

CLOSING THE LOOP

The benefits of the circular economy for developing countries and emerging economies



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This is a joint project between EPEA Brasil, Tearfund and NuReS (Núcleo de Redes de Suprimentos). It is not an official statement of Tearfund's position.

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EPEA Brasil is a Brazilian consulting firm applying Cradle to Cradle® design and the circular economic model as a transformative force to guide development beyond the boundaries of the traditional industrial model. It aims to boost the creativity of work teams to create a new pathway towards economic prosperity, which honours people and nature.



NuReS (Núcleo de Redes de Suprimentos), based in the Department of Production and Systems Engineering of the Federal University of Santa Catarina in the South of Brazil, works in the analysis of transport and logistics through a supply network approach. The mission of NuReS is to develop research and extension projects through partnerships with national public and private institutions domestically and internationally.



Tearfund is a Christian relief and development agency building a global network of local churches to help eradicate poverty.



FOREWORD

This report presents the findings of research undertaken in Brazil with the support of Tearfund and the participation of several Tearfund partners. The circular economy is a relatively new concept in Brazil, but it is related to the existing ideas of the solidarity economy and agro-ecology. Both of these perspectives are important reference points for understanding how the circular economy can be introduced in a way that has a real impact on the lives of the poorest people.

The circular economy is, without doubt, a response to the current 'extract, produce and discard' model, and has the potential to have a positive effect on industrial production processes. If it is also to promote transformation in poor communities affected by inequality and lack of opportunities, the circular economy approach should be put into practice in the right way. In this regard, it needs to dialogue and interact with the solidarity economy (an important political transformation tool in which poor people are the main drivers of the process) and with agro-ecology (an agricultural production model based on the four pillars of sustainability, stability, resilience and using one's own resources). These approaches are complementary and respond to situations of exclusion and invisibility, tackling problems of income and addressing issues of people's dignity and power to take action.



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CONTENTS

EXECUTIVE SUMMARY	5
1 INTRODUCTION: OBJECTIVES AND METHODOLOGY	10
1.1 Research questions	10
1.2 General approach	10
1.3 Literature review methodology	12
2 LITERATURE REVIEW	13
2.1 The circular economy and sustainable development	13
2.2 The circular economy and the Solid Waste National Policy in Brazil	15
2.3 Reverse logistics	16
2.4 Social and environmental benefits	18
2.5 The potential for reverse logistics in Brazil	20
2.5.1 The Solid Waste National Policy and an inclusive circular economy	22
2.6 The role of waste pickers in a circular economy in Brazil	24
2.6.1 Waste picker cooperatives in Brazil	26
3 CASE STUDIES FROM THE LITERATURE	29
3.1 Highlights from the cases	30
3.2 General description	31
3.3 Supply chains of specific types of waste	32
3.3.1 The paper package supply chain in Brazil	32
3.3.2 The plastics reverse supply chain	33
3.3.3 Steel and glass reverse supply chains	35
3.3.4 The steel reverse supply chain: the partnership between Vira-Lata, Gerdau and Porto Seguro	36
3.3.5 The glass reverse supply chain: the partnership between Vira-Lata, Diageo and Owens-Illinois	37
3.3.6 Cataunidos Cooperative: the waste pickers' 'recycling network'	38
3.4 Scenarios	39
3.4.1 Waste reverse logistics in the metropolitan area of Florianópolis: a feasibility study to increase performance of waste picker cooperatives	39
3.4.2 Municipal solid waste logistics and the inclusion of waste picker associations: a feasibility study of the material recovery facilities network	40
3.4.3 Municipal organic solid waste and domestic sewage in Campinas, Brazil: a feasibility study of organic waste recovery models	42

4	NEW CASE STUDIES	44
4.1	Summary of findings from case studies	44
4.2	Concrete examples of what a circular economy development pathway would look like in practice	47
4.2.1	AJRVI	47
4.2.2	Ratoroi	50
4.2.3	Seleta	53
4.2.4	Diaconia	57
4.2.5	Procomposto	61
4.2.6	OEKO	64
4.2.7	Nat.Genius	68
4.2.8	GRS	72
4.3	Final remarks	75
5	CONCLUSIONS AND RECOMMENDATIONS	76
5.1	Research findings	76
5.2	Recommendations	77
6	BIBLIOGRAPHY	76

FIGURES AND TABLES

SECTION 1

Figure 1	Approach of the research	11
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SECTION 2

Figure 2	Cycles of the circular economy	14
Figure 3	Technological and biological product cycles through the economic system	15
Figure 4	Forward and reverse logistics flow	17
Figure 5	The main focus of papers in the study (382 papers, 2007–2013)	18
Figure 6	Percentage of municipalities with waste-sorting collection services in Brazil	20
Figure 7	Amount of recyclable waste recovered through collection in Brazil	21
Figure 8	Percentage of sorted waste collected by different types of managers (companies, waste picker organisations or directly by the municipality) in each of Brazilian regions	26
Figure 9	Main actors of the reverse supply chain	27
Table 1	Main activities of value recovery of post-consumer products	18
Table 2	Municipalities and population with waste-sorting collection services by each Brazilian region	20
Table 3	Economic benefits of recycling: an approximation	21

Table 4	Comparison of the actual situation and the proposed scenario	22
Table 5	Pathway to build an inclusive resources management system (socially inclusive circular economy)	23
Table 6	Summary of waste pickers' social profile	24
Table 7	Average educational level of waste pickers compared to Brazilian population	25
Table 8	Percentage of recyclable waste collected by each type of operator in Brazil	25
Table 9	Number of different waste management facilities operated by different managers	25

SECTION 3

Figure 10	The basic stages in municipal waste management	31
Figure 11	Waste materials reverse supply chain	32
Figure 12	Paper supply chain	33
Figure 13	Types of plastic most recycled in Rio de Janeiro	34
Figure 14	Plastic supply chain	34
Figure 15	Reverse supply chain in the partnership between Gerdau, Porto Seguro and Vira-Lata	37
Figure 16	Glass supply chain in the case of Diageo's bottles	38
Figure 17	Cataunidos Recycling Network	39
Figure 18	Proposal of logistics organisation for waste picker cooperatives	40
Figure 19	Municipal solid waste supply chain	41
Figure 20	Pattern of profit, revenue and cost (USD/year)	42
Figure 21	Supply chain for the first scenario proposed in the study	43
Table 10	Summary presented from case analysis	30
Table 11	Scenario assessment results: comparison of the proposed scenarios and the actual situation in Campinas	43

SECTION 4

Figure 22	Ratoroi–AJRVI closed supply chain model	47
Figure 23	Ratoroi–footwear closed supply chain model	51
Figure 24	Seleta closed supply chain model	54
Figure 25	Diaconia–bio-digester closed supply chain model	58
Figure 26	Procomposto–OEKO closed supply chain model	61
Figure 27	OEKO–Procomposto closed supply chain model	65
Figure 28	Nat.Genius closed supply chain model	69
Table 12	Summary of main fieldwork findings	44

EXECUTIVE SUMMARY

This report presents evidence to the effect that emerging economies can leapfrog development stages and implement an economic model that is better both for society and for the environment. The circular Cradle to Cradle® paradigm* is a production model aimed at leveraging steady economic development for the future, without causing environmental damage. If implemented correctly, it is capable of promoting the maintenance of natural ecosystems while at the same time offering benefits to the poorest groups in society.

The report illustrates the tremendous window of opportunity provided for Brazil by the new Solid Waste National Policy. Policies such as this can help low- and middle-income countries to build on and formalise existing informal circular economic activities, thereby taking a development path that avoids many unsustainable elements of the linear production model.

The various case studies included in this report demonstrate the potential of the circular economic model to bring numerous social benefits, such as strengthening local economies, empowering the poorest families and building resilience, through stimulating the entrepreneurial spirit of businesses based on the solidarity economy.

Although the circular economy concept is not yet very well known in Brazil, this system has already taken root in various countries, in innovative businesses and major global production chains.

Why circular?

Emerging economies like Brazil frequently encounter the false dilemma of having to choose between social development or environmental protection, as the two appear somewhat incompatible. The dilemma becomes even thornier when a degree of environmental destruction seems unavoidable if social development is to be achieved.

At global level, the economy is currently following a linear model based on 'extracting, producing and throwing away' and, as a result, the planet's ability to sustain life is shrinking fast. This represents the greatest threat to recent advances in social development and has many negative environmental impacts, primarily affecting the people and economies of developing countries. The two inevitable consequences arising from the failure of the current linear production model are becoming increasingly obvious: non-renewable resources for the production of goods are quickly becoming scarce, while the damage to the environment is compromising ecosystem services such as pure water, clean air, fertile soil and biodiversity – very often irreversibly.

On the other hand, the Cradle to Cradle® concept on which the circular production system is based can offer a genuinely viable alternative to the dilemma of 'developing or preserving', because it is able to promote improvements in the natural ecosystem and, at the same time, foster human social justice. That is because this economic model is based on the same rules followed by nature's production system, which sustains life. Nothing in nature is thrown away – everything that an organism discharges throughout its life cycle becomes raw material and nutrients for other beings. This is the foundation of the circular economy which, seeing the production system from a new 'positive impact' perspective, becomes a common working framework capable of guiding creativity and innovation – the most abundant resources humanity possesses.

Making the emerging economies of developing countries circular

The majority of academic and business case studies undertaken around the circular economy concept have so far produced analyses focusing on the reality in European countries. For example, studies have shown

* Cradle to Cradle® is a design concept that was developed in the 1990s by Prof Dr Michael Braungart, William McDonough and the scientists of EPEA Internationale Umweltforschung in Hamburg. It describes the safe and potentially infinite use of materials in cycles. Cradle to Cradle® is a registered trademark of MBDC. For more information see www.epea-hamburg.org

how Europe can benefit in environmental and social terms from the principles of the circular economy, generating economic gains of €1.8 trillion by 2030 (McKinsey & Company, 2015).

But what advantages could this concept offer if it were adopted by the emerging economies of developing countries? This is an important question, because the bulk of the world's population is concentrated in those countries, and in the future global environmental and social outcomes will depend to a large extent on how countries like Brazil, China and India use their natural resources.

This study therefore aims to investigate the relevance of the circular economic system for emerging economies – and the poorest people in those countries – on the basis of recent experience in Brazil. It is particularly pertinent now because Brazil is introducing a new Solid Waste National Policy, which is triggering a series of innovations in the social, technological, economic, political, legal and environmental fields.

The analyses carried out during this work sought to discover:

- what benefits the circular economy already offers in comparison with a linear economy in the Brazilian context, for instance in existing examples of informal circular supply chains
- what economic, social and environmental benefits are linked to developing more circular supply chains in Brazil
- what role the government can potentially play in helping existing production chains to adopt the circular production model.

Results

Circular supply chains offer clear environmental benefits. Various features of circular economic activities help to minimise use of fossil fuel and reduce both the extraction of virgin raw material and sources of pollution. They can improve the carbon balance sheet and also foster responsible use of water and soil. For example, circular economic activities involving the repair, reuse/redistribution, refurbishing/remanufacturing and recycling of products help to reverse the impacts of goods production. In the same way, circular supply chains reduce the negative effects on environmental and human health (and their associated costs) – for instance, by eliminating the need for dumps and landfill. Apart from this, landfilling organic waste creates a large volume of greenhouse gas emissions and many health problems. Finally, to create genuinely beneficial circular supply chains, specific regulations need to be laid down, especially to control the toxic substances used in the components of products to be recovered or recycled. In brief, the circular economic paradigm has the potential to decouple economic growth from the intensive use of natural resources and provides evidence that circular chains can move the future in a positive direction.

CASE STUDY 1 Procomposto: The opportunity of organic waste

Procomposto is a 'start-up' offering reverse logistics services to major generators of urban organic waste. Unlike the situation in most European cities, more than half of all urban waste generated in Brazil is organic. Of the 94,000 tonne volume generated every day, less than 1 per cent is currently treated biologically or composted, the rest being disposed of in landfill or dumps. Procomposto's processing system prevents organic waste from going to landfill and emitting methane (CH₄), a very damaging greenhouse gas. Instead, the carbon can be put back into the soil through the application of organic fertiliser produced in sustainable agricultural processes. The company's business model is suitable for the great majority of small and medium-sized cities (fewer than 50,000 inhabitants) in Brazil. If the technology were scaled up to cover 25 per cent of the urban waste produced in Brazil, Procomposto's model could create more than 10,000 jobs and help to reduce CO₂ emissions by the equivalent of approximately 100,000 tonnes per day (Brown, Kruger and Subler, 2008).

There are clear opportunities to involve groups at the bottom of the economic pyramid in circular supply chains, thereby improving these people's incomes and working conditions. This relates to the activities of not only waste pickers and recyclers, but also artisans, family farmers and vulnerable communities. These individuals can more easily benefit when they are organised into a legally recognised structure such as an association or cooperative, because this means they can sign contracts with private businesses and the public sector. In Brazil, support for the formalisation of these workers' activities has come from a series of initiatives.

CASE STUDY 2 **AJRVI: The circular economy for the poorest**

In Brazil, pickers of recyclable waste represent a significant proportion of the poorest population of urban areas. By organising themselves into recycling cooperatives, these individuals can leave the informal sector behind, enjoy better working conditions and increase their income, while working to increase recycling rates for waste that would otherwise be dumped in landfills or the environment. One example is the Associação Jaraguense de Recicladores do Vale do Itapocú (AJRVI), an association founded in 2012 by a small group of waste pickers who wanted to improve their work opportunities. Three years later, AJRVI is providing work for around 100 people – 20 families – with the potential to generate average monthly income of R\$ 5,000 per family. Apart from the material received from the local rubbish collection system, half of the takings come from marketing recyclable waste purchased from other waste picker groups in the region.

Circular supply chains help to boost productivity and job creation. There have already been various cases of private companies establishing their own reverse logistics systems not only to comply with the new Solid Waste National Policy law, but also because they see the potential efficiency and productivity gains (in comparison with the cost of virgin raw materials, for instance). Profit margins are often small, but there are reasons to believe that the economic benefits could increase as more experience is gained, infrastructure expands in the sector and economies of scale are achieved. Various new businesses are being set up in Brazil as part of circular production systems, with the potential to create a significant number of new jobs and even new economic sectors.

CASE STUDY 3 **Nat.Genius: Industrial innovation**

Nat.Genius is a business unit of Embraco – a multinational in the manufacturing sector. It focuses on the reverse logistics of electronic waste, engaging in research and development to find efficient solutions for the reuse and recycling of components and materials. The Nat.Genius programme has already remanufactured more than 3 million compressors and recycled 6,200 tonnes of materials. The company expects that reverse logistics for the industry will create many more better-quality jobs than the current system of disposal in landfill. In addition, it believes that there are mutual benefits to be gained from establishing links between industries and recycling cooperatives, especially for the implementation of door-to-door collection systems for discarded products.

The government has an important role to play in creating a climate conducive to the establishment of socially effective circular supply chains. Firstly, it needs to provide the right level of economic incentives, ensuring that the environmental externalities of linear supply chains are factored into companies' costs (for example, by charging for the environmental costs of landfills or making manufacturers responsible for end-of-life products) and, in addition, ensuring that circular supply chains and the related products receive tax breaks or are at least taxed equally. Secondly, the government should facilitate cooperation between all stakeholders in each supply chain. Finally, it needs to ensure that circular supply chains are established in a way that includes or benefits the poorest groups in society. Nevertheless, the capacity to fulfil a large part of this role is very often limited. Responsibility for implementation tends to fall to municipalities and there is an urgent need to support these institutions at local level.

CASE STUDY 4 **Diaconia: A circular economy in rural areas**

Diaconia is a pioneer NGO in the field of agro-ecological technologies, and presently promotes circular production systems in rural areas for more than 4,000 people involved in family farming. The NGO has adapted and rolled out anaerobic digestion technology for the use of poor rural families in drought-stricken areas of the semi-arid Brazilian north-east. In place of wood, the families can use the biogas produced to cook for free. The process can also produce nutrient-rich fertilisers to increase agro-ecological production and, at the same time, potentially reduce the related greenhouse gas emissions.

There is a real possibility that countries like Brazil could overcome the problems of the current production system and move directly to a new economic model more beneficial for both people and the environment. While many developed countries have virtually eliminated the repair, reuse and recycle sectors of their economies, emerging economies and developing countries have economically vibrant activities in these and other circular sectors, although these activities largely reside in the informal economy. Consequently, countries with emerging economies could apply a different approach and move towards structuring circular chains on the basis of current economic initiatives. With the creation of a favourable climate, existing informal circular systems could be helped to achieve formalisation and expansion of their activities, as described in the report's case studies. In the treatment of organic waste, for example, significant environmental advantages and job creation potential can be seen when environmental and health factors are added together in a circular production approach built around composting or anaerobic digestion. Developing countries could therefore base their entire organic waste and effluent treatment infrastructure directly on these alternative circular approaches.

CASE STUDY 5 **Vira-Lata: Partnerships between companies and waste picker cooperatives**

The Vira-Lata cooperative was set up in 1998 with the aim of generating income for the community through the collection, recycling and marketing of waste. The cooperative plays a key role in reverse logistics for several large multinational industries operating in Brazil. For example, in the steel supply chain, the cooperative is responsible for collecting discarded vehicle components from the network of auto-repair shops of the Porto Seguro insurance company and selling the material to Gerdau, a leading steel company. Another example relates to the glass supply chain: the cooperative collects drinks bottles from distributors and establishments for the Diageo company and sells the material mainly to Owens-Illinois, a global producer of glass packaging. Both arrangements produce more efficient reverse logistics systems and, for both the steel and glass supply chains, the cooperative's participation makes reverse logistics economically viable, with better results than if the operation were carried out by the companies themselves. Furthermore, in enabling the circular flow of recyclable waste between generators and recyclers, the door-to-door collection and sorting services performed by the cooperative give the companies better control over the operational risks related to the illegal market – preventing the use of the glass bottles for counterfeit drinks or the improper reuse of defective car parts (Demajorovic et al, 2014).

Recommendations

The report puts forward a series of recommendations to help the Brazilian government promote the formation of circular supply chains. These recommendations are also relevant for other parties interested in the circular economy, and for emerging economies in other parts of the world. Detailed in the final section of the report, the recommendations may be summed up as:

1 Create a national-level policy framework for the circular economy

Building on the excellent start made by the Solid Waste National Policy, the new policy to promote the circular economy needs to refine some elements of current legislation. For example, there are many wasted opportunities in the fields of organic waste and agro-ecology. Unlike other countries, Brazil's urban waste comprises 51 per cent of organic matter on average, generating high levels of greenhouse gas emissions in landfills. Technologies for recovering organic waste through composting on a large scale are viable, however, and have already been tested. Similarly, agro-ecological production initiatives in rural areas offer huge potential for local production in the circular model, using simple, decentralised, cheap technologies.

2 Establish a permanent Brazilian resource panel

Open for multi-stakeholder participation, the panel would be a vehicle for identifying and promoting best circular economy practice in emerging economies at all levels, bringing together policy-makers, industry bodies, universities, business leaders and civil society organisations.

3 Build capacity and raise awareness of the circular economy

Public management capacity at municipal level is a particular cause of concern. There is a risk that the potential social benefits arising from the proper application of the Solid Waste National Policy in Brazil will be lost unless an effort is made to increase understanding of the social role of circular chains. At the same time, if they are to play a part in the circular supply chains in accordance with the Solid Waste National Policy, waste picker groups need support to organise themselves into cooperatives and acquire skills in business and production management.

4 Form international partnerships for the circular economy

Product design standards in the European Union and other major markets have considerable influence on global manufacturing chains and impact various aspects of production in Brazil, including reuse, repair and recycle capability. Similarly, valuable waste considered as secondary raw material is often sent beyond national frontiers for processing and is therefore lost. Cooperation with international partners is key to breaking into global circular supply chains.

Final considerations

The study demonstrates the potential of supply chains in the circular economic model to increase job creation and improve the working conditions and pay of the poorest groups in society. The study also provides evidence that circular chains can promote activities capable of strengthening local economies, empowering and increasing the resilience of resource-poor families and promoting an entrepreneurial spirit for the solidarity economy. Furthermore, the circular economic model makes it possible for emerging economies to move directly to a more beneficial development model, with much more effective, balanced results for society and nature.

In conclusion, we can affirm that failing to support circular economic initiatives in emerging economies is a wasted opportunity to learn how the circular economy can offer a solution which, while promoting development and enhancing the natural ecosystem, can effectively reduce poverty on our planet.

SECTION 1

INTRODUCTION: OBJECTIVES AND METHODOLOGY

This work aims to improve understanding of the benefits of the circular economy as an alternative development pathway in Brazil and to draw lessons for policy, programming and advocacy work that could drive a more systemic shift towards the circular economy in developing countries. The main goal is to find examples of best practice across Brazil and thus set out the case for the circular economy as a beneficial and feasible part of the development pathway for low- and middle-income communities. There is currently limited information available on examples of the circular economy in low- and middle-income countries and in particular there is little evidence regarding:

- the benefits that a circular economy development pathway could offer
- concrete examples of what a circular economy development pathway would look like in practice
- how the circular economy could be pursued by governments in developing countries
- which circular economy approaches are relevant for a developing country context
- how these approaches are different from those proposed in a developed country context

1.1 Research questions

The following question was posed by the research: 'To what extent does the circular economy prove itself to be a feasible and beneficial part of a development pathway for developing countries?' The research sought out information to support the analysis of the quantitative and qualitative benefits of the circular economy and its advantages over a linear economy in the Brazilian context, focusing on three main types of information:

- existing examples of circular supply chains in Brazil that show evidence of positive impacts at both community and national level
- evidence of the advantages for Brazil of developing circular supply chains, from an economic, social and environmental perspective
- the role of the government (in terms of both infrastructure and legislation) in moving supply chains to a circular model as well as formalising the existing informal circular structures

1.2 General approach

A brief explanation of the methodology applied in the work may help explain the approach taken in this document. This research was conducted in three phases: literature review, desk-based case studies and new case studies (with businesses, cooperatives and associations). These case studies are also complemented by an interview with policy-makers. The literature review looked for qualitative and quantitative information in three main areas:

- the link between the circular economy and sustainable development
- the link between the circular economy and the Brazilian Solid Waste National Policy (SWNP)
- the link between the circular economy, the SWNP and reverse logistics

PESTLE/STEEPL analysis

This exploratory research will identify and help explain some of the existing examples in the literature of supply chains that are being built towards the circular economy, to examine the environmental, economic and social impacts. In order to assess the feasibility of circular models and their benefits, we reviewed existing literature on Brazilian supply chain management case studies using the STEEPL analysis framework to have a better understanding of six dimensions. PESTLE/STEEPL analysis is primarily used by organisations to identify the various factors that shape the external environment in which the organisation operates (Babette and Fleisher, 2008). The six dimensions from STEEPL used to guide this analysis were:

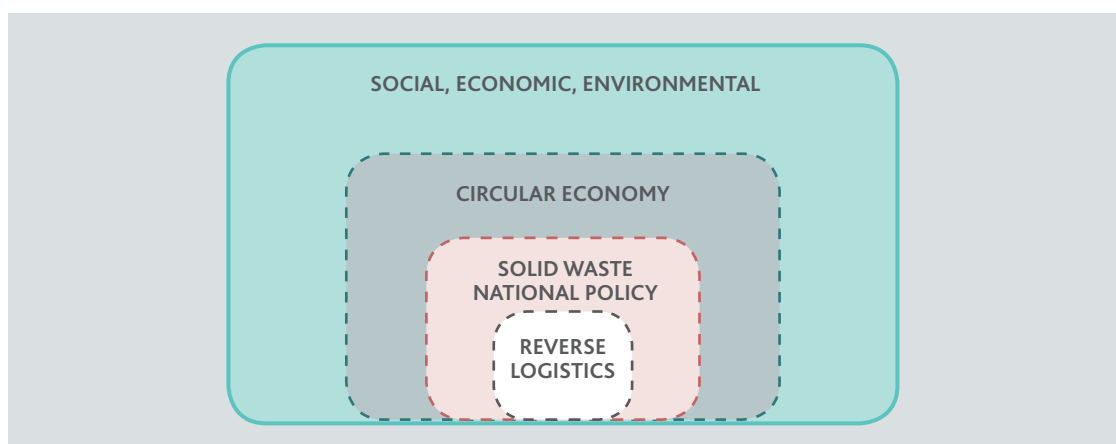
- S**ocial factors
- T**echnological factors
- E**conomic factors
- E**nvironmental factors
- P**olitical factors
- L**egal factors (where relevant)

The literature shows that the circular economy can be applied on many levels, including design standards, repair and reuse, remanufacturing and the potential for alternative business models such as the performance and sharing economies. However, attitudes and policies regarding waste appear to be the 'low-hanging fruit', especially in Brazil, where waste management is a very topical issue following the recent introduction of new legislation called the SWNP. Therefore, this study focuses primarily on waste and reverse logistics as the entry-point for a circular economy.

Reverse logistics means creating systems to enable the return of recyclable or reusable products and materials back into the supply chain (Meade and Sarkis, 2002). It involves planning, implementing and controlling the flow of materials, products in process, finished goods and related information from the point of consumption to the point of origin through reverse distribution channels, with the aim of recovering value or ensuring their proper disposal, all of which requires an efficient flow at low cost (Valle and Souza, 2014). We examine case studies in reverse logistics for several supply chains in Brazil.

The circular economy is framed inside the three dimensions of sustainable development (social, economic, environmental). Embedded in the circular economy, the SWNP is a policy instrument devised by the Brazilian government that has the potential to foster circular economic approaches in the country. Finally, reverse logistics is a key element of the SWNP, which ultimately enables the adoption and spread of the circular economy in many local initiatives. Figure 1 helps explain this approach:

Figure 1 Approach of the research



1.3 Literature review methodology

The literature review has involved the study of international scientific journals and prominent books and reports in the field. Selection of the most appropriate articles was based on a research methodology and all non-reliable sources were discarded. Three key phrases were used in the online search engine of the scientific database, Science Direct: 'circular economy', 'Solid Waste National Policy' and 'reverse logistics + Brazil'. The articles and other sources were selected by identifying their relevance through their titles and abstracts.

The case studies found were classified into two groups with common characteristics:

- The first group describes cases with value chains of specific waste fractions organised within an industrial supply chain (eg 'closing the loop' for a specific material within a certain supply chain, such as plastic, metal, glass, steel).
- The second group consists of cases that deal with the value chains of mixed waste, organised within a specific geographic boundary (ie 'closing the loop' of materials within a certain municipal or regional area).

It is noteworthy that most case studies found in the literature about product reverse logistics in Brazil have focused on recycling materials instead of the reuse/repair/remanufacture of products. This is potentially because the urgency of public health and environmental concerns – due to the present lack of waste management services and infrastructure – drives a focus on waste. However, the reuse and refurbishment sector certainly exists in Brazil, and may even be thriving, although large elements of this are not recognised by the government (or formal markets). The ease of reuse, repair and remanufacturing is mostly driven by product design controlled by developed regions of the globe, such as Europe and North America.

SECTION 2

LITERATURE REVIEW

This section brings together three main aspects: the circular economy, the Brazilian Solid Waste National Policy (SWNP) and waste pickers in Brazil. In accordance with the aims of this work, this literature review helps explain the context and gives an overview of how these aspects are connected.

2.1 The circular economy and sustainable development

In the current linear production system, product logistics describe a trajectory 'from cradle to grave'. In this paradigm it is accepted that materials turn into waste after use, becoming useless and harmful to people and the environment. In the current scenario of a linear production-consumption pattern, global society is facing some important challenges:

- high rates of production and consumption of goods
- high and volatile commodity prices and scarcity of ecosystem services
- a huge amount of valuable materials and substances turned into toxic waste
- rapid increase in demands posed by social and environmental regulation
- increasing concern and public opinion putting pressure on governments and private organisations

Decoupling environmental pressures from economic growth is one of the main aims of the OECD Environmental Strategy for the First Decade of the 21st Century (OECD, 2001).¹ Keeping the continuous flow of materials is a vital theme for global supply chains, working towards economic and social prosperity while at the same time reducing pollution and extraction. Every time a product is thrown away, the energy, materials and water used in its manufacture are also thrown away and pollution is generated. If these products or their components can be reused and remanufactured instead, this means far fewer pollutants are emitted, less water is used and less energy is required. In contrast to a linear economy, in which we make a product, use it and dispose of it, the circular economy is an economic model that establishes a framework and the building blocks for a resilient industrial system capable of succeeding in the longer term. Guided by the 'Cradle to Cradle®' design framework,² the circular production system distinguishes between and separates technical and biological materials, keeping them at their highest value, to optimise their flow and maintain or increase both technical and natural resource stocks (Ellen MacArthur Foundation, 2013). Restorative by design, the circular economy aims to decouple human development from resource depletion. This is achieved through the effective design of products and processes. Through this, the circular economy approach offers a pathway to resilient growth, provides job creation potential, reduces dependency on resource markets and is a means of reducing vulnerability to resource price shocks. In high-income countries, increasing amounts of thought and investment are being put into creating a formal circular economy, including the development of resource-efficient business models (Ellen MacArthur Foundation, 2014).

The scientific basis for, and advocacy efforts to promote, a transition from linear production to a circular model has had some particularly prominent contributions from thinkers and designers such as Michael Braungart, William McDonough (Braungart and McDonough, 2002) and Walter R Stahel,³ and also from institutions such as the Ellen MacArthur Foundation,⁴ McKinsey & Co (Nguyen et al, 2014) and the Cradle to

1 See www.oecd.org/env/indicators-modelling-outlooks/1933638.pdf

2 'Cradle to Cradle®' is a design concept that was developed in the 1990s by Prof Dr Michael Braungart, William McDonough and the scientists of EPEA Internationale Umweltforschung in Hamburg. It describes the safe and potentially infinite use of materials in cycles. Cradle to Cradle® is a registered trademark of MBDC. For more information see www.epea-hamburg.org.

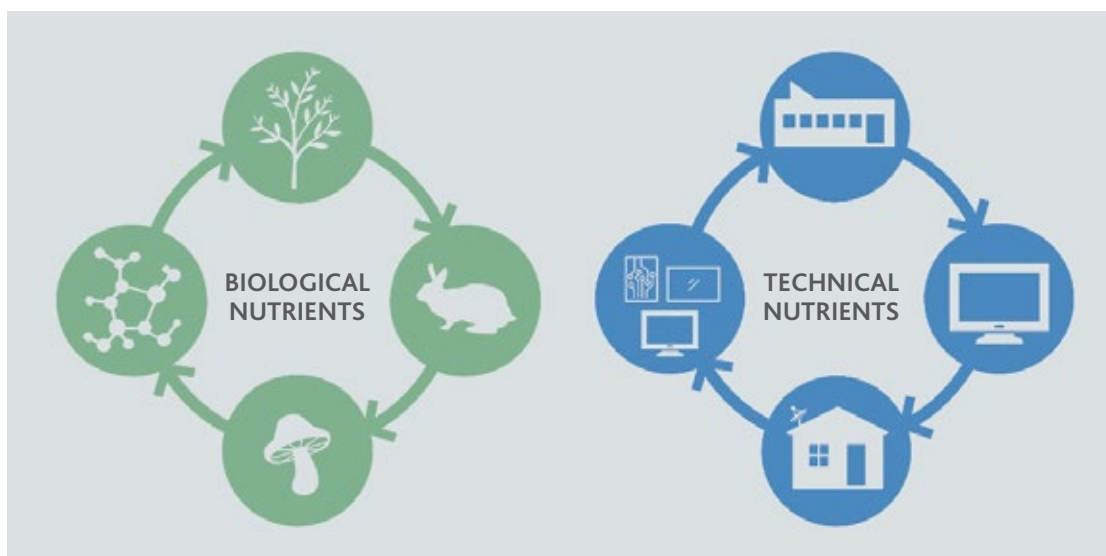
3 See www.product-life.org/en for further details of Stahel's work.

4 See www.ellenmacarthurfoundation.org for more information.

Cradle® Products Innovation Institute,⁵ among others. One example of this transition is the World Economic Forum Annual Meeting in Davos in 2013, which hosted more than 70 leaders from industry, government, academia and civil society to discuss the topic: 'How can the circular economy be scaled up?' (Ellen MacArthur Foundation, 2014). Dominic Waughray, Senior Director of the World Economic Forum, emphasises that the economic gain from saving materials alone is estimated at more than a trillion dollars a year. Furthermore, he says that a shift to reusing, remanufacturing and recycling products innovatively could lead to significant job creation: for example, 500,000 jobs have already been created by the recycling industry in the EU alone (ibid).

In order to succeed in the circular industrial system, companies adopting the Cradle to Cradle® design criteria commit to ensuring that products are chemically safe for both humans and the environment and designed for disassembly and recyclability for an eco-effective recovery of products and a full integration into the supply chain (Braungart, McDonough and Bollinger, 2007). The Cradle to Cradle® concept is an innovation tool that sets the principles and the design criteria to ensure that all substances and materials used in products are made to be safely and efficiently recovered by the industry to create new products or to go back to nature. The Cradle to Cradle® concept has a scientific approach based on observing nature's production system, where nothing goes to waste and everything sustains and nourishes the ecosystem. In this circular production system there are two cycles: the biological cycle and the technical cycle. In the biological cycle, discarded organic materials are composted back into soil. In the technical cycle, discarded synthetic materials are recycled efficiently. Both cycles are illustrated in Figure 2:

Figure 2 Cycles of the circular economy

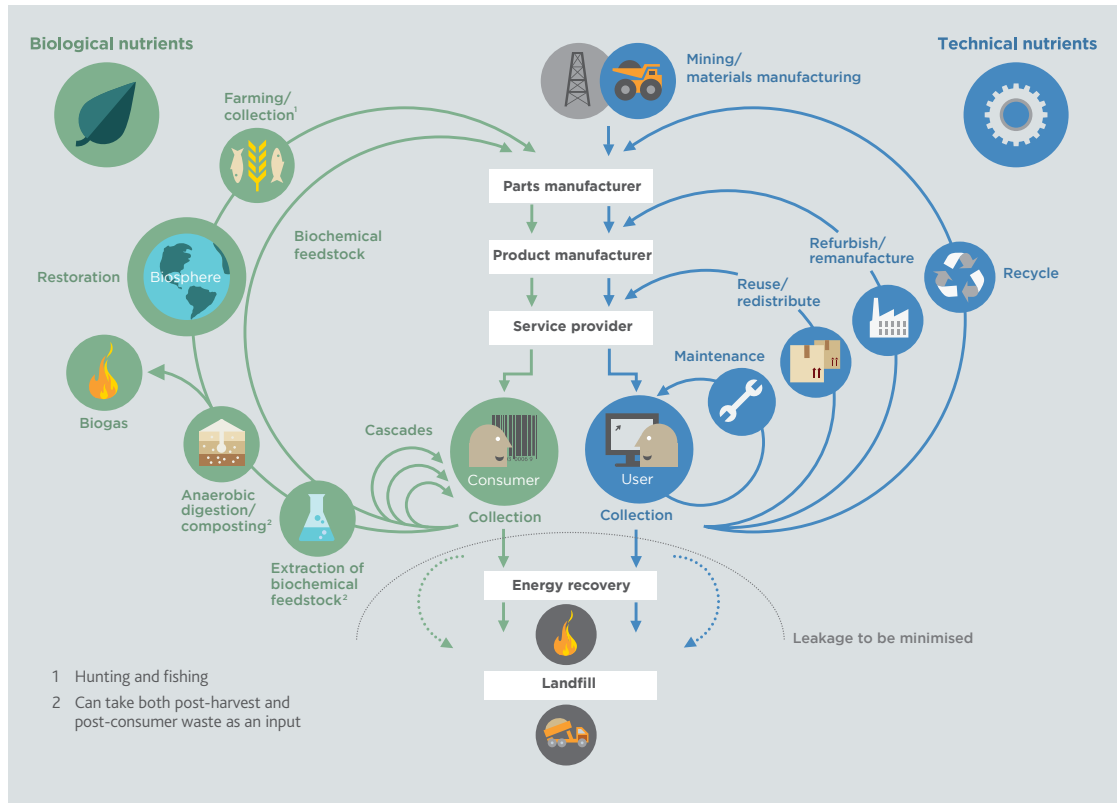


Source: Diagram © MBDC. Used with permission

Figure 3 shows the technical and biological product cycles through the economic system, each with its own set of characteristics:

5 See www.c2ccertified.org for more information.

Figure 3 Technical and biological product cycles through the economic system



Source: Ellen MacArthur Foundation, 2013 – drawn by the Ellen MacArthur Foundation Circular Economy Team

The different circular economic systems in Figure 3 will apply to different products, components or types of material, whether in a specific geographical place or a segment of the (global) supply chain. In general, the tighter the circles are, the larger the savings should be in the embedded costs, in terms of material, labour, energy, capital and externalities such as greenhouse gas emissions, water use or emissions of toxic substances. Keeping products, components and materials longer in use by their spending time within a cycle (eg extending their durability) or going through more consecutive cycles (eg multiple consecutive refurbishments) is also an advantage. Another way to get the most out of circular systems is the cascading of biological products, components or materials through quality categories, eg transforming cotton clothing into furniture fibrefill and, later, insulation material (Ellen MacArthur Foundation, 2013).

There are many studies on the circular economy regarding the context in developed economies, but there is a knowledge gap regarding how it could be implemented in low- and middle-income countries. The key question is therefore whether developing countries could avoid becoming locked into the linear 'take, make, dispose' supply chain model and leapfrog straight to a circular model.

2.2 The circular economy and the Solid Waste National Policy in Brazil

Many developing countries currently have a largely 'informal' version of a quasi-circular economy, such as the waste pickers extracting value from dumps (Manomaivibool, Lindhqvist and Tojo, 2007). However, as supply chains develop, the formal structure that replaces them currently tends to be based on 'business as usual' linear models. Even though the circular economy goes beyond the recycling of waste, waste poses many social, environmental and economic challenges and opportunities in developing countries. The related issue of landfill has been a driver of change towards recycling, further aiding community economic and environmental development. More recently, in Brazil there is increasing openness to the theme, as new regulations such as the SWNP (Brasil: Casa Civil, 2010) started to come into effect in 2014 and national and municipal waste management plans are being put in place to get the most from these opportunities.

Debate around the need to help the Brazilian waste management system evolve towards a circular model can be traced back to the mid-1990s. In an article published by the School of Business Administration FGV (Fundação Getúlio Vargas) the author states: *'The current system of waste management must have as a priority to "manage an ecological cycle", which means to build a circular system in a way that the amount of waste to be reintroduced in the industrial system gets bigger while the amount to be disposed gets smaller.'* In substitution of 'command and control' instruments, economic instruments could regulate based on market mechanisms. In theory, this economic approach towards waste could bring advantages by stimulating the private sector to develop new technologies, eliminating the need for extensive legislation and lowering the oversight costs as a result (Demajorovic, 1995).

In Brazil, the new SWNP has introduced many innovations. Overall, it recognises that waste materials have market value through their potential for future use. The law embeds a system perspective that looks for the whole product life cycle from raw material extraction, with integrated supply chain management and no waste generation as a priority. The SWNP defines 'solid waste' as any material, substance or good (solid, liquid or gas) under management, use or ownership that is discarded as a result of human activities and requires a proper destination. According to the legal definition, solid waste will be considered rejected only if there is no other means to recover it and put it to a new use by available cost-effective technologies (Brasil: Casa Civil, 2010). The law also states that the design and planning of solid waste management must bring solutions envisioning sustainability, meaning that political, economic, environmental, cultural and social dimensions should be considered at all stages of the solid waste flow. Therefore, the law understands that a solid residue is a good with economic and social value and recognises its intrinsic potential to create jobs and generate income to promote citizenship. As a principle, the new policy calls for a systemic approach in the search for solutions in the planning and decision-making process of waste management.

The SWNP obliges manufacturers, importers, distributors and traders to establish reverse logistics programmes of recyclable and reusable materials, primarily in partnership with cooperatives or other forms of waste picker associations made up of low-income individuals. Consequently, shared responsibility for product life cycle and reverse logistics for recovering waste products and materials as a social and economic development tool are subjects for lively debate in different sectors of society, including industry, public administration and consumers. In this sense, the law expresses this goal to help develop a 'base of the pyramid' (BoP) economy in the country. Both government and companies have started to adopt measures to comply with the goals of the new law with regard to urban and industrial waste management systems.

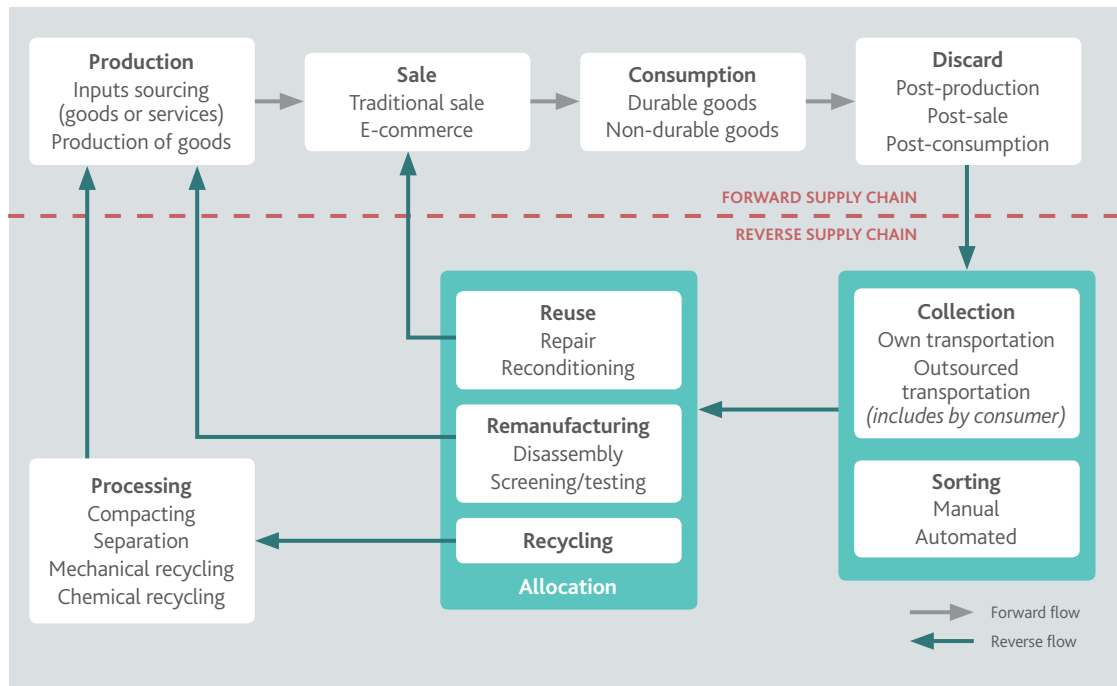
To conclude, the SWNP can be a driver for creating reverse logistics systems that improve environmental outcomes and also create economic opportunities for those at the base of the economic pyramid.

2.3 Reverse logistics

Particularly in terms of post-consumer materials, reverse logistics systems might be understood as a fundamental tool for closed-loop supply chain management in the framework of a circular economy. In the SWNP reverse logistics is defined as a tool for economic and social development, by providing the actions, procedures and means to reinstate waste as a valuable resource for industry (Brasil: Casa Civil, 2010). Reverse logistics is traditionally an activity within organisations to enable defective products or those under warranty to return to the supplier; more recently, the definition of reverse logistics from a holistic environmental perspective focuses primarily on the return of recyclable or reusable products and materials to the forward supply chain and has added importance to this area of study and practice (Meade and Sarkis, 2002). Valle and Souza (2014) state that reverse logistics involves the process of planning, implementing and controlling the flow of materials, products in process, finished goods and related information from the point of consumption to the point of origin through reverse distribution channels with the purpose of recovering value or ensuring their proper disposal, requiring an efficient flow and low cost to enable this process. For Silva, Pimenta and Campos (2013), reverse logistics is vitally important in minimising waste in landfills, since it directs reusable materials back into the production cycle. According to Meade and Sarkis (2002), reverse logistics plays a key role in helping organisations close the loop for products. More than simply a 'backward' direct logistic flow, reverse logistics systems require the reorganisation of parts of the supply chain, the appropriate management of warehousing and transportation in reverse flows,

the potential establishment of new businesses and the integrated management of reverse and closed-loop supply chains to ensure the efficiency and effectiveness of the processes involved. The design and implementation of reverse logistics systems also require specific knowledge and skills about materials management, and the availability of specific infrastructure to allocate waste to different destinations – reuse, remanufacturing or recycling – and proper disposal, such as landfill (Corrêa and Xavier, 2013). Figure 4 illustrates the flow of activities managed in a reverse logistics system:

Figure 4 Forward and reverse logistics flow



Source: Adapted from Corrêa and Xavier, 2013

In Figure 4, the forward direct flow is represented by production, sale, consumption and discard. The reverse flow starts with the collection and sorting activities. The collection activities are defined as the accumulation of products for reverse logistics systems, while sorting activities can be defined as deciding what to do with each product with the purpose of finding the appropriate destination for each material (Meade and Sarkis, 2002). The next stage constitutes the allocation, where products that have the potential to be reused should be separated to be repaired or reconditioned before being commercialised again. If the product does not have potential to be reused, it can be disassembled, separated or tested with the purpose of selecting parts to go for remanufacturing. If the material does not fit into any of these categories, it should then be recycled through separation, compacting and mechanical and chemical processes, depending on its nature. A short description of the three main activities of value recovery of post-consumer products is described in Table 1. Products without the potential for regaining value in the chain should be disposed of through environmentally friendly processes.

Table 1 Main activities of value recovery of post-consumer products

Reuse	Reusable parts and products are reinserted into consumer products. There is often a social component in the reuse of products and materials.
Remanufacturing	This is an alternative that restores the original properties of parts and products for the purpose of reinstating them into stages of manufacturing/assembly or consumption.
Recycling	This uses process and technological innovations to allow the reinsertion of materials into the manufacturing stage.

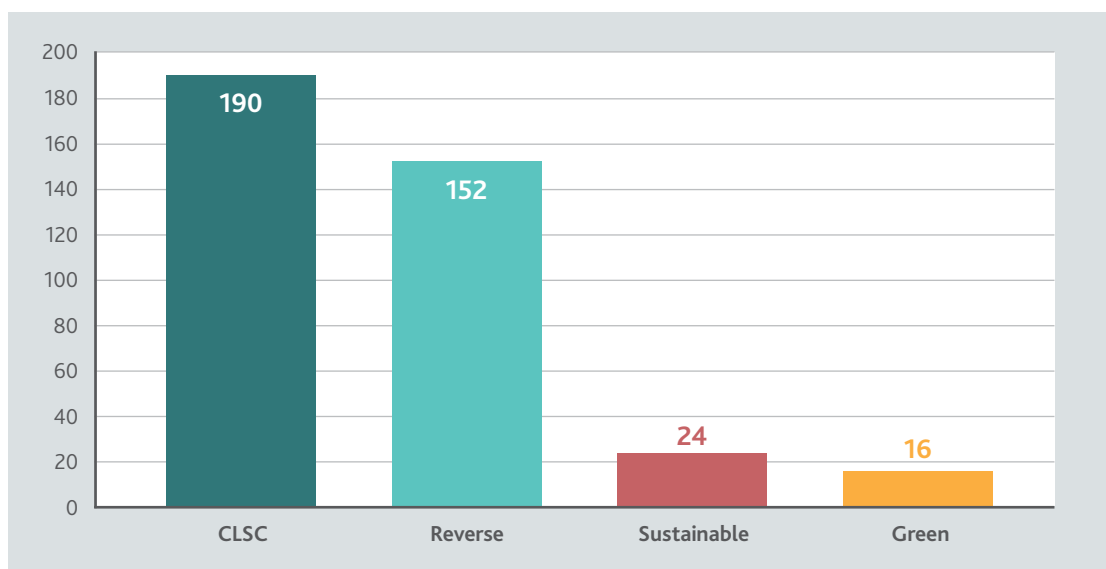
Source: Adapted from Corrêa and Xavier, 2013

Reverse logistics systems can either happen within a supply chain or within a geographical area. In the case of a supply chain, the responsibility usually lies with companies to enable collection and give an appropriate destination to the residue. Reverse logistics systems that happen within a geographical area are usually managed and sometimes operated by the public sector.

2.4 Social and environmental benefits

There is some literature on the environmental benefits of reverse logistics, but there is very little on the social benefits of recovery activities as an integrated circular supply chain. In a comprehensive literature review by Schenkel et al (2015) on relevant green reverse logistics and closed-loop supply chains, only two articles that explored the topic of the logistics social responsibility were found, and neither considered social inclusion as a benefit. In another comprehensive literature review (Govindan, Soleimani and Kannan, 2014), assessing more than 380 relevant works in scientific journals, the authors conclude that studies generally omit to integrate environmental and social issues within reverse logistics and the closed-loop supply chain (CLSC). Figure 5 summarises these:

Figure 5 The main focus of papers in the study (382 papers, 2007–2013)



Source: Govindan et al, 2014

Although moves to apply sustainability theory to supply chain management are only just starting to receive attention, a study from Sarkis, Helms and Hervani (2010) presents some good evidence that there are numerous social and sustainability trade-offs associated with reverse logistics. The authors argue that the return of goods and materials through an existing supply chain has considerable social implications that affect companies, industrial networks, communities, international supply chains and the environment. Therefore, a socially responsible organisation must manage reverse logistics plans, strategies and operations

for reuse, reclamation and recycling of products considering sustainability criteria and indicators over the full life cycle of a product or service (Sarkis, Helms and Hervani, 2010). But stakeholder communications need to incorporate the potential advantages of reverse logistics from financial, environmental and social perspectives. Shareholders want value from reverse logistics activities. On the other hand, other stakeholders that have significant influence over the implementation of recycling and reverse logistics programmes, such as customers, employees and governments, tend to focus more on social and sometimes environmental factors. Therefore, knowledge-sharing programmes emphasising a life-cycle approach for products and materials should include customers, suppliers, vendors and all members of the supply chain (Park, Sarkis and Wu, 2010).

Since the operational skills needed to sort and dismantle products require significant manual labour, reverse logistics creates many opportunities in terms of low-skilled jobs. However, these labour-intensive activities may jeopardise the economic feasibility of implementing reverse logistics. Furthermore, given the uncertainties and variability implicit in the supply of end-of-life or recycled materials, jobs are temporary in many cases, and training and career advancement are minimal. To overcome this, new reverse logistics regulations must enable the development of a new set of reverse logistics activities, skills, infrastructure and technology (Sarkis, Helms and Hervani, 2010). So developing economies face the challenge – and opportunity – of building on, rather than replacing, existing informal recycling systems. Some authors argue that training informal waste pickers and organising them into small or medium-sized enterprises (SMEs) is a very effective way to upgrade their ability to add value to collected materials, legitimise their activities and increase their income (Wilson, Velis and Cheeseman, 2006). These authors state that, if waste pickers are organised into cooperatives and associations, they can negotiate directly with local authorities and/or the private sector as intermediate dealers. But to reach this goal, public policy has to improve with regard to organising the informal recycling sector and integrating its activities within the formal waste management sector. The authors also found that public-private partnerships involving SMEs and the existing informal recycling network are an important option that needs more attention. Furthermore, Medina (2008) found that most successful experiences involving organising waste pickers to work in reverse supply chains in Brazil are based on three models: micro-enterprises, cooperatives and public-private partnerships. The micro-enterprises help the municipality serve the neighbourhoods that lack waste collection services. The cooperatives are associations of waste pickers that can provide reverse logistics services to the municipality and companies. Public-private partnerships arise when, for example, the municipality controls infrastructure and equipment, while waste pickers provide labour.

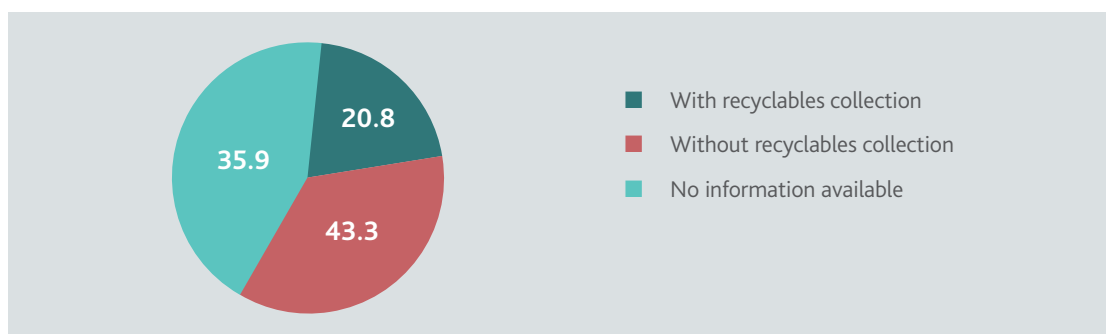
Besides the social benefits, environmental impact assessment along the supply chain also links to reverse logistics in many ways, such as life-cycle assessment, product stewardship and design-for-the-environment principles. Efficient reverse logistics of materials can reduce demand for raw materials extraction and processing and associated environmental pollution, improving public health and well-being. By contrast, a broken global reverse logistics system can have serious negative environmental and social impacts if products containing hazardous materials – such as household appliances and electronic equipment from developed countries – end up in less developed countries, in communities unable to manage the toxic materials in products (Park, Sarkis and Wu, 2010; Sarkis, Helms and Hervani, 2010). Innovations to improve reverse logistics systems can push companies to create new designs for easy disassembly and reuse for products. Depending on the type of product or material and processes, some reverse logistics activities such as shredding may cause air emissions or spillage of hazardous substances, and sorting and disassembly operations may pose health risks in the long term. So, the development of production processes and material substitutions in products to improve reverse logistics systems' health and safety may result in positive impacts for both workers and the environment by creating healthier working environments and reducing the number of injuries and potential risks. Safety for workers is also improved through the standardisation of components, the use of automated systems and the simplification of processes (Park, Sarkis and Wu, 2010; Sarkis, Helms and Hervani, 2010).

Finally, reverse logistics also has economic advantages. Strategic factors to be considered in reverse logistics must include cost-benefit analysis, supply management, quality control, customer relationships, and environmental and regulation concerns. Profitability in reverse logistics depends on the state of the competition and the nature of the markets and is also influenced by the efficiency achieved through coordination and integration of the reverse logistics channel members (Sarkis, Helms and Hervani, 2010).

2.5 The potential for reverse logistics in Brazil

The 2013 report of the Brazilian National Sanitation Information System – SNIS, or Urban Solid Waste Management Diagnosis – gives some important data analysis, which provides evidence of the hidden social and economic potential of the SWNP. The organisation of waste pickers into cooperatives could bring economies of scale and enable access to recyclable material in sufficient volume and frequency so as to be compatible with the dynamics of industrial production (Corrêa and Xavier, 2013). These cooperatives comprise 818 legally established organisations, made up of 22,412 workers, distributed across 547 municipalities (Ministério das Cidades – SNIS, 2013):

Figure 6 Percentage of municipalities with waste-sorting collection services in Brazil



Source: Ministério das Cidades – SNIS, 2013

Figure 6 shows that most of the 5,570 Brazilian municipalities did not have recyclable collection services in 2013. This work by SNIS (2013) pulls together information from 3,572 Brazilian municipalities across all regions (84 per cent of all Brazilian populations living in urban areas). In these areas 51.8 million tonnes/year of waste are collected (an average of 1.01kg/person/day). From this, it is possible to estimate that in Brazil only 2 per cent of all waste goes to sorting or composting facilities, 67 per cent goes to landfill and 11 per cent to open dumps. Around one fifth (20.8 per cent) of Brazilian municipalities have collection with sorting processes and waste picker cooperatives participate in one third (33.3 per cent) of recyclable waste collection. Table 2 shows that Brazil's north-east region has one of the biggest populations but the poorest coverage of municipalities with recyclables collection services:

Table 2 Municipalities and population with waste-sorting collection services by each Brazilian region

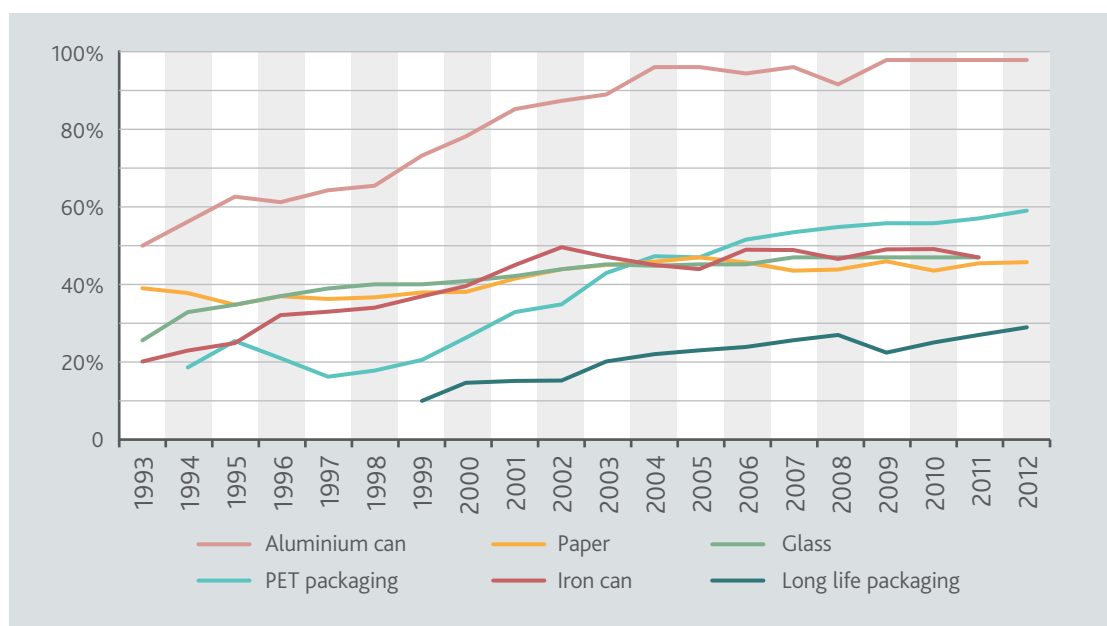
Brazilian region	Total municipalities interviewed	Corresponding urban population	Recyclable waste collection services Number	%
North	242	9,956,746	24	9.9
North-east	862	29,698,041	79	9.2
South-east	1,248	71,126,804	525	42.1
South	940	21,849,862	480	51.1
Centre-west	280	10,462,662	53	18.9
TOTAL (in 2013)	3,572	143,094,115	1,161	

Source: Ministério das Cidades – SNIS, 2013

Another governmental agency study estimated that if all recyclable materials were recovered in the country it could generate an income of 8 billion reais a year for the Brazilian economy (IPEA, 2013). In addition, in Figure 7 the percentage of recycled material for each specific material in Brazil from 1993 to 2012 (IBGE, 2015) shows that in general the amount of recyclable waste recovered through collection

is still very low in Brazil, except in the specific case of aluminium cans. It indicates that there is huge potential to increase recycling activities in the country:

Figure 7 Amount of recyclable waste recovered through collection in Brazil



Source: IBGE, 2015

Another work shows the economic gains embedded in recycling. Table 3 presents the primary production costs and the production costs from recycling the main materials with recycling potential in Brazil. The economic benefits associated with recycling plastics can be as high as 286 per cent.

Table 3 Economic benefits of recycling: an approximation

Material	Primary production costs (R\$/t) ¹	Production costs from recycling (R\$/t) ²	Net benefit (R\$/t) ³
Steel	552	425	127
Aluminium	6,162	3,447	2,715
Cellulose	687	357	330
Plastic	1,790	626	1,164
Glass	263	143	120

Notes:

- 1 The primary production costs refer to the costs associated with the production of goods inputs from virgin raw material.
- 2 The recycling costs refer to the costs associated with the production of goods inputs from secondary material (waste).
- 3 The net benefits from recycling have been calculated as a difference between the primary production costs and the recycling costs.

Source: IPEA, 2010

Another study of two scenarios illustrates the environmental, economic and social gains of reverse logistics systems for Brazil, presenting some scenario analysis of 'actual situation versus full potential' (Lino and Ismail, 2012). The proposed scenario considers the potential positive impacts generated if paper/cardboard, plastic, glass and ferrous metal were recycled and organic waste (food leftovers, plant cuttings etc) were composted to generate energy. Table 4 summarises the results in economic gains (ie financial gain in selling the recyclables), energy savings (ie energy saved due to recycling) and reduction of greenhouse gas emissions (ie CO₂ emissions avoided due to recycling):

Table 4 Comparison of the actual situation and the proposed scenario

Description	Actual situation	Proposed scenario
Total collected urban solid waste (t/day)	259,547	259,547
Recyclable fraction (%)	1.2	31.3
Total recycled solid waste (t/day)	3,122	81,224
Price of recyclable mix (R\$/t)	600.00	600.00
Financial gain from selling the recyclables (R\$/month)	56.196 x 10 ⁶	1.492 x 10 ⁹
Equivalence in national salaries (R\$ 622)	90,347	2,350,945
Equivalence in family grants (R\$ 200,00)	280,980	7.310 x 10 ⁶
Avoided energy due to recycling (GW)	1.143	29.740
Avoided CO ₂ emissions due to recycling (tCO ₂ /year)	2.246 x 10 ⁶	58.443 x 10 ⁶
Number of Certified Emission Reductions (CER/year)	0.612 x 10 ⁶	15.924 x 10 ⁶
Amount of degradable solid waste (t/day)	199,101.92	136,262
Rate of biogas generation (l/kg)	25–35	40
Generated biogas (m ³ /kg)	5.973058 x 10 ⁶	5.451 x 10 ⁶
Generated biogas (m ³ /year)	2.180166 x 10 ⁷	1.9896 x 10 ⁹
CO ₂ in the biogas (m ³ /year)	1.19909 x 10 ⁹	2.9981 x 10 ⁹
CH ₄ in the biogas (m ³ /year)	0.9810747 x 10 ⁹	0.8954 x 10 ⁹
Equivalence CH ₄ in CO ₂ (m ³ /year)	23.76381 x 10 ⁹	
Density of CO ₂ (kg/m ³)	1.83	1.83
Total emitted of CO ₂ (tCO ₂ e/year)	43.488 x 10 ⁶	3.641 x 10 ⁶
CO ₂ emissions of the biogas is flared (tCO ₂ /year)	3.9897 x 10 ⁶	
Amount of CH ₄ in the biogas (m ³ /day)		2.453 x 10 ⁶
Calorific value of CH ₄ (MJ/m ³)		33.95
Energy generated (MW)		289.13

Source: Lino and Ismail, 2012

2.5.1 The Solid Waste National Policy and an inclusive circular economy

In order to improve this situation, the SWNP was finally approved in Brazil in 2010. It sets the guidelines for the implementation and management of reverse logistics systems in the country. The SWNP has a 20-year lifespan in which to be fully implemented and it must be revised every four years. It must consider the assessment of solid waste management in the country and the proposed scenarios regarding international and macro-economic trends. The action plans at national, state and municipal levels must include assessment, scenario propositions and goals, as well as the programmes, projects and initiatives to be implemented in accordance with the SWNP law. As a general rule, the management of urban solid waste will not be assigned to municipal urban cleaning services any more. The liability for waste products, both physically and/or economically, will shift from the municipality to producers. The SWNP requires various business sectors to design and implement reverse logistics programmes for post-consumer waste. It is up to those responsible for urban waste management services to set up a collection system designed to recover reusable and recyclable materials so they can be reintegrated back into the supply chain, carrying out any activities as may be assigned by industry sectoral agreements or contracts. In addition, these service providers may deploy composting systems for organic solid waste, find the means to reuse it, and dispose of any remaining waste through environmentally sound processes (Silva Filho and Soler, 2013).

Within the scope of the SWNP, all stakeholders that generate waste are brought together to assume their responsibilities to implement reverse logistics. Shared responsibility is defined as a set of individual and linked duties with regard to discarded products shared across the whole production chain: manufacturers, importers, distributors and traders, as well as consumers and urban waste management companies.

Penalties for non-compliance may be enforced by the municipalities. To this end, municipalities must elaborate solid waste management plans in order to direct and supervise actions covered by the SWNP. Therefore, public administration, manufacturers, importers, distributors and/or dealers are required to enter into contracts of reverse logistics systems based on a shared responsibility for the product life cycle. The shared responsibility addresses some fundamental issues (Campos, 2014), such as:

- promoting waste recovery back to supply chains, thus reducing the amount of solid waste generated and the waste of materials, as well as pollution and environmental damages
- encouraging the use of inputs with fewer risks to the environment
- stimulating the development of markets and the production and consumption of recycled and recyclable products and materials
- encouraging good practice in social and environmental responsibility

The SWNP also recognises waste picker organisations as key actors in the Brazilian recycling chain. In these reverse logistics systems, the material recovery facilities are strategic and the associations and cooperatives are the priority agents to run the facilities. The major challenges to be resolved if these goals are to be achieved are to develop company reverse logistics programmes and build partnerships between public administration, companies and waste picker associations (Demajorovic et al, 2014).

The works of Chaturvedi, Vijayalakshmi and Nijhawan (2015), and Wilson (2015), show it is possible to envision a possible pathway in Brazil towards building an inclusive resources management system – a socially inclusive circular economy. This scenario is explained in Table 5:

Table 5 Pathway to build an inclusive resources management system (a socially inclusive circular economy)

Vision to pursue (future): 'Inclusive resource management (towards a socially inclusive circular economy)'
<ul style="list-style-type: none"> ■ Local government values all waste as resources, and values the saving potential (of skills, networks and decentralised infrastructure) that results from the partnership between waste sector collectives and industry to close the loop of materials. The reverse logistics systems are a great tool for the creation of jobs and income to increase social inclusion.
Waste management process
<ul style="list-style-type: none"> ■ Product design regulations make waste easy to segregate at source by generators. ■ Material sorting facilities are decentralised and managed by the waste collectives in partnership with non-governmental organisations (NGOs) and technology start-ups. ■ Local government regulates divergent objectives between waste-recycling cooperatives, state-of-the-art landfills operators and 'reuse, repair and refurbishment' markets. ■ Repair and reuse industry is actively promoted and works in close partnership with product manufacturers. ■ Financial and regulatory instruments make landfilling of recyclables and energy-rich materials prohibitively expensive for the waste disposer.
Consequences
<ul style="list-style-type: none"> ■ Manufacturers work with informal collectives, setting up take-back programmes for end-of-life products, making them a crucial link in their value chains. ■ Local government can enforce environmentally sound and working health and safety compliance. ■ Reverse logistics arrangements are facilitated by simplified regimes of taxation.
Key issues
<ul style="list-style-type: none"> ■ Minimal conflict between formal and informal sectors, since the former benefits from the latter's participation in the value chain. ■ Reverse logistics systems have active intervention from local government and other policy enablers to ensure materials do not leak back into unregulated markets.

Sources: Chaturvedi, Vijayalakshmi and Nijhawan, 2015; Wilson, 2015

2.6 The role of waste pickers in a circular economy in Brazil

According to the Demographic Census in 2010, 387,910 people in Brazil declared their main occupation to be 'waste picker'. The SWNP aims to include 600,000 waste pickers in waste management systems across all Brazilian municipalities. The goal was to include 280,000 workers by the end of 2015 (Brasil: Ministério Do Meio Ambiente, 2012). However, in 2010 it was estimated that only 10 per cent of the population working as waste pickers in Brazil are organised in associations. It is up to the Municipal Integrated Waste Management Plan to define how this will proceed locally (Ribeiro et al, 2014). In some areas, municipalities and waste picker associations are being supported by federal public policies with non-refundable grants from ministerial programmes, Banco do Brasil public bank, National Bank for Social Development – BNDES – and Petrobras, as well as international programmes. So some waste picker organisations are receiving investment to help them build facilities, acquire equipment, improve sanitary work conditions and strengthen their commercialisation networks; municipalities, meanwhile, must provide the trucks for waste collection and sites to set up sorting facilities, and must pay for water and energy.

Since 2002, the professional activities of waste pickers have been recognised and introduced into the Brazilian Code of Occupations (CBO) of the Ministry of Labour (2013). A 'waste picker' is defined as a professional who collects, sorts and sells recyclable materials, whether self-employed or part of a cooperative or association. Only in 2007 was the collection of recyclables understood to be a public policy and municipalities were allowed to contract the services of waste picker associations and cooperatives without a bidding process, through the Sanitation Public Services Federal Policy (Brasil: Casa Civil, 2007) and then the SWNP (Brasil: Casa Civil, 2010). Before that, municipalities had no legal instruments to enable them to hire waste picker organisations to perform waste collection. Likewise, these organisations had no means of meeting the legal requirements to bid for formal government contracts (Ribeiro et al, 2014).

A socio-demographic profile of waste pickers in Brazil was drawn up in IPEA's research (2012). This data comes from self-declaration interviews, through the Brazilian Census in 2010 and the annual national household survey (PNAD) in 2012. Table 6 highlights some key data:

Table 6 Summary of waste pickers' social profile

Indicator	National
Total population	387,910
Average age	39.4 years
Women	31.1%
Black and <i>pardo</i> people*	66.1%
Living in urban areas	93.3%
Average income	R\$ 571.56/month
Income inequality among waste pickers	0.42 Gini Index
Rate of illiteracy	20.5%
Rate of primary education (population above 25 years old)	24.6%
Rate of secondary education (population above 25 years old)	11.4%

* *Pardo* is a broad classification, used across Brazil and by the Brazilian Institute of Geography and Statistics, referring to people with mixed racial heritage.

Source: IPEA, 2013

Also based on the research of IPEA (2012), Table 7 summarises the data gathered on waste pickers' educational levels, as compared with the average in Brazil. It shows that the illiteracy rate among waste pickers is more than twice the national average. The table also shows that compared to the average Brazilian population above the age of 25, only half as many of the waste picker population have completed elementary school and less than a third have completed secondary school (IPEA, 2012).

Table 7 Average educational level of waste pickers compared to Brazilian population

Educational level	Illiteracy	Complete elementary school	Complete secondary school
Brazilian rate (%)	9.4	50.3	35.9
Waste pickers' rate (%)	20.5	24.6	11.4

Source: IPEA, 2012

Waste pickers (formal and informal) provide a significant proportion of all recycled materials collected in Brazil. Waste picker cooperatives are important reverse logistics actors, both as secondary raw material suppliers to industry and as collectors/receivers of post-consumer solid waste, and are also key players in the implementation of the SWNP (SNIS, 2013). Souza et al (2012) highlight that in São Paulo the work of cooperatives also contributed to public health, urban sanitation and a cleaner urban landscape. The waste picker cooperatives have spread in recent years in Brazil and today they represent a real opportunity to create productive organisations and generate income and social inclusion for thousands of families (IPEA, 2013).

Despite the fact that only 10 per cent of waste pickers in Brazil are organised into cooperatives and associations, the cooperatives play a larger role in recyclable waste management in medium-sized cities. They provide about 40 per cent of collected recyclable waste for cities in the range of 100,000 inhabitants and 46 per cent for cities of about 1 million inhabitants (SNIS, 2013). Table 8 shows the participation of municipalities, companies and waste picker organisations as operators of recyclable waste collection services in 2011, 2012 and 2013. Table 9 draws attention to the number of sorting facilities operated by waste picker organisations, which account for almost 54 per cent of this type of facility.

Table 8 Percentage of recyclable waste collected by each type of operator in Brazil

Year	Number of municipalities interviewed	Municipality %	Companies %	Waste picker organisations %
2013	692	21.1	45.6	33.3
2012	636	27.6	44.0	28.5
2011	545	25.4	42.6	32.0

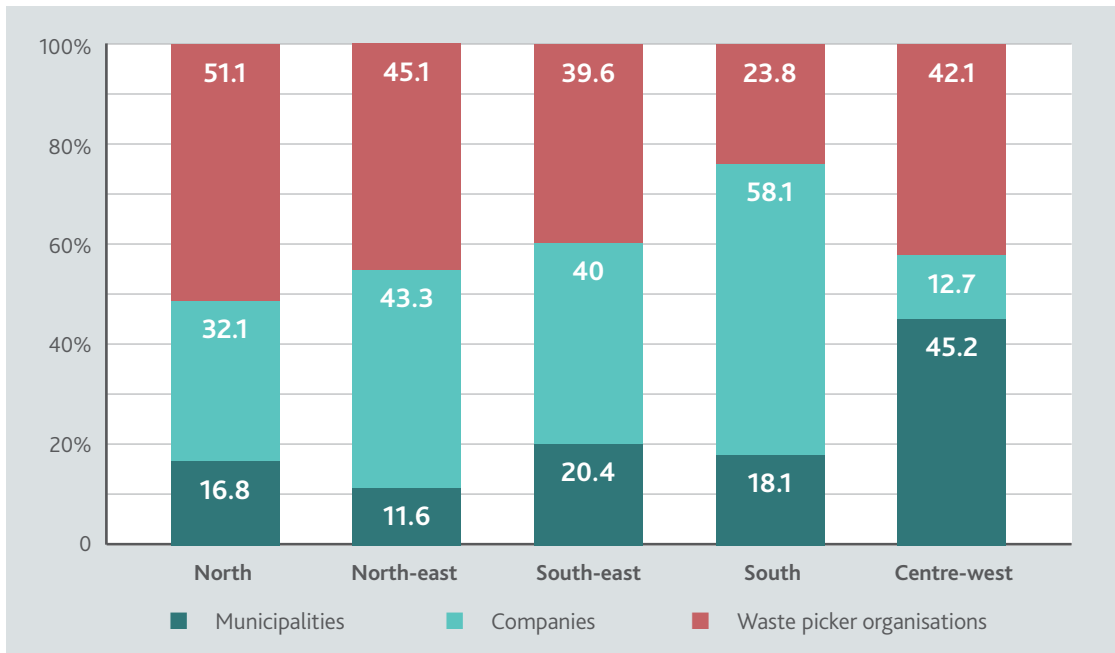
Source: Ministério das Cidades – SNIS, 2013

Table 9 Number of different waste management facilities operated by different managers

Type of processing facility	Open dumps	Landfills	Sorting facilities	Composting facilities	No information
Amount of waste (tonnes)	6,742,838	41,109,877	1,263,242	10,676	12,000,102
% of total in Brazil	11	67	2	0.02	20
Municipalities	1,137	1,102	110	44	-
Companies	42	214	47	10	-
Waste picker organisations	2	11	183	7	-
% operated by waste picker organisations	0.0017	0.0083	53.82	11.47	-

Source: SNIS, 2013

Figure 8 Percentage of sorted waste collected by different types of managers (companies, waste picker organisations or directly by the municipality) in each of the Brazilian regions



Source: SNIS, 2013

Figure 8 shows differences across Brazilian regions:

- the south region of Brazil, where companies collect most of the recyclable waste
- the north region of Brazil, where waste picker organisations collect more than half of all recyclable waste
- the centre-west region of Brazil, where most of the recyclable waste is collected by waste picker associations and by the municipality directly in almost equal measure
- the north-east and south-east regions of Brazil, where most of the recyclable waste is collected by waste picker associations and by companies in almost equal measure

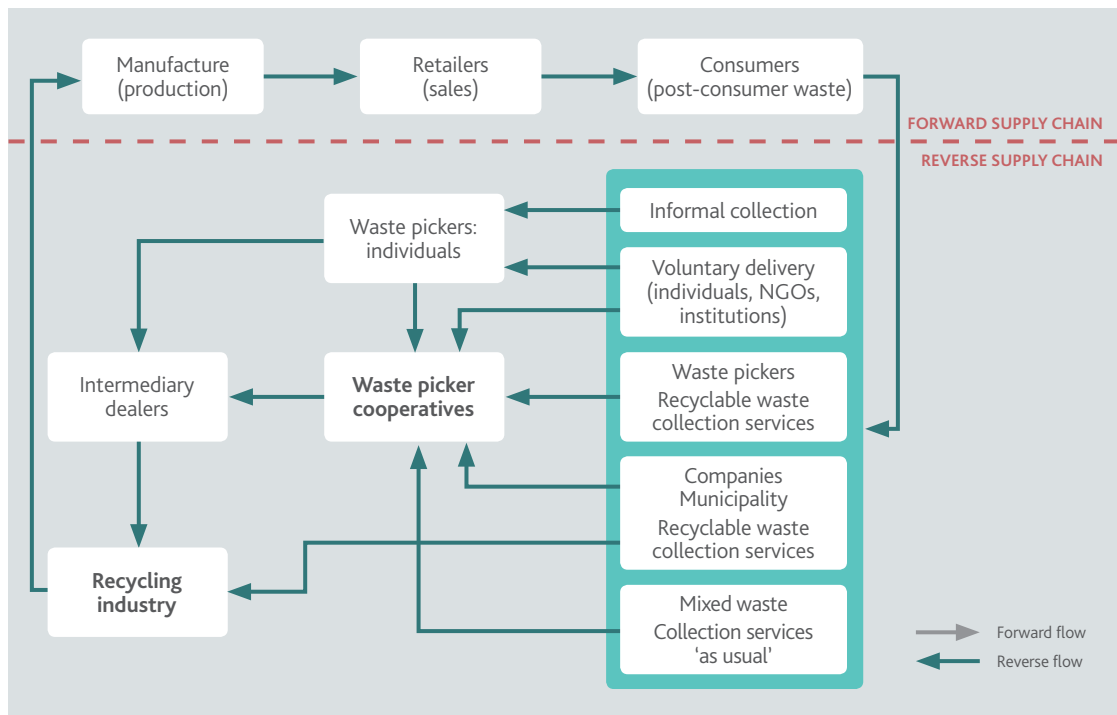
2.6.1 Waste picker cooperatives in Brazil

With the release of the SWNP, there were some important changes in the field of waste management in Brazil. The law gives priority to a formalised collection service for recyclable waste through the integration of waste picker organisations. The social inclusion of waste pickers in Brazil has been supported by public policy relating to solidarity economy and self-management models, to help waste pickers organise into professional associations or cooperatives (Singer, 2002; Pacheco and Ribeiro, 2009). The legal formalisation of activities by the creation of cooperatives and associations enables the drawing up of contracts and public-private partnerships between local public administrations and waste picker organisations (Ribeiro et al, 2014).

Informal waste pickers work without being associated with cooperatives and sell most of the waste they collect directly to intermediary scrap dealers. The material collected through recyclable waste collection programmes, by formal waste pickers or voluntary delivery, goes to waste picker cooperatives' 'sorting centres'. According to a study by Souza et al (2012), sorting centres are intermediary actors in the reverse logistics process for post-consumer products and packages before they go to the recycling industry or other recovery options. By contrast, waste collection systems managed by companies and municipalities do not usually sort the materials collected, and most of the waste collected goes to landfill.

Figure 9 shows the central role of waste picker cooperatives in reverse chains of post-consumer urban solid waste.

Figure 9 Main actors of the reverse supply chain



Source: Adapted from Souza et al, 2012

The article from Souza, Paula and Souza-Pinto (2012) points out that the cooperatives depend on intermediary dealers for the commercialisation of these materials with the recycling companies. This is due to two main reasons: 1) the recycling companies take a long time to pay for the material; 2) the cooperatives do not have sufficient amounts of waste to make the process viable. Moves towards establishing partnerships between private and public institutions may empower these negotiations and consequently promote the development of cooperatives' activities. In order for this to happen, cooperatives must also improve their organisational level and efficiency. Despite the opportunities, governmental research (IPEA, 2012) estimates that only 40 per cent of these organisations demonstrate medium or high operational efficiency. Without improving their organisation, cooperatives do not have the capacity to have business relationships, either with companies or with the government. Only 13 examples of contract services between waste picker cooperatives and municipalities or industry were found in the records of the official website of the Brazilian National Movement of Waste Pickers, MNCR. This movement was established in 2001 and is considered one of the most influential stakeholders in Brazil (MNCR, 2015).

Based on experiences in Brazil, Gutberlet (2010) highlights some fundamental lessons learnt in the design of a model for waste management integrating cooperatives:

- Integrate waste pickers into the municipal solid waste programme.
- Provide financial support to waste picker cooperatives to invest in infrastructure and capacity building.
- Gain a commitment from government recognising the work of cooperatives.
- Build a professional relationship between recycling groups and the municipality.
- Develop a social assistance approach to empower recycling groups and strengthen their autonomy.
- Uphold the dignity and citizenship of recyclers as a public responsibility.
- Build a network of recycling social enterprises.
- Create protection policies against market and price fluctuations.

The article describes how a recycling cooperative embodies the possibility of recovering citizenship, contributing towards social development and employment generation (Gutberlet, 2010). The author states that discussion on inclusive waste management is based on a theoretical framework, which has three pillars:

- **governance and deliberative democracy**, offering new forms of public-private partnerships and redefining the government's role, addressing political and social contexts in waste management
- **social and solidarity economy**, focusing on collective over individual objectives and outcomes and proposing a groundbreaking model for economic development
- **co-management**, highlighting the participation of different stakeholders in decision-making

The author explains the importance of 'participatory sustainable waste management' as an alternative to conventional waste management, defining the former as: *'Solid waste recovery, reuse and recycling practices with organised and empowered recycling cooperatives supported with public policies, embedded in solidarity economy and targeting social equity and environmental sustainability'* (Gutberlet, 2010, p 171).

The following cases selected in this report show the improvements in the organisation of waste pickers into cooperatives.

SECTION 3

CASE STUDIES FROM THE LITERATURE

This section of the literature review presents the relevant knowledge extracted from publications examining reverse logistics practices in Brazil. The current waste management system in Brazilian municipalities is described. After this, there are some case studies of industry supply chains for specific types of waste, organised within an industrial supply chain (eg plastics, metal, glass). Finally, the report includes some studies investigating solutions and proposing innovations and future scenarios to evolve municipal waste management towards compliance with the Solid Waste National Policy (SWNP).

The first batch of case studies covers the industry supply chains for specific types of waste: paper, plastic, glass and steel. These studies have five common characteristics:

- 1 The supply chains of specific waste types are organised to cross geographical boundaries.
- 2 Companies are the driving force behind these reverse logistics systems.
- 3 Supply chains are normally focused on securing income from waste material.
- 4 Partnerships between companies and waste picker cooperatives show economic advantages for both.
- 5 Waste picker cooperatives show the potential to be service providers and suppliers to recycling industries.

The second batch of studies presents the context of three cities in Brazil with different profiles, representative of medium-sized cities in Brazil. First, São Mateus is a municipality located in the Brazilian state of Espírito Santo, on the coast of the south-east region of Brazil. It has a population of 100,000 people, and the economy is mainly based on coastal oil exploration and services, as well as tourism. Second, Florianópolis is the capital city of Santa Catarina state, located on the coast in south Brazil. Its population is half a million and it is in a metropolitan area with 1 million inhabitants. The Florianópolis economy is based around technology (software, hardware and services), tourism and public services, including many universities. And finally, Campinas is a municipality in São Paulo state, in the south-east region. Being the main city in its metropolitan region, it is the 10th richest city in Brazil and is also the 14th most populous Brazilian city, with 1 million inhabitants, in a metropolitan region with a total population of 3 million. The region hosts the second largest number of industries after São Paulo, the capital of the state, including textiles, automotive, machinery, food and beverages, chemical and petrochemical, pharmaceuticals, paper and cellulose, telecommunications, computers and electronics.

The second group of case studies presents these different characteristics from the first batch:

- 1 Reverse supply chain planning and operation is designed within a specific geographic boundary as a municipality or metropolitan region.
- 2 Public management is the driving force behind these reverse logistics systems.
- 3 All municipal waste is separated into three categories: recyclable waste, non-recyclable waste and organic waste, rather than specific types of waste.
- 4 All these cases focus on proposing new alternatives to urban waste management.
- 5 Municipalities support the engagement of waste pickers who are organised in cooperatives to be part of the collection of post-consumer waste; waste picker cooperatives become waste management service providers for municipalities.

3.1 Highlights from the cases

Table 10 presents a summary of the findings from the case studies, organised according to the STEEPL framework.

Social: Is the circular economy approach socially feasible and what are the social benefits from its adoption?

Technological: Is the circular economy approach technologically feasible and what are the benefits from the adoption of circular economy approaches in the technology landscape?

Economic: Is the circular economy approach economically feasible (business case) and what are the economic benefits?

Environmental: Is the circular economy approach environmentally desirable and what are the benefits from the adoption of these approaches to the environment?

Political: Is the circular economy approach consistent with the policy architecture and what are the potential political benefits from its adoption?

Legal: Is the circular economy approach legally feasible and what are the legal benefits from its adoption?

Table 10 Summary presented from case analysis

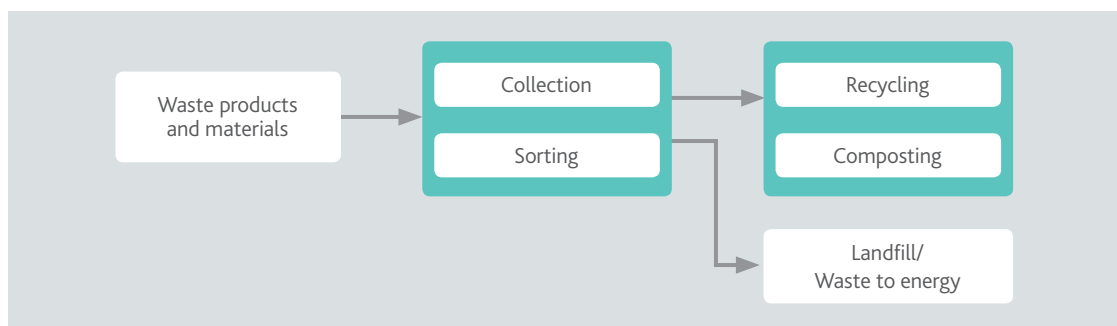
Dimension	Summary
SOCIAL	<ul style="list-style-type: none"> Reverse logistics supply chains for solid waste can involve waste picker cooperatives, allowing them to significantly increase their income and improve working conditions. However, when the price of raw materials in primary markets falls, this can shrink the market for recyclables, damaging waste pickers' livelihoods. Strong partnerships between cooperatives and government and business are required to mitigate this risk. A shift in social attitudes towards household separation of materials into organic, recyclable and non-recyclable at source would greatly improve the possibilities for reverse logistics.
TECHNICAL	<ul style="list-style-type: none"> Lack of finance systems for machinery acquisition can be a significant barrier to establishing reverse logistics systems, both for businesses and cooperatives. High-tech systems for the treatment of organic waste sewage can be prohibitively expensive to install and maintain. Lower-tech solutions involving waste pickers (for solid waste) or biological treatment of sewage/organic waste are often more appropriate.
ECONOMIC	<ul style="list-style-type: none"> The economic feasibility of reverse logistics supply chains depends to a large extent on transportation costs and how these are managed. The lack of structured markets for recyclables, high electricity costs and insufficient incentives either to recycle (rather than send material to landfill) or to use recycled material (rather than virgin material) for production can also be barriers to feasibility. Using waste pickers for door-to-door collection improves feasibility, but these groups also need to have sufficient storage capacity so that their recycled materials can be collected in bulk. Typically, waste pickers sell their recycled materials to an intermediary dealer, who then trades with recycling companies. However, in some significant cases, industry has formed direct partnerships with waste picker cooperatives, with economic benefits to both parties. Networks of cooperatives, which can operate at a larger scale, make this direct contracting with industry more feasible.

	<ul style="list-style-type: none"> Several companies have established reverse logistics systems to prevent the flow of products (such as beer bottles) to the black market, where they can be used for counterfeiting, to the detriment of the brand and official sales. This represents an interesting additional benefit from reverse logistics systems.
ENVIRONMENTAL	<ul style="list-style-type: none"> Using recycled materials for production (rather than virgin materials) saves energy and water, and reduces pollution (eg carbon emissions etc). Reducing the amount of material sent to open landfill improves the natural environment. Preventing organic waste from going to landfill can significantly reduce greenhouse gas emissions (since organic waste in landfill often produces methane). Appropriate management of sewage and organic waste can produce energy, reduce emissions and save water.
POLITICAL	<ul style="list-style-type: none"> The SWNP has been introduced since some of these case studies were undertaken, and may therefore have improved the context for reverse logistics. However, there are indications that municipalities may not yet have the capacity to fully implement the requirements of the SWNP.
LEGAL	<ul style="list-style-type: none"> The legal formalisation of waste pickers into cooperatives is essential for their inclusion in formal supply chains, and this can require technical support. In the same vein, these groups can require support to set up appropriate administrative functions (issuing invoices, for example), to access sources of finance and to establish health and safety policies. There is already provision in law for municipalities to support cooperatives in these ways, and there are examples of businesses and NGOs also offering this support. Some recycling companies have difficulty complying with environmental permits.

3.2 General description

After products and materials are discarded, waste management has two basic stages, as shown in Figure 10. The first is the collection of all mixed solid waste and its transportation to sorting facilities. The second is sorting the discarded products into two categories: recyclable materials and non-recyclable waste (ie organic waste and refuse waste). Within this stage, more dedicated sorting depends on the demand for reuse options: through specific materials recycling, composting of organic waste or other means of environmentally sound final disposal, landfill or energy recovery (Ferri, Diniz Chaves and Ribeiro, 2015). Options for sorting used products for reuse or refurbishment markets were not found in the literature review.

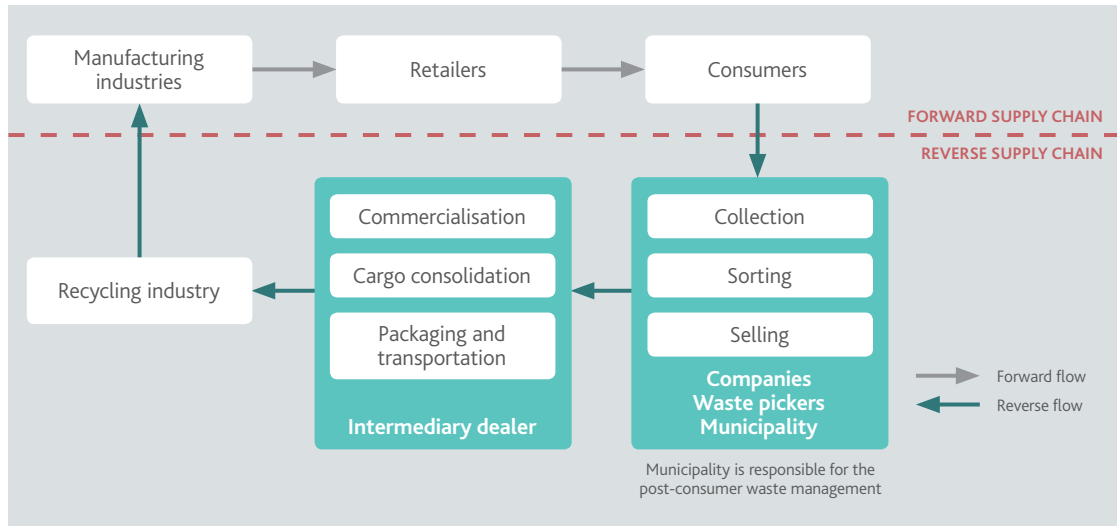
Figure 10 The basic stages in municipal waste management



Source: Adapted from Ferri et al, 2015

In Brazil, the municipalities are responsible for the management of post-consumer waste but the collection, sorting and selling of recyclable waste materials are carried out by companies, waste picker associations and, in some cases, by the municipality itself. Generally, the collected materials are sent to an intermediary dealer which purchases, processes, stores and transports it. Then, dealers sell collected materials to recycling companies, which transform recyclable material back to a form where it can supply industry. In some cases, mostly in metropolitan regions, waste pickers are organising themselves into networks, allowing them to commercialise collected material directly with recycling industries (Aquino, Castilho and Pires, 2009).

Figure 11 Waste materials reverse supply chain



Source: Adapted from Aquino, Castilho and Pires, 2009

3.3 Supply chains of specific types of waste

In this section we will present case studies related to what is documented about reverse logistics in Brazil. In the first case study, we set out the general situation of the paper package supply chain in the country. The second case study shows the plastic supply chain, specifically in the state of Rio de Janeiro. The next one deals with glass and steel collection, and the role of the Vira-Lata cooperative in the integration of companies, connecting waste generators with recyclers. The last case study describes a network of cooperatives named Cataunidos, a network of 33 groups organised in three centres, performing collection, commercialisation and processing of different recyclable materials.

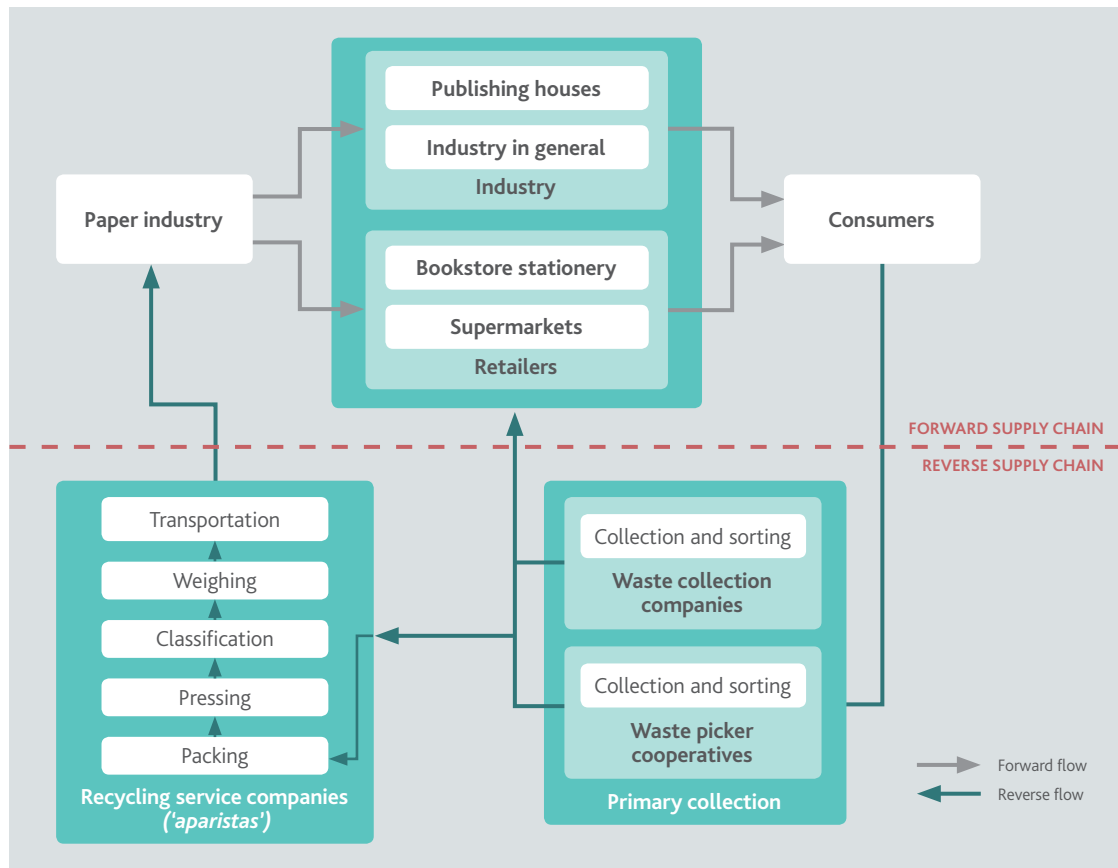
3.3.1 The paper package supply chain in Brazil

Pereira et al (2014) offer an analysis of the paper package supply chain in Brazil and the structure of reverse logistics in paper recycling. In Brazil, an assessment of 80 per cent of paper production companies showed that 45.5 per cent of the total amount of paper produced (4,481 tonnes) was recycled by the industry in 2013.⁶ It is also estimated that 70 per cent of the raw material used to produce paper packaging comes from recycled paper, both from post-production and post-consumer sources. Once the recyclable material is collected, it is sorted from other types of recyclable materials. Waste picker cooperatives have a key role in connecting up dispersed 'door-to-door' paper waste collections. In some cases, they have a monthly contract with intermediary dealers called *aparistas* (paper recyclers), selling on to *aparistas* materials they have collected. But the study found that many cooperatives do not have enough space to store the recyclable material and so the *aparistas* need to perform frequent small-volume collections, which raises transportation costs. In most cases, the *aparistas* are supplied directly by large generators of paper

6 Data sourced from Bracelpa, the Brazilian Pulp and Paper Association.

waste or through waste collection companies. The material is purchased by the *aparistas*, who carry out transportation, weighing and classification into different types of paper and possibly other materials. This process is very labour intensive. The *aparistas* also cover the legalisation of waste paper material back into the supply chain. The last step is pressing and packing for storage and shipment to supply the paper industry (Pereira et al, 2014). A representation of the forward and reverse paper supply chain, as well as the main activities in the paper recycling process, are described in Figure 12, as follows:

Figure 12 Paper supply chain

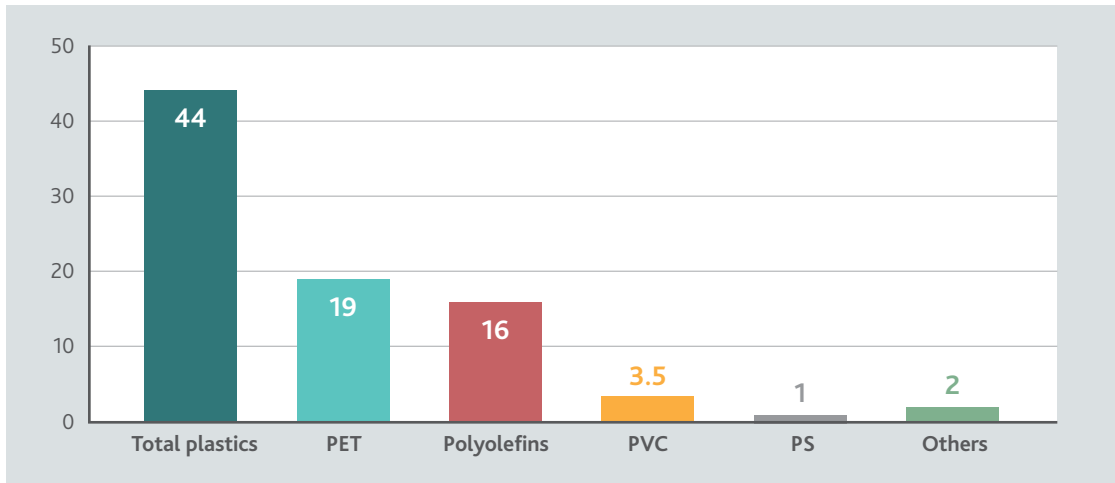


Source: Adapted from Pereira et al, 2014

3.3.2 The plastics reverse supply chain

An assessment study by Pacheco, Ronchetti and Masanet (2012) presented research on 40 plastic recycling companies located in the metropolitan region of Rio de Janeiro city in 2006. According to the Municipal Urban Cleaning Company of Rio de Janeiro in 2006, about 15 per cent (492,750 tonnes) of all of the rubbish deposited in controlled dumps is plastic. The data collected showed that 70 per cent of recycling industries use plastic waste collected from industrial consumer sources and 50 per cent use plastic waste from dumps. The research showed that most of the plastics recycled were polyolefin (HDPE, LDPE and PP) and polyethylene terephthalate (PET). However, PVC, polystyrene, PS and PC are also recycled (Figure 13). The plastics recycling supply chain can vary according to the nature of the plastic. For example, polyolefin recyclers carry out all stages of recycling in the same industrial unit. However, for PET recycling, these processes are broken up into two or multiple entities. A first-level company is responsible for the collection, packaging, grinding and washing of PET, generating flakes as a final product. A second-level company carries out PET reprocessing into pellets. A third-level company receives the pellets to transform them into new products and parts.

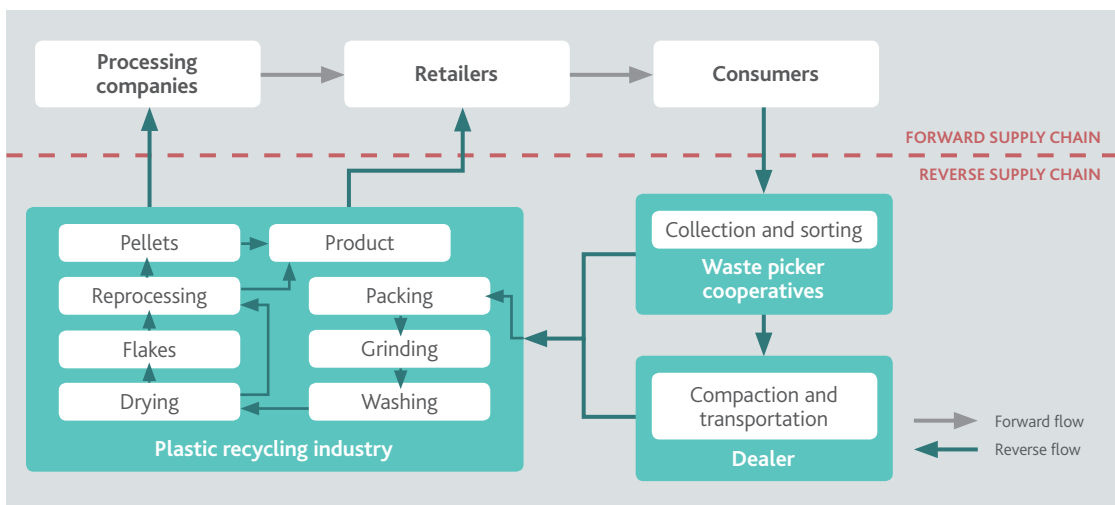
Figure 13 Types of plastic most recycled in Rio de Janeiro



Source: Adapted from Pacheco, Ronchetti and Masanet, 2012

The authors describe the stages of plastic recycling in the reverse supply chain. The main steps in plastic recycling are: collection by waste pickers, distribution by dealers and reprocessing by recyclers. In the plastics reverse supply chain, the cooperatives are groups of formalised waste pickers engaged in collection and sorting processes. This is one important step, as the main problem in this supply chain is the inefficiency of the waste-sorting processes, which can cause contamination by other materials and substances. Normally the waste picker cooperatives provide plastic material to dealers, who distribute materials to industry. The dealer companies have equipment (waste-compacting machines and trucks) to consolidate and efficiently transport the plastic to the recycling industry. In very few cases do the cooperatives sell the plastic directly to the recyclers (Pacheco, Ronchetti and Masanet, 2012). The plastic collected is submitted to different types of recycling processes: mechanical recycling, chemical (eg depolymerised) or energy (eg burning). In 2006, about 10 per cent of the companies interviewed in the Rio de Janeiro area produced flakes, 60 per cent produced plastic pellets and 40 per cent produced new products. The pellets are sold to processing companies that produce other products. According to this research, the main products made from recycled plastics are buckets, rubbish bags, hoses, packaging and containers for non-food products and flakes (to be transformed into other artefacts – mainly fibre). The structure of the forward and reverse plastic supply chain, as well as the main activities in the plastic recycling process, is described in Figure 14, as follows:

Figure 14 Plastic supply chain



Source: Adapted from Pacheco, Ronchetti and Masanet, 2012

The study identified many difficulties encountered by plastic recycling companies, most of them related to the lack of tax incentives for recycling or to the use of recyclable waste in production. Also, strong mention was made of the lack of programmes for waste sorting. Besides that, some companies identified as barriers to increased activity the absence of a structured market for recycled products in the country, the lack of financing systems for machinery acquisition, the high costs involved in transportation and the strong environmental licensing requirements (Pacheco, Ronchetti and Masanet, 2012). It is worth noting that the SWNP was introduced in 2010, and most of these barriers may have since been addressed.

3.3.3 Steel and glass reverse supply chains

This case study has assessed the work of Vira-Lata's waste picker cooperative, located in São Paulo. After integrating the municipal collection services for recyclable waste, the cooperative has become a supplier for some industries. The assessment covers the period from 2008 to 2011 (Demajorovic et al, 2014). The steel and glass industries are the two cases that have successfully achieved the necessary scale and quality of supply by integrating Vira-Lata's cooperative as a service provider.

The Vira-Lata cooperative was founded in 1998 with the aim of generating income for the community through recyclable waste collection and sales. In 1999, the cooperative had 11 people associated with it, collecting 57 tonnes of waste and generating an income of R\$ 8,000 in this year. By 2008 the cooperative had grown to 120 associates, collecting 2,000 tonnes of material sorted into more than 50 types of different materials and generating R\$ 739,000 in revenue in sales of plastic, paper, glass and metal scrap, among other things. In the middle of the global economic crises of 2009 and 2010, PET prices dropped by 25 per cent, aluminium can prices dropped 43 per cent and paper prices dropped 66 per cent. The number of associated professionals dropped to just 30 and the income dropped by a third. The recovery of activities started only in 2011, when numbers were back at the figures for 2008. The main reason for Vira-Lata overcoming the crisis was its partnerships with São Paulo municipality and Banco do Brasil Foundation. These partnerships guaranteed the improvement of the cooperative's equipment and facilities. It also enabled the cooperative to set up new contracts with companies in different arrangements, such as with Globo Newspaper company, Suzano paper company, Gerdau steel company, Porto Seguro insurance company, Diageo beverage company, Petrobras oil company, Rede Ferroviária Federal SA rail company, CISPER glass company and Ambev beverage company, among others. Among these arrangements, the author highlights the partnerships with Gerdau/Porto Seguro and Diageo, which integrated the cooperative into their reverse logistics systems. Today, the cooperative undertakes collection, sorting, pre-processing and commercialisation of waste materials, as well as 'eco-friendly tile' production (Demajorovic et al, 2014).

In two cases, Vira-Lata's cooperative has a unique role within the reverse logistics system for the industry. For the steel supply chain, the cooperative arranges the collection of metal car parts from the auto-repair shops network of the Porto Seguro insurance company and commercialises this material with Gerdau steel parts manufacturer. For the glass supply chain, the cooperative performs collection of glass bottles from Diageo retailers and commercialises them with recycling glass companies such as Owens-Illinois glass package manufacturer (Demajorovic et al, 2014). According to the authors, both arrangements resulted in efficient systems of collection and distribution. In particular, both the steel and glass recovery systems ensured lower costs than if the companies managed the reverse logistics system by themselves. Moreover, by enabling the reverse flow of materials between waste generators and recyclers, the door-to-door collection and sorting services helped companies to control the operational risks of post-consumer products, preventing used glass bottles (counterfeit beer market) and old car parts from going to the black market (Demajorovic et al, 2014).

However, it is also clear from the study that in general, waste picker associations in Brazil have many organisational and operational challenges that prevent them reaching the level of professionalism required to work directly with companies and the industry. The legal formalisation and regularisation of activities of the waste picker associations is one of the main factors that qualify them to be part of companies' reverse logistics arrangements as a material supplier. This is also important for getting financial support to improve infrastructure and implement information management systems. The low value of collected material for recycling and the high transportation costs further impede the reverse logistics in these supply chains. Furthermore, when the prices of raw materials are low in the global market, companies may stop buying recycled materials from waste picker organisations and then business relationships are lost. In addition, there

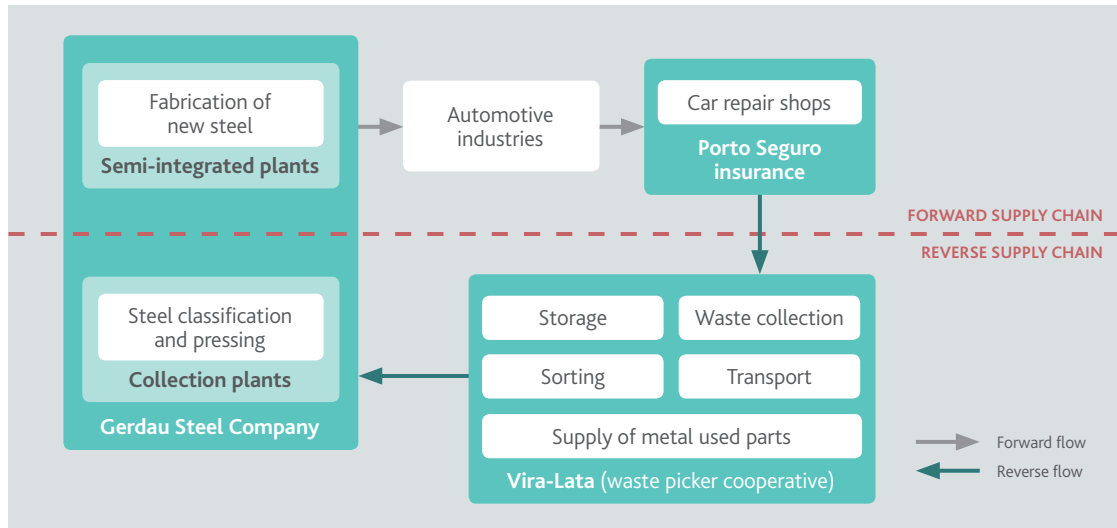
are no tax incentives to encourage the use of recycled materials in the production processes or to support companies' investment in reverse logistic arrangements. Despite all this, the two case studies described below show that in closed-loop arrangements between companies and waste associations, the reverse logistics relationships can create strong and long-lasting alliances and mutual benefits for the whole supply chain. Furthermore, it demonstrates that it is possible to overcome the challenges of improving organisational management processes and information systems in these cooperatives, and to engage other suppliers within the reverse chain (Demajorovic et al, 2014).

3.3.4 The steel reverse supply chain: the partnership between Vira-Lata, Gerdau and Porto Seguro

Gerdau's core business is to transform steel scrap and iron ore into steel products. Gerdau has an installed capacity of 26 million metric tonnes of steel per year and offers steel for civil construction and the automobile, industrial and agricultural sectors, among others. Gerdau is the leader of this reverse logistics system, buying all ferrous waste collected by the Vira-Lata cooperative, including steel cans and scraps. With no interest in operating a door-to-door system itself, the company started the Vira-Lata Project in 2005, offering the cooperative some machinery and training on sorting and work safety proceedings. This programme involves 11 different municipalities that host Gerdau's production units. The purpose of this programme is to work with existing cooperatives and support the creation of new ones. The programme is based on three pillars: waste pickers' social inclusion, avoiding waste materials polluting the environment and supplying industrial processes. The other partner in this reverse logistics system is Porto Seguro. Porto Seguro offers insurance services for vehicles, residences, health, life and business and is also the leader in the car and homeowner insurance segments in Brazil, being responsible for 20 per cent of the national market share. It has 115 branch offices all over the country and more than 8,000 service providers. In São Paulo city, Porto Seguro directs the metal car parts from 235 car-repair shops to Vira-Lata, which guarantees the insurance company that the old car parts from all networks will be properly discarded. By connecting both Gerdau's and Porto Seguro's needs, Vira-Lata developed a strategically central role in providing the services of waste collection, transport, sorting, storage and supply of metal used parts. In 2007, the cooperative collected 80 tonnes of recoverable material, generating R\$ 29,000 in revenue. By 2011 this figure increased to 300 tonnes of recovered material, and revenue earnings increased to R\$ 92,000, amounting to 13 per cent of the cooperative revenues for the same year (Demajorovic et al, 2014).

One important reason for the success of the Vira-Lata cooperative is that it had previous legal formalisation of its waste management activities through its partnership with São Paulo municipality. Vira-Lata's sorting and storage facility is one of the biggest of its kind in São Paulo. Moreover, the machinery and trucks of the cooperative set high standards for materials processing and transportation. In addition, as the waste association enrolled in the reverse logistics systems, it received support from partner companies to improve its administrative management and information systems in order to reach standard process control and reporting standards (Demajorovic et al, 2014). A representation of the reverse supply chain in the partnership between Gerdau, Porto Seguro and Vira-Lata is illustrated in the Figure 15:

Figure 15 Reverse supply chain in the partnership between Gerdau, Porto Seguro and Vira-Lata



Source: Adapted from Demajorovic et al, 2014

3.3.5 The glass reverse supply chain: the partnership between Vira-Lata, Diageo and Owens-Illinois

Diageo is a multinational beverages company, the world's largest producer of spirits, beer and wine. Owens-Illinois is a multinational company, one of the world's leading manufacturers of glass packaging products. One important motivation of these companies in building and supporting a reverse logistics system is that there is an existing black market in alcoholic beverages, which impacts sales and the image of their products. Diageo's reverse logistics programme, called 'Glass is good', started in 2010. The purpose of the programme was to collect the used glass bottles from beverage retailers (bars, restaurants and nightclubs) in order to send them back to the glass industry. Under this arrangement, Diageo's programme invites retailers (bars, restaurants, night clubs) to be a part of the system by providing the equipment and keeping track of retailer performance.

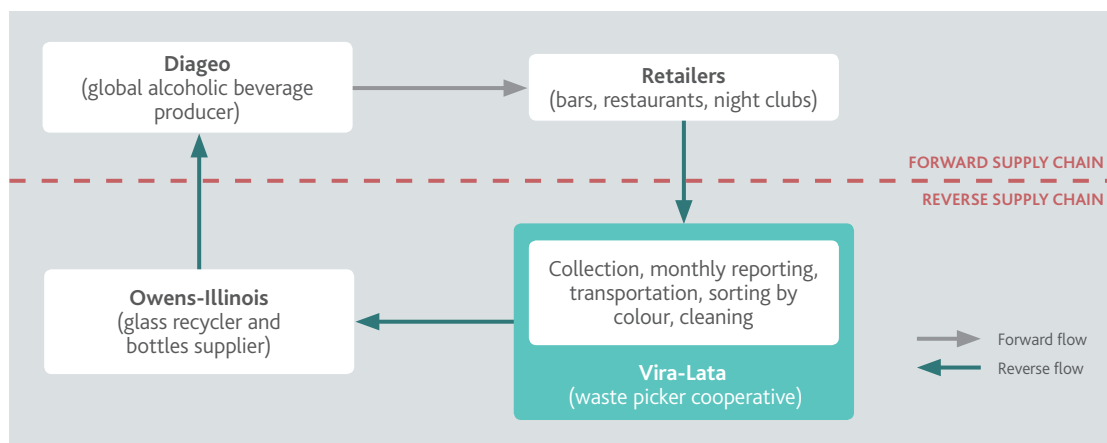
The first attempt at Diageo's reverse logistics system for post-consumer glass bottles was through the integration of its products distribution system. In this system, the same truck that delivered the beverage would bring back the empty bottles, optimising transportation costs. The system proved to be unfeasible because the amount of empty bottles that had to be brought back from the retailers was bigger than the amount of products delivered and the cost of extra transportation was too high. Moreover, glass waste has low market value, and high relative weight and handling risks.

However, the partnership between Diageo and Vira-Lata demonstrated the great potential for success in reverse logistics systems when dealing with low-cost materials (Demajorovic et al, 2014). One of the most important recyclable materials sold by Vira-Lata cooperative is glass, mainly because of its partnership with Diageo, Owens-Illinois and beverage retailers such as restaurants, bars and nightclubs (Jesus and Barbieri, 2013). Vira-Lata is responsible for the collection and transportation, monthly reporting, sorting by colour and cleaning of the glass before the material is supplied to the recyclers. Diageo also holds training programmes to enrol retailers and Vira-Lata workers to increase efficiency in the process (Demajorovic et al, 2014). Diageo does not operate directly in reverse logistics but controls the information flows between network members in order to improve operational efficiency by helping with routing planning (Jesus and Barbieri, 2013). Quality control and supply are facilitated by the tracking system for the bottles. This system became possible due to the door-to-door collection service direct from retailers.

The collected material is processed into glass shards by the cooperative before being commercialised with Owens-Illinois. Owens-Illinois tracks the supply performance by assessing retailers and the cooperative throughout monthly reporting. Owens-Illinois purchases all collected glass from the cooperative, since the recyclable glass available in the market is insufficient to meet the demand. Each 1 tonne of glass

recycling saves 1.2 tonnes of raw material, 50 litres of oil and 60 litres of water. In the case of the Vira-Lata cooperative, about 70 tonnes of glass are recovered every month (Jesus and Barbieri, 2013). The assessment shows that in 2011 Vira-Lata collected almost 387 tonnes of glass with revenues of R\$ 50,000 corresponding to 7 per cent of business annual turnover (Demajorovic et al, 2014). A representation of the glass supply chain in the case of Diageo's bottles is illustrated in Figure 16.

Figure 16 Glass supply chain in the case of Diageo's bottles



Source: Adapted from Demajorovic et al, 2014

3.3.6 Cataunidos cooperative: the waste pickers' 'recycling network'

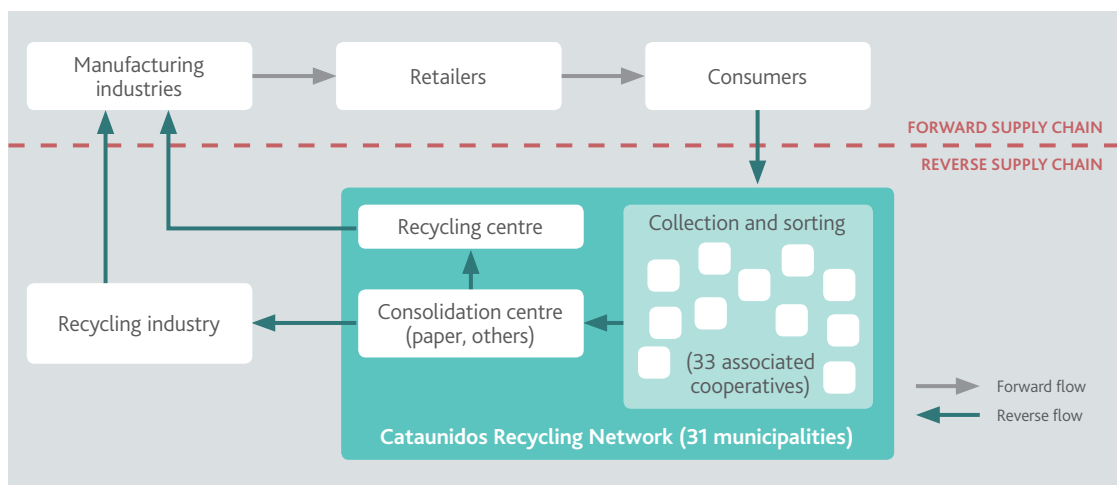
Cataunidos is a waste picker cooperative based on a solidarity economy and founded in 2006. It brings together a network of waste pickers of recyclable materials from different associations and cooperatives within the metropolitan area of Belo Horizonte, capital of Minas Gerais state in the south-east of Brazil. In 2012, Cataunidos was a network of 33 groups of waste pickers. The aim of the organisation is to promote better living and working conditions for the waste pickers by improving their income and education, while conserving the environment. Cataunidos is a Brazilian benchmark in services, commercialisation and processing of recyclable materials in a network structure. Its performance is also well recognised by the community and public authorities. According to information from the official website (Cataunidos, 2015a), the cooperative has established partnerships with municipalities as well as various NGOs and institutions such as the National Bank for Economic and Social Development (BNDES), Petrobras, Bank of Brazil Foundation and the federal government. These partnerships have supported the organisation in many ways, such as in the purchase of equipment, training, seminars and technical assistance. Cataunidos' official website says that this network directly benefits 750 waste picker professionals in 33 associations and cooperatives distributed across 31 municipalities of the Greater Belo Horizonte, mid-west and the 'royal road' regions of Minas Gerais state. In 2012, the average income of these waste pickers ranged from R\$ 200 to R\$ 1,250. The whole system recycles about 850 tonnes of materials per month. Papers and other materials are sold through a commercialisation centre run by the network. Most importantly, the network was recently able to set up its own plastics recycling facility to transform some types of collected plastics into pellets to supply the manufacturing of new products (Cataunidos, 2015b). Created by Cataunidos in partnership with the National Movement of Waste Pickers (MNCR), the 'Recycling Network – Generating Income and Citizenship' is the network platform used to build strategic coordination between the associated cooperatives. The network is an economic innovation in the recycling market. The MNCR has been one of the most active organisations advocating in favour of the waste pickers. Founded in 2001, the organisation constitutes one of the largest movements of recyclers in the world, with more than 80,000 members (Demajorovic et al, 2014).

The following factors were important in institutionalising the integration of waste pickers into municipal waste management in Belo Horizonte (Dias, 2011):

- The local authority acknowledged the important environmental contribution of waste picking activities, and the solid waste system promoted the inclusion of informal recyclers.
- External support from NGOs was an important factor in setting up the waste picker associations and cooperatives to form collectives and communicate demands.
- Public awareness campaigns changed prejudices towards waste pickers.
- Stakeholder forums are key to guarantee that all interest groups are heard and agreements are reached between all stakeholders.

For the Brazilian government, the experience of the Cataunidos Recycling Network is considered a cornerstone in urban waste management, integrating waste picker cooperatives as service providers performing collection and other reverse logistics services in materials recycling (IPEA, 2013). Figure 17 describes the supply chain:

Figure 17 Cataunidos Recycling Network



Source: Adapted from Cataunidos, 2015b

3.4 Scenarios

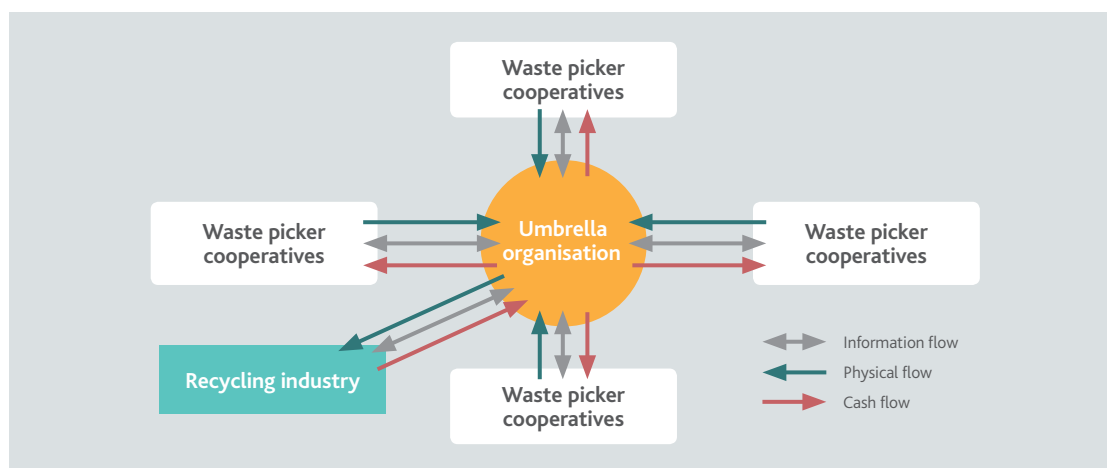
In this section, we will describe the main studies that propose new types of organisation for municipalities and cooperatives in order to improve waste management efficiency. Some authors propose new scenarios and analyse their feasibility.

3.4.1 Waste reverse logistics in the metropolitan area of Florianópolis: a feasibility study to increase performance of waste picker cooperatives

In 2014, the local public-held waste management company Comcap – located in the metropolitan region of Florianópolis – collected an average of 1,000 tonnes/month of recyclable waste, about 35.83kg per inhabitant/month (Comcap, 2014). Waste production increases by an average of 4.5 per cent each year in the metropolitan region. Most of the recyclable waste is collected door-to-door and one-third is collected at 'points of voluntary delivery' (PEVs). All collected material is donated to local waste picker associations. The biggest local cooperative is the Recycled Materials Waste Picker Association (ACMR), which works inside a Comcap facility. Comcap states that recyclable waste represents R\$ 4.8 million/year in revenue to the 300 associated waste pickers. Besides that, recycling saves the company R\$ 1.5 million/year by avoiding transportation and landfill costs. In the report released by the company, it was not clear what type of commercial relations the waste picker associations perform or if there is any network integration between the different associations at any level (Comcap, 2014).

Aquino, Castilho and Pires (2009) undertook a study in the Florianópolis metropolitan area in 2009. Its purpose was to look for an alternative to the organisation of waste picker groups in the reverse supply chain of post-consumer recyclable materials. At the time, 87 per cent of recyclable domestic solid waste was collected directly or indirectly and sent to private landfill sites. The remaining 13 per cent was recycled and was mostly collected by formal and informal waste pickers. The proposal for a new logistics organisation aims to build a network of the different groups of waste pickers in the metropolitan area. This network of waste picker associations would be coordinated by an umbrella organisation, which is run by representatives of each of the associated groups. The umbrella organisation receives the sorted and compressed materials from the associated cooperatives and performs commercialisation directly with recycling industries, as presented in Figure 18:

Figure 18 Proposal of logistics organisation for waste picker cooperatives



Source: Aquino et al, 2009

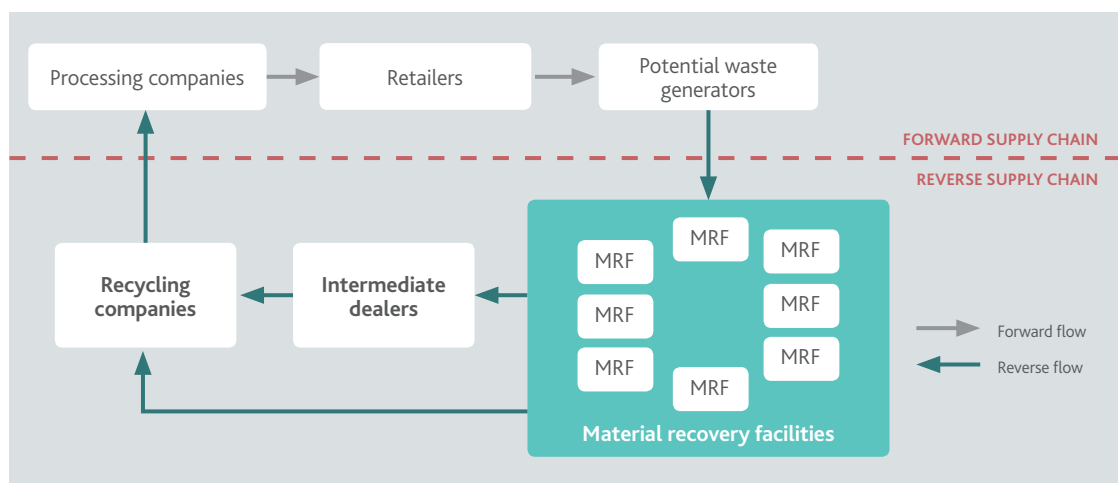
The economic feasibility study in the case of Florianópolis made by Aquino, Castilho and Pires (2009) demonstrates revenue potential 32 per cent higher than the sum of the revenue of all associations acting independently. At the time, the organised network of waste pickers could gain a revenue value addition of 39 per cent for paper, 99 per cent for plastics and 14 per cent for metals when sold directly to recyclers in the local market. The feasibility study accounted for the necessary capital investments to build infrastructure, the costs of production and transportation, the financial costs and the potential revenue from the sale of collected materials to the recycling industry or intermediary dealers. The purchase of the land to set up the facility was not taken into account, as the municipality should donate it. In addition, the authors also believe that the municipality should remunerate the waste pickers' network for the waste disposal costs avoided through reverse logistics services. The end revenue is calculated after discounting all expenditure and the payment of all members' social security (Aquino, Castilho and Pires, 2009).

3.4.2 Municipal solid waste logistics and the inclusion of waste picker associations: a feasibility study of the material recovery facilities network

This study presents an assessment of the reverse logistics system in the municipality of São Mateus, Espírito Santo state, in the south-east of Brazil, considering economic and legal requirements and the inclusion of waste pickers. Many different factors need to be taken into account in the total cost of reverse logistics, such as the number of installations, facility location and processing capacity, as well as flows between facilities. The study states that in the current situation of São Mateus municipality, the revenue from the sale of recyclable materials does not cover the costs of solid waste reverse logistics, which means that the current solution is not feasible in economic terms. The municipality has only one formally organised association of waste pickers who collect recyclable waste materials. The municipality follows a door-to-door system performed by compacting trucks collecting mixed waste without any pre-selection. This waste goes mainly to open-air dumps. In their study, Ferri et al (2015) propose a network model for a municipal solid waste reverse logistics based on generic mathematical modelling to locate facilities to make the system economically

feasible, according to the legal requirements of the SWNP. The reverse logistics network aims to integrate all of the links that are included in municipal solid waste management: the waste generators, the material recovery facilities (MRFs), the intermediate dealers of recyclables, recycling companies, sanitary landfills and incinerators. The MRFs are intermediate points between the generators of waste and the recovery or disposal facilities in the municipality. The study considered the waste picker associations as the potential MRF operators. The MRFs are sorting facilities comprising a set of equipment designed to separate recyclable from non-recyclable waste (ie organic waste and refuse) and sort it into the various types of materials. Thus, the sorting facilities would also work as consolidation points where discarded products and different recyclable materials are consolidated into large shipments, so reducing transportation costs, as well as organising door-to-door collection services in small regions, facilitating the work of waste pickers (Ferri et al, 2015). A representation of the suggested municipal solid waste reverse logistics network is shown in Figure 19.

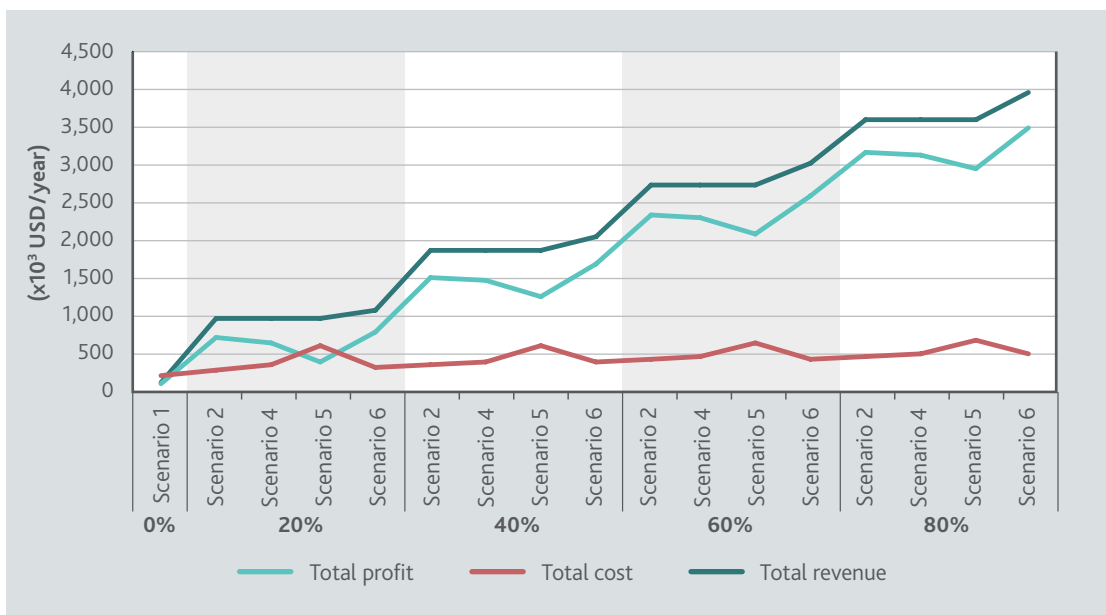
Figure 19 Municipal solid waste supply chain



Source: Adapted from Ferri et al, 2015

Figure 20 illustrates the results of a feasibility study of this network model, with profit growth versus costs as the percentage of recyclable waste collected increases. Results indicate a high level of economic feasibility. The assessment accounts for the potential revenue generated with the sale of recyclable materials and the reduction of waste management costs, including transportation, installation and operation of MRFs. The transportation costs from door-to-door collection to points of transfer are quite high and the use of MRF intermediate structures should minimise transportation costs. As the system relies on households to sort the recyclable waste at source, behaviour change on the part of households as regards separating recyclable waste at source is key to its success. The model proposed accounts for a gradual increase in the collection of recyclables by 20 per cent, 40 per cent, 60 per cent and 80 per cent, with growing participation from households. The investment in capacity building to ensure the active engagement of waste pickers was not accounted for in the research as presented. However, the potential profit calculated in the study suggests that the initial investment in the inclusion of the informal sector can be recovered easily in the long term. But the results support the hypotheses that recycling solid waste could be economically viable for the municipality and that the use of MRFs has the potential to bring revenue and income distribution across the whole network (Ferri et al, 2015).

Figure 20 Pattern of profit, revenue and cost (USD/year)

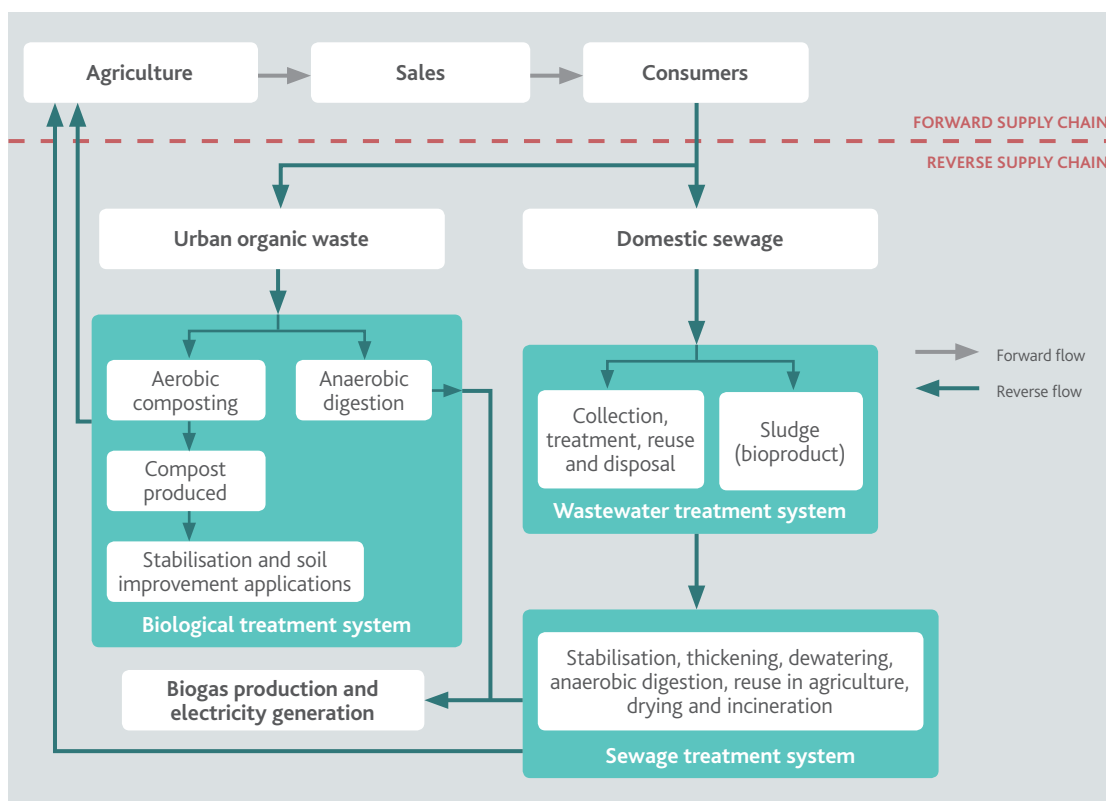


Source: Ferri et al, 2015

3.4.3 Municipal organic solid waste and domestic sewage in Campinas, Brazil: a feasibility study of organic waste recovery models

In the city of Campinas, one of the biggest cities in the state of São Paulo, the final destination of organic solid waste is a great challenge for the public administration. The current domestic sewage and water treatment in the city covers a population of almost 900,000 people and organic material makes up about 66 per cent of all collected waste (Lino and Ismail, 2013). Municipal management of organic solid waste and domestic sewage has a direct impact on public health and the environment. A feasibility study performed by Lino and Ismail (2013) evaluated different scenarios for municipal organic solid waste and domestic sewage management in the city of Campinas. The assessment study found that some technologies for biological waste treatment of organic waste and sewage are well known in Brazil and its implementation would result in minor technological impacts in the case of Campinas. The authors also argue that the biological treatment of domestic sewage, together with recycling, could contribute significantly to solving environmental issues through energy savings, emissions reduction and the recovery of water for reuse (Lino and Ismail, 2013). The authors evaluated different scenarios to assess impacts in terms of finance, water, energy, emissions and recycling. In Figure 21, the reverse logistics for the organic solid waste of the first scenario is presented. This model proposes the production of biogas, generation of electricity and the reuse of water from domestic sewage treatments while recyclables are separated and sent to recycling industries.

Figure 21 Supply chain for the first scenario proposed in the study



Source: Adapted from Lino and Ismail, 2013

In Table 11, we see the results of both scenarios' feasibility studies. This study accounts for the average amount of biogas electrical energy generated, the amount of domestic sewage generated per day, the quantity of water recovered and other information (Lino and Ismail, 2013).

Table 11 Scenario assessment results: comparison of the proposed scenarios and the actual situation in Campinas

Description	Current situation	First scenario	Second scenario
Net electric energy generated from biogas (MW)	0	0.9	6.1
CO ₂ produced by municipal solid waste treatment (tCO ₂ /day)	335	26.5	56.3
Financial gains from selling recyclables (USD/month)	71,100	2,898,000	2,898,000
Energy savings due to recycling (MW)	2.9	117.9	117.9
Emissions avoided due to recycling (tCO ₂ /day)	15.60	634.8	634.8
Electrical energy generated from domestic sewage treatment (MWe)	0	16.4	16.8
CO ₂ due to combustion of biogas and auxiliary fuel (tCO ₂ /day)	-	360.6	129.1
Recuperated water for possible reuse (m ³ /day)	0	123,138	123,138
Net CO ₂ avoided (tCO ₂ /day)	-319.4	247.7	449.4

Source: Lino and Ismail, 2013

SECTION 4

NEW CASE STUDIES

Further to examining the existing literature, we have identified additional case studies. We begin this section by summarising the key findings before describing each new case study in more detail.

This field survey aims to build on the evidence presented in the literature review. It presents qualitative and quantitative data from interviews and on-site visits relating to selected cases. This exploratory research intends to identify and understand some representative cases of reverse logistics in Brazil. As before, in order to assess the feasibility of circular models and their benefits, the data from the interviews was framed using the STEEPL analysis system to give better understanding of the information collected in the following six dimensions:

Social: Is the circular economy approach socially feasible and what are the social benefits from its adoption?

Technological: Is the circular economy approach technologically feasible and what are the benefits from the adoption of circular economy approaches in the technology landscape?

Economic: Is the circular economy approach economically feasible (business case) and what are the economic benefits?

Environmental: Is the circular economy approach environmentally desirable and what are the benefits from the adoption of these approaches to the environment?

Political: Is the circular economy approach consistent with the policy architecture and what are the potential political benefits from its adoption?

Legal: Is the circular economy approach legally feasible and what are the legal benefits from its adoption?

4.1 Summary of findings from case studies

The main findings from the fieldwork can be summarised as follows, according to the STEEPL framework.

Table 12 Summary of main fieldwork findings

Dimension	Summary
SOCIAL	<p>Waste pickers</p> <ul style="list-style-type: none"> ■ The fieldwork confirms our earlier finding that involving waste picker associations and cooperatives in reverse logistics systems can improve their income and working conditions. ■ However, for some big businesses, working with waste pickers still represents an operational, labour and environmental risk. ■ The organisation of waste pickers into associations, cooperatives and networks of cooperatives can overcome these risks and allow them to contract directly with business and government, with benefits for both sides. ■ Experience shows that waste picker cooperatives are very vulnerable to changes in supply (from municipalities, for example). Good relationships with government and business are required to mitigate this risk. <p>Other 'base of pyramid' opportunities</p> <ul style="list-style-type: none"> ■ Besides waste picker cooperatives, other types of cooperatives, such as those run by artisans (producing handicrafts or footwear from recycled materials) and small-scale farmers employing agro-ecology techniques, offer opportunities for the poorest to benefit significantly from the circular economy.

	<ul style="list-style-type: none"> ■ In all these cases, there is evidence that incomes can be increased, and living costs and conditions improved. ■ The cooperative model fits well within the Brazilian concept of the solidarity economy, and is well respected by society. With profit sharing and a horizontal organisational model, these organisations are well placed to build resilience and foster an entrepreneurial spirit among poor men and women. They also show evidence of gender empowerment and allowing the most vulnerable to reintegrate back into society. <p>Job creation</p> <ul style="list-style-type: none"> ■ A number of other formal sector start-ups working on circular economy issues (such as the reconditioning and reuse of electrical or mechanical parts, or collection and composting of organic waste) show significant potential for scaling up and job creation. <p>Other social issues</p> <ul style="list-style-type: none"> ■ A large number of consumers do not currently prioritise products that include recycled material (because of the environmental benefits), although attitudes are shifting in this area. A greater shift would create stronger incentives for reverse logistics. ■ Similarly, a consumer behaviour shift towards separating waste at source into recyclable, organic and non-recyclable waste would be beneficial.
TECHNICAL	<ul style="list-style-type: none"> ■ New businesses using waste products as an input to innovative designs are becoming available, particularly through groups of artisans. ■ Product innovations to facilitate reverse logistics systems are being created, such as compostable plastic bags. ■ Some very simple technologies, such as the bio-digester, can offer significant solutions for organic waste 'closed-loops' (in the case of the bio-digester, producing cooking gas and fertiliser from animal manure). ■ Reverse logistics would be given a significant boost if products were designed and manufactured with reuse, remanufacture and recycling in mind. This requires a change in design standards, but in this regard global supply chains are likely to set these design standards beyond Brazil to a significant extent (in the EU and elsewhere).
ECONOMIC	<ul style="list-style-type: none"> ■ They confirm our earlier finding that involving waste picker associations and cooperatives in reverse logistics systems can improve economic viability, both in public-private partnerships with municipalities, and in partnership with private companies (eg performing door-to-door collection and sorting). ■ A number of other cooperative ventures on circular economy issues (such as artisanal handicrafts, agro-ecology) are also clearly viable. ■ A number of larger, formal sector circular economy businesses also show strong potential for economic viability and scale-up, in sectors such as the reconditioning and reuse of electrical and mechanical parts and the collection and composting of organic waste for agriculture. ■ Other businesses are starting to offer design solutions for reverse logistics: this has the potential to be a significant area of growth. ■ In general, there are significant economic opportunities for a large number of business models and scales.

ENVIRONMENTAL	<ul style="list-style-type: none"> ■ Half of the municipal waste in Brazil is organic, and currently almost all of this goes to landfill or dumps. When it breaks down in landfill (under anaerobic conditions), it emits methane – a powerful greenhouse gas. There are thus huge carbon savings to be made through collecting and composting organic waste, or using a bio-digester to capture this gas for use in cooking. Similarly, the fertiliser produced through both these approaches can replace chemical fertilisers. ■ Using recycled materials for production (rather than virgin materials) saves energy and water and avoids pollution to ecosystems.
POLITICAL	<ul style="list-style-type: none"> ■ The Solid Waste National Policy (SWNP) has the potential to create significant new markets and incentives for reverse logistics approaches of all kinds, whether recycling, refurbishing, reusing or the treatment of organic waste. ■ However, the SWNP must be effectively implemented at municipality level for this to take place. Municipalities are viewed as the weakest link in the implementation process, and support from state-level government and pressure from local groups may be required to ensure that the policy is properly implemented and monitored at local level. ■ In particular, there is a lack of understanding regarding the social benefits that appropriate SWNP implementation could bring, and pressure may be required to ensure that municipalities have a broader circular economy vision, with social, economic and environmental dimensions, when drawing up their plans. ■ In a similar vein, the current charges for business use of landfill (where they even exist or are enforced) do not provide a strong disincentive against sending waste to landfill. ■ The government has a lot to gain from the shared responsibility model (from the Brazilian SWNP) as it may provide social benefits, through the inclusion of the informal sector and 'base of the pyramid' (BoP) entrepreneurship in the reverse logistics supply chains. ■ At present, there are no tax advantages to using recycled or refurbished elements as an input in the production process. ■ Finally, public procurement could be improved so that it prioritises socially and environmentally responsible services and products, in accordance with the SWNP principles.
LEGAL	<ul style="list-style-type: none"> ■ The legal formalisation of waste pickers into cooperatives is essential for their inclusion in formal supply chains, and this can require a great deal of technical support. ■ In the same vein, these groups may need support to set up appropriate administrative functions (issuing invoices, for example), access sources of finance, and establish health and safety policies. ■ There is already provision in law for municipalities to support cooperatives in these ways, and there are examples of businesses and NGOs also offering this support. ■ Micro and small businesses can also require support, but in these cases the Brazilian Support Service for Micro and Small Businesses (SEBRAE) and industry associations are the right partners.

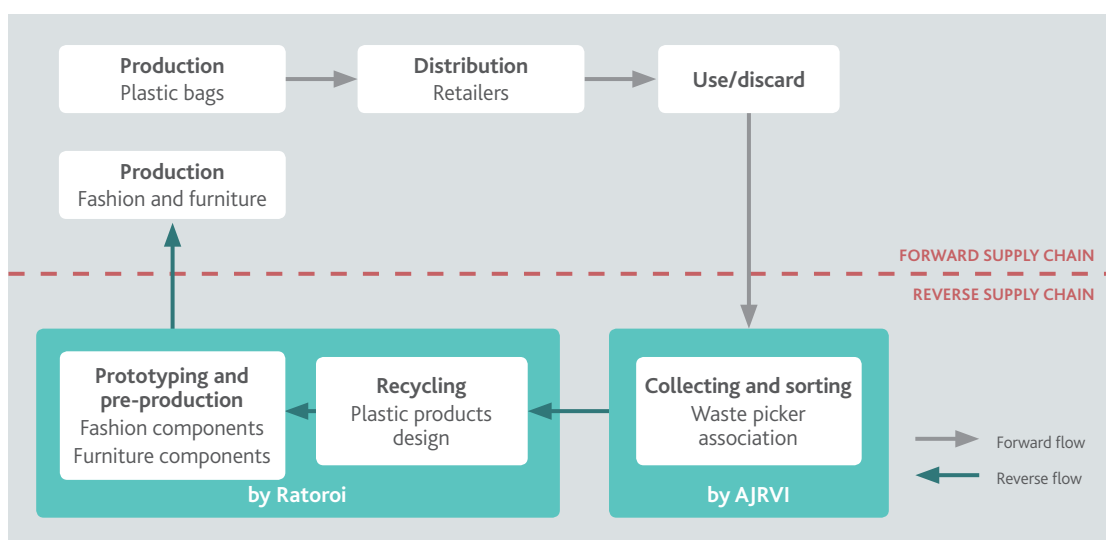
4.2 Concrete examples of what a circular economy development pathway would look like in practice

The results of the case study interviews are organised in a STEEPL framework.

4.2.1 AJRVI

The Recyclers' Association of Jaraguense Valley Itapocu, AJRVI, was founded in 2012 by waste pickers seeking better working conditions and income through collective organisation to market recyclable waste. The association's mission is to promote the organisation of people working informally in the recycling sector so they can generate an income and strengthen the local economy. AJRVI operates in the Jaraguá do Sul region, a city with 150,000 inhabitants in the state of Santa Catarina, southern Brazil. The association receives recyclable waste from the municipality and also purchases waste from other smaller groups of waste pickers in other cities in the region. It sorts, classifies by type and bundles waste to sell it on to recycling processing companies. The co-founder and now president of AJRVI was interviewed, who plays an important internal leadership role and seeks political representation, as well as centralising various functions of management and control processes, and seeking new business opportunities. The questionnaire and the field visit aimed to understand how the work of recycling cooperatives is related to the circular economic model and to the creation of reverse supply chains.

Figure 22 Ratoroi–AJRVI closed supply chain model



AJRVI STEEPL

Social

AJRVI

BENEFITS

AJRVI provides up to 20 families of 4–5 people with a 'sorting box' where they can work sorting the recyclable waste. The AJRVI board of directors chooses these families.

The association offers work opportunities for people in vulnerable situations, providing them with a safe working environment.

Sorting recyclable waste generates an income for those who work with the association, allowing them reintegration back into society.

AJRVI prioritises the value of its workers and the supply chain over production efficiency.

AJRVI focuses on balancing the purchasing cost versus the price of sale in order to pay a fair price and value the work of the waste pickers.

AJRVI performs awareness campaigns in schools and supports waste picker groups to improve their working model.

FEASIBILITY People in vulnerable situations receive training and orientation to work with AJRVI, and this creates links that strengthen the ideals of the association.

SPECIFIC ISSUES AJRVI was founded in 2012 by five waste pickers who were looking to work collectively to attain better working conditions.

AJRVI's mission is to organise informal workers from the recycling market so they can generate income and strengthen the local economy.

Today, the association's executive board has five members (two are founders) who jointly make decisions on issues and challenges.

Technological

AJRVI

BENEFITS AJRVI is recognised for the quality and organisation of its production processes and management. Recently, AJRVI started to work with computerised systems to keep track of all purchases and sales of materials, which allows daily control over what is produced. Payment is made directly to the bank account of each associated worker and an invoice is issued. AJRVI has adequate infrastructure and equipment for transporting, sorting, weighing, pressing and storing materials. Production sites are in line with work safety, organisation and cleanliness requirements. All associated workers are requested to use personal protective equipment such as gloves and boots.

FEASIBILITY AJRVI believes that the manual process of waste sorting is the most efficient because it generates fewer rejects. The high rate of materials recovered in the process – including the least valued ones – contributes to cargo consolidation, while strengthening relationships in the supply network. AJRVI leadership recognises the need to improve business management and is already seeking ways to develop this capability. Managing the waste sorting process and workers requires a great effort and sometimes it is necessary to remove people who do not fit well with the group.

SPECIFIC ISSUES Currently the association processes 1.5 tonnes of recyclable waste every day. The waste donated by the municipality goes to the sorting boxes while the waste purchased from other waste pickers goes to a large shed, both for later separation. The sorted materials are pressed into bales, stored and sold, while some rejects (non-recyclable materials) go to landfill. The AJRVI manager controls the tasks and training of all associated workers.

Economic

AJRVI

BENEFITS AJRVI activities benefit the local economy by generating wealth through the recovery of waste that would otherwise be discarded. Each sorting box for recyclable materials has an average income generation of USD 1,300 per month. High-quality sorting increases the materials' value, ensuring the demand for such materials. It generates a gross margin of 80 per cent after sales. AJRVI's current average gross income is USD 11,650 per month. The facilities already in place could raise the income to up to USD 32,000 per month. AJRVI's fair price strategy in paying for the sorting may lower its margins; on the other hand, it ensures continuous material volume and production.

FEASIBILITY

There are 13 groups of organised waste pickers in the city of Jaraguá do Sul, currently competing heavily to commercialise recyclables with industry.

Today, up to 50 per cent of the revenue made by AJRVI comes from the commercialisation of waste purchased in other cities.

Last year, AJRVI faced debts due to the decreased amount of waste received from the municipality.

AJRVI had to discontinue 16 of its 20 sorting boxes due to the decreased amount of waste received from the municipality, dropping production by 60 per cent.

If the regular volume of waste supply was restored, it would allow AJRVI to invest in equipment to increase value added in the process.

AJRVI's fair pricing practices have caused animosity among its competitors.

AJRVI's monthly expenditure is about USD 4,000 on average, which covers rental, waste collection transportation, energy for production and head office maintenance.

SPECIFIC ISSUES

AJRVI-sorted materials are commercialised with the recycling industry to supply both domestic and international markets.

In Brazil, the recycling industry requires high-quality sorting processes for recyclable waste.

Currently, the most valued materials in the market are aluminium, cardboard and PET, but AJRVI works with all types of recyclable materials.

AJRVI pays workers based on a selling price table, according to the type and amount of material sorted.

AJRVI's investments in infrastructure and machinery are registered on behalf of the association.

AJRVI states that the association performs the most 'dirty' and devalued work of the recycling supply chain.

Environmental**AJRVI****BENEFITS**

AJRVI alone has an infrastructure with the potential to receive and sort about 120 tonnes of recyclable waste per month.

The process of sorting maximises the recovery of waste (including waste of low market value) and decreases disposal rates to landfill.

FEASIBILITY

-

SPECIFIC ISSUES

AJRVI has no indicator to measure the environmental impacts and benefits of its activity.

Political**AJRVI****BENEFITS**

AJRVI has received technical and financial support from the state government through the Green Economy Project, and believes that the government has a key role to play in supporting recycling by cooperatives.

AJRVI is affiliated to UNISOL, an NGO that supports the development of cooperatives in general, but otherwise the association is not part of any other kind of support network.

The associated workers recognise the leadership of the president in negotiating with the municipality and ensuring waste supply and infrastructure for their work.

FEASIBILITY AJRVI is not able to stimulate other waste picker groups to work together due to the lack of trust between the parties.

The municipality and other local politicians do not realise the potential of the association's activity to generate income for people in vulnerable situations.

There is mutual distrust between AJRVI representatives and the local public administration.

AJRVI believes that some business people and politicians do not want the recycling activity to succeed, because it brings changes to the current waste management system.

AJRVI recognises that there are cases where other municipalities supported waste picker groups which have not succeeded, and investments were lost.

The failure of many waste picker associations is reflected in the general distrust of recycling cooperatives.

SPECIFIC ISSUES When AJRVI was created, the founding group had no awareness of the SWNP.

AJRVI management believes that success in this field of activity relies on the role of a leader and that horizontal decision-making might not be adequate.

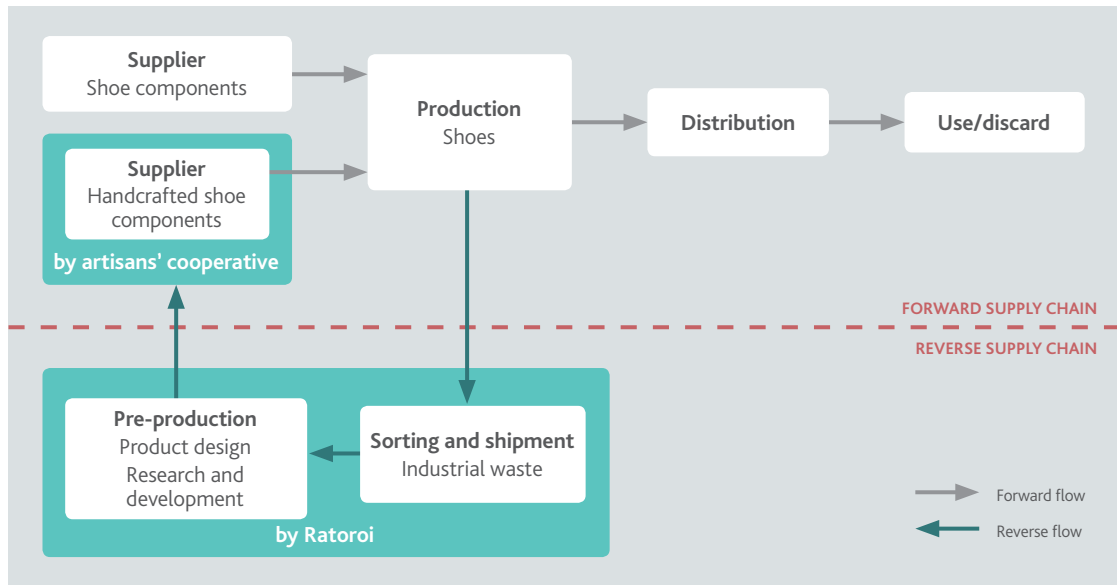
One of the main concerns in turning the association into a cooperative is to guarantee the commitment of the new board to the current organisational culture.

Legal	AJRVI
BENEFITS	<p>Recently the municipality started supplying and giving support to AJRVI in order to help legalise its activity.</p> <p>AJRVI management believes that turning AJRVI into a cooperative is a positive change: in this way they will have more support to improve the overall working conditions.</p>
FEASIBILITY	<p>AJRVI needs support to formalise and structure its activities and to improve its production processes.</p> <p>Turning AJRVI into a cooperative will legally formalise the commercial activity and relationships with associated workers.</p> <p>The municipality where AJRVI has its headquarters offers no incentives for recycling activities.</p> <p>Some of the labour laws in fact oppose the real needs of the workers involved in waste recycling.</p> <p>AJRVI believes that the government should control other careless practices of waste sorting in inappropriate places.</p> <p>Money laundering practices are a concern due to the high level of informality in the activity and the lack of control in production.</p>
SPECIFIC ISSUES	<p>Currently there is no working contract or any type of labour registration between AJRVI and its associated workers.</p>

4.2.2 Ratoroi

Ratoroi is a small design company based in Jaraguá do Sul, with a focus on innovation and sustainability: it develops new materials and products for the garment industry and fashion accessories through craft techniques using waste materials. Currently the company has been developing work using solid waste from the footwear industry and plastic bags made of post-consumer recycled polyethylene as its raw material. The materials used are obtained in partnership with local recycling cooperatives, and the manufacturing of components is conducted in partnership with groups of local artisans. The design of the components aims to meet the demands of industry, building on the manual skills within the local culture, developing partnerships with industry and the community in the north-east of Santa Catarina state in the south of Brazil. The co-founder of the company was interviewed. The questionnaire and the field visit focused on understanding the business model of Ratoroi and how it is related to circular economic models and to the creation of reverse supply chains.

Figure 23 Ratoroi–footwear closed supply chain model



Ratoroi STEEPL

Social

Ratoroi

BENEFITS

Ratoroi has partnerships with local waste picker associations and local artisan associations. Ratoroi's work helps to build partnerships between local artisan associations and the fashion industry. Ratoroi designs products inspired by local culture and based on the skills of local craftswomen. The local craftswomen groups are trained on new production processes. The craftswomen groups have flexible working hours and shared responsibilities. The production processes developed by Ratoroi prioritise employing people over technology and machinery.

FEASIBILITY

Working with partner associations requires careful management to meet deadlines and targets. The associations that are located outside the usual footwear industry logistics routes face difficulties in joining partnerships. The associations need support from Ratoroi in order to be able to negotiate with the footwear industry.

SPECIFIC ISSUES

The craftswomen associations are non-profit and members share the gains equally.

Technological

Ratoroi

BENEFITS

The prototypes created by Ratoroi are displayed at design and innovation footwear fairs. The manufacturing processes are simplified to avoid risks to the artisans. All the reverse supply chain is located in the same region, including the waste suppliers.

FEASIBILITY	<p>Ratoroi believes that there is technology available to design products for the reverse supply chain, but more investment in new product creation is required.</p> <p>The fashion industry shows resistance to adopting new manufacturing processes that would facilitate the reuse of waste.</p> <p>More research on product innovation and design is needed for acceptance by the industry.</p> <p>The artisan associations make use of safety equipment and have production management skills.</p> <p>Footwear manufacturers make use of the existing logistics routes to deliver waste to partner associations.</p> <p>The waste is sorted at source, so no processing and selection are required after delivery.</p>
SPECIFIC ISSUES	<p>Ratoroi has developed its own production process making the plastic components from polyethylene plastic bags.</p> <p>The amount of waste diverted is still small in comparison to the global amount of waste generated by the footwear industry.</p>
Economic	Ratoroi
BENEFITS	<p>The handcraft associations are benefiting from new income generated through projects with the footwear industry.</p> <p>The artisans' engagement and motivation with the production process result in higher-quality products.</p> <p>Ratoroi product design helps the footwear industry to identify new ways of using waste to manufacture value-added components.</p> <p>The components made by Ratoroi design compete successfully with similar conventional products.</p>
FEASIBILITY	<p>Ratoroi noticed a growing consumer interest in fashion fairs for these types of products.</p> <p>Ratoroi has no control over whether the final products using its components are manufactured for recyclability.</p> <p>The waste used as raw materials by the artisans is acquired free from waste generators of the footwear industry.</p> <p>The artisan manufacturing process of the components is not suited for large-scale applications.</p> <p>The product designed by Ratoroi cannot compete with similar Chinese products.</p> <p>The recycled polyethylene process has received awards in design fairs, although it has not hit the market yet.</p>
SPECIFIC ISSUES	<p>The financial success of the reverse supply chain has currently not been measured.</p> <p>The product design is focused on manufacturers of durable goods, as opposed to the 'fast fashion' market.</p> <p>The product design makes use of recyclable materials for manufacturing high value-added components for clothing, footwear and fashion goods.</p>
Environmental	Ratoroi
BENEFITS	<p>The manufacturing of plastic components developed by Ratoroi utilises recyclable material and does not generate any sort of waste.</p> <p>The manufacturing of plastic components developed by Ratoroi is safe and does not offer any type of environmental risk.</p> <p>The components designed by Ratoroi are handcrafted, making low use of energy and machinery.</p> <p>The components are designed to avoid the use of chemical additives and adhesives.</p> <p>Components are designed not to mix biological and technical materials.</p>

FEASIBILITY Ratoroi uses 5 per cent of the materials that would have been sent to landfill from the São João Batista footwear industry.

The amount of waste used by Ratoroi is still low in comparison to the amount generated by the whole São João Batista footwear industry.

Only one in 50 shoe models utilises a component designed by Ratoroi, using waste from the production process.

SPECIFIC ISSUES -

Political Ratoroi

BENEFITS The SWNP brought urgency to the waste issue and focus to training programmes in the footwear industry.

FEASIBILITY Today the SWNP has turned into an important driver in the fashion market.

There is still a lack of support from public policies to develop sustainable products.

Public procurement requirements for recycling activities do not encourage the participation of cooperatives.

There is an urgent need to overcome the organisational weaknesses of waste picker and artisan cooperatives.

The Brazilian Micro and Small Business Support Service (SEBRAE) has played an important role in the development of Ratoroi activities.

The municipal technical staff lack understanding of the social role that waste management can perform.

SPECIFIC ISSUES -

Legal Ratoroi

BENEFITS -

FEASIBILITY Participating in governmental funding programmes implies facing a high level of bureaucracy.

Funding for product design and development is scarce. Most funding available is for machinery purchasing.

There is a lack of government support for reverse supply chain activities, including the one developed by Ratoroi, especially at municipal level.

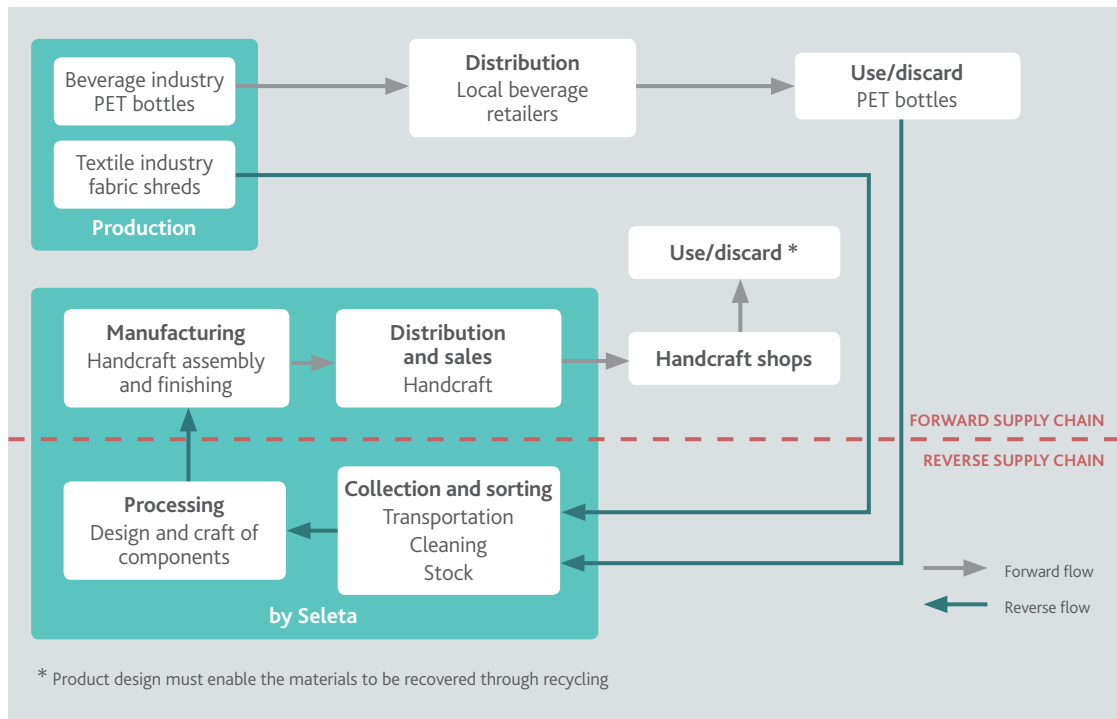
The mutual relationships between the associations, the cooperatives, industry and municipalities are not yet regulated at any level.

SPECIFIC ISSUES -

4.2.3 Seleta

The 'Seleta project' was created in 2013 by Instituto Solidare to generate income for mothers, and thereby prevent their children dropping out of other programmes run by the Institute. The Seleta project, based in Recife, capital city of Pernambuco state in the north-east region of Brazil, has its foundations in the solidarity economy in creating an artisan cooperative, gathering together 18 women. The Seleta business model is based on the collection of discarded PET bottles for the manufacture of high value-added handicrafts relating to four types of product: souvenirs, home decoration objects, home utilities and fashion accessories. The president and the executive manager from Instituto Solidare were interviewed. The questionnaire and the field visit aimed to understand how the Seleta project is related to the circular economic model and to the creation of reverse supply chains.

Figure 24 Seleta closed supply chain model



Seleta STEEPL

Social

Seleta

BENEFITS

Instituto Solidare has been promoting the development of entrepreneurial craftswomen's skills.

The activities within the Seleta project have an impact on empowering women in the local community.

By increasing the self-esteem of the craftswomen, the project has a positive effect on their relationships with other family members.

Respect for the craftswomen's activity relies on revenue generation.

The handicraft production has been gaining more status in the market and become more respected by society.

Improving the political awareness of artisans is crucial for building the understanding of the importance of their work and the value of their handicrafts.

FEASIBILITY

Empowerment methodologies help craftswomen understand the market.

Awareness methodologies help build a horizontal organisational model for the cooperative, free from hierarchies.

One vulnerability of the project was the two years of unpaid training courses for the women.

Women's involvement in activities was only possible due to the credibility the Institute had among the families.

Some husbands' distrust of the validity of all the efforts involved in creating the cooperative is still an issue for some of the women.

To ensure the autonomy of the group of craftswomen, achieving the legal formalisation of the activities of the Seleta project is a priority.

SPECIFIC ISSUES The project was created to generate income for mothers and to prevent their children dropping out of other programmes.

The project brings together 18 women with an average age of 38, who have children and who have previously participated in other Instituto Solidare projects.

A study was undertaken on the generation of waste locally and its impact on the community's quality of life.

The women of the group make their living earning aid from federal government programmes and by doing informal jobs.

The project uses two indicators for measuring social impact: income generation and political participation in the community.

The women's group exchanges personal experiences in order to strengthen their resilience with regard to gender issues.

Technological

Seleta

BENEFITS

The production process uses low-cost and simple equipment.

The production success lies in the group's ability to absorb new handicraft techniques.

Reverse logistics is simple, does not require transportation of large volumes and does not require special equipment.

The craftswomen participate in business development decisions, guided by voluntary consultants.

The craftswomen perform all business activities such as collection, selection, design, manufacturing and marketing the handicraft.

FEASIBILITY

Product design is considered as one of the most important aspects of the business.

In order to add value to the handicraft, it is necessary to develop a production process with high-end finishing.

The group has some handicraft skills but needs support in product design and quality control.

A business partner has trained the group in handicraft techniques using recyclable materials.

The group still needs support to consolidate its organisational structure and to master business management.

The group's emancipation phase starts in 2016 in order to increase business independence from external support.

SPECIFIC ISSUES

The production process consists of collecting recyclables and purchasing inputs, washing, selecting and storing, manufacturing and finishing.

To operate, the facility must have a space for the storage of raw materials and products, a manufacturing area and an administration and sales office.

For now, the training activity and the production studio of Seleta take place at the Instituto Solidare headquarters.

The group already has a routine for collecting recyclable PET bottles from local small beverage stores.

In addition to PET, the handicrafts also use scraps donated by a local textile company, which demands a certain control over handicrafts due to trade secret competition in fashion.

There is a concern to maintain the horizontal and participatory organisational model to avoid centralisation of power.

BENEFITS

The Seleta project business plan has concluded that there is a high chance of success.

Seleta's main objectives are: income generation, community organisation and women's resilience.

Artisan production creates more value added for recyclable materials than if compared to only sales for recycling.

Through the cooperative organisation, the group will be able to meet a higher production demand and have better bargaining power in commercialisation.

The reverse logistics performed by the group is simple and does not require investment.

There are opportunities for expanding handicraft sales to international business fairs.

FEASIBILITY

According to the business plan, the handicrafts made from recycled material have good potential to be sold in the shops.

Today, 50 per cent of consumers are indifferent as to whether the handicraft uses recycled material and would not pay more for it.

The business plan estimates a total of USD 31,200 of investment required in the first 12 months.

The business plan predicts a turnover of USD 7,400 by the end of the first year, including a monthly salary of USD 155 for each craftswoman.

The business plan predicts that production can reach full capacity to make USD 14,700 per month in revenues by the end of the second year.

Recyclable waste represents 60 per cent of the raw material used in the handicrafts, while the other 40 per cent of inputs have to be purchased.

SPECIFIC ISSUES

The business is based on solidarity economy principles to create a cooperative to produce handicrafts from waste materials.

The market strategy is focused on the transformation of discarded materials into high-value handicraft products.

The handicraft market of Recife is mature, well structured and open to innovations.

The first phase of the project focused on building the capacity of workers in terms of knowing their market, on policy awareness and on production skills.

The second phase of the project focused on branding, product development and market testing.

A market survey helped to understand why the previous business model, which originally focused on recycling, would not succeed.

Environmental

Seleta

BENEFITS

PET and other waste materials are diverted from landfill and reintroduced to the market as components for handicraft products, extending their value.

The Seleta project contributes to the collection of PET bottles that would otherwise be disposed of in water streams in poor neighbourhoods.

The environmental commitment can become a marketing differential for handicraft buyers.

Seleta is looking to align with a local campaign on environmental awareness to tackle flooding in poor neighbourhoods.

The handicrafts production process does not pose safety risks to workers and presents no environmental hazards.

FEASIBILITY

Seleta's connection with environmental issues is due to the beneficial impact of the activity through diverting PET waste from local beverage shops.

SPECIFIC ISSUES

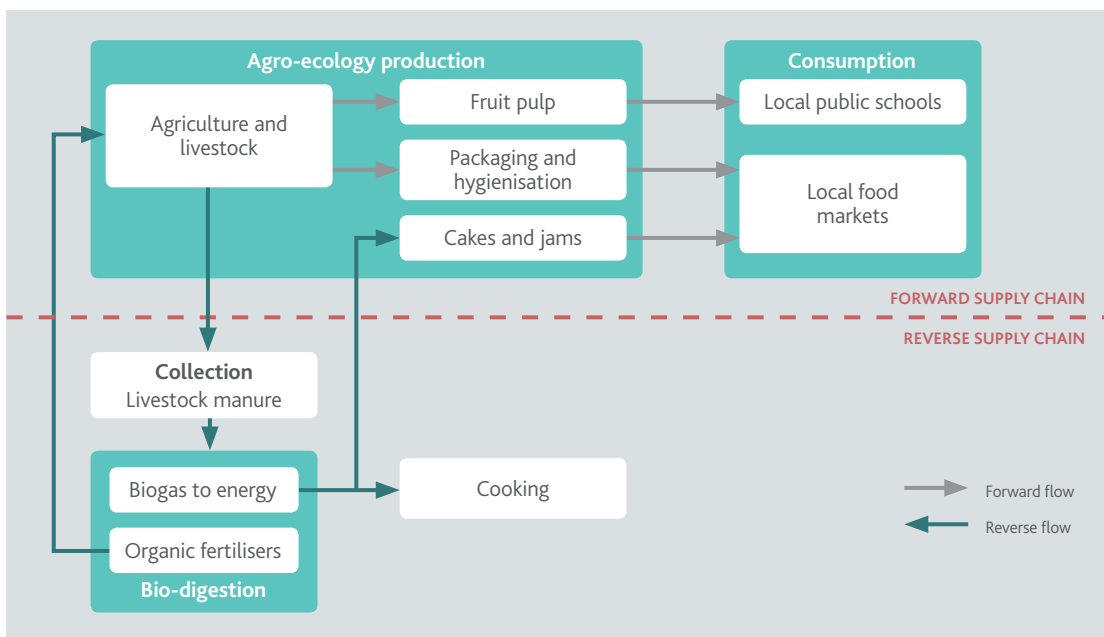
Although products are made from recycled materials, the handicraft products made are not yet considering environmental factors or designed for disassembly and recyclability.

Political		Seleta
BENEFITS	<p>Accomplishing the project involved partnerships with several institutions such as universities, companies, NGOs and churches.</p> <p>The city of Recife has recognised the value of the Seleta project and invited Instituto Solidare to help create other working groups.</p> <p>It is known that there are some companies partnering with other recycled material handicraft producers.</p> <p>Instituto Solidare believes that the SWNP is opening opportunities for the creation of other projects like Seleta.</p>	
FEASIBILITY	<p>Currently, Seleta has not had a marketing campaign aimed at companies to seek partnerships for the project.</p> <p>The Seleta project has not yet established any partnership with the government.</p> <p>The Environmental Fund of Caixa Econômica, a federal public bank, supported the entire project.</p> <p>The reverse supply chain of recyclables in the metropolitan region of Recife is still disorganised and legally informal.</p>	
SPECIFIC ISSUES	<p>The Instituto Solidare was responsible for the Seleta project idea, group coordination, alliances with partners and business development.</p>	
Legal		Seleta
BENEFITS	-	
FEASIBILITY	<p>Although the group is organised according to a cooperative model, it is not yet legally formalised.</p> <p>A newly released federal law (PL 7755/2010) will help in the support for and legal formalisation of handicraft activities.</p> <p>Waste generators are more concerned with complying with the law than partnering with social initiatives such as Seleta.</p>	
SPECIFIC ISSUES	<p>The NGO believes that with the SWNP legal landmark it is up to civil society to demand compliance from public administration and companies.</p>	

4.2.4 Diaconia

Diaconia is an NGO that works with families in rural areas to assist with agro-ecological production on a small scale, addressing key issues such as food security, access to water, the environment and climate, youth and gender, and serving more than 4,000 family farmers. Diaconia also works in advocacy for evangelical churches to occupy the spaces of influence on public policy. Today, the NGO is a pioneer in the development, adaptation and implementation of technologies such as bio-digester animal manure to make biogas for cooking and compost for soil fertilisation, and the implementation of agro-ecological production systems. The NGO uses technology to strengthen agro-ecological production activities and to support the marketing of products in agro-ecological fairs in the Sertão region of Pajeú, the central area of the state of Recife in north-east Brazil. For this work, the political-pedagogical coordinator of Diaconia and Coordinator of the Territorial Unit of Pajeú were interviewed, as well as some of the families in the rural area of Afogados da Ingazeira in Pajeú. The questionnaire and field visit were aimed at understanding how the use of digesters for production and marketing of agro-ecological fairs is related to the circular economic model.

Figure 25 Diaconia–bio-digester closed supply chain model



Diaconia STEEPL

Social

Diaconia

BENEFITS

Biogas replaces wood for cooking, eliminating soot particles, improving family health and living conditions at home.

The positive examples help to influence even the most resistant people to adopt new production practices.

Biogas simplifies home activities, allowing women to dedicate more time in the production and commercialisation of agro-ecological products while participating in the community.

Diaconia has trained more than 500 people in the implementation of family agro-ecological production units.

Poor families benefit from the agro-ecology programme through more than 200 different economic activities, including the sale of agro-ecological products in city markets.

Diaconia is monitoring the positive impacts from the use of the biogas for cooking.

FEASIBILITY

The rural producers are resistant to adopting new practices and technologies due to cultural factors.

The use of the bio-digester does not pose any risk to human safety.

The liquid bio-fertiliser is often not used because small families have no manpower to do the work.

Migration to urban areas is a barrier. Less than 20 per cent of the area population lives in rural areas.

There is still resistance to the adoption of the bio-digester regarding the operation, efficiency and risks, despite all its proven benefits.

Preventive practices of agro-ecology are a paradigm shift away from conventional agricultural practices.

SPECIFIC ISSUES

There are no indicators used by Diaconia to measure the social benefits associated with the use of the bio-digester.

The agro-ecology programme focuses on food issues and the empowerment of women to provide income for inhabitants in the semi-arid region of Brazil.

The principles of agro-ecology aim to strengthen people's resilience and the ability to generate and manage knowledge.

BENEFITS

The bio-digester produces a nutrient-rich fertiliser that can be used in agro-ecology and agricultural production.

Some bio-digesters have been in operation since 2008. The proper maintenance allows long durability of the system.

The main focus of the bio-digester is the use of methane gas to replace firewood for cooking.

The operation of the system is a daily manual process, which does not require any special effort.

The technologies are implemented in order to strengthen the family's autonomy and to build knowledge.

The main goals of technology implementation are the empowerment of families, valuing individuals and strengthening leadership.

FEASIBILITY

The bio-digester can be easily constructed using cheap materials and common tools, and its operation and maintenance are simple.

Diaconia monitors the construction and offers training and assistance on the operation and maintenance of the bio-digesters.

The maintenance demands periodic inspection in order to ensure the gas flow and eliminate leaks.

The bio-digester depends on livestock farming in order to obtain fresh manure to run it.

There are no risks in the operation of the bio-digester and no accidents have ever occurred in all the years of operation.

Because of misconceptions, many farmers only use the compost from bio-digesters in the fertilisation of taller plants, such as fruits, corn etc.

SPECIFIC ISSUES

Maintenance needs to be done due to the moving parts of the bio-digester and the gas pipelines.

The gas productivity varies mostly with the type of manure and the amount of water mixed into it.

The productivity of producing fertiliser from manure has not yet been measured.

There are no specific actions from Diaconia to promote the use of the bio-fertiliser for fertilising the soil.

The technologies are improved through the alignment of scientific and local people's expertise.

The work of Diaconia with agro-ecology and the bio-digester is a positive example of technological development, adaptation and implementation.

Economic**BENEFITS**

The soil fertiliser that results from the bio-digester process can be used in agro-ecological production.

Since 2001 the agro-ecological markets have been successfully held alongside traditional agricultural products.

166 bio-digesters have been installed in the Pajeú region and benefit more than 170 families. Since 2008 more than 300 bio-digesters have been installed throughout Brazil.

The use of biogas enables families to save about USD 25 per month in cooking gas costs.

The use of a bio-digester can decrease the production costs of pastries and cakes to sell at market.

FEASIBILITY

Both the biogas and the fertiliser produced by bio-digesters are not commercialised.

The agro-ecology association has adopted management tools to improve the production process and commercialisation of products.

The cost of bio-digester construction is approximately USD 600.

The entrepreneurial spirit strengthens the resilience of rural families.

The poorest families that have no animals to provide manure for use in the bio-digester receive donations from 'solidarity providers'.

SPECIFIC ISSUES The SEMIA⁷ project has received in total an investment of USD 900,000 to invest in family production, processing and commercialisation of agro-ecological products.

When properly managed, the bio-digester strengthens all the principles of agro-ecology to the improvement of social, political, economic and environmental issues.

Most of the families that have agro-ecological production have also installed a bio-digester.

In order to generate regular income, the families prioritise the selling of rural products at the agro-ecological market.

The management and marketing of agro-ecology production in markets are focused on supporting the empowerment of the families.

Environmental Diaconia

BENEFITS The use of the biogas for cooking eliminates the need for chopping down trees for fuel, while reducing air pollution.

The bio-digester uses small amounts of water, the bio-fertiliser replaces chemical fertilisers and the digestion process eliminates any risk of contamination from the manure.

The burning of biogas transforms methane gas into CO₂, decreasing the emission of greenhouse gases.

FEASIBILITY The use of pig manure in the bio-digester can emit an unpleasant smell to nearby sites.

When not cleaned periodically, the bio-digester can look very unappealing.

Climate change and intense drought are major barriers to maintaining the agro-ecology initiatives in the region.

Due to persistent drought in the region, there are fewer production surpluses to be sold to the government programmes.

Sludge fertiliser leakages from the bio-digester tank are unlikely.

Liquid fertiliser in the output of the bio-digester may offer a minor contamination risk to streams if not controlled properly.

SPECIFIC ISSUES According to rural standards, the bio-digester has a clean visual appearance.

The bio-digester usually does not generate an unpleasant smell in the nearby area.

In order to neutralise the methane greenhouse gases, the system must have no leaks and all the gas has to be burned in the stove.

Political Diaconia

BENEFITS About 50 families from eight different municipalities that coordinate the agro-ecology markets form an association.

There are examples of technologies started as civil society initiatives that have become public policy for the federal government.

The surplus of agro-ecological production is sold to federal government programmes for meals in state schools.

FEASIBILITY The government's National Rural Housing Programme (PNHR) is expanding the bio-digester technology across Brazil.

The National Programme to Strengthen Family Agriculture has specific credit lines to fund agro-ecology activities.

Investments in family farming in Brazil are still low. The credit offered for agribusiness is almost seven times higher than the credit for family farming.

Few agro-ecology investment lines go beyond the simple transfer of technology.

In Brazil, although there are investment banks dedicated to industry and agribusiness, none are dedicated to the development of family farming.

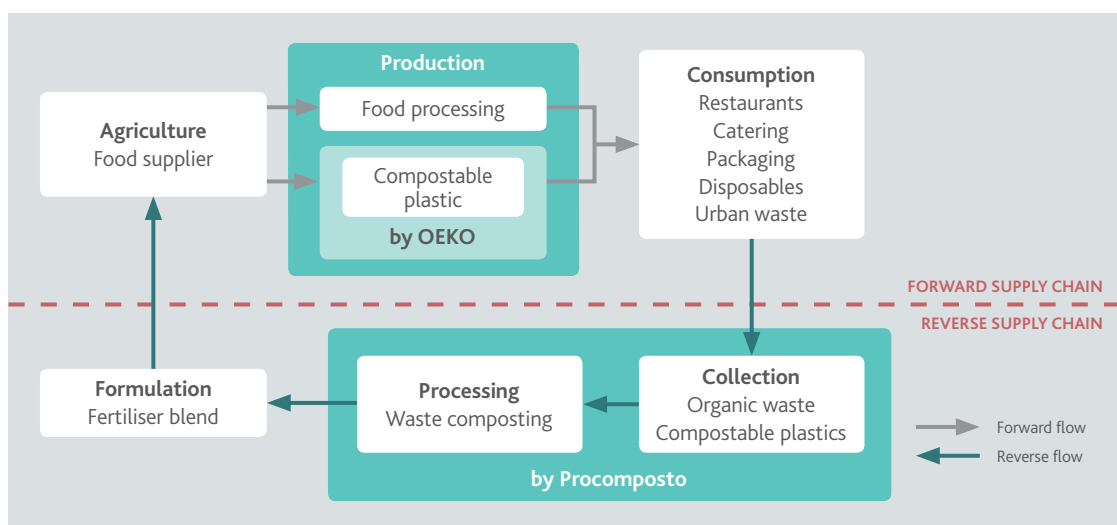
7 Developed through a partnership between Tearfund and Diaconia, and funded by the European Union, the SEMIA project aims to facilitate the generation of employment and income for women and young people in the semi-arid region of Brazil. The project also operates in four cities of the Pajeú in Pernambuco.

SPECIFIC ISSUES	<p>Diaconia's fieldwork team had no prior knowledge of circular economy concepts.</p> <p>Diaconia considered the circular economy systemic approach to be aligned to the principles of agro-ecology.</p> <p>Funds from international agencies for development have decreased for Brazil. Diaconia's programmes now rely more on Brazilian governmental funds.</p> <p>Several public, private, national and international institutions are supporting the agro-ecology and bio-digester projects.</p>
Legal	Diaconia
BENEFITS	–
FEASIBILITY	<p>The heavy bureaucracy and mismanagement of public administration creates uncertainty for the associations about participating in government programmes.</p> <p>In general, today's accountability and bureaucracy concerning funding demand a great amount of time that could otherwise be dedicated to the NGO's core activities.</p> <p>Some governmental programmes that focus on political and economic interests are often disconnected from the real issues facing local communities.</p>
SPECIFIC ISSUES	–

4.2.5 Procomposto

Procomposto is a company based in Florianópolis, the capital city of Santa Catarina. It provides reverse logistics services to major generators of organic waste, including restaurants, supermarkets, residential complexes and catering companies. The nascent company conducts on-site collection and transports the waste to a local compost centre, which processes the waste for compost production. This waste is mixed with straw and sawdust and goes through a natural process of high-quality composting. The compost can be used as fertiliser for the soil, usually for the organic farming of fruit and vegetables. The founder of the company was interviewed for this research. The questionnaire and field visit aimed to understand how the business model of Procomposto is related to the circular economic model and to the creation of reverse supply chains.

Figure 26 Procomposto–OEKO closed supply chain model



Procomposto STEEPL

Social	Procomposto
BENEFITS	<p>Procomposto's activities indirectly influence the creation of urban vegetable gardens and the prevention of unhealthy waste disposal areas in slums.</p> <p>Procomposto sited its organic waste composting facilities on land leased from a local social NGO.</p> <p>Procomposto has developed partnerships to build vegetable gardens in schools to raise awareness among children.</p> <p>Procomposto provides the compost for a vegetable garden in a local social NGO.</p>
FEASIBILITY	<p>As consumers realise their benefits, organic waste composting services will grow.</p> <p>In the near future, consumers will choose brands partly by the way they handle their waste.</p> <p>As organic waste must be separated at source, this eliminates the sorting work traditionally performed by waste picker cooperatives.</p> <p>Waste picker cooperatives could perform door-to-door organic waste collection.</p> <p>There is a lack of awareness programmes and appropriate legislation to raise awareness of the importance of composting organic waste.</p> <p>The extra costs paid by waste generators for composting services could help catalyse a reduction in food waste.</p>
SPECIFIC ISSUES	<p>In Florianópolis there have been other small-scale activities relating to composting organic waste for the last 15 years.</p>
Technological	Procomposto
BENEFITS	<p>Procomposto's compost can be used in the organic farming of fruit and vegetables.</p> <p>Currently Procomposto composts 15–20 tonnes of organic waste per week.</p> <p>The composting technology turns 30 per cent of the waste into organic compost, reducing 70 per cent of the volume.</p> <p>The organic waste processing technology used to create the organic compost was improved and tested by the Federal University of Santa Catarina.</p> <p>The organic waste reverse logistics technology used by Procomposto is very suitable for most of Brazil's small and medium cities.</p> <p>Procomposto's composting facilities require low investment and standard machinery and do not require specialised manpower.</p>
FEASIBILITY	<p>Investments in collection and transportation are a priority to improve efficiency in any reverse logistics system.</p> <p>The composting technology implemented by Procomposto takes an average of eight months to produce a high-quality organic compost.</p> <p>Procomposto's current infrastructure is able to expand to up to five times the volume currently being processed.</p> <p>Handling and storing organic waste requires a higher level of sanitary control than recyclable waste.</p> <p>Small-scale home and community composting is challenging and needs sanitary control.</p> <p>The organic waste must be separated and stored in compostable bags at the source of generation.</p>
SPECIFIC ISSUES	<p>The compostable plastic bags are an important aggregated technology used to facilitate the collection and processing of organic waste.</p> <p>The waste is collected directly from waste generators and is transported to the Procomposto composting plant.</p> <p>The collection truck is equipped with technology developed by Procomposto.</p>

Economic		Procomposto
BENEFITS	<p>There are other collection and composting initiatives in the region.</p> <p>Procomposto's success helps to reduce the amount spent by government on waste management and landfill.</p>	
FEASIBILITY	<p>The organic waste generators must absorb the cost of reverse logistics. Currently, they are not charged for the real costs of landfill.</p> <p>The reverse logistics market of organic waste is still under development.</p> <p>The average amount charged by Procomposto's reverse logistics service might vary depending on the transportation costs.</p> <p>Procomposto's reverse logistics service's average cost is only 1 per cent of a restaurant meal.</p> <p>Procomposto's main operating cost is transportation. The composting process usually has very low operating costs.</p> <p>In some cases, waste generators can match the costs of the organic waste reverse logistics service by selling their recyclable waste.</p>	
SPECIFIC ISSUES	<p>After one year of operation, Procomposto has not yet broken even, and part of the operational capacity is still idle, as expected in the business plan.</p> <p>Procomposto's business model focuses on offering organic waste reverse logistics services to large waste generators in the metropolitan area of Florianópolis.</p> <p>Procomposto's local competition does not have the same technological differential.</p>	
Environmental		Procomposto
BENEFITS	<p>The composting process reduces the emission of greenhouse gases and reintroduces CO₂ to the soil.</p> <p>Business customers can 'offset' their environmental footprint by composting their organic waste.</p> <p>The collection of organic waste using compostable plastic bags avoids the use of water in the composting process.</p> <p>The use of organic compost in agriculture can reduce its dependence on chemical fertilisers.</p> <p>The composting plant is installed in an urban area and does not pose any threats to the local environment.</p> <p>According to Procomposto, the city of Florianópolis could neutralise all its CO₂ emissions by composting its organic waste.</p>	
FEASIBILITY	<p>The composting process needs some important control procedures in order to avoid environmental risk.</p> <p>The residual liquid from the process can contaminate water bodies and must be collected safely.</p>	
SPECIFIC ISSUES	–	
Political		Procomposto
BENEFITS	<p>According to the SWNP, organic waste is a recoverable material that therefore must not go to landfill.</p>	
FEASIBILITY	<p>Creating an understanding of the benefits among the general population, better legislation and the right infrastructure are the most important aspects for reverse logistics to work.</p> <p>According to the SWNP's shared responsibility principle, everyone will have to pay for reverse logistics implementation.</p> <p>Only government regulation and an effective control system can motivate private companies to implement reverse logistics systems.</p> <p>Procomposto relies on local government campaigns to raise awareness of waste generators.</p> <p>Although society has a good awareness of the SWNP goals, the municipalities are not putting the SWNP into effect.</p>	

SPECIFIC ISSUES When the Procomposto business model was created, the entrepreneur involved had no awareness of the SWNP.

According to the SWNP's 'polluter pays' principle, large waste generators must pay for the environmental risks.

According to the SWNP's 'protector receives' principle, the composting companies should receive incentives for their environmental services.

The SWNP's goal of ending all dumps was misleading and resulted in a focus on more landfills, instead of recycling and composting.

The municipalities' goals as regards composting are long term and show little ambition.

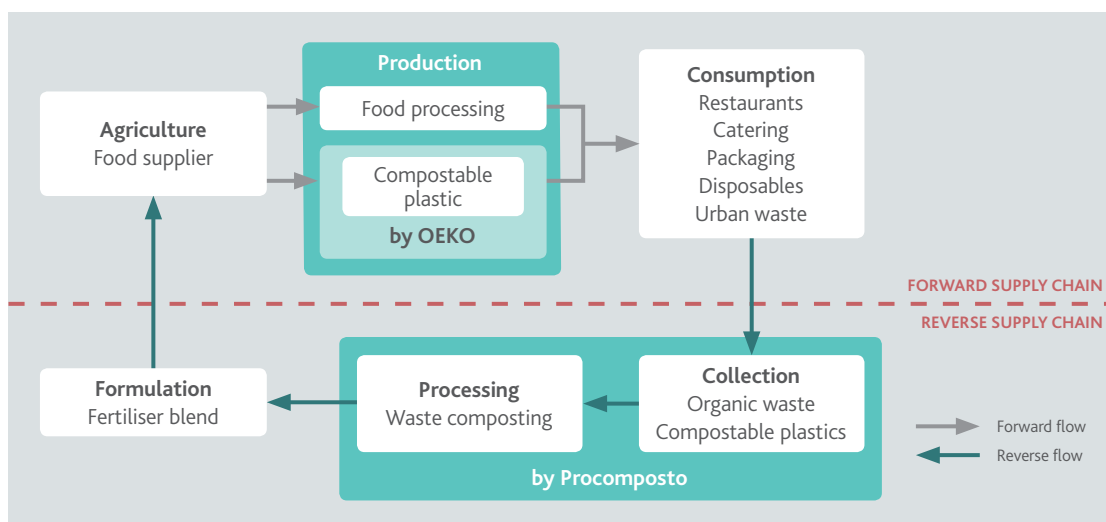
There is a lack of political action in order to enforce compliance with the SWNP.

Legal	Procomposto
BENEFITS	-
FEASIBILITY	<p>There should be a tax exemption for waste that has been previously taxed as a product.</p> <p>As an example, all disposable products used for catering should be made from compostable materials, enforceable by law.</p> <p>The proper disposal of organic waste should be closely monitored and controlled by the government.</p> <p>According to the current legislation, waste generators are not obliged to pay for the full costs of sending waste to landfill, including externalities.</p> <p>Legislation on waste management is important to build people's awareness of the issues and guide investment in infrastructure.</p>
SPECIFIC ISSUES	<p>Procomposto has no knowledge of government incentives for reverse logistics companies.</p> <p>Due to the high level of bureaucracy involved in gaining government funding, people are discouraged from going after this kind of support.</p>

4.2.6 OEKO

OEKO is a company based in Florianópolis, the capital city of the state of Santa Catarina, southern Brazil. It is a manufacturer of compostable bioplastic bags intended to meet the entire Brazilian market for urban organic waste collection, with the aim of increasing recycling and composting activities. Its great competitive advantage is that it actively works in the construction of a reverse supply chain based on the recovery of organic waste. Materials called bioplastics are used in the production of the compostable bags, an alternative that replaces fossil oil materials in the production process and allows the product to be processed to become compound fertiliser for agriculture and/or biogas to generate energy. The company is a pioneer in offering this type of product in Brazil, to meet the demands of three segments of waste collection services: public, commercial and industrial. As a strategy, the company is closely monitoring the evolution of the SWNP and the growth of organic waste composting services in the country. The company has been operating for just two years and has already broken even, and believes that the market is growing. The founder of OEKO was interviewed for this research. The questionnaire and the field visit aimed to understand how OEKO's business model is related to the circular economic model and to the creation of reverse supply chains.

Figure 27 OEKO-Procomposto closed supply chain model



OEKO STEEPL

Social

OEKO

BENEFITS

The use of compostable bioplastic bags to collect and transport organic waste has sanitary and labour safety benefits.

Using the compostable bags, a door-to-door collection of compostable waste can be performed by waste picker cooperatives or by family businesses.

Micro-composting plants with a 5 tonne per day composting capacity could be economically viable and operated by cooperatives or by family micro-enterprises in urban areas.

FEASIBILITY

In Brazil, the management of organic waste is still seen as just a part of urban sanitary control.

In general, people do not understand 'conventional' waste management to be an important service and the plastic bags are not perceived as relevant to the collection system.

There are huge barriers to working with cooperatives in reverse logistics systems, due to the lack of management structure from a legal and organisational perspective.

In general, in Brazil the waste picker cooperatives are still resistant to assume a business mentality.

In general, the waste picker cooperatives still maintain a dependency mindset, with government viewed as having a paternalistic role.

SPECIFIC ISSUES -

Technological

OEKO

BENEFITS

In Brazil, organic waste represents 52 per cent of all waste produced. It is also more technologically feasible to close the loop of biological nutrients.

The compostable bioplastic bags can be composted in the process, together with the organic waste.

The use of compostable bioplastic bags contributes to the efficiency of the collection and transportation of the organic waste.

Separating the organic waste into compostable bags prevents contamination between different types of waste.

The use of compostable bags ensures hygiene is maintained in the reverse logistics processing of organic waste.

FEASIBILITY

The lack of a market standard for plastic bags in Brazil required larger investment in the design of different compostable bag sizes.

Inadequate similar products discredit and discourage the adoption of the compostable bioplastic bags by the industry.

End-user adoption is discouraged by the fact that the conventional system mixes waste even when it has been previously separated by consumers.

The compostable bags market is highly dependent on the expansion of reverse logistics system infrastructure.

As soon as market demand increases in Brazil, the compostable bioplastic bags will become a commodity due to low technological barriers to conventional manufacturers.

In Brazil, there will soon be more market demand for more added-value products made from compostable bioplastics, such as packaging and disposable products.

SPECIFIC ISSUES In large-scale reverse logistics systems, bioplastic bags can be optimised for maximum efficiency. All composting companies in Brazil have tested and approved the product effectively.

Economic

OEKO

BENEFITS

In two years of operating, OEKO has already broken even, which indicates that the market is growing.

The low number of companies dedicated to waste composting in Brazil indicates that there are many opportunities in this market.

In Brazil, the public and industrial segments are already moving towards the proper disposal of their waste in compliance with the SWNP.

Avoiding mixing organic waste with other types of urban waste at source enables the production of a high-quality compost from which to make agriculture fertilisers.

FEASIBILITY

In Brazil, the costs from the reverse logistics of composting organic waste are still high when compared to conventional waste management landfill service costs.

OEKO adopted a low price strategy in order to ensure competitiveness and face major competitors entering the market in the future.

Today, there are not enough companies in Brazil to meet the needs of industry and the demand for composting organic waste in all the municipalities.

Even for those companies that already realise the opportunities in adopting reverse logistics for composting, service costs are still the main barrier.

Catering is one important generator of organic waste, but this segment is still less concerned about the correct disposal of its waste.

In Brazil, the costs regarding the logistics of sending waste to landfill do not consider the negative environmental externalities.

SPECIFIC ISSUES A main push factor in the demand for compostable bags is the 'zero landfill' approach adopted by multinational corporations.

OEKO's clients using compostable bioplastic bags are mainly large waste generators that already have contracts with composting companies.

Of the 36 composting companies in Brazil, only ten of them work with urban organic waste.

The cost of compostable bioplastic bags represents 15–20 per cent of the total cost of the collection services of organic waste for composting.

The production of compostable bioplastic bags is focused on supplying the public, private and industrial sectors.

OEKO claims to be the only company in Brazil dedicated exclusively to the production of bioplastic packaging and focusing on the development of a long-term partnership with suppliers, customers and organic recovery systems to close the biological cycle of their product lines.

BENEFITS

Compostable bioplastic bags are produced with bio-based raw material obtained from biomass/cellulose, vegetable oils, algae, CO₂ and others. The most common source today is agricultural, eg corn, cassava, sugar cane and residues from agro-industries.

The production of compostable plastic bags uses less energy.

Thanks to innovations developed by OEKO, 5 per cent of the product's composition is made with waste from the production process itself.

The use of compostable plastic bags in organic waste transportation prevents sanitary issues and avoids the use of water for cleaning the containers.

The separation of organic waste at source prevents other types of recyclable waste from being contaminated and sent to landfill.

The organic waste composting process reduces the emission of greenhouse gases and the compost reintroduces CO₂ to the soil.

FEASIBILITY

There are no indicators measuring rate of adoption of compostable bags for organic waste reverse logistics in Brazil.

OEKO has not performed a life-cycle analysis study of the product yet. The result would depend largely on the raw material used (corn, sugar cane, cassava).

SPECIFIC ISSUES

The products are within the carbon cycle, so are different from the production of petroleum-based plastic bags, which emit 3–8kg of CO₂ per kg of plastic items.

Political

BENEFITS

According to the SWNP, all waste that can be recovered by any feasible technological means must be diverted from landfill, including organic waste.

The Brazilian government will soon adopt a simpler system of waste separation into three categories: recyclable, compostable and non-recyclable materials (rejects or landfill).

FEASIBILITY

To OEKO, the SWNP is an important legal instrument that ensures the recovery of organic waste for composting.

In Brazil, consumer behaviour change is being influenced by the SWNP and by the pressure from government and industry.

OEKO believes that the SWNP's shared responsibility principle fails to give proper guidance on how to deal with organic waste and composting.

Regulation of the use of organic compost to make fertilisers for agriculture is ruled by a sanitation logic instead of a nutrients-recycling logic.

Government incentives to create waste picker associations fail to facilitate their legal formalisation as part of the reverse supply chain.

SPECIFIC ISSUES

In Brazil, the three government policies on waste are: SWNP, climate change, and production and sustainable consumption.

In Brazil, both the Ministry of Agriculture and the Ministry of the Environment regulate different aspects of waste composting and its use in agriculture.

OEKO has developed a positive relationship with the Ministry of Agriculture and the Ministry of the Environment.

OEKO claims to be the only company in Brazil that integrates the entire supply chain with the mission to improve the whole compostable waste reverse supply chain.

Legal

BENEFITS

There are several funds supporting R&D and product innovation.

FEASIBILITY

In Brazil, the same taxes are applied to traditional goods as to recyclable and compostable products.

OEKO is not aware of any governmental incentives for the supply chains of products and services to adopt raw materials from renewable sources.

To increase competitiveness of reverse logistics for organic waste, government should tax the environmental and social externalities related to landfill operations.

It is unlikely that municipalities will create incentive policies based on tax exemptions.

Municipalities that have a waste management plan will have access to federal funding to implement reverse logistics systems.

Currently the Ministry of Health is an important source of funding for municipalities in terms of waste management infrastructure, though this is mainly for recycling.

SPECIFIC ISSUES

In the manual on sustainable production and consumption, the government has established the technical criteria for public procurement.

In the Sustainable Production and Consumption Action Plan, the government established qualitative framework criteria to account for environmental impacts.

OEKO has positive expectations for the approval of a new federal law that will regulate sustainable consumption and production practices in the near future.

In Brazil, the current law does not regulate to help prevent organic waste being contaminated by other types of waste.

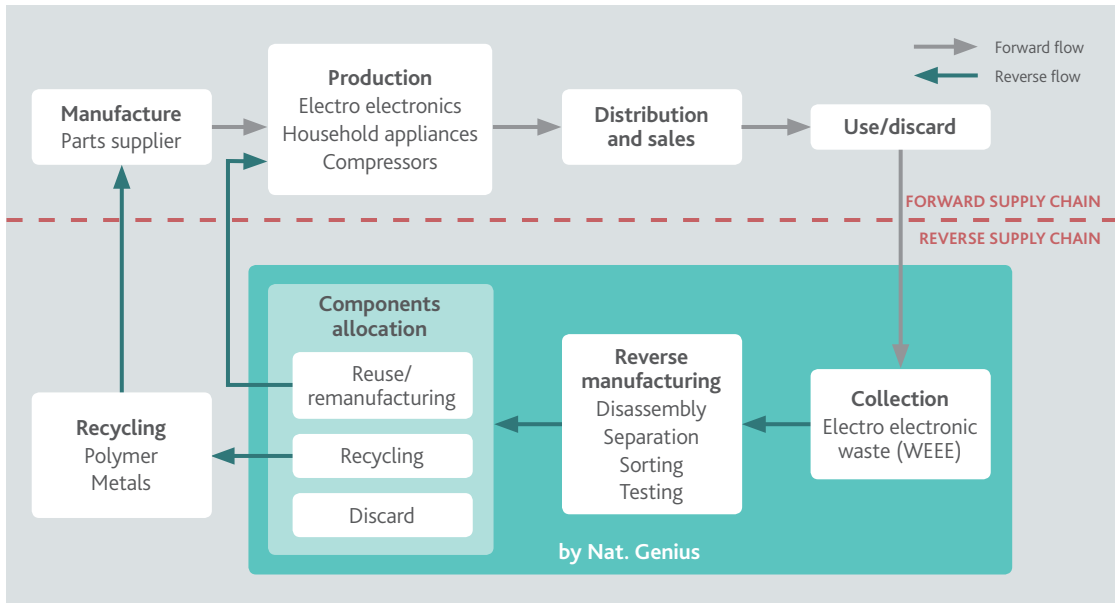
In Brazil, it is estimated that 40 per cent of the industry of plastic bag manufacturing operates informally, including large companies.

4.2.7 Nat.Genius

In 2014 Nat.Genius was created as a new business unit that is part of Embraco in Brazil, guided by a market trend driven by regulations such as the SWNP, consumer behaviour changes and new demands from investors. The Nat.Genius business model is focused on finding feasible and efficient solutions for reverse logistics, recycling and product development based on circular economy concepts. The goal is to recover all potential value from waste electrical and electronic equipment (WEEE), to recover as much as possible from end-of-use products, and to become a supplier of parts and materials or find environmentally sound solutions for waste disposal. Embraco is a Brazilian company, a global leader in technology for hermetic compressors for refrigeration systems in home appliances and commercial refrigeration equipment, and is a supplier of many electrical and electronic equipment manufacturers, including Panasonic, Electrolux, Whirlpool and Samsung, among others. Starting with Embraco and its clients, the new Nat.Genius company aims to become a strategic partner of manufacturers in dealing with end-of-life products as required by the SWNP.

The shift in the market is expected when companies start to migrate from product sales to product-services sales, as exemplified in a water purifier by Whirlpool made available in a monthly rental contract with their customers. Nat.Genius draws on Embraco's global structure of R&D professionals and laboratories for materials and chemical engineering, as well as partnerships with universities. The operation started with a recycling unit in Santa Catarina state in southern Brazil and foresees expanding to other regions within the country. Currently, the company works on product disassembly, reuse of parts and recycling of materials. In the case of compressors, some of the materials are inserted into Embraco's own supply chain and others are sold to partner companies. Although the business model expects to create closed-loop systems, Embraco has been supplying other industries with recovered parts and recycled materials from WEEE. The business unit senior manager of Nat.Genius was interviewed for this research. The questionnaire and the field visit aimed to understand how the business model of Nat.Genius is related to the circular economic model and to the creation of reverse supply chains.

Figure 28 Nat.Genius closed supply chain model



Nat.Genius STEEPL

Social

Nat.Genius

BENEFITS

Large manufacturers require higher standards of labour safety for recycling activities.

Nat.Genius is looking for win-win relationships with waste picker cooperatives to implement door-to-door waste collection.

Nat.Genius believes that the reverse logistics services to industries may create more jobs requiring better qualifications than the current landfilling.

FEASIBILITY

Changing consumer behaviour and culture regarding end-of-life products is a goal to be achieved in the long run.

One important aspect of the Brazilian market is people's creativity and openness to embrace innovation.

A negative aspect of the Brazilian market is the large amount of informal activity in the recycling sector.

Nat.Genius currently has no partnerships in place with waste picker cooperatives.

SPECIFIC ISSUES

Nat.Genius does not use any social benefit claims for marketing purposes.

Nat.Genius currently does not directly make use of any social indicator as a tool to evaluate the business.

Technological

Nat.Genius

BENEFITS

Recovering compressor cores to reuse them in fan manufacturing has become Nat.Genius's iconic business case.

Compressors are submitted to high energy efficiency requirements, therefore the reused parts also have high performance standards.

All the collected material that cannot be reused is sent for recycling.

Nat.Genius has high quality standards for reverse manufacturing, such as lean production and Six Sigma.

The demand is increasing and Nat.Genius is evaluating opening a second work shift.

Nat.Genius develops partnerships and offers R&D to clients to find the most valuable ways to recover their end-of-use products.

FEASIBILITY The company started with a recycling plant in Santa Catarina state in Brazil and plans to expand to other regions within the country.

Nat.Genius's business model is focused on finding feasible and efficient solutions for reverse logistics, materials recycling and product design improvements for the circular economy.

Nat.Genius believes that currently available technology for product remanufacturing has yet to improve to equal the quality levels of all-new products.

Nat.Genius counts on a global network of R&D professionals and laboratories for materials and chemical engineering.

SPECIFIC ISSUES Nat.Genius has been mainly supplying other industries with recovered WEEE parts and recycled materials.

Nat.Genius aims to be a strategic partner of manufacturers reaching all the requirements of the SWNP.

Economic Nat.Genius

BENEFITS After one year, the business model is proving its economic feasibility.

Electric fans made from reused parts of compressors have better energy performance and lower production costs.

Recovered compressor parts are cheaper than new ones, while having higher market value than if they are sold as scrap.

FEASIBILITY Nat.Genius is currently taking advantage of a market trend driven by new regulations, changes in consumer behaviour and emerging requirements from investors.

To overcome informal market competition, Nat.Genius offers to large manufacturers high-quality services on product recycling.

The Nat.Genius business model does not include product refurbishment or remanufacturing.

The manufacturer pays for the reverse logistics made by Nat.Genius to collect their products. In general, door-to-door collection from end-customers is not economically feasible.

A main weakness of Nat.Genius' business model is the uncertainty in WEEE recovery in order to guarantee a steady supply to buyers of recycled materials and reused parts.

The visual aspect of recovered parts is a barrier to sales, so it is more feasible to commercialise parts to be reused inside new products.

SPECIFIC ISSUES The refurbished and reused products currently do not represent competition to new products.

Nat.Genius applies economic indicators to measure the success of its business model and operations.

The Nat.Genius business model is to recover the potential value of WEEE, and be a supplier of parts, materials or environmentally sound solutions for waste products.

The market is sensitive to the risk of remanufactured products becoming a potential competitor to original products.

From an electric fan manufacturer's perspective, the supply of refurbished parts by Nat.Genius is the same as any other supplier.

A shift in the market is expected when companies start migrating from product sales to product-services sales.

Environmental Nat.Genius

BENEFITS The Nat.Genius business model focuses on searching for environmentally sound solutions for end-of-life products.

Nat.Genius's reverse logistics programme has already recycled more than 3 million compressors and recovered 6,200 tonnes of materials.

In the near future, companies will have reliable data on reverse logistics to show the environmental benefits of their supply chain.

FEASIBILITY End-consumers are not driven by environmental concerns but are sensitive to the immediate benefits and/or impacts.

With reverse logistics, manufacturers can improve accountability of their environmental impacts and use it to help improve systems in the long term.

Nat.Genius has no data on its waste recovery rates and does not give a numerical value for its environmental benefits.

There is no data available on the relative amount of end-of-life products collected and recovered.

SPECIFIC ISSUES Nat.Genius does not use environmental claims to promote the advantages of the circular model.

Nat.Genius currently does not directly make use of any environmental indicator as a tool to evaluate its business.

Political Nat.Genius

BENEFITS The release of the SWNP creates the perfect timing for Nat.Genius to become the front runner in Brazil.

The SWNP plays a crucial role in regulating and providing the means to make the reverse supply chain work.

FEASIBILITY According to the SWNP, WEEE is now a priority in reverse logistics sectoral agreements.

The specific sectoral agreement on reverse logistics for the WEEE supply chain is to be released soon.

It is more likely that large companies engage in reverse logistics services, since they are committed to environmental goals and corporate social responsibility.

Large companies still perceive large risks to be implicit in working with waste picker cooperatives in Brazil.

For Nat.Genius, working with cooperatives in Brazil is still an operational, labour and environmental risk management issue.

One way of minimising the high-risk perception of the market is to invest in cooperatives' organisational and management skills.

SPECIFIC ISSUES Nat.Genius has signed up to the Companies for Sustainable Solid Waste Management self-declaration.

There is no record of information exchange between the company and the government, either at state or municipal levels.

The relationship between Nat.Genius and NGOs is seen as an important way to influence consumer behaviour.

Legal Nat.Genius

BENEFITS -

FEASIBILITY Changes in tax rules are urgently required to increase competitiveness in key areas of product recovery services.

The creation of tax incentives is urgently required to encourage the development of reverse logistics providers.

Reducing existing taxes to manufacturers that make use of recycled parts is an important issue to be addressed.

Nat.Genius follows the market demands in complying with new industry regulations enforced by the SWNP.

Clear incentives and penalties are needed in order to enforce SMEs to adopt reverse logistics services in the short term.

It seems that the sum of all taxes paid for recovering products is higher than if the same product were sent to landfill.

SPECIFIC ISSUES There is a lack of information about the government's financial incentives on reverse logistics systems, and there are no clear strategies to push the market towards them.

4.2.8 GRS

GRS is the Solid Waste Management Technical Office inside the Sanitation Directive, which is part of the Sustainable Development Secretariat of the state of Santa Catarina. One of the roles of GRS is in developing the Integrated Waste Management Plan at state level (PGIRS), to support the state government in guiding the municipalities of Santa Catarina towards compliance with the legal obligations set out in the SWNP. GRS's role also includes training public technicians from the municipalities and their teams to implement PGIRS at municipal level, including through reverse logistics systems. A technical specialist from GRS was interviewed for this research. The questionnaire aimed to understand how the PGIRS at both state and municipal levels is related to the circular economic model and to the creation of reverse supply chains.

GRS STEEPL

Social		GRS
BENEFITS	<p>In the current phase of the PGIRS, the municipality should be defining the goals for the related social benefits.</p> <p>By developing the PGIRS, the municipality will have better control over the risks in recycling activities as they relate to workers and the local community.</p>	
FEASIBILITY	<p>The inclusion of waste picker cooperatives in reverse logistics systems is a decision to be made by the municipality.</p> <p>According to GRS, there are only a few formalised waste picker organisations in the Santa Catarina state: the exact number is unknown.</p> <p>The municipality ends up taking on most of the responsibility in contracts with cooperatives due to their weak management capability.</p> <p>Most waste pickers are organised in associations that have no legal basis to take on commitments in urban waste management.</p> <p>The incentives for forming cooperatives and the best arrangement to include them in the reverse logistic system will depend on the local context.</p> <p>Other organisations often take on the legal responsibility as an intermediary for the operation of the waste picker associations.</p>	
SPECIFIC ISSUES	<p>The PGIRS is the Integrated Waste Management Plan, in compliance with the SWNP, that needs to be developed at either state or municipal level.</p> <p>The PGIRS to be developed by the state of Santa Catarina makes no mention of the social benefits that can accrue from the implementation of reverse logistics systems in the municipalities.</p>	
Technological		GRS
BENEFITS	<p>The state-level PGIRS includes projections and proposals on reverse logistics technology solutions to address the different realities across municipalities.</p> <p>The government aims to train managers of municipalities and their teams in implementing the PGIRS and reverse logistics systems.</p> <p>A key benefit brought by the PGIRS is the training of technician staff in the public administration to build capacity in a new paradigm for waste management.</p> <p>The need to develop appropriate solutions will make the municipality look for specialised professionals in the market.</p>	

FEASIBILITY The decision about the type of technology used will determine the management model to be adopted in reverse logistics systems.

The state-level PGIRS includes a study on the regionalisation of solid waste management systems incorporating different cities in the same area.

The state has a guiding report, which presents the existing national and international technologies for waste treatment and recovery, and their applications.

The state is tracking the number of municipalities that have already developed their plans.

Most of the municipal PGIRS are in the initial phase and none has yet been fully implemented.

Municipalities have not yet adopted solutions focused on reverse logistics for organic waste.

SPECIFIC ISSUES The state PGIRS is currently in the bidding process phase and it is to be developed during 2016.

Economic GRS

BENEFITS By the time the reverse logistics system is in operation, it is expected that the whole supply chain will have productivity gains.

Over time, it is expected that the economy of scale will mitigate the operational costs of reverse logistics and will expand the environmental and economic gains.

With the PGIRS, the municipality will expand its control over waste and where it ends up.

The municipality will be obliged to have transparent management and accountability over reverse logistics operations.

FEASIBILITY The implementation of reverse logistics will require heavy investment by municipalities in infrastructure, equipment and operational organisation.

Municipalities that do not have resources to invest in reverse logistics systems are the weakest link in the implementation of the SWNP.

Municipalities will have to find ways to finance their reverse logistics systems without transferring costs to citizens.

According to the SWNP, the industry is responsible for investments in technologies for waste recovery (recycling, composting etc).

According to the SWNP, municipalities are responsible for the effective management of solid waste and its proper disposal. When recycling is possible, sectoral agreements or commitment terms ensure that reverse logistics direct waste back to the industry.

There is a chance that part of reverse logistics systems' operational costs will be paid for by citizens.

SPECIFIC ISSUES According to the SWNP, when the municipality acts as a provider of recyclable materials for industry, the costs of reverse logistics must be paid by industry.

In negotiations with government, industry recognises its responsibility for post-consumer products but refuses to pay for reverse logistics.

Environmental GRS

BENEFITS GRS believes that a great environmental contribution of the SWNP is the enforcement that all dumps in the country must be discontinued.

The environmental licensing required for landfill will help monitor and control environmental impacts.

After the PGIRS is fully implemented, municipalities will have greater control over the environmental risks related to waste.

FEASIBILITY The state of Santa Catarina has officially discontinued the dumps; nevertheless, there are still some environmental liabilities associated with former dump areas.

Unless monitored, there is still a risk that old dumps can be reactivated or that landfills can become dumps again.

Municipalities and regions are likely to take advantage of the PGIRS in order to create a favourable sustainability marketing campaign.

In the long term, the environmental costs of not implementing reverse logistics systems are greater than the cost of their implementation.

Currently there is no action to raise awareness among municipalities about the environmental and social risks associated with conventional waste management.

SPECIFIC ISSUES Reverse logistics systems run by municipalities are responsible only for waste classified as 'non-hazardous'.

Political

GRS

BENEFITS To date, only 70 per cent of the 295 municipalities in Santa Catarina have completed the PGIRS.

Once the PGIRS is fully implemented, the municipality will have a better control over its waste management and thus will be able to demand solutions from industry.

From the SWNP shared responsibility principles, the production chains will have to make sectoral agreements and set goals regarding reverse logistics systems.

The shared responsibility principles will demand a change in society's perception and behaviour while promoting discussion among all links of the supply chain.

The municipal PGIRS is a plan that must ensure the participation of society as a whole.

The SWNP is an important milestone that is promoting changes in waste management systems across the country.

FEASIBILITY The responsibility for who pays reverse logistics costs is one of the main issues between business and government, which requires a great deal of dialogue.

The state PGIRS does not have any set indicators or ways of tracking and measuring the progress of the SWNP across the state.

The municipality is the weakest link in the implementation of the SWNP and the state's government is responsible for supporting it.

Santa Catarina state government aims to invest strategically in municipalities by setting common priorities for the region.

Currently, the participation of society in outworking the PGIRS is often small.

The implementation of the PGIRS by the municipalities will put pressure on industry and commerce to provide reverse logistics solutions for recyclable and organic waste.

SPECIFIC ISSUES GRS is the Solid Waste Management Office, inside the Sanitation Directive Office, which is part of the Secretariat of Sustainable Development for Santa Catarina state.

The SWNP establishes general guidelines and goals for the PGIRS to be developed at three levels (national, state and municipal). Prior to the SWNP, there was no guidance.

The government of Santa Catarina has no partnerships in place with local industry or NGOs.

Legal

GRS

BENEFITS Through the PGIRS, the municipalities will be able to seek funding from the federal government to invest in infrastructure and technology to implement the plan.

Public hearings are mandatory during the preparation of the municipal PGIRS in order to ensure transparency and disclosure of the process.

The waste management and the reverse logistics performed by the municipal administration will be regulated and supervised by a specific agency.

At the federal level, there are proposals for tax exemptions for companies which use recycled materials in their production processes.

FEASIBILITY

There are no tax incentives in Santa Catarina state to promote reverse logistics systems.

Currently government investments for the state are focused on supporting the development of the municipal PGIRS.

There is an intention by Santa Catarina state to encourage joint solutions between municipalities to create consortia for solid waste management and to encourage businesses to commit to implementing reverse logistics for the treatment, collection and recycling of waste in their supply chains.

The current system of environmental licensing required for landfill can be used to monitor and control environmental impacts.

The municipal PGIRS will determine which types of waste are mandatory for recycling and set progressive goals for a 20-year window.

Product and packaging manufacturers have responsibility for the reverse logistics for those products.

SPECIFIC ISSUES

The mission of the Santa Catarina state PGIRS is to guide the actions of the state government to help municipalities comply with the SWNP.

SWNP guidelines and legal obligations are bringing together different parties to work in a coordinated way towards progress.

The SWNP sets the criteria and targets for waste recovery to ensure that only non-recyclables will be sent to landfill in the long term, and the use of dumps is discontinued.

4.3 Final remarks

Comparing the findings in the literature review and the interviews, it was evident that there had been an evolution from the cases in the literature – most of them in the early days of the SWNP or even before it – to the current ongoing initiatives and business models reported in the interviews.

Despite the fact that the scenarios proposed for reverse logistics and waste management in municipalities in the literature did not yet appear to be a reality, overall the findings in the interviews agree with the first assessment in the literature, showing growing reverse logistics initiatives to comply with the SWNP, both from companies in the private sector and from BoP cooperatives.

- The interviews confirmed that there are currently many good circular economy-inspired examples, both within a supply chain without geographical borders and in public-private partnerships organised within a region.
- Current initiatives are much more innovative and complex regarding their relationships with supply chain, product design, R&D technology and business management, when compared to early initiatives in Brazil which tended to be much more related to basic collection and sorting of waste.
- However, the fieldwork did not unearth more big circular economy supply chain partnerships between large companies and waste picker cooperatives, such as those reported in the literature – similar to the case of the car parts/steel supply chain or the glass bottles/beverage supply chain.
- Product design was revealed to be of great importance to the success of reverse logistics systems. A clear design for disassembly is crucial to cooperatives' sorting process efficiency, for encouraging consumers to sort waste at source, and to reverse logistics collection and transportation services. Also it is key to the development of new business in reuse, remanufacture and refurbishment of products and materials, both for big industry and for business models in the BoP.
- In the same way, creating an organic waste circular economy supply chain was revealed to be the great missed opportunity in Brazil, both in urban and rural areas, as it has the potential for great social and environmental impact in many aspects, but has yet to be made public policy.
- Finally, now seems to be a critical moment for the Brazilian government to increase understanding of the circular economy model and the social role of the SWNP at both state and municipal levels, and to raise awareness of the potential for cooperatives' activities in closed-loop supply chains. This is especially urgent for building sector-specific strategies for reverse logistics plans of municipal and regional scale, and for building future circular economy supply chains for both recycling and composting.

SECTION 5

CONCLUSIONS AND RECOMMENDATIONS

5.1 Research findings

Many assessments and examples of the circular economy are proving its benefits to developed economies, large companies and people in places such as the EU. With this in mind, this study set out to understand the benefits that a circular economy development pathway could offer to developing economies and especially to people in poor communities.

The overarching question informing this research was: 'To what extent does the circular economy prove itself to be a feasible and beneficial part of a development pathway for developing countries?' Its analysis looked for evidence of the quantitative and qualitative benefits of the circular economy and its advantages over a linear economy to the Brazilian context, focusing on:

- the existing examples of circular supply chains in Brazil that show evidence of positive impacts at both community and national level
- the evidence of the advantages for Brazil to develop circular supply chains, from an economic, social and environmental perspective
- the role of the government (in terms of both infrastructure and legislation) in encouraging supply chains towards a circular model as well as formalising the existing informal circular structures

The literature and case studies suggest that the development of circular supply chains offers a number of benefits:

There are clear environmental benefits: reuse, remanufacturing and recycling reduce the energy use, pollution, carbon emissions and resource consumption (eg water use, mining of raw materials) that are associated with manufacturing production. Similarly, closed-loop supply chains reduce the environmental and health costs associated with open dumps and landfills (eg organic waste landfill is responsible for a large amount of greenhouse gas emissions). However, there is also a risk of environmental harm if, for example, products are recycled without sufficient attention to the disposal of toxic substances. In short, the circular economy paradigm holds out the hope of decoupling economic growth from resource use, and there is evidence that closed-loop supply chains would move things in this direction.

There are clear opportunities to involve those at the bottom of the economic pyramid, improving their income and working conditions. This includes waste pickers but goes beyond them to include artisans, small-scale farmers and other groups who are in a vulnerable situation. These individuals are best able to benefit when they are part of a legal structure (such as a cooperative) that enables them to enter into formal contracts with private companies and the public sector. A number of initiatives in Brazil have shown the potential of helping these workers to formalise into associations and cooperatives.

Productivity and employment can be increased. In several instances, private companies are already establishing their own reverse logistics systems, mostly to comply with the SWNP law but also because of the potential gains in efficiency and productivity (compared with sourcing virgin materials for new production, for example). Margins are often small, but there is reason to suspect that economic benefits could increase as expertise in this sector and economies of scale kick in. A raft of new businesses are being created to help create closed-loop systems, with the potential to create significant numbers of new jobs, and perhaps even a whole new sector of the economy.

There is also a clear role for government to create the right enabling environment for socially effective closed-loop supply chains to be established. First, it could put in place an appropriate level of economic incentives by ensuring that the wider costs of linear supply chains are factored into private firms' decision-making (eg by charging for landfill or attributing responsibility for end-of-life goods), and that closed-loops

and their associated products face (at least) equal tax treatment. Second, government could facilitate (and in some cases enforce) cooperation between all of the relevant actors in each supply chain. Finally, it could ensure that closed-loops are established in a way that helps the poorest people (taking full advantage of the potential for poverty reduction and job creation, noted above). However, the capacity for enforcing much of this legislation can often be limited. Implementation will often fall to municipalities, and supporting these institutions is a pressing need.

There may also be potential for 'leapfrogging'. Developing countries already have an existing repair, reuse and recycling sector, although it resides largely in the informal economy. Many developed countries have essentially eliminated this sector and then subsequently tried to reintroduce it, as the environmental impacts of linear supply chains have become clear. Developing countries can take a different approach. With the correct enabling environment, existing circular systems can be supported to formalise and scale up, as the Brazilian example makes clear. There are a number of specific examples of leapfrogging that can also be identified. For example, in the West, the treatment of organic waste has been motivated almost exclusively by health concerns over the past 100 years. Taking environmental as well as health factors into account reveals that there are significant environmental (and potentially also employment) benefits to an alternative approach to organic waste and sewage treatment built around composting or anaerobic digestion. Developing countries could build their infrastructure around these alternative approaches.

5.2 Recommendations

In addition to these headline findings, we make a number of recommendations for the Brazilian government for fostering closed-loop supply chains, which will also be relevant to other developing country governments and those interested in the circular economy around the world:

1 Create an enabling national-level policy framework

Based on the case studies, we recommend that the Brazilian government should adopt a national-level policy framework on closing material cycles based on circular economy principles. This would build upon the excellent start made by the SWNP and have a clear focus on local, regional and national efforts to create Cradle to Cradle production systems. This framework should include:

- A **Sector-specific and regional strategies** (based on the principle of shared responsibility) for different types of secondary raw materials
- B **Economic instruments** for transitioning towards closing material cycles, including in particular ensuring that businesses pay for the wider externalities associated with linear supply chains, and that closed-loop practices face better tax treatment than they do currently
- C A clear enunciation of the role of the **informal sector and waste picker cooperatives** in closed supply chains

A Sector-specific and regional strategies

It makes sense for the government to promote the creation of **reverse logistics systems on a regional scale** to build local and regional reverse supply chains for both recycling and composting, but sector-specific strategies can also sometimes be required.

In addition to the current focus of the SWNP, we recommend:

- **Policies to foster the creation of production chains around agro-ecology practices by rural low-income families may expand the circular economy in rural areas.** For example, programmes aimed at extending the adoption of simple, well tested and decentralised circular economy technologies, such as bio-digesters for processing manure to generate fertilisers and cooking gas, can restore organic nutrients to the soil, improve food production and bring environmentally positive impacts by lowering greenhouse gas emissions. Policies must take into account the fact that the circular economy needs to be adapted

to the local context to increase its chances of success, and applied technologies must bring together scientific knowledge and people's local knowledge.

- **There are big missed opportunities around organic waste.** Unlike in developed countries, on average in Brazil organic matter accounts for 51 per cent of municipal waste. Furthermore, large-scale technologies for organic waste recovery by composting are feasible and already tried and tested. Policies to accelerate infrastructure implementation to build the composting supply chain for organic waste are missing from the SWNP, but they are key to expanding the adoption of circular economy technologies and systems by municipalities and the private sector in this field. There is a need for a paradigm shift in 'sanitation service' mindsets when it comes to dealing with organic waste as regards its environmental benefits, and there is a pressing need for current infrastructure to be upgraded. Reverse logistics systems for composting organic waste would contribute enormously to helping municipalities meet the goals of the SWNP and expand it to bring immediate social and environmental benefits to local communities.
- **Improving product design standards** for recyclability/biodegradability is key to the creation of reverse supply chains (eg for artisan cooperatives as well as for remanufacturing, refurbishment and product recovery industries). This requires policies to accelerate the development of new circular economy market standards to guide the redesign of products and production processes and to upgrade current 'linear' practices, as well as to end the use of inadequate technologies. International cooperation is likely to be important in this area, as the standards set by the largest markets (such as the EU) have great knock-on effects around the world.
- **Encourage consumer behaviour change towards waste separation at source and, above all, prevent contamination between compostable, recyclable and non-recoverable waste.** This is fundamental to the viability of many reverse logistics systems. Policies are needed to increase consumer awareness of the principle of shared responsibility and to influence behaviour change in dealing with post-consumer product disposal. This may require a joint effort between government, industry and NGOs to educate people about the benefits of circular economy product design to society as a whole.

B Economic incentives

Charging businesses for the costs of externalities associated with their activities (such as pollution and ecosystem services use) will create strong incentives for closed-loop supply chains. One of the simplest examples of this is charging for landfill. In this regard, the Brazilian government must guide municipalities to enforce the 'polluter pays' principle within the SWNP, as well as to create a more attractive market environment to encourage investments in innovations fostering new circular economy practices and technologies.

When it comes to attributing responsibility for end-of-life products, there is evidence that the shared responsibility model employed in the Brazilian SWNP may have a number of advantages in a developing country context over purely 'producer responsibility'. This is particularly true because government can help ensure that social benefits are factored in, for example through the inclusion of the informal sector and base of the pyramid (BoP) entrepreneurship in reverse logistics supply chains.

In addition, at the moment closed-loop supply chains face a number of tax barriers and are certainly not given preferential treatment by the tax system. This is problematic, as it creates a disincentive for the use of recycling streams as an input for production processes.

C Waste pickers and the informal sector

Brazil's previous encouragement of including waste pickers in reverse logistics systems has had a significant influence on improving waste pickers' social condition. These measures accelerated the evolution of waste pickers' activities, allowing them to move from an informal, vulnerable sector to an active social role through their collective organisation into recycling associations and cooperatives. In Brazil, **cooperative organisations are actually creating** circular economy small-scale business models and networks, and stimulating BoP entrepreneurial opportunities.

Cooperatives are the types of business organisations that are key to linking BoP ventures and the circular economy paradigm and deriving the most opportunities possible from the SWNP in Brazil. The cooperatives are non-profit horizontal organisations that can build solidarity economy enterprises and at the same time attain large-scale production. Agro-ecology cooperatives, waste picker cooperatives and artisan cooperatives are the three types of cooperative organisations identified in this study. As part of a reverse supply chain, cooperatives can design and make artisanal products, employ simple technology to sort and process waste, and commercialise products within the supply chain (business to business) and in local markets (business to consumer). In general, cooperative members are vulnerable people with low levels of formal education. In fact, cooperatives have shown the potential to support local economies, help build community resilience and bring indirect benefits for families and children, as well as bringing improvements on both gender- and health-related issues. One key to the success of the cooperative seems to be the spirit of entrepreneurship and a horizontal organisational model, which helps develop resilience, autonomy and leadership in group members.

Specific recommendations for informal sector integration in circular economy systems:

- Support the legal formalisation and management training of cooperatives of waste pickers, craftspeople and agro-ecology farmers. This is absolutely key, as only through this formalisation can they enter into formal contracts and put in place the necessary business processes to be able to work directly with the private sector (and government).
- Support low-tech, scalable technologies for recovering and processing waste that can be operated by cooperatives to provide small-scale and decentralised solutions to reverse logistics systems.
- Recognise the potential of urban organic waste in closed supply chains for composting and creating urban farm opportunities in poor communities.
- Build awareness among companies and government professionals of the potential social benefits of working with waste pickers in reverse logistics systems.
- Regulate relations between cooperatives, industry and public administration to clarify grey areas and misunderstandings about how organisations should collaborate to build reverse logistics systems together.

2 Establish a Brazilian resource panel

Most of the case studies clearly show that there are several ongoing efforts related to closing material cycles in Brazil. In a sense, there are several models of local and regional circular economy already operating in the country. With support from the local, regional and national government through an enabling policy framework, these initiatives could be scaled up and replicated. In order to advocate for such an enabling environment and learning from the ongoing initiatives, we would recommend the establishment of a national resource panel to promote the use of secondary resource material and closing material cycles.

A multi-stakeholder panel of this kind would bring together policy-makers, industry bodies, academics and prominent entrepreneurs, as well as civil society actors. The panel would also influence the policy framework and identify the barriers and opportunities for making the transition to a circular economy in Brazil. It would be a vehicle for identifying and promoting best practice at all levels.

3 Building capacity, raising awareness

The case studies and fieldwork undertaken in the course of this project show that, although there are significant efforts being made to develop circular economy approaches, these are still niche. There are significant capacity gaps in businesses, government organisations and civil society actors. Also, public awareness levels are relatively low. We would recommend that collaborative models that build on the city-level partnerships envisaged under the SWNP be encouraged to raise awareness, together with targeted capacity-building initiatives among all the relevant stakeholders.

Specific recommendations:

- **Capacity in municipalities is a particular cause for concern.** Municipalities are key to building partnerships between government, industry and cooperatives, to build reverse logistics systems and to foster closed-loop supply chains. The Municipal Solid Waste Integrated Management Plans (PGIRS) are the most important instruments to guide the implementation of the integrated waste management systems at local and regional levels. The involvement of municipalities is vital for opening dialogue and setting up working relationships with cooperatives. But evidence shows that municipalities are currently the weakest link in implementing the SWNP and working towards a circular economy because of their lack of capacity and vision. In most cases the social, environmental and economic goals in the PGIRS municipal plans are still unclear or even non-existent.
- **There is a particular risk that the potential social benefits flowing from correct implementation of the SWNP will be lost** unless an effort is made to increase the understanding of the social role of the SWNP by government at both the state and municipal levels and raise awareness about the potential of cooperative activities in closed-loop supply chains to generate income for people in vulnerable situations.
- To be able to play a part in closed-loop supply chains, the **cooperatives need to improve their business management and production management.** As part of reverse logistics systems, waste picker cooperatives can perform door-to-door distributed collection and do sorting and pre-processing of waste locally both for compostable and recyclable waste. Policies are needed to support cooperatives to invest in management training and improve their organisational structure to overcome the barriers to partnering with large companies. Cooperatives need support to adopt management tools and to develop production processes. If cooperatives were supported in this way, they could contribute to significantly reducing costs and increasing the commercial viability of circular supply chains for both government and the private sector.
- **Government must engage more effectively with the private sector to foster innovation.** The private sector is key to many circular economy initiatives. However, the case studies sometimes demonstrate a lack of cooperation between government and private sector. More effective solutions for reverse logistics, and also design/innovation of products and processes for closed-loop supply chains, may emerge if there are working partnerships between the private sector (both formal and informal) and the local government. The examples showed that design and innovation are crucial tools to develop solutions to comply with the SWNP; they also highlighted that efforts are needed to help share circular economy knowledge between companies and institutions and stimulate collaboration to boost R&D and build partnerships within reverse supply chains, in order to find the most valuable ways to recover products and materials in line with the SWNP.

4 International partnerships

A number of issues regarding the circular economy cross national boundaries through global supply chains. For example, design standards in the EU and other large markets have a material impact on both manufacturing and the ease of reuse, repair and recycling in Brazil. Similarly, waste is often shipped across national borders for processing. Thus, action by other governments can either help or hinder the creation of a circular economy in Brazil and in other emerging economies and developing countries. Collaboration with our international partners is required to maximise opportunities and mitigate risks in these areas.

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