Packaging Waste in Remote Communities

Opportunities and Challenges: A Case Study for Tefé, Amazon

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"Be the change that you wish to see in the world."

— *Mahatma Gandhi*

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Acknowledgements

When I started to think about the people that helped this work happen, I reflected back on 2012, when I saw for the first time waste pickers transporting PET bottles through boats in the Amazon. So the story begins…

Obrigada, Thank you, Tack, Köszönöm, ευχαριστίες (efcharistíes)

Abstract

Growing amounts of waste generation in remote areas without proper waste management systems is a problem to human health and the environment. The Amazon holds the biggest freshwater resources in the world, is a biodiversity hotspot and its communities are placed in distances that can take days by boat to be reached. A National policy with EPR instruments requires private companies to take-back packaging waste. The research aims to identify the hindering and promoting factors for good packaging waste management in remote communities, looking closely to the reality of Tefé, municipality in the Amazon. Literature regarding waste management in remote communities, developing countries, EPR Programmes and recycling markets was crossed with findings collected from Tefé. The analysis offers an overview on what are the hindering and promoting factors for packaging waste management in both literature review and case study clustered into four main topics: (1) Government support and policy framework; (2) market factors; (3) society and private sector contribution and (4) geographical and demographic factors. The results show several similarities of the findings from literature review were also observed in the case study in Tefé and that Government support and policy framework represent the majority of the hindering factors while geographical and demographic factors represent the least for promoting factors. Recommendations to stakeholders focus on what can be done in a short and long term considering the Tefé case study but can be also benchmarked to other remote places.

Keywords: packaging waste; remote communities; waste management; EPR Programmes, remote areas in the Amazon, Tefé.

Laura Arneiro Fostinone, IIIEE, Lund University

Executive Summary

Waste management is a growing concern globally and remote areas lack collection, proper treatment, disposal and awareness. Islands, mountainous areas, regions with variable seasons, like the Artic or floodplain rainforest present even more obstacles to attend to an acceptable destination of waste (UNEP, 2014).

Remote areas have unique geographical, demographic and economic characteristics, literature found for "waste management in remote communities" mainly includes case studies and is not possible to generalize the main challenges and opportunities. However, some common barriers for proper waste management in developing countries were identified, such as: the distance to waste facilities, collection infrastructure, inadequate planning and policy making, unprepared staff, low awareness of waste impacts, difficulty to access recycling markets and land availability (Chirico, 2011; UNEP, 2015).

The Amazonas is the biggest Brazilian state, with 31.27% of the Amazon rainforest. It consists of 62 municipalities with estimated population of 3.5 million inhabitants. It holds the biggest freshwater resources in the world and is a biodiversity hotspot. Along with its rivers, communities are located in distances that can vary from one hour to more than 72 hours by boat from big centres and transportation is only available through waterways.

Because of Brazil's development, industrialised products became available in these communities, but as other developing countries around the world, there is a higher demand for waste management, especially in remote communities where collection can be inexistent. The mismanagement of waste in these places – common practice is open dumping on land or rivers or burning – are threats for human health and for one of the biggest hotspot of biodiversity in the world. However, because of the National Solid Waste Policy, municipalities are required to plan how they are going to manage waste (PNRS, 2010). Combined with that, the law integrates the EPR concept and establishes that the private sector collectively presents a Sectorial Agreement to comply with the request of building a reverse logistics for packaging waste (and other seven categories of products as well).

From one perspective, the agreement may appear as a good solution, since private sectors are making investments and waste pickers are being engaged in the process. On the other hand, what remains as a gap for the packaging waste proposal is to explain and design what will happen after 24 months of implementation, especially considering that the initial sectorial agreement presented to the Ministry of Environment covers only 12 cities in metropolitan areas. The object of this case study, remote communities in the Amazon, has not been included yet and has no official plan.

The problem remains in how to integrate the National Policy instruments such as EPR in places like the case study chosen, Tefé, where generation of waste is increasing, the public staff lacks knowledge, distances from recycling centres and markets are enormous, funding to waste management is insufficient and the community is not yet aware of the impacts of waste. Previous research has identified main challenges for waste management in developing countries, remote communities, policy aspect and recycling opportunities; however, the author identified a gap in research to cross analysis of these findings around the world with a case study in a remote community in the Amazon.

Therefore, the research aims to enhance understanding of the hindering and promoting factors for good waste management policies and practices related to packaging waste management in the context of remote communities, looking closely to the reality of Tefé, municipality in the Amazon. As the National policy is very recent and implementation has not

yet reached remote places in the Amazon, the purpose of the study is to support the strategic planning and decision makers at a National and Regional level and tactical planning and implementation at local level. The results may foster recommendations for more local and simplified solutions considering scenarios where funding may not be available even in the long term. To achieve that, the following questions will guide the author:

§ Main RQ: What promotes and/or hinders packaging waste management systems and policies in remote communities, having Tefé as the main case?

> *RQ1: What is the existing knowledge on factors promoting and hindering for waste management in remote communities?*
>
> *RQ2: How does the current waste management system for packaging waste in Tefé look like?*
>
> *RQ3: What promotes and/or hinders packaging waste management in Tefé?*
>
> *RQ4: What actions can be taken in a short and longer term in Tefé's case?*

The author adopted an inductive approach, which means that started with a few assumptions related to the results and has drawn the areas of study from that starting point. It allowed the author to develop preliminary relationship of the case problem in Tefé with the other main topics stated at the Scope section above. The literature review had been taken together with fieldwork data collection and provided the author to investigate four main areas: (1) Waste management in remote communities; (2) Waste management in developing countries; (3) EPR programmes (4) Recycling Markets. The ultimate methodology extracted from the inductive approach is shown in the figure below.
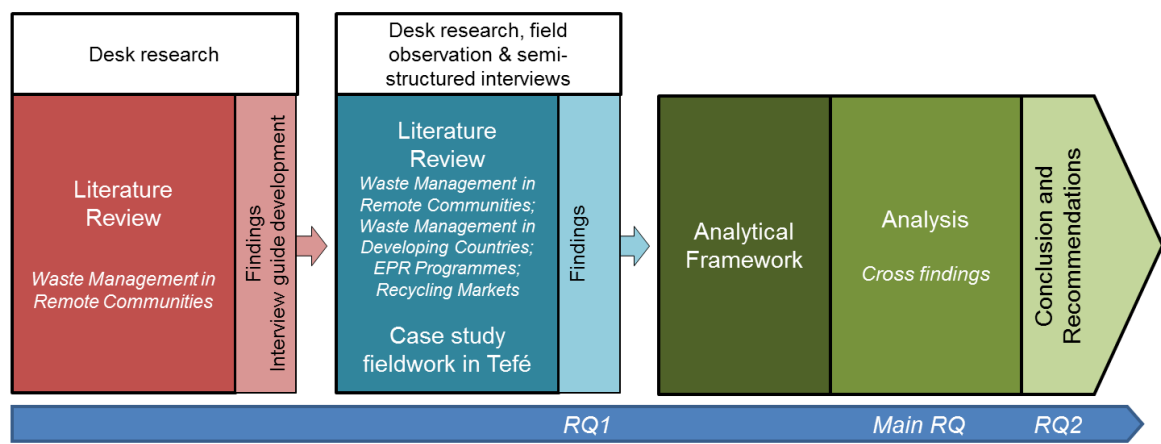
Figure. Overview of methodological approach. Source: Developed by the author based on Dorkenoo (2015).

To summarize the main findings of each section in literature review and case study, divided as Physical, Financial and Informative management of waste management systems the author identified the "hindering" factors and "promoting" factors for a good waste management system for packaging waste. The results are a crossover of the findings from both literature review and the case study in Tefé.

The research identified several similarities that hinders or promotes waste management in remote communities with the reality seen in Tefé. These factors were clustered into four categories: (1) Government support and policy framework; (2) market factors; (3) society and private sector contribution and (4) geographical and demographic factors.

From the **governmental support and policy framework area**, the lack of resources, unskilled staff result and inadequate planning result in poor collection, poor monitoring and often in more expenditures for all cases studies. Because in Tefé the PNRS – Brazilian EPR policy – is still not being implemented, it is possible to say that having an EPR policy does not mean it is effectively implemented. Regarding responsibility and financial allocation, the analysis has identified that does not matter if single (producer) or collective (shared responsibility: producer, importer, retailers, etc.) as long as EPR is implemented in a transparent and accountable way. Promoting factors seen at the other places studied are related to the adoption of waste hierarchy when planning waste management solutions, improvement of contracts content and procurements, implementation of unique, small scale and alternative solutions, and a mix of policies that would motivate inclusion of informal workers, recycling markets to be stable and competitive and new packaging.

The findings showed that recycled materials are under the influence of **market factors,** which both in the literature and the case study in Tefé have shown that for many packaging materials, the amounts and value are too low to be recycled. The only exception seen in current knowledge and in Tefé is for aluminium. The plunge on oil prices hinders recycling as well as the availability of recycling industries. Promoting factors were: Creating centralised operations and deposit refund-systems have been successful in Islands and Tefé showed a strong network that collects and transports aluminium cans from areas up to 72 hours away by boat.

For **Society and private sector contribution**, the lack of awareness of citizens and the cultural acceptability to burn or dump waste on the streets and rivers is a hindrance but also showed that an interdependent network of stakeholders (municipality, private sector, civil society, NGOs, specialists, etc.) can promote and intensify the creation of programs, especially in small municipalities like Tefé or SIDS. External pressures such as the airport security in Tefé or lack of land in small islands influenced positively the creation of recycling programs.

For Tefé's case, as mentioned, the packaging sector is not implementing anything there yet, but promoting factors to packaging waste management currently being applied in 12 cities in Brazil are related to investments to improve capacity and productivity of waste pickers' activities, being organised collectively and clear targets; however, hindering factors to the current plan so far are the lack of financial subsidies to municipal collection services, lack of remuneration to waste pickers cooperatives for the recycling services and lack of transparency in investments.

The highlight of **geographical and population factors** is that for both remote communities around the world and Tefé, a community just by being remote, is already facing several hindering factors that another geographical area would probably not.

Finally, because of all challenges presented in remote communities, it is emphasised that developing countries and especially municipalities in remote areas would not be able to self-finance recycling programs just accounting for the value of recyclable materials, or promote good packaging waste management in general, if not subsidised with more resources from other stakeholders, reason why EPR programmes are supportive.

Recommendations to decision-makers and future research focuses actions to be taken in short and long term at local level and strategic actions and further research in the national level.

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Abbreviations

ABRELPE	Associação Brasileira de Empresas de Limpeza Pública e Resíduos Especiais - Brazilian Association of Urban Cleansing and Waste
BRL	Brazilian Reais
CEMPRE	Compromisso Empresarial para Reciclagem - Business Commitment for Recycling
ELV	End of life vehicles
EPR	Extended Producer responsibility
EU	European Union
EUR	Euro
FAO	Food and Agriculture Organisation of the United Nations
FLONA	Floresta Nacional – National Forest
GPS	Global positioning system
ICMBio	Instituto Chico Mendes de Conservação da Biodiversidade – Institute Chico Mendes of Biodiversity Conservation
IFAD	International Fund for Agricultural Development
ISWA	International Solid Waste Association
MNCR	Movimento Nacional de Catadores de Materiais Recicláveis – National waste pickers 'movement
MSWM	Municipal Solid Waste Management
NGO	Non-governmental Organization
OECD	Organisation for Economic Co-operation and Development
PET	polyethylene terephthalate
PNRS	Política Nacional de Resíduos Sólidos – National Solid Waste Policy
PRO	Producer Responsibility Organisation
SIDS	Small Islands Development States
UK	United Kingdom
UN	United Nations
UNEP	United Nations Environment Programme
USD	U.S Dollar
WEEE	waste electrical and electronic equipment
WFP	World Food Programme (UN)
WWF	World Wildlife Fund

1 Introduction

The first chapter of this research introduces the background to main topics to be approached and the motivation of the researcher to choose the investigation of waste management in remote communities with a case study in a remote municipality in the Amazon: Tefé.

Following, problem statement justifies the relevancy of the case to be studied, as well as the subsequent content describes the purpose, research questions, scope, methodology, limitations and the outline of the thesis.

1.1 Background of the topic

This section aims to give background to the subject of the research – Waste management in Remote communities – and further the Brazilian scenario for waste management and policies under implementation.

1.1.1 Remote communities and waste management

Urbanization is a global trend and the number of people living in the cities has already surpassed the total of people living in rural areas (Birch, Meleis, & Wachter, 2012). Although that creates challenges to, for example, water supply, sanitation, energy supply and waste management systems, because the demand is only growing, it is also an advantage when these demands are concentrated in one geographical area than sparse, rural and placed far away from industrial solutions, here called remote areas or communities.

Remote communities can be defined as places "far away from where people live" or that lacks transportation and connection to other urban areas. However, there is not a single definition for the term and for each field of study there is a particularity related to what can be defined a remote community. In addition, remote communities face unique challenges that urban or more populated areas face less: as transportation streams may be harder, more time consuming or expensive, access to human basic needs as education, health services, and supplies, infrastructure for electrification, safe water, sanitation and waste management are main concerns for policy makers to access these places and people. These challenges can easily be matched with food insecurity, lack of employment due to low education skills, reduced market access as source of income for agricultural production, degraded health safety and others (Denkenberger, Way, & Pearce, 2015; Kramer, Urquhart, & Schmitt, 2009).

Waste management is a growing concern globally and remote areas lack collection, proper treatment, disposal and awareness. Islands, mountainous areas, seasonal places to be achieved, like the Artic or floodplain rainforest present even more obstacles to attend to an acceptable destination of waste (UNEP, 2014).

According to Kramer et al. (2009), global trends are changing access and households decisions for producing, consuming and disposing waste, making remote communities less remote to urban problems which increases a conservation risk and presents a threat to biodiversity in these areas.

Literature found for "waste management in remote communities" are mainly case studies and it is not possible to generalize what are the main challenges and opportunities overall; however, congregating the similarities especially for developing countries, the barriers for proper waste management include: the distance to waste facilities, collection infrastructure, poor planning and policy making, unprepared staff, low awareness of waste impacts, difficulty to access recycling markets and land availability (Chirico, 2011; UNEP, 2015).

The hindering factors above, a recent national policy for solid waste management and the lack of knowledge in the area are the motivations to look closely to the situation of the waste management in remote communities in the Amazon, Brazil.

1.1.2 Brazilian background

Ever since Brazil eradicated hunger and reduced poverty, (FAO, IFAD, & WFP, 2015) new sorts of consumer goods now reach people in rural and remote areas that had no culture of industrialized goods before. At the same pace, the amount of waste being generated has increased without environmental impact solutions (Bernardes & Günther, 2014).

Brazilian population has grown by 30% while waste generation has risen by 90% in the past 20 years (Veiga, 2013). Urban concentration, environmental concerns and waste pickers engagement to public policies raised the necessity of a new and innovative law that will promote reduction of the amounts delivered to landfills (PNRS, 2010). Brazilian waste data shows that recycling systems are incipient but the government is trying to improve the current situation, which is:

- Average of 1.06 kg of waste per capita per day. Annual waste production growth is superior to annual population growth (ABRELPE, 2014);
- 41.6% of the waste is disposed inadequately in dumpsites without any control (ABRELPE, 2014);
- Only 14% of the cities have collection of recyclables and 32%, with some recycling initiative (collection centres, waste pickers cooperative, social projects) (CEMPRE, 2013);
- There are 800,000 to 1 million informal workers (known as waste pickers) (MNCR, 2009);
- It is estimated that 30 million people living in rural areas, of which 70% of the waste generated is burned or dumped in open areas (Bernardes & Günther, 2014).

It is indubitable that waste pickers play an important role in Brazil's recycling scenario: 90% of the total recycled materials come by the hands of these agents (MNCR, 2009). The National Waste pickers Movement (MNCR), together with 100,000 waste pickers affiliated (MNCR, 2014), have been an active player who discusses with federal government and promote policies for waste pickers' better working situation, social and economic inclusion. The most important and inclusive policy is the "Política Nacional de Resíduos Sólidos", or Solid Waste National Law – hereafter referred to as PNRS (PNRS, 2010).

In 2010 Brazil passed a law that requires several stakeholders to provide a solution to waste (PNRS, 2010). The law asks all the supply chain and public sector to act on the take-back, to create and support recycling streams. The law is rather like the Extended Producer Responsibility (EPR) policies being implemented in many OECD countries and growing number of non-OECD countries.

It is expected that the PNRS will promote efficiency through strategy building, waste hierarchy (same as European Union) and shared actions. The law integrates the concept of Extended Producer Responsibility (EPR) and establishes that the private sector can collectively presents a Sectorial Agreement to comply with the request of building a reverse logistics for packaging waste (and other seven categories of products as well).

The concept that is engaging companies and public sector to dialogue is the *shared responsibility principle*. It states that "manufacturers, importers, distributors and dealers are responsible for

conducting the reverse logistics" with integration of waste pickers in recycling actions" (PNRS, 2010 art 3rd, XVII). In that sense, the shared responsibility concept does not clearly name one actor that is going to pay; instead names the whole supply chain. To have so many actors involved can create some confusion considering the enforcement, when it can happen that the officials do not know to which actor to send a notice or fine to (F. Ribeiro, personal communication, April 18, 2016).

In order to implement the reverse logistics concept of the law, instead of describing how the companies should proceed, the government divided the solid waste into eight big segments: (1) medications; (2) packaging in general; (3) oil and lubricants; (4) electrical and electronic waste; (5) ffluorescent lamps, sodium vapor and mercury and mixed light (6) tires; (7) batteries (8) agro toxics. Tires and agro toxics sector are in the object of the law, but as that sector has already presented a plan and it has been implemented, it is not in the priority area of the Government right now. Therefore, the other six segments should dialogue and deliver to the Government how they want to act to comply with the law.

Specifically about packaging Waste, which is the focus of this study (more detail on Section 3.4.1.1), private sectors presented to the government a sectorial agreement with commitments and goals that was analysed, rearranged and finally approved by the Ministry of Environment in November 2015.

The Sectoral Agreement for Packaging Materials approved in November 2015 has stated that the private sector will:

- Collect 3.8 tons/day in the 12 cities that hosted the 2014 World Cup: that would represent a reduction of 22% of packaging waste into landfills by 2018 and 20% material recovery;
- Triplicate the number of partnerships with waste cooperatives and triplicate the number of collection points;
- Compromise and incentivize that companies buy back the recycled material as input to their own supply chain;
- Implement monitoring system between all actors and input data to the National Solid Waste Information System (SINIR).

From one perspective, the agreement may appear as a good solution, since private sectors are making investments and waste pickers are being engaged in the process. From other, investments and chronological plan do not seem sufficient to reach the Solid Waste National Law goals (i.e. 45% reduction of waste to landfills by 2031)(PNRS, 2010). In addition, private investments and municipality efforts do not seem to be enough to reach the goals in a longer term.

Waste pickers continue collect packaging waste as source of income and to raise recycling rates in Brazil: 97.9% for aluminium cans and 58.9% for PET bottles (ABRELPE, 2014), the materials with highest payback values. There are low value materials in packaging area that even with cooperatives' investments are not feasible for the work of waste pickers, such as carton boxes, other types of plastics and glass, and no definition of how these materials can be included in a viable circular economy.

As the law covers all the Brazilian territory, what remains as a gap for the packaging waste proposal is to explain and design what will happen after 24 months of implementation, especially considering that the initial sectorial agreement presented to the Ministry of

Environment covers only 12 cities in metropolitan areas. The object of this case study, remote communities in the Amazon, has not been included yet and has no official plan.

1.2 Problem definition

The Amazonas is the biggest Brazilian state, with 18.75% of national territory and 31.27% of Amazon forest. It consists of 62 municipalities with estimated population of 3.5 million inhabitants, with particular increase of population in urban areas. It holds the biggest freshwater resources in the world and is a biodiversity hotspot. Along with its rivers, communities are placed in distances that can vary from one hour to more than 72 hours by boat from big centres and transportation is only available through waterways.

Because of Brazil's development, industrialised products became available in these communities, but as other developing countries around the world, there is a gap on waste management, especially in remote communities where collection can be inexistent. The mismanagement of waste in these places – common practice is dumping or burning – are threats for human health and for one of the biggest hotspot of biodiversity in the world.

However, because of the National Solid Waste Policy, Municipalities are required to plan how they are going to manage waste and mandate closure of dumpsites and implement a plan that follows the Waste Hierarchy (Prevent, Reduce, Reuse, Recycle, Recover, Disposal) (PNRS, 2010). Combined with that, private sectors are requested to implement take-back (or reverse logistics) solutions to the end-of-life of products they put on the market. Therefore, there is a possibility to change that scenario in the upcoming years.

The problem remains in how to integrate the National Policy instruments such as EPR in places like the case study chosen, Tefé, where generation of waste is increasing, the public staff lacks knowledge, distances from recycling centres and markets are enormous, funding to waste management is lowermost and the community is not yet aware of the impacts of waste.

Previous researchers have identified main challenges for waste management in developing countries, remote communities, policy aspect and recycling opportunities; however, the author identified a gap in research to cross analysis of these findings around the world with a case study in a remote community in the Amazon.

1.3 Objective and Research questions

This research aims to enhance understanding of the hindering and promoting factors for good waste management policies and practices related to packaging waste management in the context of remote communities, looking closely to the reality of Tefé, municipality in the Amazon.

As the National Policy is very recent and implementation has not yet reached remote places in the Amazon, the purpose of the study is to support the strategic planning and decision makers at a National and Regional level and tactical planning and implementation at local level. The results may foster recommendations for more local and simplified solutions considering scenarios where funding may not be available even in the long term.

The ultimate goal of this research is to improve the waste management scenario in remote communities in the Amazon and to achieve that, the following questions will guide the author:

§ Main RQ: What promotes and/or hinders packaging waste management systems and policies in remote communities, having Tefé as the main case?

RQ1: What is the existing knowledge on factors promoting and hindering for waste management in remote communities?

RQ2: How does the current waste management system for packaging waste in Tefé look like?

RQ3: What promotes and/or hinders packaging waste management in Tefé?

RQ4: What actions can be taken in a short and longer term in Tefé's case?

1.4 Scope

The geographical scope of the study comprised the municipality of Tefé and other eventual communities that may infer important and similar data to the case. The object is limited to "Packaging waste management" although the author will comment and contribute with other types of waste that may offer good connections to the overall waste management scenario when relevant.

Literature review sought to identify issues that other remote communities around the world experienced when managing their waste. The research reviewed the following subjects to identify the hindering and enabling factors of:

1. Waste management in remote communities
2. Waste management in developing countries
3. EPR programmes
4. Recycling markets

The findings from literature will be crossed with the findings from the case study in Tefé and most referred issues will be analysed and commented.

1.5 Limitations

While conducting the field research, the author had issues to collect accurate data regarding waste generation, population settlements and financial support in the municipality of Tefé and surrounding communities. Not to have the data can be accounted for a type of finding, however, it limits the analysis to go further in relation to the best management solution to the packaging waste in the region. The author has used previous studies from Tefé combined with another one from the area with same remoteness characteristics.

During field observation the limitation was the geographical and transportation possibilities to the communities: time and budget had been a constraint, therefore, besides the urban area of Tefé, only four remote communities were analysed closely.

Another limitation was the availability of the private sector to comment on future plans for reverse logistics of packaging waste in remote regions. Because the development of reverse logistics and recycling streams are still focused on main urban areas of Brazil, there was little to none that have been mapped to draw future scenarios.

Considering the National level, some of the findings from interviews contained information that the interviewees asked the researcher not to publish, either because it could provoke institutions or because the data did not reflect the institution opinion.

1.6 Methodology

The author adopted an inductive approach, which means that started with a few assumptions related to the results and has drawn the areas of study from that starting point. Inductive approach "involves the search for pattern from observation and the development of

explanations – theories – for those patterns through series of hypotheses" (Bernard, 2011). It allowed the author to develop preliminary relationship of the case problem in Tefé with the other main topics stated at the Scope section above.

The exploratory study utilizes a single case study and literature review. Both have provided primary and secondary data to build an analytical framework. The literature review had been taken together with fieldwork data collection and provided the author to investigate four main areas: (1) Waste management in remote communities; (2) Waste management in developing countries; (3) EPR programmes (4) Recycling Markets.

The ultimate methodology extracted from the inductive approach is shown in Figure 1-1.
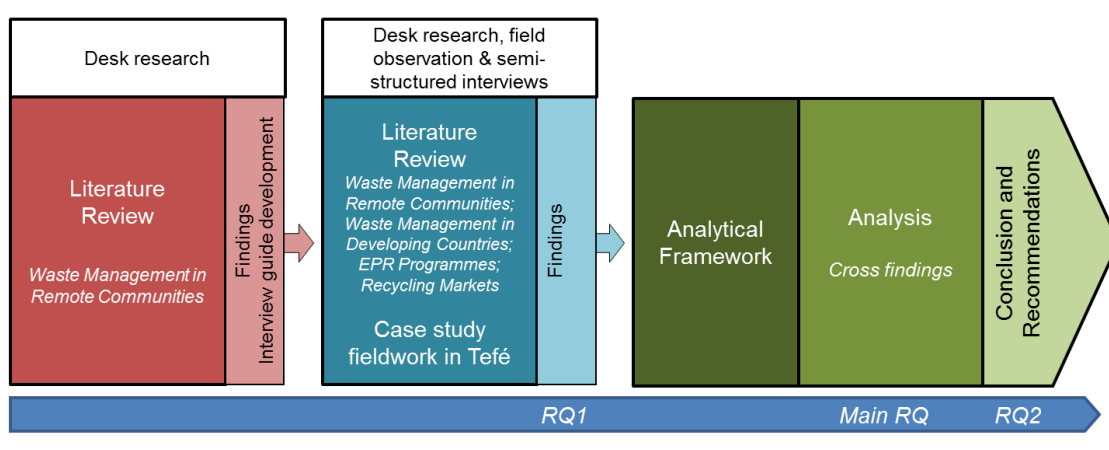
Figure 1-1 Overview of methodological approach

Source: Developed by the author based on Dorkenoo (2015).

The first phase of desk research was mainly done through Internet database that the research institution offers (Lund University) and Internet search. Main keywords used were "remote communities"; "remote areas"; "waste management in remote communities"; "waste management in islands"; "waste management in the Amazon", "challenges to remote areas" etc., combining also keywords in Portuguese language as mother language of the author and Brazil. The second phase, already involving interviews and field observation, primary data was collected from government officials, municipalities, private sector, NGOs and researchers of the area based in Brazil and other researches from abroad. These contacts were selected on their aptitude and/or involvement to provide data to answer the research questions. They have also contributed with more articles and grey literature referring to legislation and local waste management plans.

In total, there were 37 interviews, combining contributions from government staff, academic and practitioners, NGOs in Tefé and local community. The majority of the interviews were in person in Tefé urban area and other four remote communities (Figure 1-2).

To summarize the main findings of each section in literature review and case study, the researcher was inspired by Tojo (2004) framework considering Physical, Financial and Informative management of waste management systems. To be able to provide succinct summaries for each chapter, the author chose to adapt "informative management" to "institutional arrangements" and the content of each of the three areas was divided as follows in Table 1-1. Overlaps may have happened given interconnected content.
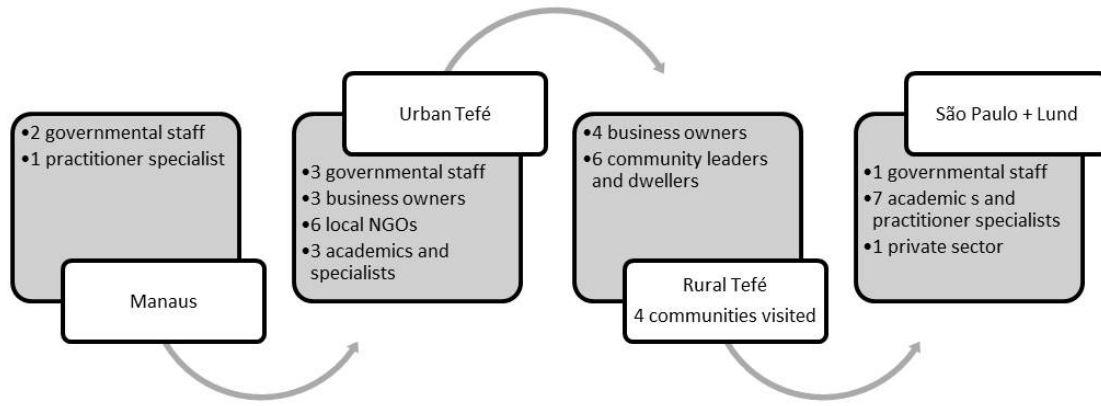
Figure 1-2 Numbers of people interviewed by sector and where interviews took place

Source: Author's own.

The division was then summarized in each section considering the "hindering" factors and "promoting" factors for a good waste management system for packaging waste (or relevant information that may incur). The Analysis Chapter is the result of a crossover of the summaries of Chapter 2 and 3 and aimed to answer the main research question.

Table 1-1 Description of Physical and Financial Management and Institutional arrangements

Physical Management	Content related to everything from collection to disposal: type of waste, type of fleet, characteristics of geography that would influence waste management (remoteness), packaging materials, data & monitoring of systems
Financial Management	Government and private sector input and constraints, policies influences, taxes, procurement
Institutional Arrangements	Knowledge and relationship of stakeholders, factors related to their interdependence

Source: Developed by the author adapted from Tojo (2004).

1.7 Outline of the thesis

The research is structured as follows:

Chapter 1 – **Introduction** to the research, definition of the problem, objective and research questions, scope, limitations and methodology

Chapter 2 – Defines main terms to be used throughout the study and presents the **Literature review** findings regarding the topics:

1. Waste management in remote communities
2. Waste management in developing countries
3. EPR programmes
4. Recycling markets

Chapter 3 – Presents the data collected and **findings** section of the Case Study in Tefé, Amazon, Brazil. Comprise Local, State and Federal level content.

Chapter 4 – **Analysis** undertook from Literature review content and Case study findings to address the main research question of this study.

Chapter 5 – **A step forward** presents the actions that can be implemented in a short and longer term.

Chapter 5 – **Conclusions and Recommendations** for stakeholders and policy makers. Answers to all RQ, which offers some alternative packaging waste management ideas to be implemented in Tefé.

2 Literature review

The chapter begins with some definitions of main terms to be mentioned along the thesis. Secondly, it outlines and gives the readers an overview of the existing knowledge regarding the chosen areas that influences the waste management in remote communities' investigation. The investigation is organised into four areas: (1) waste management in remote communities; (2) waste Management in developing countries; (3) EPR programmes (4) recycling markets.

2.1 Definitions

2.1.1 Remote communities

The importance of defining what will be called "Remote community" in this research is mainly to provide the reader a picture of what and where they are.

Oxford Dictionary defines the word "Remote" as "far away from where other people live"; and "Far" as "a long distance away". Remote communities are often described as well as rural areas, or population living in rural areas, which can vary regarding the distance to the next more populated area or the availability to transportation links to reach public services like health, education, and infrastructure.

Because they have unique geographical, demographic and economic characteristics, the definition is often made by each government and serves a function to map and provide special care to these "hard-to-reach" places. For some regions the special care can be access to telecommunications services, others can be health services, or even both combined when there is a situation of seasonality, like Canada or Lao, that remote and isolated communities can have road access for some months of the year and some not (Health Canada 2016).

Nonetheless, Australia and Canada have defined what they call "remote communities". In addition, UN definition on Small Islands Developing States (SIDS) can be included in this study for remote areas:

- **Australia:** For the purpose of the Waste Management Guidelines for Small Communities in the Northern Territory, a 'small community' has less than 1,000 permanent residents (LGANT, 2009), while remoteness concept was classified by demographic structure. It was created to form a new dimension of policy development since many government services depend on distances that people have to travel from and to major metropolitan areas (ABS, 2014).
- **Canada:** Remote is defined as a combination of latitudes 60 degrees south the limit of the territory or 350 km from the nearest service centre having year-round road access. Isolated concerns connection to flights and good telephone services, but no year-round road access. Facts such as changes of access related to the weather also counts into the isolated definition (Health Canada, 2016).
- **Small island Developing States (SIDS)** can be vulnerable due to their "small size, remoteness, narrow resource and export base, as well as exposure to global environmental challenges, and external economic shocks" (UNEP, 2014).

There are not many examples for defining what is a remote community and what is not, even looking specifically to one government. Australia, Canada and also United States have a statistical equation to define rural and remote, regarding the demographics and distance to other big urban centre. Even for the UN, there are not yet a unified definition of SIDS or

remote communities, however it is possible to infer that these places face unique vulnerabilities (UNEP, 2014).

For this study the statistical definition is not necessarily enough, because as the places to be investigated in literature review vary, it is hard to define what is far and remote for one reality compared to other. Not only, because this analysis will focus on waste management, there may be people living closely to more populated areas, but with primitive infrastructure to handle the management of waste. Such a community, therefore, can be considered for this research remote because the community does not have access to proper infrastructure services.

Specifically, about Brazil, there is no official definition of remote areas. In the Amazon, for example, road transportation is very rare, still being built, or impossible to be built due to soil challenges and seasonality of the rainforest (Silva & Pinheiro, 2010), however, ships and boat are often common and serve as a replacement for transportation. Even though there are some transportation solutions for communities to access urban areas, there are other matters of discussion related to time consumed in travels, costs and the burden for public sector to be able to serve these regions in terms of staff and infrastructure.

Concluding, as remoteness vary for each demand, for the specific Amazon case study to be analysed and other places examples, based on Canada's definition, this research will be looking for remote communities that are at least 350 km far from urban centres, waste management facilities and recycling centres.

2.1.2 Packaging Materials

Solid Waste (which includes the remote communities waste as well), contains the residues of households, commercial, public sector entities, sweeping and gardening. Part of this waste is just packaging materials, usually used for food containers, cosmetics and hygiene products, and as a material solution for transportation of goods.

The definitions for packaging and packaging waste are quite similar amongst non-European countries, which describes the types of materials. In European countries and most probably the commonwealth countries as well, the definition is based on material functionality.

- **Brazil:** Means the dry portion of urban solid waste, except the ones characterised as hazardous. It can be: paper, cardboard, plastic, aluminium, steel, glass and these materials combined, such as carton boxes.
- **EU:** Uses a more extensive definition considering the functionality of packaging, which is to provide to raw materials or processed products protection, containment, delivery, among others. The broad categories reported by Member States are: Plastic, metal, paper/cardboard, glass, wood and other (94/62/EC).
- **Australia:** Follows the above Directive 94/62/EC.
- **Canada:** Packaging waste is considered "recyclable waste" and is identified by white paper, other paper and cardboard, plastics, glass, metal and cans (Canada Environmental Act 1999).

For this thesis purpose, the Brazilian definition will be the one used to guide the revision and analysis since Tefé is the centre of the case study.

2.1.3 Land disposal practices

This section will describe the differences between an open dumpsite, controlled dump (or controlled landfill) and sanitary landfill. This definition is important for the reader to

understand what are common practices in most developing countries and understand the differences (UNEP, 2005).

- **Open dumpsites:** Are the least developed, the cheapest in operational costs and the most harmful form of disposing waste on land. It can threat public health and the environment as it does not plan if the space used is safe and far from settlements and water resources; it does not offer control of waste quantities, types and sitting time; frequently does not have the necessary equipment for collection and control of liquid and gaseous emissions. Also, they can easily attract vectors like rats, vultures and other insects, posing an extra risk to human health.
- **Controlled dump or controlled landfill:** It contains a small improvement from an open dumpsite in its operation and management, like measuring how much waste is disposed and where on the land waste will be placed. It does not imply substantial investment related to the structure and it is common to evolve from a dumpsite situation.
- **Sanitary landfill:** It is a planned engineered site designed to receive limited quantities and types of waste, that collects and treats liquid and gaseous emissions and have the least risk to public health and environment. It is the most appropriate type of waste disposal on land and the most expensive (yet, not accounting external costs with environmental damages and public health).

As said, the latter type is the most desirable; however, municipalities struggle to implement it due to costs and management. In the case of remote communities or smaller settlements (population with less than 100,000 habitants), it is normal to find all three types above being shared amongst municipalities.

2.2 Existing knowledge

This section aims to address the research questions presented in the introduction by a comprehensive literature review on four main areas chosen by the author. The areas were chosen based on the relationship that they may have to the whole *waste management in remote communities'* topic and the research questions stated on Section 1.3.

This chapter is divided in five sections that each present essential knowledge outside Brazil scenario before analysing the case study findings. Section 2.2.1 looks into case studies on waste management in remote communities around the world and maps out the main challenges and recommendations. Section 2.2.2 presents the reality of waste management in developing countries, the main issues faced by governments to develop good practices. Section 2.2.3 looks closely to more advanced policies that are making a difference to packaging waste recycling and forms of financing systems. Section 2.2.4 analyses the factors behind the recycling markets and how fluctuation of prices can influence the implementation of recycling programs.

2.2.1 Waste management in remote communities

This section focuses on the understanding what are the hindering and promoting factors to packaging waste management in remote areas (or remote communities). It differs from the content of the remoteness definition and the next section on waste management in developing countries because it investigates only cases where the variables of remoteness and packaging waste management were cited. Thus, there is an assumption during this investigated related to distances, where the author aims to understand if long distances or difficulties of transportation are hindering the implementation of recycling programmes.

Several case studies and grey literature were analysed. Materials have shown that for every case there are crucial factors to make waste management work or fail, but one thing in common among all cases is that cost effectiveness are hardly met, therefore, following what is environmentally sound and socially accepted may not always agree with economically viable solutions.

Because the cases analysed different parameter, the author discusses the most relevant examples and finalizes the section with a summary of hindering and promoting factors for packaging waste in remote areas.

2.2.1.1 Cases highlights

Greece

European Member states with remote areas, such as Greek islands, that have to follow EU waste related directives have shown that the transposition of Directive does not imply effective implementation. Although local governments perceive recycling as inevitable, there was an upcoming challenge regarding the value of packaging waste and cost of logistics in islands (here; Lesvos Island) to transport materials to mainland, where recycling industries are (Harnnarong, 2009).

Centralisations of warehouse and densification equipment are among successful factors to the economics of waste for remote communities. (UMA, 1995) In Greek islands, the idea to have one ship travelling each island and compacting waste to containers has proven to be a viable option if the routes are optimized.(Zis, Tolis, Rentizelas, Tatsiopoulos, & Aravossis, 2011) The same can happen for places like Canada and Australia, with most of its area in places classified as remote (Health Canada, 2016) (ABS, 2014).

Canada

Although Canada has a clear definition regarding its remote areas, no significant studies were found related to different schemes or financial hindrances to the collection of packaging waste. The only research on packaging in remote areas is from 1995 (UMA, 1995) and from then to today, Canada has strongly evolved its policies and has been pioneering in most of provinces on EPR systems.

Small Islands Developing States (SIDS)

A total of 52 islands were analysed in terms of their whole MSWM but also point out the main challenges regarding packaging waste recycling programs (Mohee et al., 2015).

Regarding the waste composition, although many islands have low-income, the households of the Pacific and Caribbean islands have approximately 45% organic waste and the remaining is packaging waste. The level of collection services vary from high to very poor, mainly depending on municipal budget access, resulting in improper vehicles and bins, and geography of the island, where some have very narrow road and no space for landfilling (Mohee et al., 2015).

Recycling is not yet a common practice mainly because of the difficulty of collection, transportation, space to store material and low market value to some packaging materials. Technologies available and scale are also hindering. Low level of awareness of public sector and society as well. However, even with cited challenges, the SIDS are still able to commercialize and recycle good percentages of packaging materials. The most successful material is metal, which 43 out of the 52 islands are recycling it.

Mohee et al. cite the example of recycling streams in Mauritius Island with collaboration of informal sector which has proven to be successful together with deposit-refund scheme for beverage containers. Ever since, Mauritius Island also strengthened infrastructure and services together with legal framework and institutional capacity (UNEP, 2015).

Kiribati has also been able to implement beverage deposit refund system since 2004, for PET bottles and aluminium cans, with a levy on importers passed to commercialization and finally to consumers. There was a Special Fund to kick-off the system passed by Kiribati government. In early 2000 the Government also introduced a Green Bag system where citizens can segregate waste. The results in two years was 60% less waste going to landfill, however, it was discontinued due to systems costs. When reintroduced in 2012 the island launched the Green Bag, and user-pays systems, the citizen has to purchase to dispose the waste and in the price of the bag it is already input the cost of collection by private sector. It encourages households to produce less waste since who generate more would need more bags and to pay more. (UNEP, 2015).

Hence, with all examples, recycling in SIDS is a reasonable option that would need to grow on scale and maybe improve the legal framework for all the Islands. (Figure 2-1) (Mohee et al., 2015)
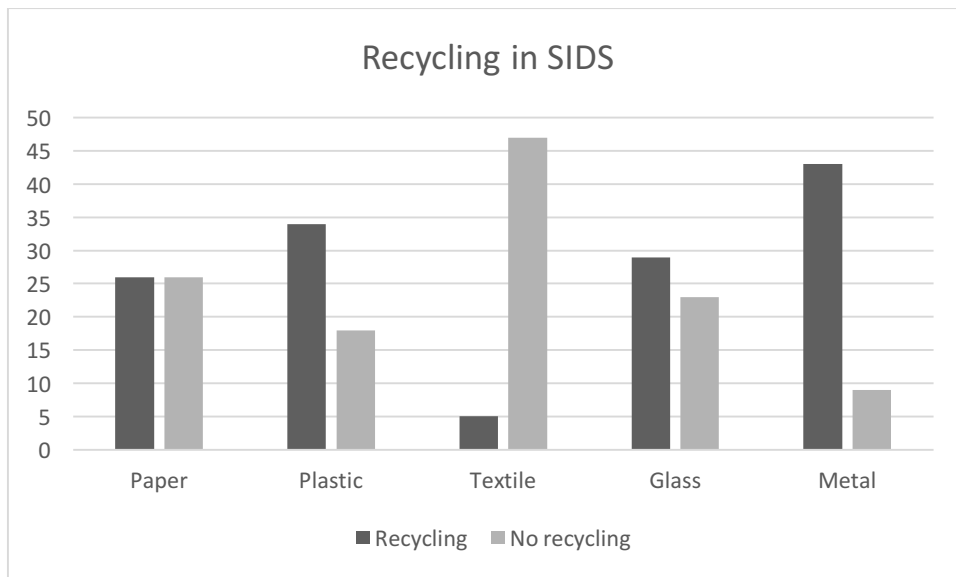
Figure 2-1 Recycling in SIDS

Source: Mohee et al. (2015).

Galapagos Island
Mainly known because of its National Park and tourism, Galapagos archipelago is part of Ecuador and waste generation has been increasing the past few years. Nonetheless, from 2007 on Santa Cruz Island was able to install a successful waste management plan with the help of Toyota and WWF (Dunn, 2010).

The efforts focused on developing a waste management system with the inclusion of recycling and a empowering awareness campaign, which at first did not succeed, but after resulted in an institutional change (a creation of a Municipal Environmental Department) and in a recycling centre (Dunn, 2010).

The household and municipal waste is sorted from its source into three types: organic waste (green bin), recyclable (blue bin) and non-recyclable (black bin). There is also separation for hazardous and bulky waste. The centre receives organic and recyclable waste. The first is composted and used by the municipality as fertilizer. The second is sorted, sometimes shredded and sold to companies in main land (UNEP, 2015). Dunn (2010) also highlights the important of encouraging citizens and tourist to separate composting waste and deposit-refund systems. The latter has more than 90% return rate and mainly because the deposit is quite high: 1 dollar per bottle or can.

The gain for the mix of recycling materials (Scrap metal, paper, plastics, glass) is USD 590/ton[1] (EUR 519/ton) of which aluminium cans represent the biggest value (Ragazzi, Catellani, Rada, Torretta, & Salazar-Valenzuela, 2014). Despite this program, there is still a big amount of waste that needs to be shipped to mainland or landfilled that cannot be commercialized, increasing the cost of operations and environmental impact (Dunn, 2010). Nonetheless, in 2012, 50% of the overall waste generated in the island was recycled (UNEP, 2015).

Greenland

Colony of Denmark, Greenland has only 56,000 inhabitants of which 27% live in the capital Nuuk and the remanence live in towns, villages and settlements (Eisted & Christensen, 2011). Despite being Danish, one of the most developed countries of the world, Greenland has unreliable waste quantity and characteristic data, which normally results to a poor waste management on site.

Eisted and Christensen (2011) verified that most of its waste is incinerated and landfilled, in facilities with not so environmentally sound technologies and only about 1000 tons of metals are exported for recycling each year, being the only material mentioned in the study with that treatment.

The authors attribute the challenges of waste management mainly to sparse population settlements, unreliable data, long distances and small quantities of waste to be able to create local recycling centres. Distances to Europe and North America result in less attractiveness for recycling (Eisted & Christensen, 2011).

Hawaii

Hawaii depends on other federal states for its waste disposal, and the distance is seen as a major barrier. The case research by Chirico (2011) comprises one county of one Hawaiian island, it points out that besides being an American state, has less financial support and in several areas residents are "excluded" from county's collection, resulting in illegal dumping. Interviews mapped that the main driver for improving the waste management scenario is to avoid more punitive action from the EPA (US Environmental Protection Agency). (Chirico, 2011)

The major town has the recycling centre that collects "cardboard, plastics, aluminium cans, tin cans, newspaper, plastic bags, and used motor oil". However, the activity is seen as expensive, due to small population of the island, finance inability to build internal material recovery Facilities, distance to markets and price volatility (Chirico, 2011).

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[1] Source for conversion of currencies: https://www.oanda.com/currency/converter/

For future parameters, conversion made in June 5, 2016; 1 EUR = 1.13 USD

One main contribution of the dissertation is the definition of what Chirico called as "Internal Remoteness" and "External Remoteness" (Figure 2-2Figure 2-2 Internal and External Remoteness.):

- **Internal Remoteness:** the distance or the difficulty relation to reach other industrial areas of the county, for example unpaved or narrow roads. Regarding waste, the challenge is to guarantee proper collection and disposal to these internal remote areas, under the same legislation.
- **External Remoteness:** relates to importing goods and exporting waste. The thesis mapped discussions related to the difficulty to impose policies on importers, to take-back (at least) WEEE and automobiles; and the challenge to export recyclables from island to island and finally to mainland. Isolation from mainland is an economic disadvantage.
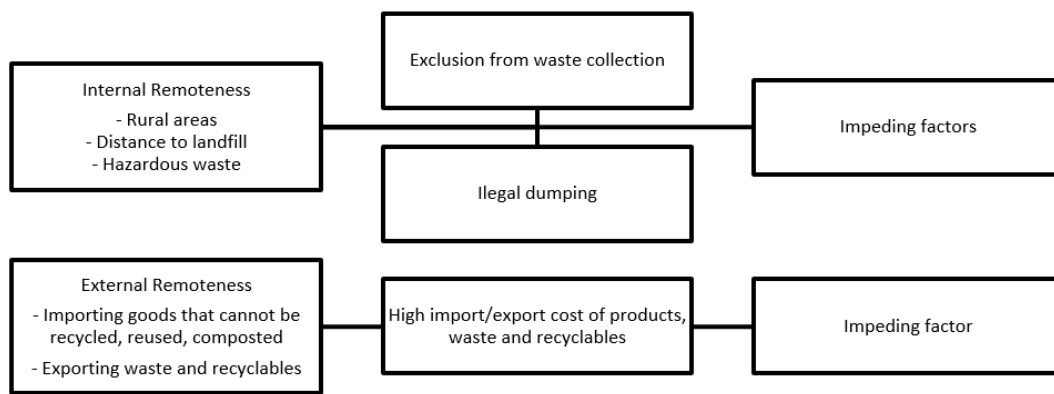
Figure 2-2 Internal and External Remoteness.

Source: Chirico (2011).

2.2.1.2 Summary

To address the first research questions, the review on remote communities' case studies tried to identify, among other factors, if logistics or costs with transportation played an important role on recycling schemes and to identify the most recycled materials in distance circumstances. Most of the studies lacked visualization of transportations costs and the commercialization chain. The studies somehow showed that there is a price that has not been paid neither by private sector or consumers, yet being extracted from the commercialization of recycling materials. Therefore it is possible to infer that Governments, environment or people (here we can remember that most waste pickers work only for what they can sell) are paying for the service of collection and recycling.

The review has confirmed that the distance to landfills and infrastructure are hindering factors to sustainable waste management, especially recycling (Parrot, Sotamenou, & Dia, 2009). In addition, most of the cases also presented some external pressure factor to implement waste management programs, for example external funds (Galapagos), lack of land space (Mauritius) or policy intervention (Hawaii, Canada and Greece). Regarding the recyclable materials, most of the case studies showed that it is feasible to recycle aluminium even with long distances.

To summarize what can hinder or promote packaging waste management in remote communities, the author compiled the Table 2-1 below.

Table 2-1 Hindering and Promoting factors of waste management in remote communities

	Hindering	Promoting
Physical Management	Type of pre-collection undertaken (Curb side, drop-off, and buy-back centres); Route and transportation access usually too distant from recycling centres.	Centralized operations: able to raise scale; Metals are, in all cases, being recycled easily due to market value; Pressure of some kind: lack of space in landfills, health and environmental hazards, etc.
Financial Management	Lack of governmental subsidies for packaging waste recycling; Low value of the recyclables; Critical population: the amount of people or waste is not enough to establish economically viable system; Limited markets: Even when the city or community can concentrate considerable amount packaging waste that would interest recycling industry, there may not be environmentally viable because of distances and types of transportation.	Economic instruments: deposit-refund systems for beverage containers.
Institutional Arrangements	Low level of awareness of citizens, public sector.	Implementation of EPR and Waste Hierarchy policies.

Source: Author's own, based on sources previously mentioned.

2.2.2 Waste Management in developing countries

Because the main case of this study is Tefé and it is in a developing country, the author investigated existing knowledge of waste management in developing countries to understand if there is a national context, as politics or financial, that could influence remote areas.

While OECD countries (or also called "industrialized countries") generate approximately 2.2 kg of waste per capita per day, developing countries in average are now surpassing 1 kg (UNEP, 2016). Other variables like emerging economies, rapid population growth, increasing waste per capita, lack of appropriate land and human and financial resources are factors that are aggravating the situation of municipal solid waste management in developing countries (UN Habitat, 2010)

Besides local environmental impacts and threats to human health, it is projected that waste generation in these countries are to rise from 1 kg to 1.42 kg per capita per day (Hoornweg et al., 2012) and its mismanagement can affect across borders and overseas. For instance, from the top 20 countries polluting the oceans (of which represents 83% of all plastics in the oceans), 19 are developing countries (US is the only exception) (Figure 2-3) (Jambeck et al., 2015).
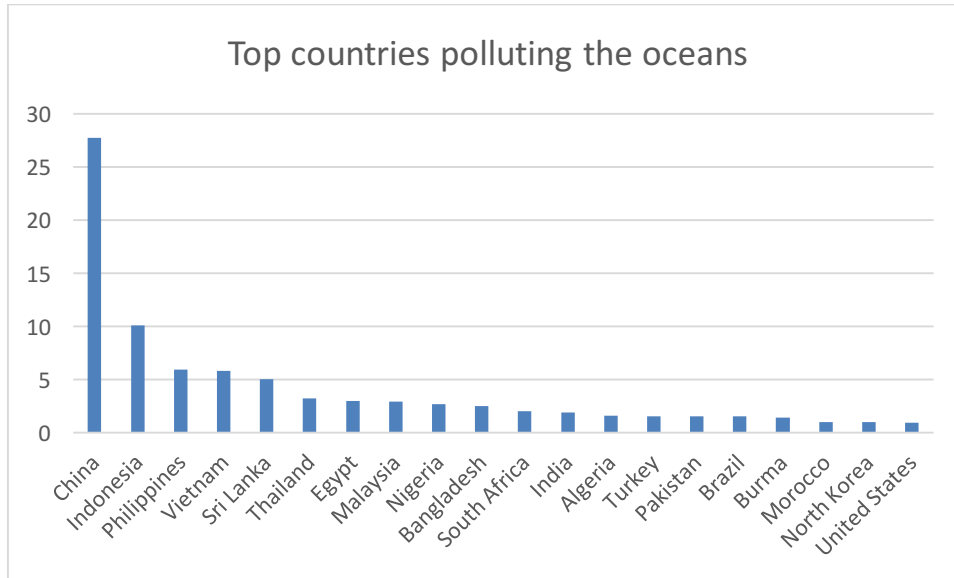
Figure 2-3 Top countries pollution the oceans

Source: Developed from Jambeck et al. (2015)

This section is dedicated to identify what are the main challenges and points of success for waste management in developing countries. Recycling potential and its specific issues will be further described on Section 2.2.4.

2.2.2.1 Financial management

The management of municipal solid waste is one of the most costly services to provide to society, taking from 20 to 40% from municipal funds from developing countries and, from that range of expenditure, 70 to 80% are invested only on collection and transportation of waste. Even when this revenue is put to the service, often the collection and appropriate disposal area irregular and inadequate (UN Habitat, 2010).

A study evaluated 23 case studies in MSWM in developing countries and in 77% of the cases, government finances were considered as a hindering factor to appropriate waste management services (Troschinetz & Mihelcic, 2009). Not only governments, but private sector is also struggling to raise capital (Busse, 2012).

Since developing countries have informal communities and have difficulty with issuance of property documents and land title, taxes revenues to cover waste management costs are harder to get. And opposite to what may be concluded, UN-Habitat (2010) cites that Brazil, Indonesia, Sri Lanka and other places would consider paying taxes for their land title and other urban services. Zurbrügg (2003) also confirms that the willingness to pay for quality services is high in developing Asian countries.

2.2.2.2 Physical management

UN-Habitat (2010) estimates that more than half of waste generation in urban areas of developing countries remains uncollected, while areas with more dense settlement and even lower income citizens can be completely neglected. Most of these citizens cannot arrange another solution to their waste, ending on open space dumping, or at rivers, or burning(UN Habitat, 2010). It is estimate that poor waste collection and segregation are present in 79% of all cases (Troschinetz & Mihelcic, 2009).

Regarding the physical management, the literature analysed connect the unsuccessfulness mainly to the type of design of collection systems (fleet, containers, schedule, etc.), technology and monitoring chosen.

Consultants and engineers that randomly try to import solutions from industrialized countries assume that it will work even in a completely different scenario; however, experiences prove that there is no unique solution to be copied to all countries; instead the recommendation is to investigate several areas and plan before adopting a model (UN Habitat, 2010; Zurbrügg, 2003).

From collection, the costliest item is the vehicles. As the Figure 2-4 shows, UN-Habitat considers that the central key to a good municipal solid waste implementation relies on a good choice of the fleet.
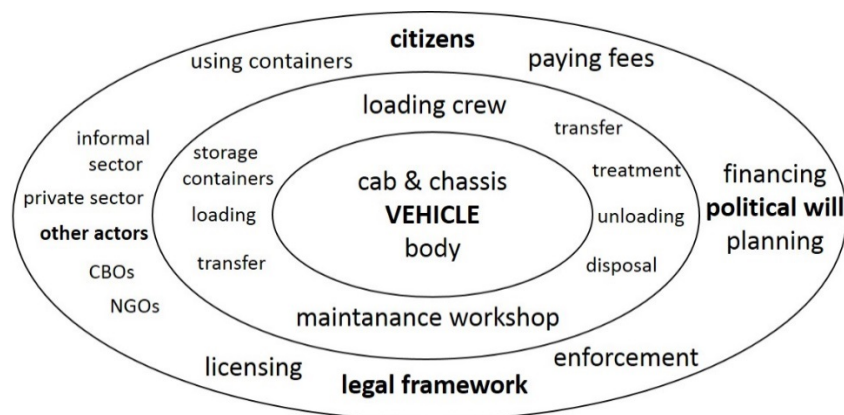
Figure 2-4 Factors affecting the municipal solid waste system in developing economies

Source: UN Habitat (2010).

It is common that the lack of knowledge from public staff to choose correct fleet for each situation results on unsuitable vehicles, which leads to waste of funding. Also, there is a lack of planning for maintenance of vehicles. An example from an African city example showed that even when external aid was received, because of different types of tires, trucks were abandoned because maintenance could not be done. This can be a result of standardized vehicles models imported from industrialized countries and not suitable to serve the reality of cities in developing countries (UN Habitat, 2010). In Asian cities and also identified in low-income neighbourhood in Ecuador, it is common to have door-to-door collection with small vehicles, which some of them may not even be motorized. These vehicles are perceived as a good solution for collection in narrow streets (Stern, Southgate, & Strasma, 1997; Zurbrügg, 2003).

Waste generation and characteristics are an important data for planning. In developing countries, when such data exist, they are often unreliable. Waste characteristics vary a lot, even in the same city. The amount of newspapers one purchases, the seasonality of fruits and vegetables, and geographic and climate conditions can also generate changes on the waste collected, for example more leafs and more humid waste. Warm weather countries need more often collection of kitchen waste because of smell, while, for example, households in England are used to have collection of food waste every two weeks (Manaf, Samah, & Zukki, 2009; UN Habitat, 2010).

Another point of attention is the city's layout: slums narrow streets, condition of roads (some muddy, some that do not support heavy weight), topography and geography characteristics play important challenges when planning the fleet, the frequency of collection, the types of containers to be used. Same as imported vehicles, storage containers are frequently not design considering the culture of the city or community in developing countries. Or too expensive and are often stolen or used for other function. Because low-income areas present more obstacles, a special attention to provide adequate service is needed (UN Habitat, 2010; Zurbrügg, 2003).

Final disposal faces "financial and institutional constraints", says Zurbrügg. Sanitary landfills are frequently too expensive to developing countries municipal budgets, especially smaller towns. Even with subjects like climate change rising, environmental awareness is low. Some citizens and public sector are not yet preoccupied in providing adequate disposal to their waste as long as it is not in their back yard (the NIMBY factor, *Not in my back yard*) (Manaf et al., 2009; UN Habitat, 2010; Zurbrügg, 2003).

2.2.2.3 Institutional arrangements

To make municipal waste management effective in developing countries, there are a number of stakeholders that need to be in harmonic relationship and the governance was pointed out as the most important area of action, that hinders or promotes good waste management systems (UNEP, 2015).
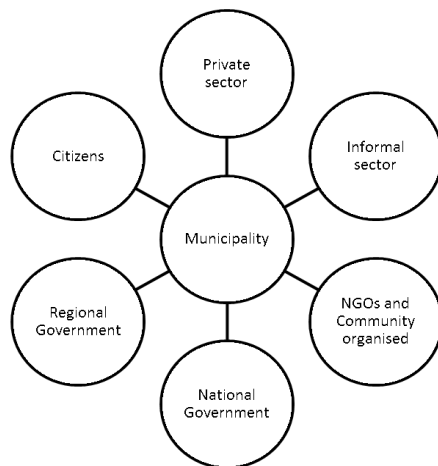
Figure 2-5 Harmonic relationship of waste management stakeholders

Source: Author's own based on UN-Habitat (2010) and Zurbrügg (2003).

National governments have small participation on the daily routine of municipal waste management. Their focus is more on creating and enforcing policies and guidelines, while the Regional Government role depends on each country. They can congregate the municipalities to a shared plan, as for example, the collective use of a sanitary landfill.

In general, it is at the municipal level that most is decided and implemented; however, because it is common to follow a regional or national framework, municipalities may face obstacles to suit their local necessities to, for example, procurement, modifying penalties, etc.

UN-Habitat highlights that the most common issue regarding municipalities is unskilled employees; or with many other responsibilities, frequently resulting in high costs and poor quality of the service. Also, because labourer's wages are low, they can be unproductive and

demotivated. Education level of the personnel can be an issue for 83% of cases in MSWM in developing countries.

Other key actor is the private sector, whose involvement presents advantages and disadvantages. The advantages are related to efficiency, as access to equipment and technologies are easier, more expertise staff, and the profit driven factor can promote efficiency of the service. The disadvantages are that public sector can lose expertise, potential monopoly played by the private company and corruption (UN Habitat, 2010).

Corruption is a big topic not only for developing countries but it is there that the population suffers most by waste mismanagement. Newman (2016b) cites that in 2012 World Bank estimated the need of 30 billion USD (26.3 billion EUR) to promote waste management services in all developing countries. In 2016 that number would be approximately 60 billion USD (52.7 billion EUR). According to Newman (2016) 12 trillion USD (10.44 billion EUR) that goes for tax evasion and corruption globally. From that amount, only 0.5% would be able to provide waste infrastructure globally (Newman, 2016; Transparency International, 2015).

Based on a lot of positive experiences in developing countries, the informal sector have been in the spotlight for researchers and policy makers, because their inclusion promotes not only reinsertion of products to the economy, but also saves space in landfill and generates income for their families (Wilson, Velis, & Cheeseman, 2006). The recycling is carried out by people in vulnerable situation and it is estimated that up to 2% of the population in Asia and Latin America have their livelihood from waste picking (Medina, 2000). There are some examples of emerging countries facing problems related to the ownership of the waste, often the municipality losing revenues because of informal activity influence or leaving all its responsibility behind and not providing collection. UNEP affirms that "Municipal authorities have the responsibility to address waste, but they do not own the waste" (UNEP, 2015).

Recovery rates can be as high as 80% when done by waste pickers, which are considered to be very efficient. However, there are also negative aspects related to human health and keeping steady services (or even keeping vehicles and other equipment maintenance). Measuring pros and cons of integrating these actors, the cases studies by Wilson et al. (2006) still find social, economic and environmental advantages to do so (Wilson et al., 2006).

Overall, the interdependence of actors makes waste management successful; when the municipality consults public opinion, NGOs regarding for example the frequency and time of collection, the methods, the choice of containers and fleet, etc. Zurbrügg (2003) also defends that integration of local community in participatory plan building and monitoring can decisively help for the provision of effective service.

2.2.2.4 Summary

The table sums and represents hindering and promoting factors for a good MSWM in developing countries.

Table 2-2 Hindering and Promoting factors of waste management in developing countries

	Hindering	Promoting
Financial Management	Financial constraints, tax evasion and corruption; International loans with high interest; Collection of taxes from citizens to	Procurement processes and Public private partnerships; Citizens are willing to pay for waste management services.

	subsidize services.	
Physical Management	Irregular collection services; Inadequate purchase of fleet and use of equipment for collection; Lack of data and monitoring.	Well-built contracts with private sector with stringent monitoring; Design and plan adequate to each specific scenario.
Institutional Arrangements	Lack of skilled staff resulting in inadequate planning and waste of funding; Poor relationship with stakeholders; Undefined ownership of the waste: formal and informal sector fighting for revenues.	Public policies towards informal waste recycling; Engagement of children in education and awareness; Interdependent relationship with stakeholders; Adopting waste hierarchy; Socio-economic status is not a barrier: households are willing to recycle.

Source: Author's own, based on sources previously mentioned.

2.2.3 EPR programmes

This section will review the policies regarding packaging waste and other products that may be relevant for the research discussion. The aim, besides describing the possible differences in each experience is to identify responsibility, finance and implementation schemes that have been successful and other variables that the studies have mapped.

EPR policies implemented have shown importance in promoting not only waste management scenario but also the engagement of several stakeholders to address environmental impacts of the whole lifecycle of products put on the market. Here the content is more related to the end-of-life of packaging waste and other products that may be relevant.

2.2.3.1 Extended Producer Responsibility (EPR)

As one of the major economic instruments to enforce waste hierarchy and environmental protection in the EU, Extended Producer Responsibility (EPR) has been put in practice since the 90's in a few Europeans countries, then incorporated to EU policy in the 2000 and expanded to a lot of places abroad nowadays. It is a concept based on putting the responsibility of the product's life cycle to the producers; therefore, investments on eco-design, collection systems and recycling are key for complying with the policy terms (EC 2014).

The Swedish Ministry of the Environment commissioned a study that led to the formulation of the concept in 1990 and published in a report the first complete definition for EPR:

> *Extended Producer Responsibility is an environmental protection strategy to reach an environmental objective of a decreased total environmental impact from a product, by making the manufacturer of the product responsible for the entire life-cycle of the product and especially for the take-back, recycling and final disposal of the product. The Extended Producer Responsibility is implemented through administrative, economic and informative instruments. The composition of these instruments determines the precise form of the Extended Producer Responsibility (Lindhqvist, 1992).*

The term reflected on new forms of environmental policy making by promoting change of the basis of end-of-pipe solutions and remediation, to prevention through incentive mechanism involving industries and government (Tojo, 2004). A trend of a lifecycle thinking motivated other European Directives and policies to act together with the EU Waste Directive, such as

the Eco-design Directive, which describes a set of rules to prevent waste and ensure energy efficiency when planning a product and specific directives for the areas of Packaging, Batteries, ELVs and WEEE.

EPR comes as a decisive solution for financing collection, treatment and disposal of waste. It works through participation of producers to managing the system. Each packaging area can have a different design and some may actually not need financial input of producers, e.g. some deposit-refund systems are financed by the circulation of the deposits itself (Lindhqvist, 2015). Overall, EPR can derive several instruments instead of just a single policy. To name a few (OECD, 2014):

- **Producer take-back:** Requires the producer or retailer to collect the products and ensure end-of-life treatment. Incentives to consumers are key measures to successful rates.

- **Economic and market-based instruments:** Deposit-refund systems, levy on materials, tax and subsidies, etc.

- **Regulations and performance standards:** This relates to the mentioned Eco-design Directive, which can regulate minimum recycled content, put standards or push industries to drive to voluntary agreements.

- **Information-based instruments:** Focused on raising public awareness, such as imposing labelling, informing products components in a certain way, information about end-of-life, etc.

2.2.3.2 Type of responsibility and financing

One of the central issues to address the research questions of this thesis relies on the type of responsibility and financing. Lindhqvist (1998) definition on types of responsibilities clarifies what will be discussed further:

> *"**Liability** refers to a responsibility for proven environmental damages caused by the product in question. The extent of the liability is determined by legislation and may embrace different parts of the life-cycle of the product, including usage and final disposal.*
>
> ***Economic responsibility** means that the producer will cover all or part of the costs for e.g. the collection, recycling or final disposal of the products he is manufacturing. These costs could be paid for directly by the producer or by a special fee.*
>
> ***Physical responsibility** is used to characterise the systems where the manufacturer is involved in the actual physical management of the products or of the effects of the products.*
>
> *The manufacturer may also retain the **ownership** of his products throughout their life cycle, and consequently also be linked to the environmental problems of the product.*
>
> ***Informative responsibility** signifies several different possibilities to extend responsibility for the products by requiring the producers to supply information on the environmental properties of the products he is manufacturing".*

As EPR is a concept and its implications may differ in each policy and country, it will depend how each program will be designed. For example, Lindhqvist definition above mainly cites the ownership to manufacturers; however, in many programs there are other actors along the

supply chain that are also contributing to the economic, physical and informative responsibility.
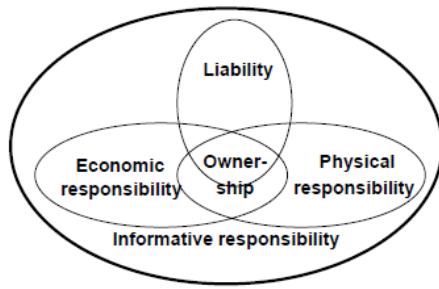
Figure 2-6 Model for Extended Producer Responsibility.

Source: Lindhqvist (1992).

Jacobs and Subramanian (2012) discuss further the issue of ownership to the supply chain: should the packaging material producers be responsible or the brands? Despite what some researchers may conclude on EPR and European Directive, because it has "producer" on the concept name, most EU Member States decided that both packers and fillers are responsible for the take-back and environmental impact of that product. Most producers can decide how to implement it and the possibility of sharing costs and how. Here are some examples of ownership and economic responsibility:

- **UK:** the packaging recovery program shares the costs with all supply chain players, with more allocated value to retailers (48%) (Jacobs & Subramanian, 2012). Lindhqvist also mentioned in personal communications with the author that UK obliges producers to buy recycling credits and recyclers issue those credits.

- **United States:** responsibility is often assigned as individual to brand owners, and measured by share of returned products or weight of products put on the market. Implementation in some states can acquire a "government administration" option, as for example electronics in Maryland and mercury-containing lamps in Washington (Hickle, 2013).

- **Canada:** Implementation also varies among provinces. Four of them (New Brunswick, Newfoundland and Labrador, Ontario, and Quebec) have created third-party organisations (here called as PRO – Producer Responsibility Organisations) to monitor the programs. Regardless the system each province chooses, what they have in common is that regulatory authority, together with recyclers and local government, approves the financial and operation plan that brand owners are willing to implement (Hickle, 2013).

- **EU:** as previously mentioned, the responsibility allocation and financial scheme will depend on each Member State (Jacobs & Subramanian, 2012), but most of the EU Members adopt a "Green Dot" scheme, where industries contribute monetarily and a PRO is responsible for collection, recovery and monitoring actions (Sinclair & Quinn, 2006)

- **South Africa:** has been expanding and implementing EPR policies, however, still on a voluntary basis (Wiesmeth & Häckl, 2011).

- **Brazil:** Because it is the centre of the discussion, details of packaging waste sector will are detailed on Section 3.4.1.1.

The economic or financial schemes frequently takes the form of eco-fee charges, advanced disposal fees, cost-sharing equations, etc., (Tojo et al., 2003) PROs, as physical organisations, would be included in the cost-sharing scheme. In some provinces of Canada, eco-fees are used particularly because they believe it promotes transparency about the costs of the end-of-life program and as a communication tool (Hickle, 2013).

The cited examples also present difficulties and debates on the burden of free riders and inequality of charges throughout the supply chain (UK example). However, case studies showed that if allocations of responsibilities are transferred from private sector to subsidise implementation, the results go beyond reducing MSWM costs and environmental benefits. There are business advantages and savings with design, production and distribution improvements; consumer awareness and a corporate cultural trend to adopt more environmentally sound practices (Jacobs & Subramanian, 2012).

2.2.3.2.1 Shared responsibility and compliance mechanisms

This sub-item aims to reflect further on the difference in the concept of the producer-responsibility and shared responsibility and their compliance mechanisms.

As outlined on item 1.1.2, the Brazilian Solid Waste Law has an EPR policy but instead of having only producers, states that "manufacturers, importers, distributors and dealers are responsible for conducting the reverse logistics" with integration of waste pickers in recycling actions" (PNRS, 2010 art 3rd, XVII). Whereas EPR concept uses only the word producer, leading to believe that the producers are the only responsible actors, most of the EPR programs in place considers several actors to act together and comply with legislation.

An analysis taken with 11 of the 28 Member States of the European Union shows that all of them have more than one actor being held responsible for compliance with its National legislation. The detailed description for some of the countries is the same as the Brazilian shared responsibility principle or quite similar, as for example the Belgium "Producers (packer/fillers or brand owners, importers or end-users) obliged to take back amounts of packaging placed on the market and bear the full cost of collection, recovery and treatment of packaging waste" or Italian "Producers, importers and end users share responsibility for recovery of packaging waste and are required to join the national compliance scheme, CONAI." The latter already states that the compliance mechanism is mandatory to all; instead the Belgium compliance mechanism leaves the choice of joining a PRO or complying individually with the stakeholder (Cahill, Grimes, & Wilson, 2011).

An interesting study ran by Jacobs and Subramanian (2012) compares several scenarios where responsibility is under one actor (producer) or shared within the supply chain. Also, they cross these factors with other assumptions of a centralized or decentralized supply chain operation that could or could not result in having recycling or recovery actors set as responsible as well and contributing for more social, economic and environmental welfare. Jacobs and Subramanian only fail to exemplify a system where the producer is the only responsible party for financing the system, because as identified previously, most of the EPR programs states more than one stakeholder responsible. Nonetheless, the study concludes that sharing targets of product recovery responsibility potentially reduces the costs of the program and improves social welfare (Jacobs & Subramanian, 2012).

A study has shown that among five European countries (Portugal, France, Germany, UK and Romania), only Germany has 100% of packaging waste management system financed only by the industry (Marques, Ferreira, da Cruz, Pereira, & Simões, 2012). Comparing these countries, Germany has the most established collection and recycling system, mainly related clear

responsibilities among actors and time of implementation. However, a negative side of German system are the "Free riders": Among EPR complying countries, there can be a private actor not paying for their end-of-life management costs. In Germany, for example, that number of the Green Dot system is 23% of the whole amount of waste and the costs are shared between the private companies (Marques et al., 2012).

Those examples and definitions shows that, for packaging waste, the importance of clear responsibility for financing and the physical mechanism to successfulness (Cahill et al., 2011). Further on the discussion chapter, these concepts will be compared with Brazilian Packaging compliance mechanism.

Most of the recent studies found that analysed the problems on responsibility allocation and financial schemes were focused on WEEE (Kalimo, Lifset, Atasu, Van Rossem, & Van Wassenhove, 2015; Lifset, Atasu, & Tojo, 2013; Mayers & Butler, 2013). However, Sinclair and Quinn (2006) looked through cutting edge programs for packaging in several countries and provinces (Germany, Austria, Sweden, Australia, and Canada – provinces of Ontario, Manitoba, Nova Scotia, and British Columbia) and through qualitative and interactive interviews, they pointed out the key success factors for EPR programs. The author organized them in Table 2-3.

Is important to cite that although the physical management suggests only PROs as a successful option, there are other examples where industries contribute directly to the municipality and they manage the packaging waste collection and recovery. Nonetheless, these examples were not cited as a recommendation from the cases studied (Jacobs & Subramanian, 2012).

2.2.3.3 Summary

The table below summarizes the promoting factors of implementing policies and EPR programmes. The reason why the author chose to emphasize in the summary only the promoting factors is because there are no hindering factors related to the concept of installing and EPR programme. There are hindering factors on the implementation (one example are the "free riders") and/or in between each system adopted (single, shared) but in general the adoption of EPR programmes has promoted only advances in waste management, and not the contrary.

Table 2-3 Promoting factors of EPR Programmes

	Promoting
Financial Management	The use of Economic instruments: landfill taxes, landfill bans, user-pay collection systems;
	Integrated and transparent finances based on actual costs according to packaging weight, volume and material type.
Physical Management	PRO or other collective packaging waste management systems.
Institutional Arrangements	Brand/importer responsible for take-back programs;
	Encourage new products and markets for recycled material;
	Single or shared responsibility will depend on implementation and enforcing level;
	Programs are transparent to public accountability, including awareness campaigns, research and development of new packaging and new final treatment of materials.

Source: Author's own, based on sources previously mentioned.

2.2.4 Recycling markets

This section investigates how much of the recycling market prices can influence the recycling programs.

Recycling is one way many governments are using to reduce the use of landfill space and enhancing economic value of materials. Not only that, but to reintroduce materials like paper and cardboard saves new input of wood resources, water consumption and uses less energy when compared to virgin material. From the social and economic side, recycling businesses employ 1.5 million people and turns over 160 billion USD (140 billion EUR) (OECD, 2007; UNEP, UN DESA, & FAO, 2012). If considered the number of informal workers together in the supply chain, which in Latin America are responsible for 90% of all recyclable waste collection and sorting and represents 2% of the population of these countries, the number of workers would rise significantly (Medina 2000; MNCR 2009).

In developing countries recycling is still very incipient, but the amount of recyclable waste in the whole waste generation infers to a promising future: it is expected that from 20% up to 40% of waste can be recycled (Saeed, Hassan, & Mujeebu, 2009; Zurbrügg, 2003).

However, the fluctuation of market prices can threaten the development of municipal programs, especially if the physical management and financial mechanism is based only on the value that the materials have on the market. Not for all materials, but there is evidence that for some it can. That is why successful and steady programs count with policies involving the supply chain, so that volatility of recycling markets will not influence the existence of ongoing programs (OECD, 2007; UNEP, 2015).

2.2.4.1 Factors influencing recycling markets

A study by the OECD (2007) identified that price volatility for recyclable material compared to virgin resources is "generally greater", which for some can be five times greater, resulting in a scenario of uncertainty and undermining feasibility of recycling. Geographic areas and amount of materials put on the market in a certain period of time are factors influencing recycling markets, of which recyclers demand by-products that sometimes are not available or far from their plants. For that reason, local authorities of OECD countries have been investing in making public the buyers and sellers demand, to minimize costs of counter parts to find each other.

Other variables that influence market prices besides virgin materials prices and trade are (OECD, 2007):

- Quality of sorted materials
- Consumer's resistance to recycled content
- Product design, for instance, mixing different types of materials in the same packaging

The OECD (2007) report claims that some materials will always be subject to failures and obstacles. However, it also claims that the market has the capacity to overcome these obstacles by industries standards and integration; and if not, policy intervention would be necessary.

Most of materials prices have been quite unsteady but showing still more advantage for recycled materials than virgin. The plastic market is the one that shows the closest margin from primary to secondary material sources (UNEP, 2015).

The plunge of oil prices

No matter where it is analysed, plastic recycling all over the world has been facing challenges in the past three or four years related to drop down oil prices. Articles about the reality in India, United States and Britain confirm that a few recycling facilities for plastic have been closing their business.

Dharavi, in India, known for being a recycling hub, counts on 1,000 small scale recycling business which employs 10,000 people. The perspectives in a good scenario are that these people work in average 70 hours per week to earn from 100 to 300 USD (87.96 to 263.88 EUR). With plastics prices dropping from 1.45 to 0.71 USD (1.27 to 0.62 EUR) (50%), many of the small companies are closing. Operation costs have also gone up considering work space and electricity (Toloken, 2015).

The British Plastics Federation, in a more alarming note, stated that low oil prices were "uncompetitive" and "threatening not only the viability of businesses but also, potentially, the recycling record of the whole supply chain"(Toloken, 2015*).

Two reviews document a transition about the recycling programs in United States that are also struggling with lower oil prices and that new plastic resin is cheaper than the recycled resin. The article highlights that there has been an expansion in the US on recycling programs, but at same pace more types of plastics to be sorted, especially light weighting containers, which significantly increased operation costs to sell the same amount of plastic (Elstein, 2015; Johnson, 2015).

New York City's program has been able to be maintained because the city has a long-term contract with a private company, even with the company not being able to commercialize rigid plastics that may have been shipped to landfills; however, because contract cannot last more than two years, soon the private company will adapt to market prices (Elstein, 2015). And that could influence the coverage of the city's recycling program.

Newman, the current President of the International Solid Waste Association (ISWA) warns that in United States waste that was destined a year ago to recycling has come back to landfilling due to energy and commodities values. And he goes further with some questions (Newman, 2016a).

> *"Will Governments react with greater subsidies (waste taxes and EPR contributions) to underwrite the lower value of recycled materials? And what is the value today of a circular economy model? Will linear return to fashion? In the USA these questions are finding answers in the closure of recycling plants opened just a few years ago." (Newman, 2016a)*

The main explanation is that China has cooled its markets of all kinds of commodities. Not only plastics, but scrap metals prices have also dropped by 14% and tires and rubbers more than 20% (Elstein, 2015). China accounts for 60% of all global imports of aluminium scrap, 70% of recovered paper and 56% of recycled plastics (UNEP, 2015).

To the other questions, there may be a possible better scenario if several possibilities are combined (See next Section 2.2.4.2).

2.2.4.2 Other possibilities?

Considering such dramatic scenario for the maintenance of recycling business all over the world, what would be the perspectives for the future?

An article that envisioned more than one recycling industry has documented that the sector knows it is not unusual to face times like this and that "they have faced it before". They have also been hopeful with corporate sustainability goals and laws that have been supporting recycled markets. A law in California, for example, requires at least 25% of recycled content in rigid plastic containers (Johnson, 2015).

For India, Dharavi seeks Government subsidies to create a recycling zone in the city to help operational costs: tax breaks and cheaper electricity were cited (Toloken, 2015).

What Governments can do (OECD, 2007; UNEP, 2015):

- Include recyclable materials in their own procurements
- Standardize or publicize the quality of recyclable materials: EU has criteria and protocols for iron, steel and aluminium scrap and preparing for copper scrap, recovered paper, glass cullet and biodegradable waste/compost.
- Well-designed EPR policies with transparent costs of systems that would influence product design
- Inclusion of waste pickers: quality of sorting types of materials is higher
- Reward manufacturers with economic instruments would be one option.
- Market power: introduce a mix of policies that maintain general competition and anti-monopoly.

2.2.4.3 Summary

The table below condenses the main outcomes of the influence that the market can have on recycling programs. It evaluates the recycling market in general and in Section 4 the factors that influence packaging waste management in remote communities will be further analysed and commented.

Table 2-4 Hindering and Promoting factors of recycling markets

	Hindering	Promoting
Financial Management	Volatility of market prices for primary and secondary materials.	Economic instruments to motivate the use of recyclables in the supply chain.
Physical Management	Mixed materials in the same packaging: hard to find markets that would recycle.	Standardize quality of recyclables; Know-how of waste pickers in sorting materials.
Institutional Arrangements	Consumers and market resistance to recycled content.	Motivate recycling materials in public procurements; Mix of policies to maintain general competition and anti-monopoly.

Source: Author's own, based on sources previously mentioned

3 Case study: Tefé, Amazonas state

In this chapter, the case study of Tefé will be presented. Section 3.1 presents the background of political, geographical and environmental characteristics of the case study region. The subsequent sections describe the state of waste management systems in the region of Tefé and present the findings based on interviews, fieldwork observation, current policies and publications found on the Internet.

The data and observation during field research was collected between February, March and April 2016, with onsite visits in Tefé in the month of March 2016. Personal interviews conducted with public sector are described together with other interviews with NGOs, entrepreneurs, specialists, and local researchers.

3.1 Background

3.1.1 Amazonas state

The Amazonas is the biggest Brazilian state, with 18.75% of national territory and 31.27% of Amazon forest. It consists of 62 municipalities with estimated population of 3.5 million inhabitants, with particular increase of population in urban areas. Despite that, it is still the region that has the biggest rural settlements (20%). It is divided into four administrative regions (North, Southwest, Centre, South) and subdivided into 13 micro regions, determined by its rivers: Alto Solimões, Boca do Acre, Coari, Itacoatiara, Japurá, Juruá, Madeira, Manaus, Parintins, Purus, Rio Negro, Rio Preto da Eva e Tefé (Amazonas State Government, 2015).

It holds the biggest freshwater resources in the world and is a biodiversity hotspot. Along with its rivers, communities are placed in distances that can vary from one hour to 78 hours by boat from big centres. Because of Brazil's development, consumption of new goods is available to these communities, leaving a waste trace with no solution implemented than burning, burying or sparse recycling initiatives.

However, because of the National Solid Waste Policy, all the States and Municipalities are required to plan how they are going to manage waste and mandate closure of dumpsites. The strategy must be thoughtful considering the climate and geography of the Amazon and that many families nowadays still live with the waste collection from dumpsites, and closing these places may infer putting waste pickers even more outside of society (PNRS, 2010).

3.1.2 Tefé: Case study

The area chosen as case study comprises the urban and some rural areas of Tefé, the sixth biggest municipality among the 62 municipalities in the Amazon state. It has 62,000 inhabitants, with 88% in the urban area and 12% sparse in the villages, communities and small settlements. The whole municipal area has approximately 24,000 km2 (IBGE, 2016). As a reference, the size of the municipal territory is between the size of Slovenia – 20,000 km2 according to CIA (2016) – and Macedonia - 25,000 km2 (CIA, 2016) – or twice the size of Scania, the southern province in Sweden.

It is located in the middle of the Amazon State and also middle of the Solimões River, the reason why the place is called "Medium Solimões". It is 633 km away from Manaus, the capital of the Amazonas state. To reach the area, there are mainly three options: one hour flight from Manaus; 12 hours in a speed boat or 36 hours in a slower boat. There are no roads connection between Manaus or other cities in the Amazon area to Tefé.

Economic activities of the urban area of Tefé are related to public services (employment in the public sector, such as Military, University, Justice, etc.), fishery and wood sector (Silva & Pinheiro, 2010).

Figure 3-1 The state of Amazonas surrounded by other Brazilian states and other countries. In highlight is the area of Tefé (urban and rural areas).

Source: IBGE (2016).

As can be seen at the map (Figure 3-1), Tefé comprises land and waterway areas, at which the municipality has the responsibility to provide public services like health, education, waste management, among others. Because it is in a floodplain area, Tefé landscape changes twice a year, depending on precipitation level: the river height fluctuation can vary up to 40 meters (Ayres, 2006) That means that in dry season, it is possible to reach areas by foot and automobile, known as terra firme areas (mainland). On flood season, these areas can only be reached by boats, known as várzea (lowland), that remains flooded for almost half a year(Bernardes & Günther, 2014). In addition, even if there was infrastructure to build roads that connects one municipality to another or even the small villages, the soil characteristic is muddy and soft. Another challenge to create transportation systems in the area.

Rivers in the Amazon area carry out sediments that reach the ocean, presenting an enormous threat to biodiversity when waste management is not done properly: there are remote communities living in waterways that do not have access to collection or other solution, therefore, they throw the packaging waste directly to Tefé River.

Inside the area of Tefé, there are a few conservation units controlled by ICMBio, the federal agency connected to the Ministry of Environment. The biggest is the National Forest of Tefé

(here called FLONA). In the FLONA, there are 100 communities placed sparsely (55 in the Tefé municipality area and 45 in Alvarães area), which represents 1115 families.

Because these rural communities are placed in rural and remote areas from the centre of Tefé's municipality (Vila Moura, for example, can take up to 72 hours to be reached), they rely on a network of leaders to represent their interest. The agenda is mainly related to social benefits, agriculture production and dialogues about communitarian tourism, topic still being evaluated and constructed by the communities.

3.2 Waste characteristics

3.2.1 Amazonas

A report from the ABRELPE, the Brazilian Association of Urban Cleansing and Waste, revealed that while the Brazilian municipal waste generation in 2014 was an average of 1 kg per capita, the Amazonas state accounted approximately the same amount (ABRELPE, 2014). It is surprising because the Amazonas lacks infrastructure and still is one of the least developed states in terms of access and economy. However, it is generating approximately the same amount as average Brazilian people.

The collection in the State appears to be 0.936 kg per capita, which is a very high number (87.4% of what is generated) considering the challenges the municipalities face to perform waste collection in their territorial areas.

Related to disposal, the Amazonas state claims to have one sanitary landfill in Manaus, that represents 55% of final disposal to the whole waste generated in the state, while 23.8% goes to controlled landfills and 21.2% ends up in dumpsites (ABRELPE, 2014). The author believes that there are more waste going to dumpsites considering the findings in Tefé (which states that has a controlled landfill but it is actually a dumpsite, as will be described).

3.2.2 Tefé's urban area

A study carried out in 2010 estimated that the average waste generation in Tefé is 1.3 kg per capita per day (Silva & Pinheiro, 2010) while other estimated more than 2 kg per capita per day (Guimarães & Bernhard, 2015). The Environment Secretary estimates that Tefé produces more than 30 tons of solid waste per day (I. Lins; personal communication, March 9, 2016; F. Pinheiro, personal communication, March 9, 2016) and Silva and Pinheiro (2010) estimated 20 tons per day in 2010. The big discrepancy of these data testifies the lack of monitoring: the present data from the municipality is an estimation done per bag of waste generated and there is no scale at the dumpsite or on the trucks. Guimarães and Bernhard (2015) notes a possible bias related to the streets that were sampled (half of the streets of Tefé), which is not representative of social and economic level of the dwellers, and the possibility of people retaining more waste at home on the researched days than normally.

To have accurate data on waste generation is important for two main reasons: first to be able to build a waste management plan accordingly to what the area produces; secondly because without a plan, the municipality cannot access federal funds to implement the plan.

Guimarães and Bernhard (2015) carried out a picking analysis that examined the types of waste generated in the urban area of Tefé. Table 3-1 describes the result.

Table 3-1 Waste Characteristics and composition of urban Tefé

Category	Percentages
Organic waste	18.7%
Paper and Cardboard	13%
Plastics	10%
Glass	9%
Metals non "iron"	2.7%
"Iron" Metals	2.2%
Other materials*	44.4%

*Rock, clay, ceramics, wood, cloths, leader, rubber, biological and chemical contaminants and others.

Source: Adapted from Guimarães and Bernhard (2015).

From this specific study, it is not possible to infer what are the percentages related only to packaging waste, however, summing paper and cardboard, plastics, glass and metals, it is possible to conclude that, theoretically, 36.9% of all waste produced in the urban area of Tefé could have a recycled end of life.

3.2.3 Tefé's rural area

Because this research did not conduct a gravimetric analysis on the waste generation in the communities visited, the parameter for analysis will be a study carried out by Bernardes and Günther (2014). Their publication investigated the quantity and composition of household waste in an area in the Amazon with conditions very similar or the same as Tefé rural areas. The study observed:

- Reserva Extrativista do Médio Juruá (RESEX), a federal conservation unit with estimated population of 1152 distributed among 12 communities;
- and Reserva de Desenvolvimento Sustentável–Uacari (RDS), state conservation unit with an estimated population of 1,117 distributed among 24 communities.

Some of these communities are in *terra firme* (mainland) and others in *várzea* (lowland), which can be flooded half a year. Their access to next municipality is only possible via Juruá River and can take from 8 to 56 h.

The highlights of the data collection are:

- 0.5 kg of waste per capita per day
- 90% of all waste is organic, and is used for animal feed or composted
- Inorganic waste represents 10%, as it is divided in: 46% of plastics, 12% paper, 29% metal and 13% of batteries and lamps. The inorganic waste is burned or dumped somewhere.

Surprisingly, the study does not mention anything about glass.

3.2.3.1 Consumption habits and logistics

The urban area of Tefé has an intense trade and commerce centre. It is possible to find products of all kinds, from groceries to electroeletronics and automobiles. These products come by ferries from Manaus or in smaller boats, by request.

At the communities visited that can only be reached by waterway, the habit is to go to Tefé centre every two or three months to purchase goods for the family and a few neighbours. It is not yet normal to have a refrigerator in all households (besides most of the communities have already access to electric generator), so the shopping list is restricted to products that can last the warm climate without conservation.

In bigger communities, with more than 20 families approximately, it is normal to have a trader that has stock of common goods like rice, sugar, soft drinks, soap, alcohol, gasoline, etc. Therefore, in case of urgent need, the community has access to these industrialized products by a higher price.

This was observed in communities from one to two hours away from Tefé centre; however, because there are communities far up to 78 hours also depending on the supply from Tefé and surrounding communities, the dynamic and prices can be different. This is the case of Vila Moura, for example, the community furthest from the urban centre in the FLONA area, and the dwellers go to the urban area less frequently due to time and logistics costs.

The families interviewed at the communities in the FLONA reaffirmed that there is a change on consumption habits: the main diet used to be fish, fruits and cassava, but nowadays it is normal, when possible to afford, to have chicken, sausages, apples and sodas (cited brands were guaraná Bare, Real and Fanta Uva). On average a family has four members consumes four sodas of 2 litres per week. Other industrial goods observed in these people's homes that generate packaging waste were: powder juices, butter, milk, cookies, margarine, coffee, cream milk, tomato sauces, coconut milk, mayonnaise, wheat flour, rice, beans, pasta, detergent, disinfectant, washing soap, softener, soap, bleaching, deodorant, shampoo, conditioner and other hair creams, perfumes. Mr. Costa, the President of Bom Jesus Community, states that nowadays the packaging has changed from glass to plastics. (F. Falcão, personal communications, March 20, 2016; J. Costa, personal communications, March 20, 2016; E. Lopes, personal communications, March 20, 2016; N. Santos, personal communications, March 20, 2016; J. Sousa, personal communications, March 20, 2016)

One opportunity pointed by the Environment Secretary regarding the traffic of products, is that there are many ferries from the Amazonas State that travels the Solimões River to deliver school food. And these ferries they go back to Manaus empty. She points out that it could be negotiated with the state to use the space to carry packaging waste when returning to Manaus.

3.3 Collection, disposal and monitoring

3.3.1 Urban area

The waste management of Tefé is fully paid by the municipality and collection should cover the entire city area. Silva and Pinheiro (2010) observed that some neighbourhoods did not have systematic collection: out of the 21 neighbourhoods in the urban area of Tefé, 8 did not have proper collection.

When asked about the collection routine of the trucks, the Secretary had difficulty to describe, which meant that there is not a precise schedule followed by the hired operator. Citizens are satisfied with the collection in some neighbourhoods whose waste collection happen daily but in other neighbourhoods the waste collection is unlikely to take place or in a very irregular calendar. Especially for the houses built on the river margins, where the trucks are not able to reach, there is no collection service or point of disposal (such as: containers). The solution found by the dwellers of this region is to dispose the waste directly at the river. The waste

floats and easily sinks or is carried away with the river seasonality. (See Appendix I for photo of Igarapé Xidarini)

Throughout the urban area there are a lot of "vicious points" of incorrect disposal, places where the citizens dump waste very frequently. To those the municipality pays more attention to.

What the municipality roughly monitors is the number of trucks that arrives to the final disposal, mainly to control fuel expenses. There are approximately 700 trips per month being done when the present research is conducted. The trucks transport exposed and mixed waste: household, industrial, commercial, gardening, hospital, hazardous waste, etc. Therefore, it is not possible so far to verify the amounts of each type of waste because there is no weighing monitoring.

Regarding the trucks, a new solution must be considered because the structure of some streets do not allow heavier trucks that could compact the waste, and therefore, carry more weight per trip (Silva & Pinheiro, 2010).

The collected waste is disposed at a "controlled landfill" (not safe enough for sanitary parameters). Despite what the municipality and previous literature mention, the research observation would consider the area where the waste is disposed as a dumpsite. Due to the facts that there is no control of the amounts and places where the waste is being disposed, it cannot be called a "controlled landfill" (See Section 2.1.3). The only thing that the Environment Secretary guarantees is that there is material distribution. In addition, there are waste pickers living close to the area and collecting recyclables as source of income ((I. Lins; personal communication, March 9, 2016; F. Pinheiro, personal communication, March 9, 2016).

Silva and Pinheiro (2010) cites that there is a waste pickers association that collects informally in the streets of Tefé and receives support from municipality. Nonetheless, the author does not name what kind of support (infrastructure, payment for environmental services, etc. (Silva & Pinheiro, 2010). During fieldwork and interviews, these concrete forms of support could not be confirmed. The people that live in the dumpsite area, named to be six to eight people, are not included within the municipality routine or support. However, they do sell packaging waste collected at the dumpsite and sell to the main buyers of the urban area of Tefé (I. Lins; personal communication, March 9, 2016; F. Pinheiro, personal communication, March 9, 2016).

Lastly, it is important that the municipality had the actual and accurate numbers about waste generation and characteristics to be able to perform a Waste Management Plan. According to Federal Guidelines, only with an Integrated Solid Waste Management Plan the municipality would be able to access federal funds to install a sanitary landfill, for example, and other investments in the area.

3.3.2 Rural and remote areas

The Environmental Secretary does not have the data of how many families live in each area or the communities and how often the collection trucks go in each area. It is possible to infer, according to the interviewees, that there is no collection at all in rural areas or just the closer areas to the city centre.

The communities visited by this research were: Agrovila, land based community, reached by road; and the rest were communities that could only be reached by boat, approximately one

hour from Tefé urban area: Bom Jesus, Vila Sião and Vila São Francisco (See Figures Figure 3-2).

For all the visited communities, the waste management functions the same way: organic waste goes to animals and the rest is burned behind their houses. The community does not concentrate the burning at one place and also they burn at different times. Air pollution is pointed as a problem, because the smoke can last up to 6 hours (N. Santos, personal communication, March 20, 2016).

The communities visited by boat are placed in a Conservation area, in the FLONA of Tefé: Mr. Falcão, who is the leader responsible for all the 100 communities in the national forest area confirms that the main practice is to use organic waste to animal feed, burn the rest and sell the aluminium cans to intermediaries in the communities. They gather the materials and sells approximately in every three months to the buyers in Tefé (see Table 3-2). In the past there had been also commercialization for PET and glass bottles, however, Mr. Falcão believes that the price was too low to be economically viable.
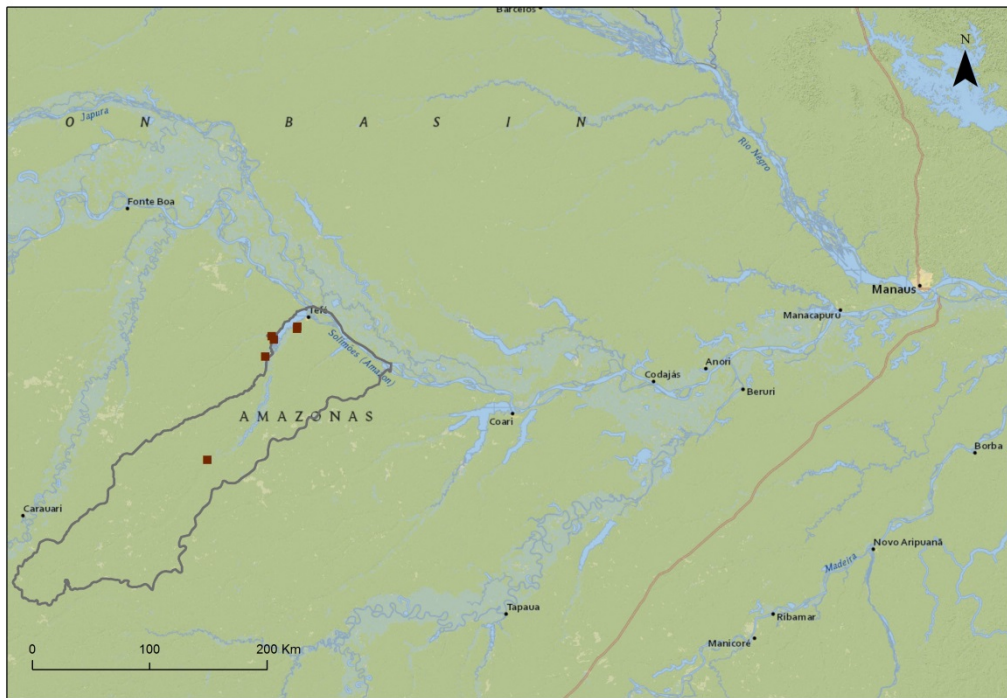
Figure 3-2 Map of cities along the river Solimões, the capital Manaus and highlighted is the territory of Tefé. The squares represent the communities visited. The farthest is Vila Moura, on the left corner, which can be up to 72h away from Tefé urban areas. Vila Moura was not visited.

Source: Author's own based on ICMBio data.

ICMBio, the federal agency responsible for conservation units' management remarks that in most of the remote communities the waste is being burned and only what cannot be burned is buried, as an example, metals. The PET bottles, however, are being collected to use as containers for the local production (usually cassava flour or forest fruits) and fuel and the owners are used to leave PET bottles as spare tanks in the boats) (I. Debien, personal communication, March 11, 2016).

Vultures, dogs and cats

The location of the dumpsite is in the middle of airplanes routes and vultures represent risks to safety. The Environment Secretary estimated that there were 4,000 vultures in the past but now seems that the population has risen to 10,000.

The Ministry of Justice has already notified the city and closed the airport temporarily, and demanded that new sites for landfilling would be identified and implemented (Silva & Pinheiro, 2010). It does represent a high risk of accidents since the dumpsite is 1.8 km from the threshold of the runway and having the airport and pressure from the Ministry of Justice to improve conditions can be a good factor to find other solutions to waste management as a whole.

The city also struggles with an enormous population of dogs and cats: 5,000 and 3,200 respectively. The animals open the bags left for the collection service and waste is spread all around the city. The only positive side of these populations is that they are also performing an ecosystem service, while the vultures eat faeces of dogs and cats and all of them eat food waste left behind by the collection.

Environmental Education

Mr. Alves is the coordinator responsible for the environmental education in the Municipal Secretary, among other roles. The main effort that he reports has been to create awareness to the pharmacies and the need to take back the medications. Besides that, Mr. Alves has been talking to boats staff, regarding throwing waste to the rivers and claims a big effort has been done to create awareness to the commercial establishments in the city. When asked about what the agenda is or what has been the outcome of the effort, both of the actions turned out to be anedoctical and have no written or other instrument of monitoring the actions (F. Pinheiro, personal communication, March 11, 2016; S. Alves, personal communication, March 11, 2016).

Waste Culture

There is a cultural acceptability to dispose waste by the houses front door, streets, by the river, at the "vicious points". However, at the same time, vicious points are a result of the lack of management and patience, when the normative behaviour is not to store waste at their homes and wait for the day of collection, even when the collection exists.

3.4 Governance and Policies

This section will outline the PNRS, which is the main legislation regarding packaging waste, other regional and local policies taking place and their current implementation. Stakeholders from government, private sector and specialists in the area of waste management were interviewed and provided substantial knowledge to understand current scenario in Brazil and especially in Tefé. The content starts from federal level up to municipal level.

3.4.1 Federal level

Coming back to the National Solid Waste Policy and the Packaging Sectorial Agreements, law and grey literature were reviewed with contribution of specialists, policy makers and private sector.

3.4.1.1 Packaging waste sectorial agreement

The Packaging Agreement is a binding contract concluded between the Ministry of the Environment of Brazil and more than a hundred associations and companies, known as the Coalition (Coalizão) in order to comply with the PNRS. Other organisations such as Cempre, a non-profit organisation that since 1992 has been working to promote recycling in the country, funded by the private sector is also included in the contract. Cempre is the organisation that facilitates the communication between the Environment Ministry and the Coalition.

The Agreement is valid under the whole Brazilian territory and aims to comply with the Article 3, XII of the PNRS related to Reverse Logistics or Reverse Logistics Systems:

> *"instrument of social and economic development characterised by a set of actions, procedures and means to enable the collection and recovery of solid waste to the private sector, for reuse in its cycle or other productive cycles, or other disposal environmentally appropriate"*
> *(PNRS, 2010)*

The activities are divided into two phases. Phase 1 covers the first 24 months from the signature date (November 2015), therefore, until November of 2017; and Phase 2 starts after that and has yet no other next definition or phase. As already done in other section of this thesis, the details on the main aspects of the agreements for Phase 1 will be divided into Physical, Financial and institutional agreements areas.

Physical Management

The Coalition agrees to triplicate partnerships with waste pickers organisations (cooperatives) and also triplicate the number of collection points (called Voluntary points of disposal, only for recyclable material) in the 12 metropolitan areas of the cities that hosted the 2014 World Cup (Belo Horizonte, Brasília, Cuiabá, Curitiba, Fortaleza, Manaus, Natal, Porto Alegre, Recife, Rio de Janeiro, Salvador e São Paulo).

The partnership of the private sector and cooperatives intends to improve the conditions, productivity and knowhow of workers by acquisition of equipment, technical trainings, and business orientations.

The packaging waste collected at the collection points or other source of collection will, at first, be transported by waste pickers cooperatives or recyclers. The responsible for the transportation will be nominated for every point of collection.

Financial Management

In order to achieve the targets, the Coalition compromise to invest on waste pickers cooperatives to improve infrastructure and knowhow. These investments can be directly made (Company-Cooperative) and a part of it should be used to technical training. The document mentions that investments are "one form of remuneration on the amount of recovered packaging and labor offered by these entities in order to achieve the goals set forth in this agreement sector" (ASISLREG, 2015).

The agreement also highlights that the private companies will not be financially responsible for the activity costs of MSWM, but that can be agreed if both parties feel inclined.

Governance costs will be shared equally between the Coalition members and the implementation costs will be divided according to market share.

Institutional arrangements

Besides what has been mentioned previously, the upcoming commitments and targets for the packaging sector agreement are:

Commitments

- Implement monitoring system of quantities of packaging put into the internal market and quantities recovered by reverse logistic systems
- Deliver first performance report after 14 months of the signature
- Create a technical committee, responsible for improvements of the system, directives, annual reports, etc.
- 90 days after Phase 1 ends, the Coalition will have to present implementation plan to the Environment Ministry, in which the targets will be renegotiated.
- Federal Government is obliged to monitor the effectiveness of the reverse logistics system in place; publish the performance results at the National Information system; collaborate with disclosure of this Sectoral Agreement programs.
- Penalties: In case of non-compliance with the targets, the members will be subjected by penalties under national legislations (not only PNRS).

Targets

- 22% packaging waste reduction at landfills of the 12 metropolitan cities areas, by 2018 (or 20% recovery rate)
- Triplicate waste pickers cooperatives partnerships and offer of points of collection
- Within 36 months from the start of the agreement, the monitoring system will have to account for at least 50% of the weight volume what has been collected by the members of the agreement and the whole weight volume put on the market
- The agreement also stated that the targets can be revisited if verified the impossibility to reach them and if the achievement of other structuring targets is proven.

3.4.1.2 Future plans for packaging waste sector

Private sector, consultants and NGOs interviewed revealed that there are no plans for other regions in the Amazonas state besides the capital Manaus. They all recognize the relevance and challenge to implement collection, sorting and recycling in the area but right now all the efforts are focused to fulfil the developed agreement for the 12 cities under the Packaging Sectorial Agreement (J. Taguti; personal communication, March 20, 2016; L. Silva; personal communication, March 20, 2016; M. Mendonça, personal communication, April 1, 2016).

3.4.2 Amazonas State level

The Amazonas Labour Secretary has a project together with MNCR (National Waste pickers' movement), Federal and State universities to update and diagnose the work of informal waste pickers at dumpsites and around the state's cities. According to Mrs. Borges, the work will be the basis to benefit the network of waste pickers in the state regarding:

- Technical capacity building, cooperativism, entrepreneurship;

- Equipment acquisition: 15 "kits" (press, vehicles, individual protection equipment, etc.);
- Creation of a Centre in Manaus: usually called as a Second Level cooperative, it stocks the materials from other cooperatives around the state to raise price according to volume and market fluctuation;
- Congresses and meetings, books and other investments to expand knowledge about recycling in the region.

At the time of the interview the project had not started because it faced several adaptations and procurement issues but the waste pickers associations are anxious to see the results and receive the promised equipment to enhance productivity, and, therefore, their income.

Also, one of the reasons why the Labour Secretary project has not started yet is because it overlaps with the Environment state diagnosis project and they had to re-plan the scope. There is already a document that mapped waste management situation in all 62 municipalities of the state, however, the Environment State Secretary, Mr. Stroski, said that the work is inconsistent and that is why there is a need to oversee the reality again (A. Storski, personal communication, March 3, 2016).

One big challenge that the Secretary has mentioned is that waste management is not one of the priorities right now, although the PNRS is in force. He highlights that the Environmental Secretary has issues with deforestation, indigenous lands, industrialization and other matters that gain more attention to the environmental situation in the Amazon (A. Storski, personal communication, March 3, 2016).

Nonetheless, the state is planning to build its own Waste Management Policy that would complement the PNRS with local realities such as distances, transportation and responsibilities of stakeholders. How to finance the logistics and final disposal (landfill and recycling) are some of the challenges. Storski emphasizes that "doing the reverse logistic of materials will be more expensive than anywhere else in the country".

Mr. Storski remarks that the responsibility of fulfilling the National Law is entirely on the municipalities' hands and currently they have not presented basic information regarding the waste management reality in their areas, such as amount of waste generated, treatment, final disposal and selective collection (A. Storski, personal communication, March 3, 2016).

Besides organizing a Waste Management Policy for the Amazon State, the Secretary mentions that they will request the private sector to comply with goals and facilitate programs that can bring more knowledge and solutions to the municipalities (A. Storski, personal communication, March 3, 2016). That can sound promising but also important to mention that in the whole Amazon area, the Amazon State is the only state that has not approved a State Policy regarding waste management.

3.4.2.1 The State Plan

Recently released (2015), the Amazonas State Plan of Solid Waste comprises 730 pages of diagnosis for the municipalities containing waste samples, demographics, geographic measures, costs for each type of waste, economic activities, industries in place, etc. It is, by far, the most important document of secondary data for this research because it contains statistical value and was formed by the hands and with consultation of main stakeholders: Universities, Environmental Agencies, NGOs and Civil society seem to have been deeply involved to construct the diagnosis (Amazonas State Government, 2015).

Amazon is the last state in sanitation and still holds health issues because of water quality and open dumping or burning waste. Only three municipalities have controlled landfill, and only Manaus has sanitary landfill. That is mainly because population among main cities is sparse and investments are insufficient to justify sanitary landfill in low population areas. Manaus, Coari, Itacotiara, Manacapuru, Parintins, Tabatinga and Tefé would fit into sanitary landfill requirements and the need is funding these projects and the outcomes for improvements of waste management in these regions (Castro, 2012). However, none of the municipalities have plans or date to build a sanitary landfill (Prestes, 2015).

The analysis also points out that the collection costs cannot be assured only by taxes collection and financial participation of private companies would be fundamental to close the loop, including the possibility of paying for the reverse logistics with credits promoted by the amounts of recycling (Amazonas State Government, 2015)

From all the cities that were analysed, 41% of all waste is recyclables and the share and amounts are increasing. That number already meets the national mean for organic and recyclable materials from households, however, the number of recycling programs and initiatives are still incipient to address the problem: only four out of 62 municipalities have recycling initiatives) (Amazonas State Government, 2015).

Besides the document is called "State Plan" and is supported by a website to show transparency, it does not include an actual plan with calendar or with financing options to build sanitary landfills and recycling programs. It lacks the input of the sectorial agreement investment to waste management in the packaging area and calculations of cost effectiveness of waste transportation to recycling facilities, which is also not fully mapped (Amazonas State Government, 2015).

3.4.3 Tefé, municipality level

The subject of waste management is under the Environmental Secretary of the municipality of Tefé. The Secretary has mainly three employees: the Secretary, two coordinators and other employees that are out in the fieldwork managing the dumpsite and trucks. The author interviewed them to understand how well the employees are familiar with the National Waste Management Policy (PNRS), what has been done to implement it and collect data regarding the reality of waste management in Tefé.

When asked about how much they know about the PNRS, the Secretary and the Coordinator reported that they know very little and the country should have a policy to Reverse Logistics. That statement by its own shows that the employees are not familiar with the National law, because the law clearly states and defines reverse logistics. However, they are familiar with the municipal law 050/2013 regarding what establishments can and cannot do and penalties, but still have not managed to comply with the law and previous laws of sanitation (I. Lins; personal communication, March 9, 2016; F. Pinheiro, personal communication, March 9, 2016).

Regarding plans for the future, they verified that Tefé has delivered a Waste Management Plan to the Federal level (it is a requirement of the PNRS), however, other sources refute that this plan was copied to every municipality of the state and does not match each area's reality (R. Rossato, personal communication, March 17, 2016). A stated reason for this is that there is an ongoing project for diagnosis the waste in Tefé to be delivered in 2016, as well as for other Amazonas cities. It is not certain that this project is the same mentioned by the Environment State Secretary or if it is another contract (I. Lins; personal communication, March 9, 2016; F.

Pinheiro, personal communication, March 9, 2016). Nonetheless, the plan was analysed and highlights are stated in Section 3.4.3.1.

The city has an Environmental City Council formed by 12 entities: governmental, non-governmental, civil society. The monthly agenda is to follow up on urgent demands, collaboration in shared projects with other Councils and follow up on the Environment Secretary's work.

Besides the lack of knowledge shown by the city's employees, there are other two challenges stated by the interviewees: financial input to the waste management area and management continuity inside the secretary (I. Lins; personal communication, March 9, 2016; F. Pinheiro, personal communication, March 9, 2016).

Discontinuity of management is a problem inside of the whole Brazilian political system. The people working in the public sector in Brazil can be voted, state employed (which needs to go through an intense and competitive exams and procurement) or directly hired. In Tefé's reality, the City's Environment Secretary and the rest of employees were directly named by the Mayor, therefore, if the former Mayor was evicted (mainly because of corruption), the new Mayor can bring his own staff. It is common to hear that when this happens, the former staff deletes files and history, leaving the new team with a page blank and no previous data to plan their own department.

That has happened to Tefé's Environment Secretary: The mayor voted for the period of 2013-2016 was impeached and another one took place in 2014-2015. When that happened, all the staff was substituted and, as previously mentioned, no history of the work has been left behind (G. Freire, personal communication, March 10, 2016).

Mrs. Lins and Mr. Pinheiro emphasize that waste management nowadays is a mere continuation of what has been done in the past: the collection contract is the same but will go to a procurement process in 2016, which has already started. One challenge stated by the Secretary is that there are not enough players to compete in the procurement. The present contract has several problems: object of contract lacks clarity; measurement for what is being paid (is collected weight the unit or km spent?), basic rules for employees' health security and protection during labour, monitoring how the contracted company is performing their work. Also, it does not include the sweepers, which are freelancers being paid with checks directly from the municipality (I. Lins; personal communication, March 9, 2016; F. Pinheiro, personal communication, March 9, 2016).

In addition, as mentioned under the section "Collection" (Section 3.3), the Secretary is trying to reunite waste generation data to produce a more accurate waste management plan.

3.4.3.1 The Municipal Solid Waste Management Plan

As previously said, the document appears to have been adapted to every municipality of the state just changing a few informations. That is not intrinsically bad considering that most municipalities have the same waste management challenges and context. The problem is that the plan was built with no perspective of being put into practice.

Geographical context, population, waste generation and collection present the same data as this research found. The plan considers most of "good practices" guidelines, as for example, reducing amounts of waste, starting a waste separation and recycling, inclusion of waste pickers, among others.

Besides the main solid waste federal law (PNRS, 2010) the document outlines other 116 policies related to solid waste management and sanitation. That shows that the legal framework has been built, but it has "not left the paper", meaning, being implemented or being enforced (Associação Amazonense de Municípios & Amazonas State, 2012).

Regarding specifically packaging waste, the plan demands that from August 2013 on establishments that commercialize products under the "reverse logistics" legislation will have to promote actions to its collection, devolution to its producers and feedback the municipality about what and how it has been done (Associação Amazonense de Municípios & Amazonas State, 2012).

The municipality of Tefé would be responsible to promote environmental education to citizens regarding sorting, storing and disposal of different types of waste, under the possibility of being penalized (Associação Amazonense de Municípios & Amazonas State, 2012).

The document ends with cost estimates for the implementation of an integrated waste management plan, installation of facilities (sanitary landfill and sorting/recycling centre), and remediation of the environmental impacts of the dumpsite, among others. The initial investment is around 4 million BRL (~1 million EUR).

Enforcement

The Environmental Secretary is responsible for monitoring and fining eventual environmental crimes under Law 050/2013 and ICMBio can also enforce crimes that affect the Conservation Units. However, in the municipality case, although several actors have been notified, the municipality has not started to fine because there is a barrier regarding the Environmental Fund where the money of the fine should go to. The subject has been followed up in the Council agenda but no success to create that fund so far. Therefore, the Environmental Secretary is not able to fine the environmental crimes (not only mismanagement of waste, but also commercialization of protected species, etc.) (R. Rossato, personal communication, March 17, 2016).

3.5 Mapped Recycling in the region

As previously mentioned, considering packaging waste, the region recycles only aluminium cans. Among non-packaging waste scrap metals, batteries (mainly from automobiles), copper recycling of these materials raise the value for logistics viability. According to interviewees, there had been initiatives in the past that collected and recycled also cardboard, glass and plastic (mainly PET bottles). The values by that time were approximately: 0.15 BRL (0.03 EUR)[2] per kilo for cardboard and 0.75 BRL (0.18 EUR) per kilo for PET bottles. However, in addition to when that happened, there used to have some support from the municipality, army or with the boat owners (J. Pinheiro, personal communication, March 22, 2016; R. Souza, personal communication; March 29, 2016; G. Pires, personal communication; March 29, 2016).

All the interviewees mention that other materials such as plastics, iron, paper and cardboard are not economically viable to collect and sell. "If there was a cooperative that could work with the mix of the products, then it could be more viable", says Mr. Pires, the biggest recycler in the region.

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[2] Source for conversion of currencies: https://www.oanda.com/currency/converter/

For future parameters, conversion made in June 5, 2016; 1 EUR = 4 BRL.

In the urban area, all the players that commercialize recyclable materials claim that the municipality employees are already doing the sorting of material and selling to them. These are the 300 sweepers that are hired by the Environmental Secretary that works as freelancers and also called as waste pickers by some of the citizens. They collect aluminium cans and other valuable materials and sell to the main three players in Tefé (J. Pinheiro, personal communication, March 22, 2016; R. Souza, personal communication; March 29, 2016; G. Pires, personal communication; March 29, 2016). This fact can be confirmed when observing the dumpsite situation, where aluminium cans are seldom to be found. In addition, bars and commercial places also sort and sell materials to these three buyers, leaving no aluminium can behind to be landfilled, burned or thrown at the river.

Out of the urban area, or communities that can be reached by roads, the recycling network is strong and can bring aluminium cans from distances up to five days by boat transportation (in the case of Juruá). There are three intermediaries people/business commercializing recyclable materials in the city of Tefé and other players mapped in the rural regions (see Table 3-2).

From the interviews and observation, it is possible to conclude that the social network to bring aluminium to a recycling end is strong and working well, even from places 700 km to Tefé centre, there are intermediate buyers that will in the end sell to one of the three buyers in urban Tefé.

Table 3-2 Recycling business or actors in urban and rural Tefé

Location	Person/Business	Materials	Buys at	Quantity per month	Price/kg in BRL	Price/kg in EUR	Press?
Urban area	Point da Sucata (Mr. Pires)	Aluminium cans, scrap metals, coper, batteries	In Tefé but material arrives from the region. Has partnerships with communities up until Maraã, Juruá	16.6 tons of cans	Buys at 2.80 to 3.00 BRL and sells to Cometais in Manaus	Buys at 0.69 to 0.74 EUR	Yes, subsidized by buyer from Manaus
	João Batista dos Santos Pinheiro			5.2 tons (only cans), 292 bags of unpressed cans and pays 1,100 BRL (273.8 EUR) to transport	Buys at 2.30-2.40 BRL up to 2.80 Sells to Cometais in Manaus 3.50 BRL	Buys at 0.592-0.597 up to 0.69 EUR. Sells at 0.87	Does not have press
	Rei da Sucata (Mr. Souza)			1.33 ton (only cans)	Buys at 2.00-2.10 BRL range and sells for 2.80 BRL for an intermediary in Manaus	Buys at 0.49-0.52 EUR range and sells for 0.69 EUR for an intermediary in Manaus	Plans to have but will depend on Manaus' owners of the business
Rural	Claudemir de	Aluminiu	São	Not	Buys at	Buys at	

area (remote communities)	Olviera Salles	m cans	Francisco	accounted	range 1.80-2.00 BRL Sells for 2.20 BRL to Mr. Pinheiro	range 0.44-0.49 EUR Sells for 0.54 EUR to Mr. Pinheiro	
	Manoel Rocha Lopes	Aluminium cans and coper	São Francisco	105 kg/month	2.20 BRL pressed by hand 2.00 unpressed Sells to Mr. Pires	0.54 EUR pressed by hand 0.49 unpressed Sells to Mr. Pires	

Source: Author's own based on Personal Communication with Mr. Pires, Mr. Pinheiro, Mr. Souza, Mr. Salles and Mr. Lopes during March, 2016.

As most of the mapped recycling chain is informal, when asked about invoices, Mr. Pinheiro clarifies that he sells the materials to Manaus with an invoice (which indicates taxation and a formal company known by the Government). To buy the materials from the intermediaries throughout the region, he would only consider an invoice if the partners that asks for it (J. Pinheiro, personal communication; March 22, 2016).

At the time of the interview, Mr. Pinheiro paid the transport per bag, and not per weight. "Having a press would save space"; therefore, price per bag transported would drop dramatically. On another scheme, Mr. Souza from "Rei da Sucata" pays per weight: 200 BRL (49.79 EUR) per ton. Yet Mr. Pires only commercializes his materials already pressed into bales and sells to Cometais in Manaus on ferries. Because he sells the material in "blocks" (bales), he has an advantage on budget logistics: while other players would pay per bag, he gathers 3 bags into one bale.

3.5.1 Financial benefits from Recycling packaging Waste

Guimarães and Bernhard (2015) estimated that 27% of all waste generated in Tefé (household and commercial establishments) can be commercialized and would generate a revenue of 117,510 BRL to 255,150 BRL (29,257 to 63,525 EUR). They consider that the revenue could be a good source to subsidize a creation of Waste pickers cooperative to sort and commercialize the recyclable materials and the logistics until Manaus.

Unfortunately, the possibility of commercializing plastics and paper were not confirmed when this research interviewed the same players in Tefé. That may be because market prices have fluctuated from 2010 to 2016 and/or because potential support for the logistics, as mentioned above, was discontinued.

3.6 Recycling markets in the Amazonas State

According to the consultant of INSEA (Institute Nenuca of Sustainable Development) in Manaus, Marcela Vieira, and also observed during this research fieldwork, all the packaging waste flows from Tefé end in Manaus. Not only Tefé, but other cities within the state send their materials to Manaus. From there intermediate buyers benefit and sell the products along the chain.

In Manaus, there are three recyclers for paper and cardboard, plastics (60 types can be recycled at this industry) and batteries. Besides that, there are 19 intermediate buyers listed for

the rest of the materials that are usually sent to the Southeast of Brazil. The only material that has no market player in the whole region is glass (Cempre, 2016).

The North region of Brazil, when compared to others, has tremendously less recycling industries in place. It is accounted to have just 26 recycling industries for the whole seven states that compose the North region, in contrast to 540 only in the state of São Paulo, Southeast of the country. Table 3-3 presents the number of recycling industries in each Northern state.

Table 3-3 Number of recycling industries and types of materials in each state of the North of Brazil

States from the North region of Brazil	Number of recycling Industries	Materials
Acre	0	Packaging waste: Paper, cardboard, plastics, metals Other: rubber, batteries, electronic waste, lamps, wood, etc.
Amapá	0	
Amazonas	4	
Pará	10	
Rondônia	10	
Roraima	0	
Tocantins	2	

Source: Website database from Cempre (2016).

Mr. Vilhena, the director of CEMPRE (Business Commitment for Recycling), believes that there should be more public policies to bring investors to the region. (D24AM, 2013) At same pace, Mr. Mendonça, specialist in waste management and recycling, believes that Brazil should invest in a strategic plan so that the recycling industries are allocated in each region, so that the recycled materials can be also commercialized closely (M. Mendonça, Personal Communication, April 1, 2016).

3.7 Summary of the case study findings

The table below condenses the outcomes verified through literature review, grey materials, personal communication, legislation that influences packaging waste management in urban and rural areas of Tefé.

Table 3-4 Hindering and Promoting factors of packaging waste management in Tefé

	Hindering	Promoting
Financial Management	Corruption; Mismanagement of contracts: the object and monitoring are not clear; Costs of transportation are too high to recycle other packaging materials besides aluminium; Low number of recycling industries in Manaus hinders competition.	Aluminium cans, scrap metals and other waste have economic feasibility to be collected and commercialized in Manaus; The use of waste equipment, like press, has proven to increase the value of materials because of reduced space in transportation; Subsidies from federal level.
Physical Management	Poor collection in urban and rural areas ends in burning and dumping; Geographical characteristics and distances of Urban centre of Tefé, communities and Manaus;	New procurement process in Tefé will start for collection infrastructure; Pressure from city council, government and airport to find a safe solution to the dumpsite management;

	Lack of data and monitoring; Packaging sector is not willing to contribute with collection and municipality infrastructure.	State ferries deliver industrialized products and return to Manaus empty.
Institutional Arrangements	PNRS and packaging sector are not yet planning how to proceed with waste management beyond the packaging agreement scope; Lack of skilled staff at the local level; Lack of enforcement of policies; Lack of continuation of governance; Awareness: Burning and dumping are normal and cultural acceptable practices; Inadequate state planning; Too many policies in the waste area (116): confusing and ineffective.	Targets to private sector are clear and measurable; Strong and coherent network of players (including waste pickers) to collect, buy and sell packaging materials, even for places 72h away from urban centre; Penalties are defined in local and national level.

Source: Author's own.

4 Analysis

4.1 Analysis framework

Based on the data collected from literature review and case study findings (Chapter 2 and 3), the author organised the information into a matrix, considering summaries of the hindering and promoting factors regarding the physical management, financial management and institutional arrangements when implementing waste management plans put together at the end of each section.

These factors were crossed and combined into clusters, considering the most cited and overlaps of hindering and promoting factors in each topic from Chapter 2 (waste management in remote communities; waste management in developing countries; EPR programmes and recycling markets), Chapter 3 and the areas evaluated (physical management, financial management and institutional arrangements). Appendix II has pointed the clusters into a colour scheme which led into the categories below showed in Table 4-1 Cluster categories & Hindering and Promoting factors of each area: The Table also shows how many mentions each cluster had considering its hindering and promoting factors, which will further be discussed.

Table 4-1 Cluster categories & Hindering and Promoting factors of each area

Areas/Clusters	Hindering	Promoting
Government support and policy frameworks	18	15
Market factors	8	10
Society and private sector contribution	3	8
Geographical and demographic factors	3	0

Source: Author's own

When the evaluated factor would fit into two categories, the author chose the cluster that applies more influence to it. For example, "Interdependent relationship with stakeholders" would fit into the Government area but also Society contribution, however, if the Government does not facilitate this relationship with other stakeholders, it is unlikely to happen; therefore it is discussed under Government support and policy frameworks. Another example just to make clear is "Economic instruments" that could fit both into Government area and Market factors. In this case the author chose to cluster into Market factors because makes the successfulness of the Economic instrument more decisive than government factors.

4.2 Analysis and results

This section aims to answer the main research question considering the framework presented together with RQ1, RQ2 and RQ3. The next chapter will address RQ4 and, following the purpose of this research, include future opportunities to address the problem of poor waste management in remote communities.

4.2.1 Hindering factors

Government support and policy frameworks
Most cited amongst all the factors that hinders waste management in remote communities (18 out of 32) was the government influence. Here, to discuss the results, it involves the whole governmental structure, considering national, regional and local level.

The literature review that combined other cases around the world showed that the reality seen in Tefé is very similar to what happens in other places that are far away from urban centres and in a developing country. Other cases have also shown that the lack of good waste management practices are damaging the environment and threatening human health.

At the local level, the problem has its main roots in the cited inadequate planning and lack of financial resources. These factors combined leads municipalities to "act as they go", instead of analysing the reality they have in hands, together with policy framework, and plan in advance a good path for the future.

The lack of resources and skilled staff results in the poor choices of fleet and monitoring, which further results in poor collection. Obviously, as previously mentioned, remote communities require more financial input if considered the geographical challenges, nonetheless, the cases reviewed and observation in Tefé showed that in some cases there could have been an improvement with no financial input whatsoever. One example observed that makes that clear is the case of the contract that the municipality of Tefé has with a private company. During interviews, when asked about the routine of collection, the Environment Secretary could not measure the daily work of the private company hired. The consequence was that a few neighbourhoods had collection everyday while other neighbourhoods that are accessible by roads, did not have collection at all, resulting in dumping or burning. The author did not find out if that example happens because of lack of knowledge to re-plan the routine of collection or lack of will of the municipality staff, which can be a bit of both as well. However, when asked about the possibility to track the collection plan and rearrange so that more neighbourhoods had collection even if less frequently, the municipality showed then inclination to do so.

Contributing to financial constraint is the collection of taxes in areas where people do not have issuance of property right. In these areas, taxes revenues to cover waste management costs are harder to get (UN Habitat, 2010). This was verified in both literature review and case study in Tefé.

UNEP (2004) confirms that in most developing countries the low quality of knowledge and inadequate planning creates even more expenditures in the waste management areas. So places that are already facing resources constraints, end up spending it in the wrong way because they do not know how to do better. In other cases, the financial constraint is a matter of corruption (Transparency International, 2015; Newman, 2016). For that factor, the author did come across concrete figures in the literature and field observation. She considers that it would be very rare to find a publication clarifying that "from a budget of X to waste management, other Y was lost due to corruption". What could be found is the average cost for waste management (20 to 40% of municipal budgets) (UN Habitat, 2010) and the overall level of corruption in a country, leaving impossible to infer if the cases analysed would have enough money to implement good waste management systems or not without corruption.

At regional and federal level, the experiences mapped showed that having progressive policies with EPR instruments does not mean its effective implementation. Especially in developing countries, where governments tend to be fragile to private sector lobby. However, it can be a matter of time for policies to reach remote areas, which was shown by the Greek islands case, that little by little shows that the country is trying to implement the EU Directive but facing distance and recycling market challenges (Harnnarong, 2009).

Another important issue that surrounds all levels is that the policy framework for waste management can be very confusing for the local level to implement and enforce. In the Tefé

case there was a 116 policies mapped for Municipal Solid Waste Management. (Associação Amazonense de Municípios & Amazonas State, 2012) and staff was not aware of the main contributions the PNRS has made to waste management advances in Brazil. The other case studies evaluated did not mention much about the knowledge of staff about their policies, yet the studies focused more into the technological choices for collection and disposal services.

Regarding the PNRS and the potential to be implemented in a remote area such as Tefé, the policy could have emphasized and given different instruments to be implemented in places so different to one another. As other cases confirm, one thing is to implement EPR and reverse logistics systems in California, Toronto, Athens, and São Paulo. Other and more challenging is to implement in Hawaii, Yukon (Canada), Lesbos island (Greece), Tefé (Amazon).

The *Shared Responsibility* concept in the Brazilian law is a kind of EPR when verified that from manufacturers up to the consumer, the last in the chain, are all responsible. Therefore, it is possible to infer that it is an EPR. However, as mentioned in previous chapters, the way the law is structured, leaves a few doubts behind:

- Collection responsibility: Municipalities are responsible for collection, however, the greater the amount of waste, greater will be the cost. The law does not verify specifically the necessity of private companies to help with collection costs, but states "responsible to create reverse logistic systems". On the other hand, private sector already stated that they will not support collection (See Section 3.4.1.1)
- Inclusion of waste pickers: PNRS asks that waste pickers organizations should be prioritized when they exist. What are the principles or criteria for prioritisation? It is considered to be an opportunity for developing countries to include waste pickers in the formal waste management system, but in the case of Brazil, the way it is done, waste pickers are not yet being paid for the whole service they provide. Instead, private sector is investing with human resources (trainings) and equipment, but this method has been criticized by specialists.
- Enforcement: As a long supply chain of players are responsible for the packaging waste, it is not clear which stakeholder should receive a penalty if needed.
- Financing: A few materials, especially aluminium, are worth to collect and sell, even in remote places. Others, as seen in literature review and Tefé case study, are not. There is no specification in the law or in the packaging sectorial agreement forcing private sector to help financing logistics in specific places.
- Reverse logistics system: The law does not require companies to comply with a PRO or a National Organisation. Instead companies can opt in to be part of a Sectorial Agreement or comply individually. The same has been shown in Section 2.2.3.2.1in a few countries in Europe and the United States which does not necessarily mean hindrance to the effective implementation of the policy. However, having one system and one organisation to relate with the government that could congregates the total cost of the reverse logistics, could turn into a promoting factor to share costs from one "easy" waste management, such as big urban centres, to area to other more remote areas, such as Tefé.

Market factors

The market value of the recycled material is the top of the iceberg of all the other services that is necessary: collection, transportation to a second storage, pressing to optimize volume, transportation to maybe one or more intermediate buyers and finally to the recycler. Among this chain, if the people are contributing correctly to taxes of all workers and invoices (which

is not common practice in the informal sector), the costs will also infer to the final price of the material.

Throughout the study, there were 8 citations in the summary tables related to hindering factors of market. The most frequent and evident related to packaging waste is the low value of materials besides aluminium. Aluminium is the only material among the packaging waste that has shown to pay off the whole supply chain cost in all the case studies analysed (for both literature review and Tefé).

In Brazil, the index for aluminium recycling varies from 97 to 99% in the past decade (ABRELPE, 2014). That shows that the country has been recycling almost its entire aluminium put on the market regardless the location. Also, it is the material that waste pickers can find most revenue from collection.

Considering other packaging waste materials, the volatility of price markets can hinder a municipal recycling program or the stability of a waste pickers' cooperative. And that is not unique to remote communities. New York, as cited in Section 2.2.4 has been struggling with the low prices of oil to find destination of waste plastics. Business and cooperatives all over the world have struggled to balance revenue considering the plunge of oil prices.

Another subject that hinders recycling markets is the offer of recycling industries close enough to remote communities. The closest recycling industries from Tefé are in Manaus, and there are only three recyclers there. Galapagos and Hawaii case have also shown that the closest recycler to most of the packaging material would be found only in mainland. Therefore, costs of transportation to reach recycling make the business economically unviable.

Important issues but less mentioned in the studies were the design of packages, that can combine more than one material and have even more limited markets to be reinserted; and consumers and industries resistance to recyclable content.

Society and private sector contribution
There has not been much reference to hindering factors that involve the society and private sector in the studies reviewed. Nonetheless, the lack of awareness of citizens to the environmental and health impacts of poor waste management was documented. Not only that, in remote communities in the Amazon and in SIDS, to burn or dump waste is culturally acceptable (Bernardes & Günther, 2014; Mohee et al., 2015; M. Mendonça, personal communication, April 1, 2016).

Related to the private sector contribution, because waste management in remote communities presents more challenges due to distances, recycling markets and unskilled local government staff, it is expected that reverse logistics of packaging waste will cost more if compared to urban and industrialized areas. "If companies are resistant to implement reverse logistic systems in urban context, imagine implementing in remote areas in waterway context", said one of the specialists. In fact, in the case of Brazil, the packaging sector already indicated that it is not willing to contribute to building up infrastructure for waste management. The packaging industry has played an important role during the PNRS law negotiations and including that issue which appears to have never been on the table before.

The law had been under discussion since the 80s and the main barrier to be promulgated was the post-consumption responsibilities. Many of the existing EPR policies in OECD countries had proved the efficacy of the measure; however, in Brazil the private sector was still reluctant to approve such a drastic change when the law project arrived at the Ministry of Industries

and Commerce. The main victory of the government in that sense was to input the "reverse logistics" under six product categories (V. Zveibil, personal communication, April 15, 2016; F. Feldman, personal communication, April 15, 2016; R. Abramovay, personal communication, April 13, 2016).

To the inclusion of waste pickers into the reverse logistics systems, the private sector has committed to help raise their quality and productivity, but does not mention the possibility of paying for the services (for instance, with recycling credits as applied in UK or even the attempt of doing so in Brazil). (Abramovay, Simões Speranza, & Petitgand, 2013; M. Mendonça, personal communication, April 1, 2016). Lindhqvist believes that the moment the value to support waste pickers cooperatives starts to be more expensive, market will open up to private sector to manage recycling waste (T. Lindhqvist, personal communication, May 24, 2016).

The lack of transparency and accountability of the reverse logistics proposed by the packaging agreement is a hindrance, especially when compared to European countries. Private companies in France, for example, have paid in 2011 equivalent of 1 billion euros to EPR programs, and from that, 600 million euros were directed to regional administrations. (Abramovay et al., 2013) The investment made in Brazil is not yet publicly available and there is no sign at the Packaging Agreement if it will ever be.

There had been advances when compared to responsibilities before 2010, when the PNRS bill was signed. However, it is still uncertain that the private sector will be financially responsible for all the burden that packaging waste reverse logistics will cost to urban and more challenging, the remote areas.

Geographical and population factors
The evaluation of the studies in remote communities and the Case study in Tefé confirms that distance and transportation costs are hindering factors to promote recycling of packaging waste in remote areas. Those challenges can be even bigger when combined with sparse and small settlements, where the amount and type of packaging waste generated is not sufficient to pay-back the work and transportation costs. On another opinion, Mr. Mendonça believes that more challenging than distances is the cultural acceptability to dumping and burning.

Chirico (2011) has defined that there are internal and external remoteness and that can be transferred to most of the cases analysed. Internal when in the same political area, for example Greece, Amazonas, or her own case in Hawaii, the waste logistics and treatment from one area to other are decisive hindering factors. In Tefé, for example, it would be very difficult to implement a collection of glass in all the remote communities, due to weight and volume and the logistics obstacles of distance, time and cost. Even being in the same municipality. External remoteness relates to the access of materials to be treated or commercialized, also the case for Tefé, Greece, Greenland, SIDS, among others.

4.2.2 Promoting factors

Government support and policy frameworks
Similarly to hindering factors, promoting factors related to the government and policy building were the most cited among the studies reviewed. It is hopeful to perceive that, besides all the challenges that remote municipalities in developing countries have, there are still a lot of good examples to be benchmarked.

A few studies mentioned the adoption of a waste hierarchy and the adaptation of MSWM to it (Brasil, 2012; Manaf et al., 2009; Ragazzi et al., 2014). To change the mind set and implementing such measure creates a future where waste is not seen as something to "throw away" and get rid of, but as a resource. Most of cases that adopted the waste hierarchy were able to use the by-products of food waste and recyclables and, therefore, extending the lifetime of the landfill, or even the dumpsite.

Another promoting factor that should be benchmarked and is incentivised at the Waste Management Guidelines of UN (UN Habitat, 2010) is to have better written contracts with a stringent monitoring. As previously mentioned the lack of knowledge of public staff can led to poor partnerships, therefore, having a contract with clear object and how to monitor the service being provided can minimize expenditures and create data for further development of the system. Connected to that, procurements can also be revised into a model where public-private partnerships are an option. In Tefé, for example, there is a possibility this year (2016) to review the procurement and the contract; however, the Environment Secretary has stated that there are not many companies willing to provide collection services in the region (I. Lins, Personal Communication, March 9, 2016). UN recommends that procurements and contracts are built considering every location uniqueness and one idea for Tefé could be to contract several small private companies instead of just one to provide the service. Local government needs to be more flexible and creative to be able to meet their own necessities.

An idea deeply criticised in a few of the literatures is importation of solutions that had been successful from other places to remote communities and developing countries. Reports mention that consultants or public staff eventually falls into that mistake and that generates unknown expenditures with equipment or cultural differences hinders the implementation. Instead, these studies and reports consider that to promote good waste management, solutions and technologies should be planned for every case. During field observation the author did not come across with that reality in Tefé, however, she believes that having external consultants would be positive to the future plans of waste management.

Related to financial constraints, as mentioned as a hindering factor the difficulty to collect taxes because people would not have land title, the good news is that citizens in Brazil and most of Asian countries have shown interest to pay additional fees to have waste management services and other services provided by entering in a tax system (UN Habitat, 2010; Zurbrügg, 2003).

Considering policies framework, it is indubitable that EPR based policies are promoting better waste management. OECD countries have shown that waste is more often used as a resource and private sector is sharing the costs. To adopt and implement an EPR driven policy for remote communities is possibly the only solution to overcome the challenges these places present. In that matter, the studies point out that a mix of policies and the use of economic instruments is extremely advisable if combined with:

- Transparent accountability based on actual costs;
- Motivate and establish targets for recyclable materials in public procurements;
- Mix of policies to maintain general competition and anti-monopoly to favour recyclable markets;
- Awareness campaigns;
- Inclusion of informal workers/waste pickers;
- Clear and enforced penalties;

- Research and development of new packaging and treatment of materials (Eco-design guidelines);
- Interdependent relationship with stakeholders.

The last point, interdependent relationship with stakeholders, was mapped during fieldwork in Tefé as a possibility to implement a solution with no cost: The State of Amazon delivers food to schools by ferries and the Environment Secretary noticed that ferries goes back to Manaus empty. Petrobras, which is Brazil's state owned oil company and has a few plants across the Amazon, has a program that collects and transports in containers all the waste to a correct disposal in Manaus, which could also be shared (D. Cunha, personal communication, March 1, 2016).

Being logistics the main obstacle to recycle other materials than aluminium, an harmonic and flexible relationship of local government with regional government could facilitate the logistics of a mix of packaging waste materials from Tefé to Manaus, where they can be commercialized or disposed properly at the only sanitary landfill of the state. The same applies to awareness campaigns, where schools can play an important role in education and improve drastically the quality of separation at source. Nonetheless, as Zurbrügg highlights that the local government should be the main facilitator of these networks; the same was not observed in Tefé, where the dialogue with state or federal level is very limited.

Market factors

Although there are a lot of hindering factors to establish a balanced market for packaging waste in remote communities, there are a lot of examples and factors pushing it to happen.

The SIDS Mauritius and Kiribati and Santa Cruz in the Galapagos Archipelago have shown that deposit-refund systems were key to the development of recycling programs. Especially for beverage containers, deposit-refund systems help to minimize the costs of collection, sorting of materials and internal remoteness issues (See Section 2.2.1.1) that have low value in the market, like plastics and glass. In the Brazilian context, this option is not yet in place for two main reasons: first because waste pickers organisations believe that if people start to earn with the take-back of recyclables, waste pickers will lose share in collecting valuable materials like aluminium cans and PET bottles. Second because the industry believes that there is a high management cost of those systems, and are not willing to invest right now.

Island cases identified that having the deposit-refund systems for these remote places helped other two main factors influenced by the market: promote centralized operations and raise scale, in realities where population is sparse and generation of packaging waste is small. That promoting factor was seen as important not only in cases where deposit-refund system was installed, but in Tefé as well, where Mr. Pires (the main intermediate buyer of recyclables in Tefé) is able to gain more from aluminium cans because he is able to centralize all in Tefé and press, gaining scale to negotiate and reducing volume space of materials to be transported to Manaus.

The experience of the aluminium flow shows that Tefé and other places have a strong network of players that can promote the reverse logistics of that material especially because there is high price in the market. There are materials coming from up to 72 h distances by boat to Tefé (the farthest place mapped bringing materials to Tefé was Vila Moura). Unfortunately, the take-back is not due to awareness or policy implementation factors, but exclusively because aluminium has been paying enough to cover the cost of sending materials to mainland or nearest recycler.

Other economic instruments were cited among the studies. Landfill taxes, landfill bans would motivate implementation of waste hierarchy, which would lead to developing recycling markets; tax subsidies and standardisation of quality to help industries in purchasing recyclable materials; among others (See Appendix III). That was not observed in Tefé, where implementation of economic instruments to motivate packaging recycling or just to motivate compliance with waste hierarchy is not a reality yet.

Last but not least, the work of the informal sector is an important promoting factor in remote communities and overall recycling indexes in developing countries. It is unfortunate that the social and economic vulnerability of these people result in finding their income often in very hazardous situation, however, they have become specialists in sorting materials and without their extensive work, the situation in most developing countries could be a lot worse.

One example from the quality of sorting is that in industrialised Southeast Brazil, often cooperatives are working with BOPP (Bi-axially Oriented Polypropylene, vastly used for cookies and snacks packaging) and Styrofoam, which are considered difficult materials to be recycled. Both these examples are not statements that waste pickers can work with any material. On the contrary: these are very low value and not worth for them. But the point here is the quality of sorting and market offer to buy those materials. If there are incentives for waste pickers to sort more challenging materials, they will probable succeed better than mechanised sorting.

Society and private sector contribution

Mapped promoting factors are mostly related to government action as well, but without the willingness of society and private sectors, it would not occur.

Having the pressure of some kind to institute waste management systems has been pushing change in SIDS because they lack space and often are under protected areas. In the case of Tefé, the stronger pressure comes first from airport security reasons and secondly because the dumpsite is almost full and contaminating groundwater (not scientifically proved but likely to be happening since dumpsite is meters away from water sources). Civil society organised at the city council have been pressuring local government to find a solution and raising the subject, which creates awareness for the whole population and maybe more stringent action from public sector.

Cascading EPR instruments, asserting responsibility and creating a PRO or other collective packaging waste system has been indicated as a recommended action to government and private companies, because it assures transparency, credibility with supply chain and eases government monitoring (Engel, Stuchtey, & Vanthournout, 2016). At same pace, government policies and subsidies encouraging private sector to improve packaging are seen as positive strategies. Since the PNRS is not yet being implemented in Tefé, there is no comment regarding private sector involvement.

More about awareness from the society end, the engagement of children and schools in campaigns has proved to be quite successful. And even though awareness and cultural acceptability with dumping has been pointed out as hindering factor in Tefé, Troschinetz and Mihelcic (2009) found out that socio-economic status is not a barrier to source separation of waste in households.

Geographical and population factors

Interestingly enough, there were zero mentions of how the geography and population factors in remote communities could be a promoting factor to develop waste management systems.

Maybe if cases focused the argument of being a Preserved area, Conservation Unit, but none has cited those as a promoting factor. That confirms the assumptions of the author that internal remoteness and external remoteness are big challenges to be faced.

Hage and Söderholm (2008) suggest that morals and environmental awareness can be determinant factors for recycling indexes in distant places. That is because they have found out that in most places in Sweden, plastic recycling is not cost effective. And they defend that recycling should, as any other policy, meet LCA (life cycle assessment) and standards of cost benefit and efficiency test. Remote areas with small population most certainly will not meet standards and morals and what is best for the environment should prevail against economic advantages.

In the case of Sweden, the authors were most probably motivated by comparing the availability of high-end incineration facilities in the country, but as this option is not available in most of developing countries and in just one of the remote communities evaluated (Greenland), the cost of inaction is left behind to human health and environment.

The calculation of cost of inaction is sensitive for each area and most of the times inconclusive, nevertheless, the estimated values are enough to prove the argument that is cheaper to manage waste (5 to7 USD per capita; or 4.39 to 6.15 EUR) than continue on dumping (20 to 50 USD per capita; or 17.59 to 43.98 EUR) (UNEP, 2015).

5 A step forward

This is a summary of main opportunities mapped during interviews, literature review and author's own reflections. This section addresses RQ4 (*What actions can be taken in a short and longer term in Tefé's case?)* and to understand what actions can be taken in short and long term considering the hindering and promoting factors discussed, the author has collected the opportunities and combined with another axis, here chosen to be the financial input in the reality of Tefé. Previous knowledge from findings gave basis regarding time and monetary aspects of the recommended actions stated in this section.

To a better visualization of what can be done the author placed the actions in a chart (Figure 5-1) and the actions in a Table 5-1, hence decision makers at national and local level can find easily what are the "low hanging fruits" and the actions that needs more time and financial input.
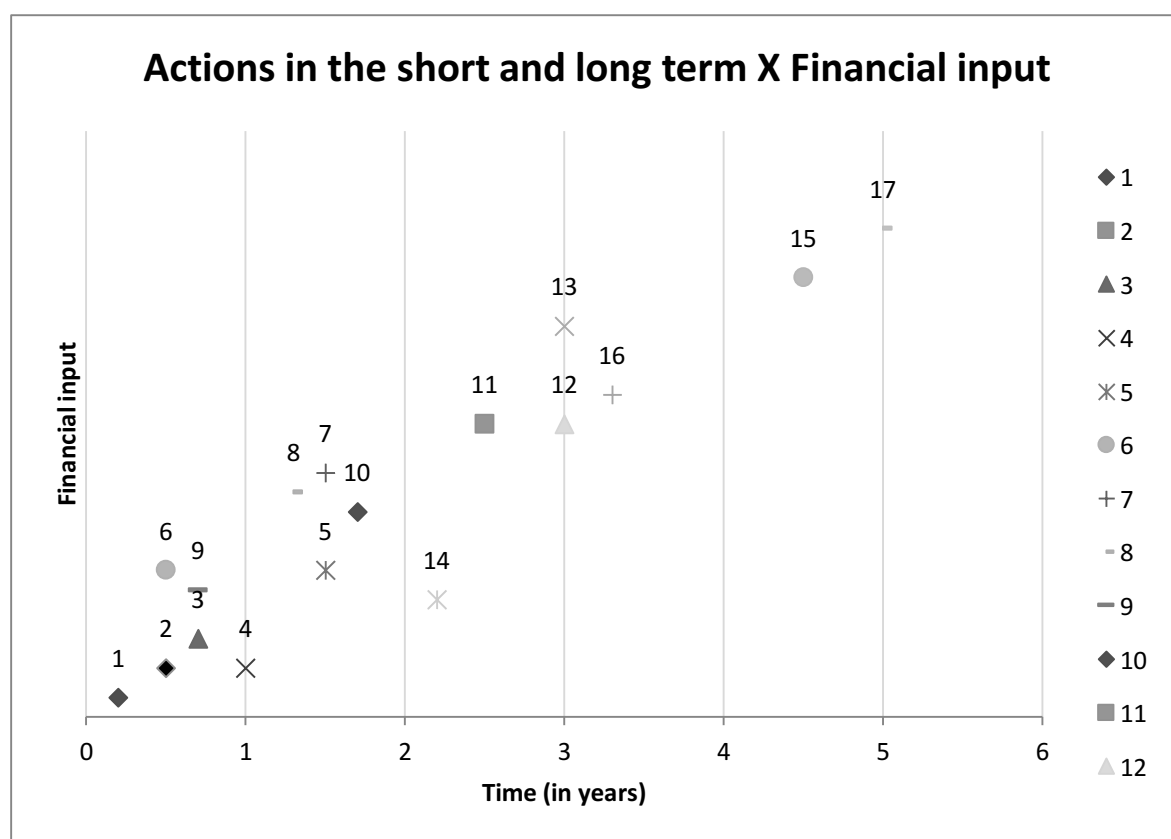
Figure 5-1 Actions in the short and long term X Financial input.

Source: Author's own.

Table 5-1 Actions in the short and long term

Short term	Long term
1. Remote communities: Burning in one site	11. Stringent policies for specially challenging areas
2. Improve collection contract	12. Recycling credits as an imposition or option
3. Revision of collection routines to compass more neighbourhoods	13. Special packaging for remote communities in the Amazon
4. Partnerships for reverse logistics	14. Input waste management cost into waste bags costs

5. Local products from waste	15. Regional hubs and exclusive systems for reverse logistics
6. Equipment infrastructure to intermediate recyclers and smaller bales	16. Recycling benefits to citizens and/or deposit-refund system
7. Support local waste cooperative including informal sector	17. Final disposal: waste to energy or waste to ashes
8. Collection points for recyclables ("PEV"- Voluntary point of delivery")	
9. Comprehensive research on distribution networks, industries and recycling markets for the region	
10. Organic waste as an alternative to compost and biogas	

Source: Author's own.

The specialists interviewed and the researcher's own thoughts recommend that stakeholders chase creative solutions, unique for each specific region, cultural background and challenges. Since for the majority of the packaging waste materials the value does not pay off, specialists believe that, at least in a short term frame, local, small and craft solutions can minimize social and environmental impacts of mismanagement of waste.

It requires flexibility to negotiate project by project, structure by events, programs, here and there a support. To wait for a complex and thoroughly recycling program can paralyze smaller actions, therefore the recommendation is to "not make everything as complex as it is and just do something" (M. Mendonça, personal communication, April 1, 2016).

5.1.1 Actions in short term

Short term actions are more related to the local level.

1. Remote communities: Burning in one site

As observed in Section 3.3.2, at rural areas, the most common practice is to burn the remaining waste that is not used to feedstock. Each household is burning at their own backyard and at their own time. Although burning is not *per se* a recommended attitude, specialists from Mamirauá Institute and ICMBio (Organisation and agency working directly with sanitation issues and conservation units) believe it is the least harmful action considering the lack of infrastructure. Therefore, to find a common site in the community to concentrate the burning is an action to will minimise impacts to the environment (one polluted place instead of several) and human health (setting time for burning instead of burning at different times).

2. Improve collection contract

First action to be taken that needs none financial input (or very little if accounted the human resources from the municipality staff) is the improvement of the collection contract with the private company.

The author has analysed the valid contract and as Tefé's Environment Secretary rose the upcoming possibility of a new procurement opening, the most "long hanging fruit" is to build a more structured contract and monitor the service more stringently. To be more specific, the previous contract flaws were: the object was not clear, did not mention how much of waste the private company should collect, or how many hours the trucks would be working, how

many employees were involved, health and safety requirements for employees, responsibility of the truck's maintenance, and last but not least, how to monitor the service provided. Therefore, as UN Habitat (2010) also suggests, if the new contract addresses the flaws raised and starts to be monitored, there may be a service improvement with additional data generation for the municipality.

The ongoing contract for collection is under the Infrastructure Secretary department and the waste management responsibility belongs to the Environment Secretary department. Accordingly, another action that would require revision of responsibilities and budget relocation is to change the contract of collection to be under the Environmental Secretary, so that monitoring can be better implemented.

One hindering factor mapped is that there are not enough private companies willing to provide the service in Tefé. UN Habitat (2010) suggests the strategy to split the collection into several companies hence smaller and new companies would be able to apply. The procurement and contracts as well would have to be adapted.

3. Revision of collection routines to compass more neighbourhoods

Because there is currently no monitoring, the collection services in the urban area of Tefé are very random. While some neighbourhoods have collection daily, others have none. The action would be to identify exactly the work of the private company and rearrange the routes in order to provide collection to places that have no collection at all, even if less frequently.

To apply that action, the financial input can vary from zero to a small amount. Private company's employees can document the routes daily for a month (if considered there is a level of trust), or municipality's employees can do that job, or, more systematic, implement GPS equipment in each truck and let it collect data for a month. It could be easier using Tracker apps and a smartphone, however, the region does not have trustworthy internet network.

With GPS the next challenge would be to read the data collected, nevertheless, local partnerships with State University or Mamirauá Institute that has good computers and knowledge would be able to help the municipality very easily. Collected the data in hands, the municipality's job is to set a new routine for the private company to follow, communicate citizens about the new schedule and monitor collection through citizen's surveys.

4. Partnerships for reverse logistics

It has been mapped that there are state ferries returning to Manaus empty, and that Petrobrás also transports some types of waste back to Manaus to be treated. The action would be to tie closer relationships with both institutions and better understand the possibilities of using extra space in their ferries to transport packaging waste for commercialisation in Manaus. If positive, as packaging waste collection networks are strong and easy to activate, Tefé would be able to send cardboard and PET bottles as previously had, and stopped because the market value of these materials nowadays are not paying for the transportation costs. Monitoring amounts should also be easy: either by weighing on the ferry or by invoice information.

5. Local products from waste

Suggested by Mrs. Lopes and Mr. Ribeiro, specialists in waste management, the author has investigated the possibilities of using packaging waste materials for local production. And, in

fact, there is one opportunity that meets triple bottom line goals (social, economic, environmental).

Currently the municipality buys 300 brooms per month for street sweeping. The brooms are made locally but from *cipó*, which is a natural fiber and not as renewable as the local extraction to it. In addition, the brooms have very short life but the cable made with wood is reused. Therefore, the idea is to start a local business that would produce brooms with PET bottles and sell to the municipality. Partnerships that can include waste pickers that are working at the dumpsite to work with PET broom manufacturing or people in vulnerable situation in Tefé; space can be offered by the municipality (there is a big storage available); infrastructure would most probably follow normal banking system, but as there is a buyer guarantee, loans for infrastructure of the business would be paid very quickly.

The outcome of this business would be: savings for the municipality with more robust brooms, economic and social inclusion for people in vulnerability situation and natural material savings for the environment.

6. Equipment infrastructure to intermediate recyclers and smaller bales

The case study in Tefé mapped three entrepreneurs buying recyclables from distant places (mainly aluminium cans and scrap metals). The reason why "Point da Sucata" is the most successful business between the three of them is due to infrastructure: they can press the materials, saving space in their storage and transportation costs. Mr. Pires, owner of the business, accessed a loan from the Amazonas bank and was able to purchase equipment. Therefore, the recommendation for the other two business and new ones that may arise is to look for funds that would improve capacity, profit and open doors to the possibility of including other packaging waste materials to be commercialised.

Mr. Mendonça highlights that packaging waste in these regions are packed in smaller and lighter bales, from 50 to 100 kg maximum, in order to facilitate transport in not so specialized fleet and to be able to be transported in passenger's boats to Manaus, instead of ferries (M. Mendonça, personal communication, April 1, 2016).

7. Support local waste cooperative including informal sector

There are five to eight people living right across Tefé's dumpsite and surviving from scavenging activities. According to Mr. Pires, other network of informal waste pickers in the urban area exists. Excluding the negative aspect of the poverty that this may reveal, the positive aspect is that the city already has specialised work force to start a recycling cooperative.

It is a reality in developing countries that informal sector works the way they can, and lack of infrastructure can hinder maximisation of chain value. Packaging waste management and recycling should be planned in the mix of materials, not separately; otherwise it is not economically feasible. Therefore, a cooperative work for sorting and maximising scale is a solution for the region.

Partnerships with local level for infrastructure support (the municipality has a storage available that can be used; see photo in Appendix IV); commercialising (engaging the three buyers) and transport (using state's ferries) would be sound enough to be able to send the materials to Manaus, compensate workers and save from 27% to 37% of packaging waste going to the dumpsite (Guimarães & Bernhard, 2015).

8. Collection points for recyclables ("PEV"- Voluntary point of delivery")

The cultural acceptability of dumping waste out in the streets, at the rivers or burning in people's backyard is a hindering factor to start a recycling program. However, studies have also shown that if given infrastructure and awareness, citizens are most likely to engage and participate in sorting and disposal at indicated places.

As a pilot, the recommendation is to install collection of recyclables in closed containers in more populated areas, much similar to the ones installed in Lesvos (Harnnarong, 2009) and little by little expand to other areas. Awareness campaigns are prerequisite for the success of recyclable collection and the implementation of previous action (item 7), otherwise the mixed materials would not have proper destination and treatment.

As mentioned in Chapter 2, the issue with the type of container and cultural aspect should be deeply investigated concerning limited municipal budget to invest at all and the possibility of theft or damage of containers.

This solution of closed containers may also facilitate to dislodge the growing vulture population of urban Tefé due to reduced availability of open dumping.

9. Comprehensive research on distribution networks, industries and recycling markets for the region

The Packaging sector, together with the Sectorial Agreement, has presented an Annex concerning a feasibility study and cost benefit analysis for reverse logistics in the 12 cities aimed at the first phase of implementation. However, the author has found a research gap on assessing the same for the Amazonas state or other remote areas. Therefore, it is recommended a study in the Amazonas area to provide knowledge in order to expand the plans for the second phase of the Packaging Waste Agreement. Specialist's advice that content should have not less than (M. Mendonça, personal communication, April 1, 2016; F. Ribeiro, personal communication, April 18, 2016; V. Zveibil, personal communication, April 15, 2016):

- Mapping of distribution flows: how products arrive to remote regions, how they could return and where they are actually going when recycled;
- Strategic analysis of recycling industries that should be allocated in the region concerning the necessity of secondary material of industries already placed.

The outcome of this study would permit the state to cluster or regionalise flows and solutions to gain scale and enable yield of recycling (or other treatment); and to recommend federal government on types of economic instruments that should be offered to install new recycling industries in the area.

10. Organic waste as an alternative to compost and biogas

Besides not the scope of this study, the author would like to recommend that Tefé treated organic waste as a resource. Out in the communities along the river, food waste is not an issue because it is used as feedstock. But in the urban area, representing 36% of what could have been used, the waste is either dumped out in the streets or collected and taken to the dumpsite, both contributing to the vectors, such as vultures and rats.

Attending to the waste hierarchy, local business in India have shown even with separation or organic waste as low as 8%, the compost being sold covered about 45% of operations costs.

Other municipal small scale biogas projects in India and Africa have shown feasibility to collect and extract biogas from anaerobic digestion (Engel et al., 2016).

A vast amount of examples around the world (to name a few: Galapagos, India, Portland, Toronto, Flemish region in Belgium, Swedish municipalities, etc.) of diverting organic waste to fertilizer or biogas have shown in a few years that public resistance was overcome.

Tefé relies on gas canisters for cooking and diesel for electricity, as well as the other surrounding municipalities. Therefore, organic waste can be better used for composting, biogas or even biogas to electricity, if combined other municipalities and gain scale. Availability of financial resources would be decisive for each solution, and a study on the type of technology and the financial availability would be necessary.

5.1.2 Actions in a long term

Long term actions are more related to regional, national level and all stakeholders involved.

11. Stringent policies for specially challenging areas

The Environment Secretary of the state, Mr. Storski, mentioned in personal communications that the State of the Amazonas presents bigger challenges due to geographical and environmental characteristics; therefore, a specific policy is being planned. The Secretary has placed a draft for the Solid Waste State Policy to the federal level and is waiting for feedback and/or approval. The author's analysis of the draft is that it does not offer much more responsibility to the packaging sector than the PNRS, hence the participation of the private sector to promoting reverse logistics could present the same hindering factors that already does to the ongoing implementation.

After verifying results of the study recommended in item 8 of Section 5.1.1 the recommendation is to include in the State and local policy a reverse logistic demand, meaning that everything that arrives in Tefé and communities, should by the same trader or other system, be taken to treatment or recycling.

Another state of Brazil, Mato Grosso do Sul, has just published a resolution asking six sectors, including packaging waste, to comply with reverse logistics, forcing private sector to go beyond what is now presented in the Sectorial Agreement (that comprises only 12 metropolitan areas by 2018) (Mato Grosso do Sul, 2016).The Amazonas state has the same opportunity since the PNRS gives the overall basis but state and municipal level can be more stringent, as long as it follows the PNRS legislation.

The policy could also include economic instruments to provide intermunicipal articulation and consortiums, so that municipalities feel more engaged to collectively plan recycling programs, sanitary landfill and other solutions that require high investments that could be shared among local level.

Another improvement learned from the PNRS and São Paulo's Solid Waste Policies is to establish a range of companies that should comply with the law instead of all companies. Mr. Ribeiro mentions that there are 30,000 companies in São Paulo and for the stage of implementation it is a lot to be monitored. "There are many companies that put very small quantities into the market", he says. He suggests that Brazil adopts the Netherlands system, where only companies that put more than 50 tons per month needs to comply, facilitating the public sector management of the biggest amount of waste in reverse logistics.

12. Recycling credits as an imposition or option

Connected to previous recommendation, the state could propose that the private sector contributed purchasing recycling credits, as done in the UK (See Section 2.2.3.2.1). To mention a few systems operating in Brazil, there is Bolsa Verde, New Hope Ecotech, Reverse and Sponge. They are all quite recent in the Brazilian market and they work differently. Some are offering credits, which connect waste pickers cooperatives to recyclers that issue and guarantee the amount of material being recycled and monitoring; other just certification by tracking invoices, etc. Adopting these systems can facilitate the monetary return throughout the chain with less effort from the government.

13. Special packaging for remote communities in the Amazon

This action would require the study mentioned in item 9 from Section 5.1.1 to understand which materials that will not have, at least in the near future, recycling markets in the Amazon. The solution then could be that either by policy making or private sector positive agenda that some packages are especially made for commercialisation in the remote communities such as Tefé's. To exemplify: instead of soap packaging, a package that melts with water and becomes soap; instead of cardboard, plastics and Styrofoam (which is plastic), a biodegradable material made from sugarcane or cassava or other, etc. Specialists from Mamirauá Institute cite the BOPP material, commonly found in snacks (chips, cookies, gums), is vastly seen floating on the rivers and is hardly collected. Therefore, the developing of new packaging to minimise environmental impacts should be strongly motivated considering the reverse logistics conditions of these regions.

In addition, because glass is the only material that has no recycling industry in the whole region, a special attention is required (Cempre, 2016). Returnable glass bottles can be a solution.

14. Input waste management cost into waste bags costs

Tefé, as well as other municipalities in developing countries, lacks funding to provide waste management services to the whole population. The suggestion is to establish a standardised bag for waste, in which by purchasing it, the citizens would be contributing to waste management services.

This action would have strong resistance at first, because it is not a practice in Brazil to standardise bags for collection or even to purchase them, because they are given for free at supermarkets; however, it has been proven in Kiribati (SIDS) that not only improved collection services by identifying the waste bags, but also helped financing the system.

15. Regional hubs and exclusive systems for reverse logistics

Following suggested study on item 9 from Section 5.1.1, the Amazonas state is already studying the possibility of creating regional hubs for collective waste management systems (among many municipalities) and the use of ferries exclusively for waste collection.

One benchmark idea to finance the system is to install a fund such as "Closed Loop Fund", which is a social impact fund to increase recycling of products and packaging. They meet that goal by providing loans to build recycling infrastructure with measurable financial and environmental returns. Municipalities can have loans at zero interest while private investors

can access loans with interest below the market. The investors are big corporations such as Walmart, Coca-Cola, Unilever, PepsiCo, and Unilever, to name a few.

Instead of relying only in policy making and economic instruments, corporations in Brazil that are part of the Packaging Agreement could also create a pool to motivate more recycling business and infrastructure in the Amazon (Close Loop Fund, 2016).

16. *Recycling benefits to citizens and/or deposit-refund system*

While in other countries investigated in this research implemented deposit-refund systems, Brazil has not yet tried a monetary refund system. Instead, there are several projects being implemented that benefit citizens that take back their packaging waste to a collection station. The benefits are discounts on purchase of products, electricity bill, mileage credits on customer's programmes, and other forms (Light, 2016). These projects are connected to a host institution that aims to achieve other goal(s) besides recycling, such as creating database, motivating new purchases, etc.

It is a suggested action to expand these initiatives to remote communities, either like how it is happening in Brazil or common deposit-refund systems. The advantage of common deposit-refund system is that after a while, the implementation investment is paid back by interests (Lindhqvist, 2015) but would require a specific infrastructure at the communities that they may not have.

Nonetheless, as the Kiribati and Galapagos cases showed, citizens would be motivated to take-back recyclables to a certain collection point (for Tefé, usually in urban central areas or at rural areas nearby boat parking). This action is especially recommended for glass containers.

17. *Final disposal: waste to energy or waste to ashes*

Studies reviewed in this research saw that incineration or waste to energy is not common practice in developing countries. However, St Helena in the South Atlantic and Jersey, both UK territories, have found viable small solutions with waste to energy plants and anaerobic digestion (Waste Management World, 2013).

Because Brazilian Waste Hierarchy is the same as in the EU, it would not count as an ideal packaging waste solution, but if we consider the cost effectiveness especially in the Amazon area, it may be proven to be best to incinerate or bury than transport waste along the rivers for some materials, especially the ones with low market value or not possible to recycle yet. Therefore, the investigation and implementation of small scale incineration or a waste to energy hub for municipalities could be a possibility for the region.

6 Conclusions

The problem investigated in this research is the growing amount of waste in developing countries especially in remote areas such as Tefé, the lack of proper waste management and the challenge of transferability of EPR concept policies to packaging waste management in places distant from recycling markets. The consequences of these problems combined are threatening human health and ultimately, accelerate the loss of biodiversity in the Amazon.

Fieldwork observation and data collection provided the researcher with a closer look to the reality in Tefé. Meanwhile a very limited number of other cases in remote communities were found in existing knowledge that encompasses the implementation of an EPR policy. Therefore, this last chapter contributes to the ultimate goal of this research, which is to enhance the understanding of the waste management scenario in remote communities with focus in Tefé and to support the strategic planning and decision making on local level implementation. To address that purpose, the research questions were elaborated as follows:

§ Main RQ: What promotes and/or hinders packaging waste management systems and policies in remote communities, having Tefé as the main case?

> *RQ1: What is the existing knowledge on factors promoting and hindering for waste management in remote communities?*
>
> *RQ2: How does the current waste management system for packaging waste in Tefé look like?*
>
> *RQ3: What promotes and/or hinders packaging waste management in Tefé?*
>
> *RQ4: What actions can be taken in a short and longer term in Tefé's case?*

The first section of this conclusion refers to Main question, RQ1, RQ2 and RQ3. It highlights the main takeaways, author's reflection on what was found in the literature reviewed and case study findings. Subsequently, the recommendations section presents the findings and author's view on RQ4 and lastly a recommendation on future research and identification of this research gaps will close the thesis.

6.1.1 Main findings

Through the two sources of data collection, literature review and the case study in Tefé, the research identified several similarities that hinders or promotes waste management in remote communities and the reality seen in Tefé. These factors were clustered into four categories: (1) Government support and policy framework; (2) market factors; (3) society and private sector contribution and (4) geographical and demographic factors.

One result to highlight from the analysis is that for both remote communities around the world and Tefé, a community just by being remote, is already facing several hindering factors that another geographical area would probably not.

From the **governmental support and policy framework area**, Tefé's hindering factors matches with other existing knowledge about remote communities and MSWM in developing countries: lack of resources, unskilled staff result and inadequate planning result in poor collection, poor monitoring and often in more expenditures.

Because in Tefé the PNRS – Brazilian EPR policy – is still not being implemented, the direct hindering and promoting factors for the region could not be evaluated from the policy perspective. However, considering the current plan of the Packaging Sector, it is possible to say that having an EPR policy does not mean its effective implementation. That is the reality

seen currently in Brazil, where the PNRS is valid nationally but Packaging Sector is implementing in only 12 cities and also seen in the Greek islands case study. Regarding responsibility and financial allocation, the analysis has identified that does not matter if single (only one actor, as producer) or collective (shared responsibility: producer, importer, retailers, etc.) as long as EPR is implemented in a transparent and accountable way.

Promoting factors from government and policy frameworks seen at the other places studied are related to the adoption of waste hierarchy when planning waste management solutions, improvement of contracts content and procurements, implementation of unique, small scale and alternative solutions, and a mix of policies that would motivate inclusion of informal workers, recycling markets to be stable and competitive and new packaging.

Recycled materials are under the influence of **market factors,** which both in the literature and the case study in Tefé have shown important hindering factors. The main problem is that for most of the packaging materials, the value is too low to be recycled. The only exception seen in current knowledge and in Tefé is aluminium, which has greater value and quite stable market. Yet for plastics, because of the plunge on oil prices, even municipalities in developed countries are struggling to keep up with their recycling programs and in developing countries and remote regions, because other packaging materials besides aluminium have low value, they are just abandoned from the recycling circuit and landfilled. Also influencing the price of the recyclable materials is the availability of recycling industries. The whole North region of Brazil lack more infrastructures to promote recycling and the same is seen in other remote communities' studies.

Creating centralised operations and hubs for recycling and implementing deposit refund-systems were seen as promoting factors to handle market challenges in Small Island Development States (SIDS) and in the Galapagos Archipelago. Only mapped in the case study of Tefé was the strong network of players currently collecting and recycling aluminium cans. The network (informal waste pickers and communities' dwellers) comprises the urban area of Tefé and more than 100 communities that live along the river. It can transport the aluminium cans from areas up to 72 hours away by boat. As said, that is only possible for aluminium cans due to material value.

Regarding **society and private sector contribution**, it is a recurring hindering factor to good waste management practices in most of the cases studied, including Tefé, the lack of awareness of citizens and the cultural acceptability to burn or dump waste on the streets and rivers. Despite that, literature has shown that the creation of an interdependent network of stakeholders (municipality, private sector, civil society, NGOs, specialists, etc.) can promote and intensify the creation of programs, especially in small municipalities like Tefé or SIDS. Also considered a promoting factor is the pressure of some kind to rapidly solve the mismanagement of waste. In the case of Tefé it is the airport security imposing pressure on the municipality to find another solution or place to final disposal of waste, which is currently dumping. In other places, like seen in Mauritius Island and Galapagos, the lack of space for landfilling or tourism influenced positively the creation of recycling programs.

As for the private sector contribution from literature review, there were not as many relevant mentions, but one: the creation of a PRO (Producer Responsibility Organisation) or other collective packaging waste management system has been indicated to assure transparency, credibility and ease government monitoring.

For Tefé's case, as mentioned, the packaging sector is not implementing anything there yet, but promoting factors to packaging waste management currently being applied in 12 cities in

Brazil are related to investments to improve capacity and productivity of waste pickers' activities, being organised collectively and clear targets; however, hindering factors to the current plan so far is the lack of financial subsidies to municipal collection services, unclear intention to pay waste pickers cooperatives for the recycling services and not transparent investments.

Geographical and population factors were cited in all the studies as a main hindering factor and had no cited promoting factors. There are challenges for waste collection inside the same territory, sorting and gaining scale to access recycling markets. The amounts of waste generated in sparse locations area also complicates creating value along the recycling chain. That was evidenced in all cases highlighted in remote areas and Tefé as well. However, the main difference between literature and Tefé case study is the seasonality related to the rainforest context. The rural areas of Tefé are under water half of the year, and the other half on the dry season. That is a hindrance to collection and transportation planning and only described in Tefé case, not others.

Finally, because of all challenges presented in remote communities, it is emphasised that developing countries and especially municipalities in remote areas would not be able to self-finance recycling programs just accounting for the value of recyclable materials, or promote good packaging waste management in general, if not accounted more resources from other stakeholders, reason why EPR programmes are supportive.

6.1.2 Recommendations

Following the research questions answers above, this recommendation section aims to answer RQ4 (*What actions can be taken in a short and longer term in Tefé's case?*) and the content present has the ultimate goal of providing an action plan to stakeholders put in practice and improve the packaging waste management scenario in Tefé, and other recommendations relevant for a more sustainable approach. As explained in Chapter 5, the actions are divided into short term and long term compared to the financial input that each of them would require.

The first recommendations focus actions that need no financial input from government, but still would require human resources to make it happen. In that area it would already improve the current scenario in Tefé's rural areas if communities would burn their waste in one site, instead of each household backyard. In urban Tefé, to build contract with collection services with more binding clauses', enforcing and monitoring is encouraged and would also promote the revision of collection routes that currently do not cover the entire area. Other initiatives taking advantage of regional partnerships, using their assets like ferries, would provide zero or low cost transportation of recyclable materials, because of low market value, are not being taken from Tefé to Manaus.

Actions that require more financial input but would reduce the amounts of packaging waste going to landfill and to the environment are related to supporting packaging waste collection and installing a local cooperative to sort, press and send materials to recycling industries. These actions have also the provision of adding value to new business to come (products made from the waste collected) and social and economic inclusion of informal workers that are already contributing to recycling activities.

More focused on understanding and expanding recycling programs, the author recommends a comprehensive study regarding the distribution networks of products, reverse logistics possibilities and possible new recycling industries to be installed in the North region of Brazil. This recommendation connects with other long term actions such as the creation of regional recycling hubs and exclusive logistics systems to transport materials in the Amazonas state

with the purpose of raising scale, market value and minimising environmental impact, in contrast to leaving the materials to be dumped in Tefé.

Considering the challenges that remote communities present compared other industrialised areas, the author recommends that more stringent policies at state level take place, in order to finance logistics and, in the end, an environmentally sound solution to the packaging waste generated in remote areas. Actions related to that are to engage the private sector to develop special packaging for the region, promoting take-back incentives such as deposit-refund systems or recycling benefits in other forms.

Besides actions for packaging waste management, the author recommends that the municipality follows the waste hierarchy and implement an organic waste collection to start to use as a resource for fertilizers or biogas. That would require a study, but benchmark available in developing countries has shown as a feasible opportunity to be taken.

At last, a deeper understanding of the environmental and economic benefits of installing a waste to energy hub in the Amazon region, especially concerning the low value of recyclable materials or materials that cannot be recycled, is strongly recommended in a long term scenario.

6.1.3 Research gaps and future research

This research presents the starting point of an investigation field for remote communities that can be vastly enhanced. There were a few research gaps in the literature reviewed and in the Tefé case study, therefore possible hints to future research include:

- Deeper understanding on EPR policies and implementation in developing countries and remote communities, especially focused on how to finance, monitor and enforce.
- Life cycle assessment: Among the Brazilian Packaging Waste Sectorial Agreement there is an LCA constructed to meet the implementation plan of the 12 first main cities. Therefore, an LCA considering the Amazonian characteristics would be necessary because these 12 areas are completely different from Amazonian outback. That is also a research gap to other remote communities studies, because only one study made in Sweden territory was able to affirm that plastic packaging recycling is not cost effective however it is done for moral and environmental reasons (including legislation).
- Taxation and waste fees: That seems to be a gap in the waste area of study. Costs are not transparent, especially when it considers PRO systems (Producer Responsibility Organisation). Only two studies have mapped and included costs for the private and public sector, but the specific cases in remote communities here studied have not been able to show concrete figures.
- Recycling industry: In the literature review, most of the studies did not reveal where the recycling industries were in terms of distances and types of materials.
- Local solutions: Besides the possibility of waste to energy and sanitary landfills in some of the remote areas (Waste Management World 2013), other solutions related to small scale recycling and reuse of packaging have not been explored by the literature.
- Design of packages: This research did not investigate private sector's efforts to improve packaging materials.

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Appendix I – Current situation at Igarapé Xidarini, Tefé

Appendix II – Matrix of cluster categories & Hindering and Promoting factors of each area

Legend:

(light blue)	Government support and policy frameworks
(green)	Market factors
(orange)	Society and private sector contribution
(yellow)	Geographical and demographic factors

		Hindering	Promoting
Remote communities and Waste Management	Financial Management	Lack of governmental subsidies for packaging waste recycling	Economic instruments: deposit-refund systems for beverage containers
		Value of the recyclables.	
		Critical population: the amount of people or waste is not enough to establish economically viable system;	
		Limited markets: Even when the city or community can concentrate considerable amount packaging waste that would interest recycling industry, there may not be environmentally viable because of distances and types of transportation;	
	Physical Management	Type of pre-collection undertaken (Curb side, drop-off, and buy-back centres).	Centralized operations: able to rise scale
		Route and transportation access usually too distant from recycling centres	Other waste treatments: avoidance, reuse, composting and incineration can contribute to recycling as well.
			Metals are, in all cases, being recycled easily due to market value
			Pressure of some kind: lack of space in landfills, health and environmental hazards, etc.
	Institutional Arrangements	Low level of awareness	Implementation of EPR and Waste Hierarchy policies
Waste Management in developing countries	Financial Management	Financial constraints, tax evasion and corruption	Procurement processes and Public private partnerships
		Collection of taxes from citizens to subsidize services	Citizens are willing to pay for waste management services
		International loans with high interest	
	Physical Management	Irregular collection services	Well-built contracts with private sector with stringent monitoring
		Inadequate purchase and use of equipment for collection	Design and plan adequate to each specific scenario
		Lack of data and monitoring	
	Institutional Arrangements	Lack of skilled staff resulting in inadequate planning and waste of expenditures	Public policies towards informal waste recycling
		Poor relationship with stakeholders	Engagement of children in education and awareness
		Undefined ownership of the waste: formal and informal sector fighting for revenues (UNEP; ISWA, 2015)	Interdependent relationship with stakeholders
			Adopting waste hierarchy

Category	Management type	Barriers / Challenges	Opportunities
			Socio-economic status is not a barrier: households are willing to recycle (Troschinetz & Mihelcic, 2009)
EPR programmes	Financial Management		The use of Economic instruments: landfill taxes, landfill bans, user-pay collection systems
			Integrated and transparent finances based on actual costs according to packaging weight, volume and material type
	Physical Management		PRO or other collective packaging waste management systems
			Brand/importer responsible for take-back programs
	Institutional Arrangements		Encourage new products and markets for recycled material
			Programs are transparent to public accountability, including awareness campaigns, research and development of new packaging and new final treatment of materials
Recycling Markets	Financial Management	Volatility of market prices for primary and secondary materials	Economic instruments to motivate the use of recyclables in the supply chain
	Physical Management	Mixed materials in the same packaging: hard to find markets that would recycle	Standardize quality of recyclables
			Know-how of waste pickers in sorting materials
	Institutional Arrangements	Consumers and market resistance to recycled content	Motivate recycling materials in public procurements
			Mix of policies to maintain general competition and anti-monopoly
Case Study in Tefé, Amazon	Financial Management	Corruption	Aluminium cans, scrap metals and other waste have economic feasibility to be collected and commercialized in Manaus
		Mismanagement of contracts: the object and monitoring are not clear	The use of waste equipment, like press, has proven to increase the value of materials because of space in transportation
		Costs of transportation are too high to recycle other packaging materials besides aluminium	
		Number of recycling industries in Manaus hinders competition	
	Physical Management	Poor collection in urban and rural areas ends in burning and dumping	New procurement process in Tefé will start for collection infrastructure
		Geography characteristics and distances of Urban centre of Tefé, communities and Manaus	Pressure from city council, government and airport to find a safe solution to the dumpsite management
		Lack of data and monitoring	State ferries deliver industrialized products and return to Manaus empty
		Packaging sector is not willing to contribute with collection and municipality infrastructure	
	Institutional Arrangements	PNRS and packaging sector are not yet planning how to proceed with waste management beyond the packaging agreement scope	Targets to private sector are clear and measurable
		Lack of skilled staff at the local level	Strong and coherent network of players (including waste pickers) to collect, buy and sell packaging materials, even for places 72h away from urban centre
		Lack of enforcement of policies	Penalties are defined in local and national

		Awareness: Burning and dumping are normal and cultural acceptable practices.	level
		Inadequate state planning	
		Too many policies in the waste area (116): confusing and ineffective	

Source: Author's own, inspired by Dorkenoo (2015).

Appendix III – Common economic (Market-based) instruments in Solid Waste Management

Revenue-generating instruments	Revenue-providing instruments	Non-revenue instruments
•User charges (including pay as you throw) and gate fees •Taxes on waste management options (e.g., landfilling, incineration) •Green taxes (eco-taxes) on consumption and production (e.g. taxes on plastic carrying bags, packaging, or the use of hazardous substances in products)	•Subsidies •Tax credits (fiscal instruments) for private companies •Development rights and property rights (e.g. for land reclaimed from disposal sites) •Host community compensations for facility siting •Grants (e.g. for research) •Funds for environmental improvements (e.g., Superfund)	•Liability for environmental damage •Public procurement requirements (e.g. price preference for goods with specific percentage of recycled materials) •Tradable pollution rights •Deposit-refund systems (e.g., for beverage containers) •Extended producer responsibility

Source: Adapted from UNEP (2015)

Appendix IV – Tefé's warehouse available

Source: Author's own.

Appendix V – List of personal communications

Semi-structured interviews Governmental staff from Manaus, Tefé and São Paulo					
Interviewee	**Position**	**Organisation**	**Location**	**Means**	**Date**
Lucelize Borges	Financial and management Chief	Labour Secretary of the Amazon State	Manaus	In person	March 2, 2016
Antonio Ademir Stroski	Environment State Secretary	Amazonas State Government	Manaus	In person	March 3, 2016
Ivanete Rodrigues Lins	Environment State Secretary	Municipality of Tefé	Tefé	In person	March 9, 2016
Francisco Pinheiro	Environment State Secretary	Municipality of Tefé	Tefé	In person	March 9, 2016
Sebastião da Silva Alves	Environment State Secretary	Municipality of Tefé	Tefé	In person	March 11, 2016
Flávio de Miranda Ribeiro	Executive Assistant of vice-presidency of CETESB	CETESB	São Paulo	In person	April 18, 2016

Semi-structured interviews Dwellers, business owners and community leaders in urban and rural Tefé					
Interviewee	**Position**	**Organisation**	**Location**	**Means**	**Date**
Francisco Cardoso de Moraes	President of the Community Association of Caiambé	Association of Caiambé	Tefé	In person	March 11, 2016
Francisco Darso Falcão	President of the Association of Agroextrativism Producers of Tefé National Forest (APAFE)	Association of Agroextrativism Producers of Tefé National Forest (APAFE)	Tefé and Vila Sião community	In person	March 17, 2016
Juscelino Oliveira da Costa	President of Bom Jesus Community	President of Bom Jesus Community	Bom Jesus community	In person	March 20, 2016
Edina Rocha Lopes	Vila Sião dweller	dweller	Vila Sião community	In person	March 20, 2016
Neila Batalha dos Santos	Vila Sião dweller	dweller	Vila Sião	In person	March 20, 2016
Janilson da Costa Sousa	Bom Jesus dweller	dweller	Bom Jesus	In person	March 20, 2016
Bernaldino Miranda dos Santos	Owner of small business	Owner of small business	Vila Sião community	In person	March 20, 2016
Raimundo Farias da Cunha	President of São Francisco Community	Owner of small business	São Francisco community	In person	March 20, 2016
Claudemir de Oliveira Salles	Owner of small business	Owner of small business	São Francisco community	In person	March 20, 2016

Manoel Rocha Lopes	Owner of small business	Owner of small business	São Francisco community	In person	March 20, 2016
João Batista dos Santos Pinheiro	Recycler intermediary of Tefé	Owner of small business	Tefé	In person	March 22, 2016
Renato de Souza	Recycler intermediary of Tefé	Rei da Sucata	Tefé	In person	March 29, 2016
Glaucio Pires	Recycler intermediary of Tefé	Point da Sucata	Tefé	In person	March 29, 2016

Semi-structured interviews					
NGOs in Tefé, AM					
Interviewee	**Position**	**Organisation**	**Location**	**Means**	**Date**
Polliana Ferraz	Researcher	Mamirauá Institute	Tefé	In person	March 11, 2016
João Paulo Borges Pedro	Researcher	Mamirauá Institute	Tefé	In person	March 11, 2016
Maria Cecília Rosinski Lima Gomes	Researcher	Mamirauá Institute	Tefé	In person	March 11, 2016
Felipe Pires	Researcher	Mamirauá Institute	Tefé	In person	March 11, 2016
Otacílio Soares Brito	Researcher	Mamirauá Institute	Tefé	In person	March 11, 2016
Rafael Suertegaray Rossato	Environmental Analyst	ICMBio	Tefé	In person	March 17, 2016

Semi-structured interviews					
Academic, practitioners and private sector					
Interviewee	**Position**	**Organisation**	**Location**	**Means**	**Date**
Débora Cunha	Sanitation Engineer	Specialist	Manaus.	In person	March 1, 2016
Guilherme Freire	Professor	Amazonas State University	Tefé	In person	March 10, 2016
Rafael Berhard	Professor	Amazonas State University	Tefé	In person	March 10, 2016
Luciana Lopes	Consultant	Visões da Terra	Lund	Skype call	November 20, 2015
Iury Valente Debien	Specialist	Climate Change and Conservation Units department	Tefé	In Person	March 11, 2016
Juliana Taguti	Environmental specialist	Ambev	São Paulo	Phone call	March 20, 2016
Luciano Marcos Silva	Specialist	INSEA	São Paulo	Phone call	March 20, 2016
Thomas	Associate Professor	IIIEE	Lund	In	May, 24,

Lindhqvist				person	2016
Ricardo Abramovay	Associate Professor	FEA-USP	São Paulo	In person	April 13, 2016
Victor Zveibil	Consultant	Consultant	São Paulo	Phone call	April 15, 2016
Fábio Feldman	Consultant	Consultant	São Paulo	Phone call	April 15, 2016
Mateus Mendonça	Consultant	Giral viveiro de projetos	São Paulo	In person	April 1, 2016