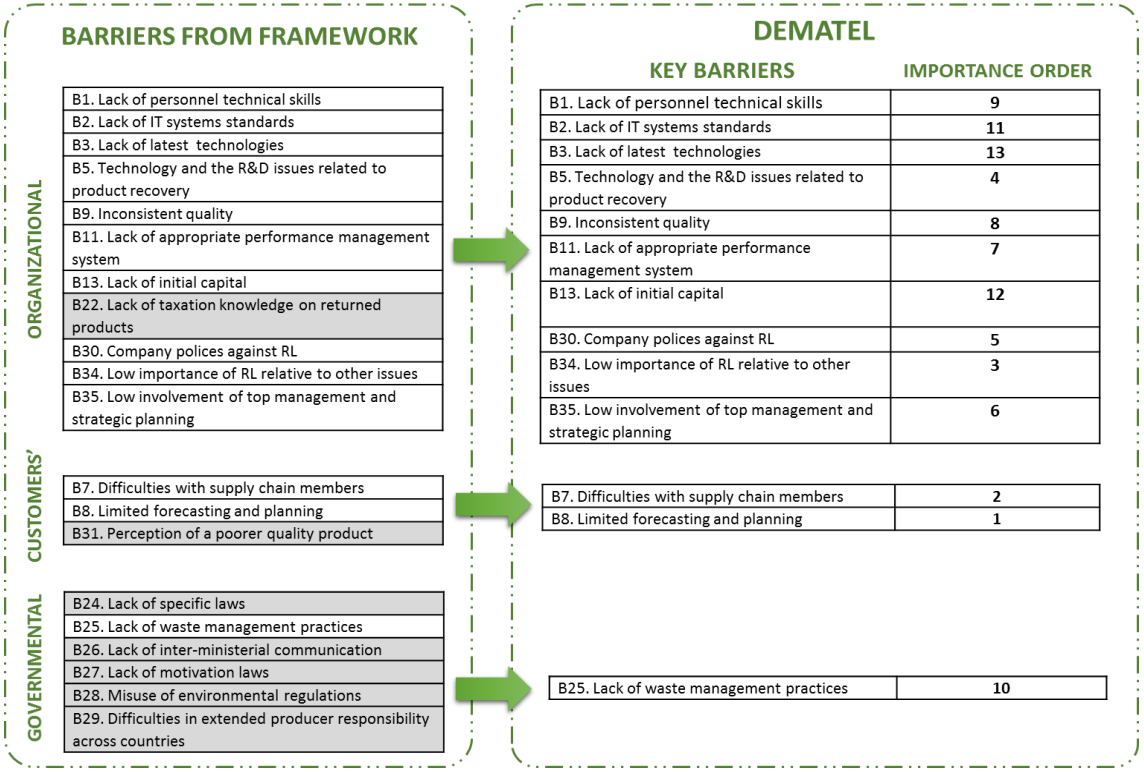


Figure 23 – Selected barriers using grey-DEMATEL approach based on the overall perspective.

On the barriers side, Figure 23 highlights the selected barriers from the multi-perspective framework, regarding the most important factors according to the overall perspective. It is evident that there is a predominance of internal barriers, i.e., from within the organization. This stakeholder holds 10 out of 13 key barriers for RL implementation. This is a very relevant outcome from this work, as it denotes that companies may start product return implementation by tackling key internal barriers at first. However, generally RL operation is not a one-sided effort. This fact is clear in Figure 23, where barriers Limited forecasting and planning (B8) and Difficulties with supply chain members (B7) are the two most prominent factors in the system. These barriers come from the customer side.

## 7.2. Concluding topics

Reverse Logistics, which is driven by environmental, social and legislative issues, is growing in importance and application. RL is influenced by stakeholders and RL programs encounter factors that can enable or impede its development. Thus, the main objective of the present study was to evaluate the interrelationship among RL drivers and barriers under the perspectives of the most important reverse logistics stakeholders in the Brazilian context.

To attain this purpose, a research design was developed, including:

- a comprehensive literature review on RL and on RL in Brazil;
- case-based research in two Brazilian companies;
- a specific literature review on drivers, barriers, and stakeholders for RL implementation, including the creation of a multi-perspective framework;
- validation of these influential factors from the multi-perspective framework with experts by means of a MCDM tool named grey-based DEMATEL.

The primary contributions of this work are hereby discussed. This study created a unique research design to solve the proposed research problem, classified each adopted step in literature investigation, formulated a conceptual development from the authors,

and completed field research. Moreover, this design also elucidated the achievement of each specific objective of this research.

Another contribution of this research is the comprehensive review on RL of the largest economy in Latin America and, more recently, the seventh largest economy in the world. This investigation offered a structured systematic literature review procedure, a classification framework for RL literature categorization, a Brazilian panorama on RL publications, and a comparison to international body of literature as well.

In the empirical perspective, case-based research also provided significant outcomes. A field research was conducted in two companies located in Southern Brazil: a Brazilian-based multinational corporation from the machinery manufacturing industry sector focusing on RL drivers; and a third party reverse logistics service provider (3PRL) focusing on RL barriers. RL influential factors were classified in organization, operational environment and general environment levels. This step offered a primary practical basis for the continuation of this research.

From the specific literature review performed in this work, other contributions emerged. This phase reviewed more than a decade's worth of research focusing on reverse logistics, stakeholders, and influential factors issues. More than one hundred fifty articles were identified, from which 49 were utilized in the analysis of the research. The data were collected and analyzed from the literature with the objective of furthering our understanding of the factors that enable and inhibit RL implementation from a multiple stakeholder perspective. A systematic approach of content analysis was applied in order to enhance the validity and reliability of results. Papers have been analyzed according to the structural dimensions and analytic categories, extracted deductively, and deductively/inductively respectively. Thirty-seven RL drivers were identified in literature, while 36 barriers emerged from the paper portfolio. All influential factors were classified as internal or external and assigned to one or more stakeholders. In sum, the overall contribution of this step was to gain insights about the factors for implementing RL from a multiple company–society–government-customer association perspective, creating a RL multi-perspective framework for RL drivers and barriers.

Finally, an association of grey theory and DEMATEL approach was proposed for the evaluation of RL factors according to different stakeholders' perspectives. One expert from each stakeholder was consulted to obtain the pair-wise comparison of RL drivers and barriers. The net effect and the importance level of each factor was provided from each perspective separately, and from the aggregated form (overall perspective).

Given the main contributions, the next Section addresses the accomplishment of the research objectives.

### 7.2.1. Achievement of research objectives

The evolution of this work was aimed at meeting the main objective and specific objectives of this research. To clarify this issue, Table 24 summarizes the achievement of each purpose of this study.

Table 24 – Accomplishment of research objectives.

| **Objectives** | **Accomplishment** |
|---|---|
| **Specific Objective 1**: Provide a synthesis of the state-of-the-art of RL in Brazil; | This SO was accomplished in Chapter 3, where a detailed picture of RL in the Brazilian context through a systematic literature review process is provided. |
| **Specific Objective 2**: Explore RL practices in Brazil in order to gather practical knowledge on the field in this country; | This SO is attained in Chapter 4, where two different exploratory case-based studies performed in Brazil were presented. The outcomes from this Chapter offered a primary practical basis for the continuation of the research. |
| **Specific Objective 3**: Identify the most relevant RL drivers, barriers, and stakeholders and classify them into a framework; | This SO is accomplished in Chapter 5, where a thorough literature review on RL drivers, barriers and stakeholders was provided. In this step, the multi-perspective framework for RL drivers and barriers is also given. |
| **Specific Objective 4**: Provide a multiple stakeholders' | This SO is achieved in Chapter 6, where an evaluation of RL influential factors from experts in the Brazilian context is |

| | |
|---|---|
| perspective analysis for RL drivers and barriers in Brazil and a research agenda based on the research gaps found during this study; | provided using grey-based DEMATEL. The research agenda is given in topic 7.2.3. |
| **Main Objective:** Evaluate the interrelationship among RL drivers and barriers under the perspectives of the most important reverse logistics stakeholders in the Brazilian context. | The primary objective of this research is finally accomplished in Chapter 6 and in the present Chapter, which presents significant cross analysis of the main outcomes from this research. |

### 7.2.2. Practical and managerial implications

Concerning its general implications, this research may be considered as relevant. There is a great waste problem, and it is an issue that must be considered. A substantial part of the waste from EOL products is still dumped in landfills or incinerated, polluting the environment severely. In order to reduce this impact, RL operations must take place to guarantee a proper destination for used products. To do so, companies must take advantage of the motivational factors to implement it and, at the same time, to deal with the impediments placed by their stakeholders. To accomplish that, a broader understanding of these complex relationships seems necessary. Thus, companies that can effectively and efficiently implement RL contribute to the increasing environmental challenge. Besides, this work can also contribute to a reduction of the scarcity of raw materials. Fundamentally, the more materials are recovered, the less nature is exploited.

Concerning the managerial implications, knowledge of the barriers and drivers that influence the adoption of product returns and recovery management helps manufacturers to understand their corporate responsibility towards environmental conservation. In

addition, a critical analysis of these factors, as well as knowing the actors causing them or being affected by them, can be a valuable source of information to decision makers. Evaluating the multiple stakeholder perspectives helps to diminish uncertainties in implementing RL as more thoughtful strategic initiatives are pursued. The understanding of the influential factors from a multiple stakeholder perspective is crucial for developing a holistic industry strategy of effectively implementing RL.

We focused on factors with greater influence and greater relevance or importance for each perspective. The explanation for this rationale is the prioritization of actions for entities implementing or managing RL. That is, with the purpose to better understand the issues concerning RL implementation and management, it is considered that firms should firstly deal with the most influencing and important factors, i.e., manage the important root causes of the system. In other words, knowing the causal factors allow companies to draw a priority list of actions towards RL implementation, considering these most causal and influential factors. Moreover, beyond that, the findings of this research have valuable implications not only for companies, but for a variety of RL stakeholders including public policy makers, industry practitioners, and academic researchers. Concerning the latter, the results of this study may be also useful for learning more about RL adoption in Latin America, since Brazil is the most relevant economy of this region.

### 7.2.3. Limitations and future research paths

Although this study was thoroughly completed, there are still limitations, which provide an opportunity for future research. Reverse logistics factors were carefully gathered from literature by a systematic procedure, but the classification according to the stakeholders involved and their nature (internal, external) was subjective. That is, despite the fact that three researchers were involved in the validation and the content analysis for the framework construction, the categorization remains interpretative and hence subjective. More comprehensive bibliometric citation analyses appear as a further solution and structured approach to classify these factors.

Concerning the adopted solution methodology, even with all the advantages of grey-based DEMATEL, some limitations can also be pointed out. The first main drawback is the massive evaluating effort required from experts when performing the pair-wise comparisons. Each respondent had to compare a multitude of pairs from 17 drivers and then from 20 barriers. Therefore, fatigue may have occurred as the number of factors judged is relatively high. In order to mitigate this problem, one possible solution is to perform this analysis using clusters of factors instead of factors. These clusters are already provided in Table 14 and Table 15.

Moreover, even considering the representativeness of Brazil in Latin America, this research is focused on a country context. Beyond that, the evaluators are from the Southern part of the country. The results observed in the case area may not be consistent with other regions in Brazil. Expanding the study to other regions of Brazil may determine if these results are representative of these other regions. Furthermore, the chosen companies for DEMATEL application (organization and customer perspectives) are big enterprises. Thus, generalizations to smaller and medium sized enterprises (SMEs) can be made with further study. That is, direction for future research and understanding on RL drivers and barriers should include more attention on SMEs.

Another limitation from this piece of work remains on the fact that the social condition of Brazil was not further analyzed. That is, the influence of the poverty scenario and the survival activities on RL practice was not directly considered, although it was briefly discussed in Section 3.3.4.

In this sense, these limitations leave room for future research on these RL topical areas. Relevant future paths of research were already discussed in detail, but we can still add some fertile areas of research. First, academicians may try to use other multi-criteria decision making tools to evaluate the interactions among RL influential factors using this multiple perspective framework. Future works may also examine and compare different nations' contexts for RL implementation based on the framework presented in this research.

In general terms, we also believe that further empirical research is necessary to deepen the knowledge about the factors and implementation of reverse logistics processes in the context of emerging economies. More research is needed to understand, evaluate

and overcome particularly the barriers hindering the RL development in countries such as Brazil. Additional nuances of what is causing companies and the government to engage in conflict on this issue seems necessary. This research is one of the first to look into these issues systematically in Brazil. Evaluating the multiple stakeholder perspectives can help reduce uncertainties in RL implementation as more thoughtful strategies can be drawn jointly. Knowledge of the influential forces in their RL environment may help industries to better implement and manage reverse flows and to bridge the gap between existing and future green solutions for reverse logistics.

## 8. REFERENCES

ABDULLAH, N.; YAAKUB, S.; ABDULLAH, H. H. The impact of customer and stakeholder pressure, financial and competitive pressure, regulatory pressure and corporate citizenship pressure on reverse logistics adoption. *2nd International Conference on Management proceedings*, 2012. p.842-852.

ABDULRAHMAN, M. D.; GUNASEKARAN, A.; SUBRAMANIAN, N. Critical barriers in implementing reverse logistics in the Chinese manufacturing sectors. *International Journal of Production Economics***,** v. 147, n. Part B, p. 460-471, 2014.

ABRAHAM, N. The apparel aftermarket in India - a case study focusing on reverse logistics. *Journal of Fashion Marketing and Management***,** v. 15, n. 2, p. 211-227, 2011.

AITKEN, J.; HARRISON, A. Supply governance structures for reverse logistics systems. *International Journal of Operations & Production Management***,** v. 33, n. 6, p. 745-764, 2013.

AKDOĞAN, M. Ş.; COŞKUN, A. Drivers of Reverse Logistics Activities: An Empirical Investigation. *Procedia - Social and Behavioral Sciences***,** v. 58, n. 0, p. 1640-1649, 2012.

AL ZAABI, S.; AL DHAHERI, N.; DIABAT, A. Analysis of interaction between the barriers for the implementation of sustainable supply chain management. *The International Journal of Advanced Manufacturing Technology***,** v. 68, n. 1-4, p. 895-905, 2013.

ALVAREZ-GIL, M. J.; BERRONE, P.; HUSILLOS, F. J.; LADO, N. Reverse logistics, stakeholders' influence, organizational slack,

and managers' posture. *Journal of Business Research***,** v. 60, n. 5, p. 463-473, May 2007.

ANDIÇ, E.; YURT, Ö.; BALTACıOĞLU, T. Green supply chains: Efforts and potential applications for the Turkish market. *Resources, Conservation and Recycling***,** v. 58, n. 0, p. 50-68, 2012.

ARKADER, R.; FERREIRA, C. F. Category management initiatives from the retailer perspective: a study in the Brazilian grocery retail industry. *Journal of Purchasing and Supply Management***,** v. 10, n. 1, p. 41-51, 2004.

ASSAVAPOKEE, T.; WONGTHATSANEKORN, W. Reverse production system infrastructure design for electronic products in the state of Texas. *Computers & Industrial Engineering***,** v. 62, n. 1, p. 129-140, 2012.

AVKIRAN, N. K.; MORITA, H. Benchmarking firm performance from a multiple-stakeholder perspective with an application to Chinese banking. *Omega***,** v. 38, n. 6, p. 501-508, 2010.

AZAR, A.; ARDAKANI, D. Application of gray-based DEMATEL technique in designing of the aggregate green supply chain management's model. *Uncertain Supply Chain Management***,** v. 2, n. 3, p. 199-208, 2014.

BAI, C.; SARKIS, J. A grey-based DEMATEL model for evaluating business process management critical success factors. *International Journal of Production Economics***,** v. 146, n. 1, p. 281-292, 2013.

BALLOU, R. H. *Gerenciamento da Cadeia de Suprimentos*. 5. Porto Alegre: Bookman, 2006.

BARNEY, J. B. Firm resources and sustained competitive advantage. *Journal of Management***,** v. 17, n. 1, p. 99-120, 1991.

BERNON, M.; ROSSI, S.; CULLEN, J. Retail reverse logistics: a call and grounding framework for research. *International Journal of Physical Distribution & Logistics Management***,** v. 41, n. 5, p. 484-510, 2011.

BERNON, M.; UPPERTON, J.; BASTL, M.; CULLEN, J. An exploration of supply chain integration in the retail product returns process. *International Journal of Physical Distribution and Logistics Management***,** v. 43, n. 7, p. 586-608, 2013.

BOWERSOX, D. J.; CLOSS, D. J. *Logística Empresarial*. São Paulo: Ed. Atlas S.A., 2001.

BRANDENBURG, M.; GOVINDAN, K.; SARKIS, J.; SEURING, S. Quantitative models for sustainable supply chain management: Developments and directions. *European Journal of Operational Research***,** v. 233, n. 2, p. 299-312, 2014.

CERTO, S. C.; PETER, J. P. *Strategic Management: a focus on process*. Irwin, 1993.

CHAN, F. T. S.; CHAN, H. K. A survey on reverse logistics system of mobile phone industry in Hong Kong. *Management Decision***,** v. 46, n. 5, p. 702-708, 2008.

CHAN, F. T. S.; CHAN, H. K.; JAIN, V. A framework of reverse logistics for the automobile industry. *International Journal of Production Research***,** v. 50, n. 5, p. 1318-1331, 2012.

CLEMENS, B.; DOUGLAS, T. J. Does coercion drive firms to adopt `voluntary' green initiatives? Relationships among coercion, superior firm resources, and voluntary green initiatives. *Journal of Business Research***,** v. 59, n. 4, p. 438-491, 2006.

COELHO, T.; CASTRO, R.; GOBBO JR, J. PET containers in Brazil: Opportunities and challenges of a logistics model for post-consumer waste recycling. *Resources, Conservation and Recycling***,** v. 55, n. 3, p. 291-299, 2011.

CRANE, A.; RUEBOTTOM, T. Stakeholder theory and social identity: rethinking stakeholder identification. *Journal of business ethics***,** v. 102, n. 1, p. 77-87, 2011.

DA ROCHA, A.; DIB, L. A. The entry of Wal-Mart in Brazil and the competitive responses of multinational and domestic firms. *International Journal of Retail & Distribution Management***,** v. 30, n. 1, p. 61-73, 2002.

DE BRITO, M. P.; CARBONE, V.; BLANQUART, C. M. Towards a sustainable fashion retail supply chain in Europe: organisation and performance. *International Journal of Production Economics***,** v. 114, n. 2, p. 534-553, 2008.

DE BRITO, M. P.; DEKKER, R. *A framework for reverse logistics*. Springer, 2004.

DE SOUSA JABBOUR, A. B. L.; DE SOUZA AZEVEDO, F.; ARANTES, A. F.; JABBOUR, C. J. C. Green supply chain management in local and multinational high-tech companies located in Brazil. *The International Journal of Advanced Manufacturing Technology***,** v. 68, n. 1-4, p. 807-815, 2013.

DE SOUZA, M. T. S.; DE PAULA, M. B.; DE SOUZA-PINTO, H. O papel das cooperativas de reciclagem nos canais reversos pós-consumo. *RAE-Revista de Administração de Empresas***,** v. 52, n. 2, p. 246-262, 2012.

DENG, J.-L. Introduction to grey system theory. *The Journal of grey system***,** v. 1, n. 1, p. 1-24, 1989.

DIABAT, A.; GOVINDAN, K. An analysis of the drivers affecting the implementation of green supply chain management. *Resources, Conservation and Recycling***,** v. 55, n. 6, p. 659-667, 2011.

DOU, Y.; SARKIS, J. A multiple stakeholder perspective on barriers to implementing China RoHS regulations. *Resources, Conservation and Recycling***,** v. 81, n. 0, p. 92-104, 12// 2013.

EISENHARDT, K. M. Building theories from case study research. *Academy of management review***,** v. 14, n. 4, p. 532-550, 1989.

EL SAADANY, A.; JABER, M.; BONNEY, M. Environmental performance measures for supply chains. *Management Research Review***,** v. 34, n. 11, p. 1202-1221, 2011.

FINEMAN, S.; CLARKE, K. Green stakeholders: industry interpretations and response. *Journal of Management studies***,** v. 33, n. 6, p. 715-730, 1996.

FINK, A. *Conducting research literature reviews*. Sage, 2013.

FLAPPER, S. D. P.; GAYON, J. P.; VERCRAENE, S. Control of a production-inventory system with returns under imperfect advance return information. *European Journal of Operational Research***,** v. 218, n. 2, p. 392-400, 2012.

FLEISCHMANN, M.; BLOEMHOF-RUWAARD, J. M.; VAN DER LAAN, E.; VAN NUNEN, J.; VAN WASSENHOVE, L. Quantitative models for reverse logistics: a review. *European Journal of Operational Research***,** v. 103, n. 1, p. 1–17, 1997.

FREEMAN, R. E. *Strategic management: A stakeholder approach*. Boston: Pitman, 1984.

FU, X.; ZHU, Q.; SARKIS, J. Evaluating green supplier development programs at a telecommunications systems provider. *International Journal of Production Economics***,** v. 140, n. 1, p. 357-367, 11// 2012.

GABUS, A.; FONTELA, E. World problems, an invitation to further thought within the framework of DEMATEL. *Battelle Geneva Research Center, Geneva, Switzerland*, 1972.

GIANNETTI, B. F.; BONILLA, S. H.; ALMEIDA, C. M. V. B. An emergy-based evaluation of a reverse logistics network for steel recycling. *Journal of Cleaner Production***,** v. 46, n. 0, p. 48-57, 2013.

GONZÁLEZ-BENITO, J.; GONZÁLEZ-BENITO, Ó. The role of stakeholder pressure and managerial values in the implementation of environmental logistics practices. *International Journal of Production Research***,** v. 44, n. 7, p. 1353-1373, 2006/04/01 2006.

GONZÁLEZ-TORRE, P.; ÁLVAREZ, M.; SARKIS, J.; ADENSO-DÍAZ, B. Barriers to the Implementation of Environmentally Oriented Reverse Logistics: Evidence from the Automotive Industry Sector. *British Journal of Management***,** v. 21, n. 4, p. 889-904, 2010.

GOVINDAN, K.; KALIYAN, M.; KANNAN, D.; HAQ, A. Barriers analysis for green supply chain management implementation in Indian industries using analytic hierarchy process. *International Journal of Production Economics***,** v. 147, p. 555-568, 2014.

GOVINDAN, K.; KANNAN, D.; SHANKAR, K. M. Evaluating the drivers of corporate social responsibility in the mining industry with multi-criteria approach: A multi-stakeholder perspective. *Journal of Cleaner Production*, 2014.

GOVINDAN, K.; KHODAVERDI, R.; JAFARIAN, A. A fuzzy multi criteria approach for measuring sustainability performance of a supplier based on triple bottom line approach. *Journal of Cleaner Production***,** v. 47, p. 345-354, 2013.

GOVINDAN, K.; PALANIAPPAN, M.; ZHU, Q.; KANNAN, D. Analysis of third party reverse logistics provider using interpretive structural modeling. *International Journal of Production Economics***,** v. 140, n. 1, p. 204-211, 2012.

GOVINDAN, K.; SARKIS, J.; PALANIAPPAN, M. An analytic network process-based multicriteria decision making model for a reverse supply chain. *The International Journal of Advanced Manufacturing Technology***,** v. 68, n. 1-4, p. 863-880, 2013.

GOVINDAN, K.; SOLEIMANI, H.; KANNAN, D. Reverse logistics and closed-loop supply chain: A comprehensive review to explore

the future. *European Journal of Operational Research***,** v. 240, n. 3, p. 603-626, 2015.

GUIDE JR, V. D. R.; VAN WASSENHOVE, L. N. The evolution of closed-loop supply chain research. *Operations Research***,** v. 57, n. 1, p. 10-18, 2009.

HARLAND, C.; LAMMING, R.; WALKER, H.; PHILLIPS, W.; CALDWELL, N.; JOHNSEN, T.; KNIGHT, L.; ZHENG, J. Supply management: is it a discipline? *International Journal of Operations & Production Management***,** v. 26, n. 7, p. 730-753, 2006.

HILLARY, R. Environmental management systems and the smaller enterprise. *Journal of Cleaner Production***,** v. 12, n. 6, p. 561-569, 2004.

HO, G. T. S.; CHOY, K. L.; LAM, C. H. Y.; WONG, D. W. C. Factors influencing implementation of reverse logistics: A survey among Hong Kong businesses. *Measuring Business Excellence***,** v. 16, n. 3, p. 29-46, 2012.

HODGKINSON, G. P.; MAULE, A. J.; BOWN, N. J. Causal cognitive mapping in the organizational strategy field: A comparison of alternative elicitation procedures. *Organizational Research Methods***,** v. 7, n. 1, p. 3-26, 2004.

HSU, C.-C.; TAN, K. C.; ZAILANI, S. H. M.; JAYARAMAN, V. Supply chain drivers that foster the development of green initiatives in an emerging economy. *International Journal of Operations & Production Management***,** v. 33, n. 6, p. 656-688, 2013.

ILGIN, M. A.; ONDEMIR, O.; GUPTA, S. M. An approach to quantify the financial benefit of embedding sensors into products for end-of-life management: A case study. *Production Planning and Control***,** v. 25, n. 1, p. 26-43, 2014.

JABBOUR, A. D. S.; JABBOUR, C.; SARKIS, J.; GOVINDAN, K. Brazil's new national policy on solid waste: challenges and opportunities. *Clean Technologies and Environmental Policy***,** v. 16, n. 1, p. 7-9, 2013/03/29 2014.

JANSE, B.; SCHUUR, P.; BRITO, M. A reverse logistics diagnostic tool: the case of the consumer electronics industry. *The International Journal of Advanced Manufacturing Technology***,** v. 47, n. 5-8, p. 495-513, 2010/03/01 2010.

JAYARAMAN, V.; GUIDE JR, V.; SRIVASTAVA, R. A closed-loop logistics model for remanufacturing. *Journal of the operational research society*, p. 497-508, 1999.

JINDAL, A.; SANGWAN, K. S. Development of an interpretive structural model of drivers for reverse logistics implementation in Indian industry. *International Journal of Business Performance and Supply Chain Modelling***,** v. 5, n. 4, p. 325-342, 2013.

JU-LONG, D. Control problems of grey systems. *Systems & Control Letters***,** v. 1, n. 5, p. 288-294, 1982.

KANNAN, D.; DIABAT, A.; ALREFAEI, M.; GOVINDAN, K.; YONG, G. A carbon footprint based reverse logistics network design model. *Resources, Conservation and Recycling***,** v. 67, n. 0, p. 75-79, 2012.

KANNAN, D.; DIABAT, A.; SHANKAR, K. M. Analyzing the drivers of end-of-life tire management using interpretive structural modeling (ISM). *The International Journal of Advanced Manufacturing Technology***,** v. 72, n. 9-12, p. 1603-1614, 2014.

KAPETANOPOULOU, P.; TAGARAS, G. An empirical investigation of value-added product recovery activities in SMEs using multiple case studies of OEMs and independent remanufacturers. *Flexible services and manufacturing journal***,** v. 21, n. 3-4, p. 92-113, 2009.

_____. Drivers and obstacles of product recovery activities in the Greek industry. *International Journal of Operations & Production Management***,** v. 31, n. 2, p. 148-166, 2011.

KIM, S. T.; LEE, S. Y. Stakeholder pressure and the adoption of environmental logistics practices: Is eco-oriented culture a missing link? *International Journal of Logistics Management***,** v. 23, n. 2, p. 238-258, 2012.

KOLBE, R. H.; BURNETT, M. S. Content-analysis research: an examination of applications with directives for improving research reliability and objectivity. *Journal of consumer research*, p. 243-250, 1991.

KOSKO, B. Fuzzy cognitive maps. *International journal of man-machine studies***,** v. 24, n. 1, p. 65-75, 1986.

KOVÁCS, G.; SPENS, K. M.; KORKEILA, R. Stakeholder response to future changes in the reverse supply chain. *International Journal of Logistics Systems and Management***,** v. 2, n. 2, p. 160-176, 2006.

KRIKKE, H.; HOFENK, D.; WANG, Y. Revealing an invisible giant: A comprehensive survey into return practices within original (closed-loop) supply chains. *Resources, Conservation and Recycling***,** v. 73, n. 0, p. 239-250, 2013.

KUMAR, S.; PUTNAM, V. Cradle to cradle: Reverse logistics strategies and opportunities across three industry sectors. *International Journal of Production Economics***,** v. 115, n. 2, p. 305-315, 2008.

LAGE JUNIOR, M.; GODINHO FILHO, M. Variations of the kanban system: literature review and classification. *International Journal of Production Economics***,** v. 125, n. 1, p. 13-21, 2010.

LAI, K. H.; CHENG, T. C. E.; TANG, A. K. Y. Green retailing: factors for success. *California Management Review***,** v. 52, n. 2, p. 6-31, 2010.

LAU, K. H.; WANG, Y. Reverse logistics in the electronic industry of China: a case study. *Supply Chain Management: An International Journal***,** v. 14, n. 6, p. 447-465, 2009.

LEITE, P. R. *Logística reversa: meio ambiente e competitividade*. Pearson Prentice Hall, 2009.

_____. *Hábitos de Logística Reversa - versão 2010/2011*. Tecnologística. 15**:** 68-75 p. 2011.

LI, P.; TAN, T.; LEE, J. Grey relational analysis of amine inhibition of mild steel corrosion in acids. *Corrosion***,** v. 53, n. 3, p. 186-194, 1997.

MALLAWARACHCHI, H.; KARUNASENA, G. Electronic and electrical waste management in Sri Lanka: Suggestions for national policy enhancements. *Resources, Conservation and Recycling***,** v. 68, p. 44-53, 2012.

MANGLA, S.; MADAAN, J.; CHAN, F. S. Analysis of Performance Focused Variables for Multi-Objective Flexible Decision Modeling Approach of Product Recovery Systems. *Global Journal of Flexible Systems Management***,** v. 13, n. 2, p. 77-86, 2012/06/01 2012.

MANSOUR, S.; ZAREI, M. A multi-period reverse logistics optimisation model for end-of-life vehicles recovery based on EU Directive. *International Journal of Computer Integrated Manufacturing***,** v. 21, n. 7, p. 764-777, 2008.

MARTINS, P. P. P.; BOAVENTURA, J. M. G.; FISCHMANN, A. A.; COSTA, B. K.; SPERS, R. G. Scenarios for the Brazilian road freight transport industry. *foresight***,** v. 14, n. 3, p. 207-224, 2012.

MATHIYAZHAGAN, K.; HAQ, A. N. Analysis of the influential pressures for green supply chain management adoption—an Indian perspective using interpretive structural modeling. *The International Journal of Advanced Manufacturing Technology***,** v. 68, n. 1-4, p. 817-833, 2013.

MEREDITH, J. Theory building through conceptual methods. *International Journal of Operations & Production Management***,** v. 13, n. 5, p. 3-11, 1993.

MITCHELL, R. K.; AGLE, B. R.; WOOD, D. J. Toward a theory of stakeholder identification and salience: Defining the principle of who and what really counts. *Academy of management review***,** v. 22, n. 4, p. 853-886, 1997.

MUDULI, K.; GOVINDAN, K.; BARVE, A.; KANNAN, D.; GENG, Y. Role of behavioural factors in green supply chain management implementation in Indian mining industries. *Resources, Conservation and Recycling*, 2013.

NADKARNI, S.; SHENOY, P. P. A causal mapping approach to constructing Bayesian networks. *Decision Support Systems***,** v. 38, n. 2, p. 259-281, 2004.

NAIMING XIE, D. Y. Y.; DR CHUANMIN MI, P.; HUANG, Y. Development prediction of logistics industry in Henan province and its dynamic analysis. *Grey Systems: Theory and Application***,** v. 4, n. 2, p. 186-194, 2014.

NIKOLAOU, I. E.; EVANGELINOS, K. I.; ALLAN, S. A reverse logistics social responsibility evaluation framework based on the triple bottom line approach. *Journal of Cleaner Production***,** v. 56, n. 1, p. 173-184, 2013.

NUNES, K. R. A.; MAHLER, C. F.; VALLE, R. A. Reverse logistics in the Brazilian construction industry. *Journal of Environmental Management***,** v. 90, n. 12, p. 3717-3720, 2009.

PHILLIPS, R.; FREEMAN, R. E.; WICKS, A. C. What stakeholder theory is not. *Business Ethics Quarterly*, p. 479-502, 2003.

POHLEN, T. L.; FARRIS, M. T. Reverse logistics in plastics recycling. *International Journal of Physical Distribution & Logistics Management***,** v. 22, n. 7, p. 35-47, 1992.

RAHIMIFARD, S.; COATES, G.; STAIKOS, T.; EDWARDS, C.; ABU-BAKAR, M. Barriers, drivers and challenges for sustainable product recovery and recycling. *International Journal of Sustainable Engineering***,** v. 2, n. 2, p. 80-90, 2009.

RAVI, V.; SHANKAR, R. Analysis of interactions among the barriers of reverse logistics. *Technological Forecasting and Social Change***,** v. 72, n. 8, p. 1011-1029, 2005.

ROGERS, D. S.; TIBBEN-LEMBKE, R. S. *Going backwards: reverse logistics trends and practices*. Pittsburgh, PA: Reverse Logistics Executive Council, 1999.

ROGERS, D. S.; TIBBEN-LEMBKE, R. An examination of reverse logistics practices. *Journal of business Logistics***,** v. 22, n. 2, p. 129-148, 2001.

SAAVEDRA, Y. M. B.; BARQUET, A. P. B.; ROZENFELD, H.; FORCELLINI, F. A.; OMETTO, A. R. Remanufacturing in Brazil: case studies on the automotive sector. *Journal of Cleaner Production***,** v. 53, n. 0, p. 267-276, 2013.

SARKIS, J.; GONZALEZ-TORRE, P.; ADENSO-DIAZ, B. Stakeholder pressure and the adoption of environmental practices: The mediating effect of training. *Journal of Operations Management***,** v. 28, n. 2, p. 163-176, 2010.

SARKIS, J.; ZHU, Q.; LAI, K.-H. An organizational theoretic review of green supply chain management literature. *International Journal of Production Economics***,** v. 130, n. 1, p. 1-15, 2011.

SASIKUMAR, P.; KANNAN, G. Issues in reverse supply chains, part II: reverse distribution issues – an overview. *International Journal of Sustainable Engineering***,** v. 1, n. 4, p. 234-249, 2008/12/01 2008.

SEURING, S.; GOLD, S. Conducting content-analysis based literature reviews in supply chain management. *Supply Chain Management: An International Journal***,** v. 17, n. 5, p. 544-555, 2012.

SEURING, S.; MÜLLER, M. From a literature review to a conceptual framework for sustainable supply chain management. *Journal of Cleaner Production***,** v. 16, n. 15, p. 1699-1710, 2008.

SHAHARUDIN, M. R.; ZAILANI, S.; TAN, K. C. Barriers to product returns and recovery management in a developing country: investigation using multiple methods. *Journal of Cleaner Production*, n. in press, p. doi: 10.1016/j.jclepro.2013.12.071, 2014.

SHAIK, M. N.; ABDUL-KADER, W. Transportation in reverse logistics enterprise: a comprehensive performance measurement methodology. *Production Planning & Control***,** v. 24, n. 6, p. 495-510, 2013.

SHAIK, M. N.; ABDUL-KADER, W. Comprehensive performance measurement and causal-effect decision making model for reverse logistics enterprise. *Computers & Industrial Engineering***,** v. 68, p. 87-103, 2014.

SHANG, K.-C.; LU, C.-S.; LI, S. A taxonomy of green supply chain management capability among electronics-related manufacturing firms in Taiwan. *Journal of environmental management***,** v. 91, n. 5, p. 1218-1226, 2010.

SHAPIRO, G.; MARKOFF, G. Methods for drawing statistical inferences from text and transcripts. In: ROBERTS, C. W. (Ed.). *Text Analysis for the Social Sciences*. Mahwah, NJ: Lawrence Erlbaum Associates, 1997. p.9-31.

SHARMA, S.; PANDA, B.; MAHAPATRA, S.; SAHU, S. Analysis of barriers for reverse logistics: an Indian perspective. *International Journal of Modeling and Optimization***,** v. 1, n. 2, p. 101-6, 2011.

SHEAR, H.; SPEH, T.; STOCK, J. Many happy (product) returns. *Harvard Business Review***,** v. 80, n. 7, p. 16-17, 2002.

ŠKAPA, R. Reverse logistics in the Czech Republic: Barriers to development. *Acta Universitatis Agriculturae et Silviculturae Mendelianae Brunensis***,** v. 59, n. 4, p. 363-370, 2011.

SRIVASTAVA, S. K. Green supply-chain management: a state-of-the-art literature review. *International journal of management reviews***,** v. 9, n. 1, p. 53-80, 2007.

SRIVASTAVA, S. K. Network design for reverse logistics. *Omega***,** v. 36, n. 4, p. 535-548, 2008.

SRIVASTAVA, S. K. Issues and Challenges in Reverse Logistics. In: GUPTA, S. M. (Ed.). *Reverse Supply Chains: Issues and Analysis*. Boca Raton, FL: Taylor & Francis, 2013. cap. 2, p.61-82.

STAROSTKA-PATYK, M.; ZAWADA, M.; PABIAN, A.; ABED, M. Barriers to reverse logistics implementation in enterprises. *Advanced Logistics and Transport (ICALT), 2013 International Conference on*, 2013. IEEE. p.506-511.

STOCK, J. R. *Reverse logistics: White paper*. Council of Logistics Management, 1992.

STUART, I.; MCCUTCHEON, D.; HANDFIELD, R.; MCLACHLIN, R.; SAMSON, D. Effective case research in operations management: a process perspective. *Journal of Operations Management***,** v. 20, n. 5, p. 419-433, 2002.

SUBRAMANIAN, N.; GUNASEKARAN, A.; ABDULRAHMAN, M.; LIU, C. Factors for implementing end-of-life product reverse logistics in the Chinese manufacturing sector. *International Journal of Sustainable Development & World Ecology*, n. ahead-of-print, p. 1-11, 2014.

SUBRAMONIAM, R.; HUISINGH, D.; CHINNAM, R. B. Remanufacturing for the automotive aftermarket-strategic factors: literature review and future research needs. *Journal of Cleaner Production***,** v. 17, n. 13, p. 1163-1174, 2009.

SUBRAMONIAM, R.; HUISINGH, D.; CHINNAM, R. B.; SUBRAMONIAM, S. Remanufacturing Decision-Making Framework (RDMF): research validation using the analytical hierarchical process. *Journal of Cleaner Production***,** v. 40, n. 0, p. 212-220, 2013.

TAN, K. H.; PLATTS, K. Linking objectives to actions: A decision support approach based on cause–effect linkages. *Decision sciences***,** v. 34, n. 3, p. 569-593, 2003.

THIERRY, M. C.; SALOMON, M.; JO, J. V. N.; LUK, L. V. W. Strategic issues in product recovery management. *California management review***,** v. 37, n. 2, p. 114-135, 1995.

TSENG, M.-L. A causal and effect decision making model of service quality expectation using grey-fuzzy DEMATEL approach. *Expert systems with applications***,** v. 36, n. 4, p. 7738-7748, 2009.

UNITED_NATIONS. *Resilient People, Resilient Planet: A future worth choosing*. New York: United Nations, 2012.

VAN DER WIEL, A.; BOSSINK, B.; MASUREL, E. Reverse logistics for waste reduction in cradle-to-cradle-oriented firms: Waste management strategies in the Dutch metal industry. *International Journal of Technology Management***,** v. 60, n. 1-2, p. 96-113, 2012.

VOSS, C.; TSIKRIKTSIS, N.; FROHLICH, M. Case research in operations management. *International journal of operations & production management***,** v. 22, n. 2, p. 195-219, 2002.

WASSENHOVE, L.; BESIOU, M. Complex problems with multiple stakeholders: how to bridge the gap between reality and OR/MS? *Journal of Business Economics***,** v. 83, n. 1, p. 87-97, 2013/02/01 2013.

WU, W.-W.; LEE, Y.-T. Developing global managers' competencies using the fuzzy DEMATEL method. *Expert systems with applications***,** v. 32, n. 2, p. 499-507, 2007.

XIA, X.; GOVINDAN, K.; ZHU, Q. Analyzing internal barriers for automotive parts remanufacturers in China using grey-DEMATEL approach. *Journal of Cleaner Production*, 2014.

XIE, Y.; BREEN, L. Greening community pharmaceutical supply chain in UK: a cross boundary approach. *Supply Chain Management-an International Journal***,** v. 17, n. 1, p. 40-53, 2012.

YAMAGUCHI, D.; LI, G.-D.; CHEN, L.-C.; NAGAI, M. Reviewing crisp, fuzzy, grey and rough mathematical models. *Grey Systems and Intelligent Services, 2007. GSIS 2007. IEEE International Conference on*, 2007. IEEE. p.547-552.

YANG, Y.; JOHN, R. Grey systems and interval valued fuzzy sets. *EUSFLAT Conf.*, 2003. p.193-197.

YE, F.; ZHAO, X.; PRAHINSKI, C.; LI, Y. The impact of institutional pressures, top managers' posture and reverse logistics on performance—Evidence from China. *International Journal of Production Economics***,** v. 143, n. 1, p. 132-143, 2013.

YIN, R. K. *Case study research: Design and methods*. California: Sage Publications, 2009.

YING, L.; QINGHUA, Z.; XIQIANG, X. Analysis of Barriers to Green Food Sustainable Supply Chain on Grey-DEMATEL Basis. *Contemporary Economy & Management***,** v. 6, p. 006, 2013.

YUSUF, I.; RAOUF, A. Reverse logistics: An empirical study for operational framework. *Proceedings of the Pakistan Academy of Sciences***,** v. 50, n. 3, p. 201-210, 2013.

ZHANG, T.; CHU, J.; WANG, X.; LIU, X.; CUI, P. Development pattern and enhancing system of automotive components remanufacturing industry in China. *Resources, Conservation and Recycling***,** v. 55, n. 6, p. 613-622, 2011.

ZHU, Q.; GENG, Y. Drivers and barriers of extended supply chain practices for energy saving and emission reduction among Chinese manufacturers. *Journal of Cleaner Production***,** v. 40, n. 0, p. 6-12, 2013.

ZHU, Q.; SARKIS, J. Relationships between operational practices and performance among early adopters of green supply chain management practices in Chinese manufacturing enterprises. *Journal of Operations Management***,** v. 22, n. 3, p. 265-289, 2004.

ZHU, Q.; SARKIS, J.; GENG, Y. Barriers to environmentally-friendly clothing production among Chinese apparel companies. *Asian Business & Management***,** v. 10, n. 3, p. 425-452, 2011.

ZHU, Q.; SARKIS, J.; LAI, K.-H. Green supply chain management implications for "closing the loop". *Transportation Research Part E: Logistics and Transportation Review***,** v. 44, n. 1, p. 1-18, 2008.

_____. Supply chain-based barriers for truck-engine remanufacturing in China. *Transportation Research Part E: Logistics and Transportation Review***,** v. 68, n. 0, p. 103-117, 8// 2014.

# APPENDIX

# APPENDIX A

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# Managing end of life products: a review of the literature on reverse logistics in Brazil

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## Abstract

**Purpose** – The environmental consciousness of customers and the emergence of stricter environmental regulations has pushed industries to think about environmental management by means of reverse logistics (RL) implementation. The purpose of this paper is to provide a current panorama of RL in Brazil and a comparison to international RL body of literature as well. It also seeks to provide a systematic literature review procedure and a conceptual framework for RL literature categorization.

**Design/methodology/approach** – A descriptive and content analysis approach was adopted. First, a topic delimitation phase was aimed at defining the main research areas and related keywords. Second, a material collection phase focussed on a selection of peer-reviewed Brazilian and international journals. Third, a total of 34 papers were assessed by quantitative indicators, and a conceptual RL framework was employed to classify them. Finally, papers were evaluated using content analysis.

**Findings** – The RL research gaps in Brazil are in information technology, facility location, inventory control, outsourcing, and performance measurement. It is also reported that, In Brazil, RL is predominantly linked to recycling activities, and the practice of RL is driven by social conditions and economics in some specific industrial sectors.

**Research limitations/implications** – The focus is restricted to RL applications in Brazil and the corresponding articles published by Brazilian researchers.

**Originality/value** – Practitioners and academics might find this review useful, as it outlines gaps and limitations of existing research in the largest Latin America economy. This work is built on the recent research in RL. No systematic literature review of this kind has previously been undertaken.

**Keywords** Content analysis, Brazil, Reverse logistics, Literature review, Conceptual framework, End of life product

**Paper type** Literature review

## 1. Introduction

The environmental impact of products has become an important issue of concern over the past few decades (Gurtoo and Antony, 2007). As governments are making stricter environmental regulations and customers have become more environmental conscious, the industries need to reduce the environmental impact of their products. Companies have been trying to improve their own environmental performance and have involved the supply chain (SC) in this process (Chiarini, 2013). This fact has pushed industries to think about environmental management by means of responsible waste disposal and reverse logistics (RL) implementation. Thus, RL activities

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# APPENDIX B

ADLMAIER, D.; SELLITTO, M. A. Embalagens retornáveis para transporte de bens manufaturados: um estudo de caso em logística reversa. Produção, v. 17, n. 2, p. 395-406, 2007.

ANDRADE DE ABREU, J. C.; ARMOND-DE-MELO, D. R.; LEOPOLDINO, C. B. Entre fluxos e contra-fluxos: um estudo de caso sobre logística e sua aplicação na responsabilidade socioambiental. Revista Eletrônica de Ciência Administrativa, v. 10, n. 1, p. 84-97, 2011.

AQUINO, I. F. D.; CASTILHO JR., A. B. D.; PIRES, T. S. D. L. A organização em rede dos catadores de materiais recicláveis na cadeia produtiva reversa de pós-consumo da região da grande Florianópolis: uma alternativa de agregação de valor. Gestão & Produção, v. 16, n. 1, p. 15-24, 2009.

CASTANHO, S. C. R.; SACOMANO NETO, M. Análise dos canais reversos sob a perspectiva de redes de empresas. Revista Gestão Industrial, v. 5, n. 3, p. 23-40, 2009.

CHAVES, G. D. L. D.; BATALHA, M. O. Os consumidores valorizam a coleta de embalagens recicláveis? Um estudo de caso da logística reversa em uma rede de hipermercados. Gestão & Produção, v. 13, n. 3, p. 423-434, 2006.

COELHO, T. M.; CASTRO, R.; GOBBO JR, J. A. PET containers in Brazil: Opportunities and challenges of a logistics model for post-

consumer waste recycling. Resources, Conservation and Recycling, v. 55, n. 3, p. 291-299, 2011.

DA ROSA PORTELLA TONDOLO, R.; DENICOL JÚNIOR, S.; HONORATO SCHUCH SANTOS, C. A quarta forma de verticalização da cadeia reversa: um estudo de caso no setor da borracha. GEPROS. Gestão da Produção, Operações e Sistemas, v. 2, n. 2, p. 25-36, 2009.

DAHER, C. E.; SILVA, E. P. D. L. S.; FONSECA, A. P. Logística Reversa: Oportunidade para Redução de Custos através do Gerenciamento da Cadeia Integrada de Valor. Brazilian Business Review (Portuguese Edition), v. 3, n. 1, p. 58-73, 2006.

DE FIGUEIREDO, J. N.; MAYERLE, S. F. Designing minimum-cost recycling collection networks with required throughput. Transportation Research Part E: Logistics and Transportation Review, v. 44, n. 5, p. 731-752, 2008.

DEMAJOROVIC, J.; HUERTAS, M. K. Z.; BOUERES, J. A.; SILVA, A. G. D.; SOTANO, A. S. Logística reversa: como as empresas comunicam o descarte de baterias e celulares? Revista de Administração de Empresas, v. 52, n. 2, p. 165-178, 2012.

FEHR, M. Measuring the environmental impact of waste flow management in Brazilian apartment buildings. Environment, Development and Sustainability, v. 11, n. 2, p. 319-328, 2007.

FEHR, M.; MELO VASQUES DE CASTRO, M. S.; CALÇADO, M. D. R. Condominium waste management by private initiative: A report of a 10-year project in Brazil. Waste Management and Research, v. 28, n. 4, p. 309-314, 2010.

FEHR, M.; SANTOS, F. C. Landfill diversion: Moving from sanitary to economic targets. Cities, v. 26, n. 5, p. 280-286, 2009.

GIACOBO, F.; ESTRADA, R. S.; CERETTA, P. S. Logística reversa: a satisfação do cliente no pós-venda. Revista Eletrônica de Administração, v. 9, n. 5, p. 01-17, 2003.

GIANNETTI, B. F.; BONILLA, S. H.; ALMEIDA, C. M. V. B. An emergy-based evaluation of a reverse logistics network for steel recycling. Journal of Cleaner Production, v. in press, 2012.

GIOVANNINI, F.; KRUGLIANSKAS, I. Fatores críticos de sucesso para a criação de um processo inovador sustentável de reciclagem: um estudo de caso. Revista de Administração Contemporânea, v. 12, n. 4, p. 931-951, 2008.

GOMES, F. P.; TORTATO, U. Planejamento e gestão da logística reversa no setor de energia elétrica–um estudo de caso. Revista Gestão Industrial, v. 6, n. 4, p. 197-214, 2010.

GONÇALVES-DIAS, S. L. F. Há vida após a morte: um (re)pensar estratégico para o fim da vida das embalagens. Gestão & Produção, v. 13, n. 3, p. 463-474, 2006.

GONÇALVES-DIAS, S. L. F.; TEODÓSIO, A. D. S. D. S. Estrutura da cadeia reversa: "caminhos" e "descaminhos" da embalagem PET. Produção, v. 16, n. 1, p. 429-441, 2006.

GONÇALVES, M. E.; MARINS, F. A. S. Logística reversa numa empresa de laminação de vidros: um estudo de caso. Gestão & Produção, v. 13, n. 3, p. 397-410, 2006.

GUARNIERI, P.; CHRUSCIACK, D.; OLIVEIRA, I. L. D.; HATAKEYAMA, K.; SCANDELARI, L. WMS -Warehouse Management System: adaptação proposta para o gerenciamento da logística reversa. Produção, v. 16, n. 1, p. 126-139, 2006.

HOJAS BAENAS, J. M.; CASTRO, R.; GOMES BATTISTELLE, R. A.; GOBBO JR, J. A. A study of reverse logistics flow management in vehicle battery industries in the midwest of the state of São Paulo (Brazil). Journal of Cleaner Production, v. 19, n. 2-3, p. 168-172, 2011.

LADEIRA, W. J.; MAEHLER, A. E.; NASCIMENTO, L. F. M. D. Logística reversa de defensivos agrícolas: fatores que influenciam na consciência ambiental de agricultores gaúchos e mineiros. Revista de Economia e Sociologia Rural, v. 50, n. 1, p. 157-174, 2012.

LAGARINHOS, C. A. F.; TENÓRIO, J. A. S. Tecnologias utilizadas para reutilização, reciclagem e valorização energética de pneus no Brasil. Polímeros, v. 18, n. 2, p. 106-118, 2008.

NUNES, K. R. A.; MAHLER, C. F.; VALLE, R. A. Reverse logistics in the Brazilian construction industry. Journal of Environmental Management, v. 90, n. 12, p. 3717-3720, 2009.

PEDROSO, M. C.; ZWICKER, R. Sustentabilidade na cadeia reversa de suprimentos: um estudo de caso do Projeto Plasma. Rev. Adm.(São Paulo), v. 42, n. 4, p. 414-430, 2007.

PEREIRA, A. L.; SILVA, J. T. M.; TEIXEIRA, L. A. A. Healthcare waste reverse logistics: A case study of Brazilian public hospitals. International Business Management, v. 6, n. 2, p. 95-98, 2012.

REZENDE, A. J.; DALMÁCIO, F. Z.; SLOMSKI, V. Impacto econômico-financeiro da logística reversa: uma aplicação no segmento de distribuição de matérias-primas farmacêuticas. Revista Eletrônica de Administração, v. 12, n. 6, p. 1-26, 2006.

SILVA, E. A. D.; MOITA NETO, J. M. Logística reversa nas indústrias de plásticos de Teresina-PI: um estudo de viabilidade. Polímeros, v. 21, n. 3, p. 246-251, 2011.

SILVA FILHO, J. C. L. D.; ABREU, M. C. S. D.; LIMA, D. C. Fatores determinantes para a configuração da cadeia reversa de embalagens de aço para bebidas. Revista Pretexto, v. 11, n. 3, p. 58-80, 2010.

SILVA FILHO, J. C. L. D.; CANTALICE, F. L. B. D. M.; BARBOSA JUNIOR, C. D. S. C.; ABREU, M. C. S. D. Proposta de categorização dos estudos de logística reversa através de uma análise longitudinal da produção científica entre 2003 e 2009. Revista Ciências Administrativas, v. 17, n. 3, p. 856-882, 2011.

SOUZA, M. T. S. D.; PAULA, M. B. D.; SOUZA-PINTO, H. D. O papel das cooperativas de reciclagem nos canais reversos pós-consumo. Revista de Administração de Empresas, v. 52, n. 2, p. 246-262, 2012.

VEIGA, M. M. Flaws in Brazilian take-back program for pesticide containers in a small rural community. Management Research News, v. 32, n. 1, p. 62-77, 2008.

ZARATIN, M. H.; FRANCISCHINI, P. G. ECO-Kanban ea sistematização da comunicação no reaproveitamento de resíduos industriais: um estudo de caso de uma indústria produtora de vidros automotivos. GEPROS. Gestão da Produção, Operações e Sistemas, v. 4, n. 4, p. 115-123, 2009.

# APPENDIX C

Production Planning & Control

**Decision Letter (TPPC-2013-0183.R1)**

**From:** s.j.childe@ex.ac.uk

**To:** marinabouzon@gmail.com

**CC:**

**Subject:** Production Planning & Control - Decision on Manuscript ID TPPC-2013-0183.R1

**Body:** 06-Oct-2014

Dear Ms Bouzon

"Reverse Logistics Drivers: empirical evidence from a case study in Brazil"

Thank you for submitting your revised paper to Production Planning & Control. Subject to satisfactory improvements based on the reviewers' recommendations, we will be pleased to publish the paper. Please see the modifications indicated by the reviewers at the end of this letter. Please also ensure that full reference is made to relevant work already published in Production Planning & Control or elsewhere.

When you revise your manuscript please highlight the changes you make in the manuscript by using the 'track changes' mode in MS Word or by using bold or coloured text. Please also ensure that your paper meets the guidelines laid out here:
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Under "Actions", click on "Create a Revision". Your manuscript number has been appended to denote a revision.

Please enter your responses to the comments made by the reviewer(s) in the space provided. You can use this space to document the changes you made to the original manuscript. Please be as specific as possible in your response to the reviewer(s).

Would you please provide a photograph of each author and a 100-word biography of each author. These may be included as supplementary files.

IMPORTANT: Your original files still remain. Please delete any redundant files.

Thank you for submitting your manuscript to Production Planning & Control. I look forward to receiving your revised paper.

Yours sincerely

Dr Stephen J Childe
Editor

# APPENDIX D

22nd International Conference on Production Research

# BARRIERS AND DRIVERS ON PRODUCT RETURN: A CASE STUDY IN A REVERSE LOGISTICS SERVICE PROVIDER IN BRAZIL

**Abstract ID: SCML10380**

Abstract
Academic and corporate interest in reverse logistics (RL) has risen considerably in recent years. More industries are adopting it as a strategic tool to achieve sustainable profitability, to avoid wastage, to benefit the customer relationship, and to improve their image by greening the supply chain. However, mostly, RL is a complex process. For that reason, many companies decide to outsource its implementation and management in order to avoid dealing with its barriers and impediments. In this sense, the objective of this paper is to identify the most important drivers and barriers that enable or impede RL development in Brazil. For that, a systematic content analysis approach was adopted in order to find the most cited drivers for RL. Secondly, a case-based research was conducted in a Reverse Logistics Service Provider (RLSP) located in Southern Brazil. This aimed at determining the main RL barriers in order to compare them to the data gathered from the literature. Multiple sources of evidence have been used, enabling triangulation data analysis and improving data validity. The prime source of data used was semi-structured interviews, backed up by unstructured interviews, personal observations, and document analysis of company archival sources. The empirical results indicate that five significant barriers hinder the RL development: (1) high taxation on recyclable materials; (2) dispersion of collecting points for end oflifeproducts and the lack of Brazilian consumer awareness of environmentally friendly disposal options; (3) lack of shared responsibility in the reverse supply chain; (4) presence of many parties in the return flow increases its costs; and (5) high RL costs. Both practitioners and academics might find this study useful, as it outlines the Brazilian barriers for RL, the largest Latin America economy. In addition, this work is built on the recent research in RL. The paper closes with a discussion onthe RL barriers and by suggesting future research in the area.
Keywords:
Reverse logistics; case study; reverse logistic service provider;Brazil.

## 1 INTRODUCTION

In the past fifteen years, the interest in closed-loop supply chains, product recovery and reverse logistics (RL) has attracted the attention not only of companies and professionals but also of academia [1-5]. In addition, RL has become a key competence in modern supply chains [6]. Despite RL's apparent current relevance, the available literature on the field is relatively scant[7] and little research has been conducted on the subject[8].

In fact, reverse supply chains (RSC) have not been broadly researched or developed[9]. Therefore, there is great opportunity for the advancement of RL[10]. Although RL is strategically important[11] and the RL concept is gaining popularity in practice, the available literature and theory on the strategic sphere are limited[12].

Many authors have recognized RL's strategic value [13-15]. Although the RL literature has been growing over the past years, limited empirical research has been undertaken to define the management aspects involved [16].

Interestingly most existing research on the drivers and barriers of RL implementation are focused on developed countries, with relatively little attention being paid to developing countries[17], such as Brazil. Moreover, researchers[18, 19] have stated that the scarcity of RL studies for developing countries is hardly surprising because while RL is a mandatory component of the supply chain in developed countries, RL is still in a state of infancy in emerging economies.

Given the current RL scenario, this paper aims to contribute to the RL literature and RL practice by means of a RL case study on a Brazilian Reverse Logistics Service Provider (RLSP). By drawing on the RL literature and the insights obtained from the case study, the present paper aims to identify the most important drivers and barriers that enable or impede RL development in Brazil.

This paper is structured as follows. Section 2 provides the research methods.Section 3 reviews the literature on the concept and processes of RL, RL drivers and the development of a RL environment framework.Section 4 presents the case study and its empirical results. In the final section, final remarks and conclusions are drawn, as well as future work is discussed.

## 2 RESEARCH METHODS

The objective of this research was to identify the most important drivers and barriers that enable or impede RL development in Brazil. To fulfill this purpose, this investigation is twofold. Firstly, international peer-reviewed publication on RL was considered in order to develop a RL environment framework. Secondly, a field research was conducted in a Reverse Logistics Service Provider (RLSP) located in Southern Brazil. A summary of the research design is presented in Figure 1.

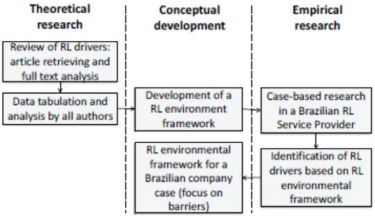


Figure 1: Research design.

### 2.1 Literature review process

This work firstly required methods that would uncover the drivers considered in existing RL literature. For that, it was necessary to obtain meaningful contents to address this particular research purpose from a large amount of

# APPENDIX E

# Research Protocol – Organizational Perspective

***Doctorate researcher**: Marina Bouzon [a,b] – marinabouzon@gmail.com*
***Supervisors**: Carlos M. T. Rodriguez [a] and Kannan Govindan [b]*

[a] *Federal University of Santa Catarina, Brazil*
[b] *University of Southern Denmark, Denmark*

## 1. Research presentation

This is a questionnaire on the barriers (impediments) and drivers (motivational factors) for Reverse Logistics (RL) implementation. Drivers and barriers were taken from previous studies in the field and compiled in a systematic way. For this research, a multiple stakeholder approach is used, considering four perspectives: organizational, customers', governmental and societal. Drivers and barriers from each of the referred stakeholders are presented In Figure 1.

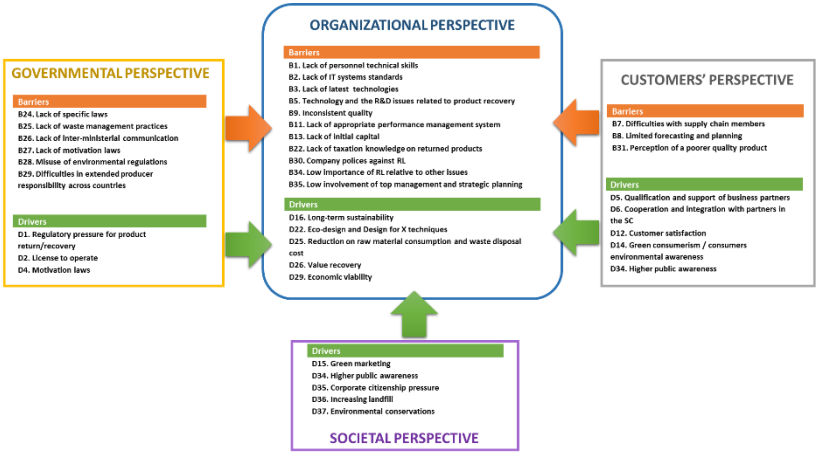


Figure 1: Multi-perspective framework for RL implementation.

Next step for this work is to get experts to analyze these influential factors. Experts from each of the perspectives are chosen, i.e.: at least one respondent from each entity should answer this questionnaire. For data analysis, the grey-DEMATEL multi-criteria decision-making tool is applied. The objective of this application is to obtain the interrelationship between the variables. Drivers and barriers will be evaluated separately. Respondents should complete survey matrices by fulfilling paired comparisons for all influential factors from the presented framework. With this approach, drivers and barriers can be classified in two groups: the cause group and the effect group. Furthermore, this method also delivers strengths of relationships amongst these relationships quantitatively portrayed. Given this, next section brings some basic definitions for this study.

## 2. Definitions

Some definitions are presented to better align the understanding of this project:

- Drivers are considered as factors which cause a particular phenomenon to happen or develop.
- Barriers are the obstacles, both internal and external, which hinder a phenomenon to happen.
- Stakeholders are any group or individual who can affect or is affected by the achievement of the organization's objectives (Freeman, 1984, p. 46). Persons, groups, neighborhoods, organizations, institutions, societies, and even the natural environment are generally thought to qualify as actual or potential stakeholders (Mitchell et al., 1997).
- Reverse logistics is the process of moving goods from their typical final destination for the purpose of capturing value or proper disposal. Reverse logistics comprises all the activities involved in managing, processing, reducing, and disposing of hazardous or nonhazardous waste from production, packaging, and use of products, including the processes of reverse distribution (Govindan et al., 2013; Rogers et al., 1999; Rogers & Tibben-Lembke, 2001).

## 3. General Questions

The main questions to be asked during the interview are presented below. However, the intention is to conduct a semi-structured interview in order to better understand the company's reality on RL. Thereby, the discussion, as well as the questions, are not limited to this list.

General information:

- Respondents name:
- Number of employees:
- Main activity:

Questions:

- Does your company have a RL program? Is there a specific program for end-of-life products?
- How old is the program?
- What are the main activities of this program? Which other companies or entities are involved in the return process?
- Who are the main stakeholders of this program?
- Which are the barriers for RL implementation?
- What are the driving forces for RL implementation?

**4. Specific questions (survey matrices)**

The following questions belong to the grey-DEMATEL approach. A pair-wise comparison among drivers and barriers is performed

separately. The respondents are asked to answer each question with the following linguistic terms: no influence (0), very low influence (1), low influence (2), high influence (3), and very high influence (4). Questions are posed as follows to complete the matrices: How does factor i (row element) influences factor j (column element)?

| Drivers | D1 | D2 | D4 | D5 | D6 | D12 | D14 | D15 | D16 | D22 | D25 | D26 | D29 | D34 | D35 | D36 | D37 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| D1. Regulatory pressure for product return/recovery | 0 | | | | | | | | | | | | | | | | |
| D2. License to operate | | 0 | | | | | | | | | | | | | | | |
| D4. Motivation laws | | | 0 | | | | | | | | | | | | | | |
| D5. Qualification and support of business partners | | | | 0 | | | | | | | | | | | | | |
| D6. Cooperation and integration with partners in the SC | | | | | 0 | | | | | | | | | | | | |
| D12. Customer satisfaction | | | | | | 0 | | | | | | | | | | | |
| D14. Green consumerism / consumers environmental awareness | | | | | | | 0 | | | | | | | | | | |
| D15. Green marketing | | | | | | | | 0 | | | | | | | | | |
| D16. Long-term sustainability | | | | | | | | | 0 | | | | | | | | |
| D22. Eco-design and Design for X techniques | | | | | | | | | | 0 | | | | | | | |
| D25. Reduction on raw material consumption and waste disposal cost | | | | | | | | | | | 0 | | | | | | |
| D26. Value recovery | | | | | | | | | | | | 0 | | | | | |
| D29. Economic viability | | | | | | | | | | | | | 0 | | | | |
| D34. Higher public awareness | | | | | | | | | | | | | | 0 | | | |
| D35. Corporate citizenship pressure | | | | | | | | | | | | | | | 0 | | |
| D36. Increasing landfill | | | | | | | | | | | | | | | | 0 | |
| D37. Environmental conservations | | | | | | | | | | | | | | | | | 0 |

| **Barriers** | **B1** | **B2** | **B3** | **B5** | **B7** | **B8** | **B9** | **B11** | **B13** | **B22** | **B24** | **B25** | **B26** | **B27** | **B28** | **B29** | **B30** | **B31** | **B34** | **B35** |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| B1. Lack of personnel technical skills | 0 | | | | | | | | | | | | | | | | | | | |
| B2. Lack of IT systems standards | | 0 | | | | | | | | | | | | | | | | | | |
| B3. Lack of latest technologies | | | 0 | | | | | | | | | | | | | | | | | |
| B5. Technology and the R&D issues related to product recovery | | | | 0 | | | | | | | | | | | | | | | | |
| B7. Difficulties with supply chain members | | | | | 0 | | | | | | | | | | | | | | | |
| B8. Limited forecasting and planning | | | | | | 0 | | | | | | | | | | | | | | |
| B9. Inconsistent quality | | | | | | | 0 | | | | | | | | | | | | | |
| B11. Lack of appropriate performance management system | | | | | | | | 0 | | | | | | | | | | | | |
| B13. Lack of initial capital | | | | | | | | | 0 | | | | | | | | | | | |
| B22. Lack of taxation knowledge on returned products | | | | | | | | | | 0 | | | | | | | | | | |
| B24. Lack of specific laws | | | | | | | | | | | 0 | | | | | | | | | |
| B25. Lack of waste management practices | | | | | | | | | | | | 0 | | | | | | | | |
| B26. Lack of inter-ministerial communication | | | | | | | | | | | | | 0 | | | | | | | |
| B27. Lack of motivation laws | | | | | | | | | | | | | | 0 | | | | | | |
| B28. Misuse of environmental regulations | | | | | | | | | | | | | | | 0 | | | | | |
| B29. Difficulties in extended producer responsibility across countries | | | | | | | | | | | | | | | | 0 | | | | |
| B30. Company polices against RL | | | | | | | | | | | | | | | | | 0 | | | |
| B31. Perception of a poorer quality product | | | | | | | | | | | | | | | | | | 0 | | |
| B34. Low importance of RL relative to other issues | | | | | | | | | | | | | | | | | | | 0 | |
| B35. Low involvement of top management and strategic planning | | | | | | | | | | | | | | | | | | | | 0 |

## 5. Additional information

If possible, the interview is going to be recorded. However, it is important to mention that the recording is not going to be used for any other purpose than further analysis by the researchers. No reproduction of the recording will be made in full or in part for distribution to any unauthorized person. Likewise, names are not going to be cited, unless formally allowed by the company.

## References

Freeman, R. E. (1984). Strategic management: A stakeholder approach. Boston: Pitman.

Govindan, K., Sarkis, J., & Palaniappan, M. (2013). An analytic network process-based multicriteria decision making model for a reverse supply chain. The International Journal of Advanced Manufacturing Technology, 1-18.

Mitchell, R. K., Agle, B. R., & Wood, D. J. (1997). Toward a theory of stakeholder identification and salience: Defining the principle of who and what really counts. Academy of management review, 22, 853-886.

Rogers, D. S., Tibben-Lembke, R. S., & Council, R. L. E. (1999). Going backwards: reverse logistics trends and practices (Vol. 2): Reverse Logistics Executive Council Pittsburgh, PA.

Rogers, D. S., & Tibben-Lembke, R. (2001). An examination of reverse logistics practices. Journal of business Logistics, 22, 129-148.