Working Towards a Sustainable Curaçao

How Curaçao can Shift from Landfilling to a More Sustainable Waste Management System

Source: Sustainable Curacao

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Executive Summary

The country of Curaçao, a Small Island Developing State, is currently dealing with the challenge of waste mismanagement. Inhabitants generate approximately 2.5 kilograms of waste per day per capita, and the majority of this generated waste is landfilled at the Malpais landfill. The current issue is that Malpais landfill is almost full, with a remaining lifespan of approximately 10 to 15 years. Therefore, solutions must be sought to try to solve the island's waste management issue.

The aim of this report is to research and identify possible solutions that may help in solving Curaçao's waste management issue. To research possible solutions, the central research question is as follows: "**How can Curaçao transform its current landfilling waste management system into a more sustainable waste management system?"**. For this report, sustainable waste management is managing generated waste using a method that is more environmentally friendly based on the waste hierarchy, thus diverting from landfilling.

The central research question is answered through desk research conducted and is based on benchmarking factual country information publicly available on the internet. First, Curaçao's current situation is analyzed. Subsequently, based on the waste hierarchy, solutions are sought by identifying and analyzing the waste management practices of five best performing countries. Additionally, the practices of four islands identified as having waste management methods other than only landfilling are analyzed, and are considered as possible solutions for Curaçao.

The results indicate that Curaçao has ineffective policies and regulations pertaining to waste management, with incompetent institutional and limited human resource capacities enforcement. To solve these issues, the government should invest in the waste management system. Second, waste avoidance programs need to be implemented with consistency, while focusing on the program's effectiveness. Third, the community needs to be educated on the effects of their actions. Fourth, for recycling, waste separation at source may be essential. Fifth, a deposit-refund system, compatible with extended producer responsibility, may need to be employed by supermarkets to enhance recycling activities. Subsequently, there may be an opportunity for inter-regional partnerships for waste export in the future if recycling is not possible on a large scale. Lastly, considering the fact that Curaçao does not have an incineration facility, it was found that building an incinerator may not be feasible for a small island as Curaçao, and may therefore be more feasible to export waste.

The research shows that it may be possible for Curaçao to divert from landfilling and work towards more sustainable practices for waste management. It is therefore recommended to conduct further research into more practices suitable for islands, and to research the possibilities to establish inter-regional collaboration schemes for waste exportation.

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Acronyms

AD	Anaerobic Digestion
C2C	Cradle-to-Cradle
DRS	Deposit-Refund System
EC	European Commission
EPR	Extended Producer Responsibility
EPA	Environmental Protection Agency
FKLB	Fundashon Kòrsou Limpi Bunita
GF	Green Force
ISWM	Integrated Solid Waste Management
MSW	Municipal Solid Waste
MSWM	Municipal Solid Waste Management
OECD	The Organization for Economic Cooperation and Development
PAYT	Pay as You Throw
PPP	Polluter Pays Principle
SIDS	Small Island Developing States
UNEP	United Nations Environment Program
WTE	Waste to Energy

Chapter 1: Introduction

1.1. Background

The unsustainable use of resources and the excessive waste generation practices put pressure on both the society and the environment. The current global production and consumption patterns severely threaten the rehabilitation capacity of planet Earth, as well as the economic success and the well-being of societies that inhibit it. Effectively promoting a more sustainable use of resources and effective waste management thus constitutes an important challenge (Montevecchi, 2016). Growing municipal waste mismanagement and potential correlated environmental influences should be an environmental concern for developing countries such as Curaçao.

The country of Curaçao, Dutch Caribbean is a small island in the Caribbean with a population of 149,648 inhabitants (The Central Intelligence Agency, 2017), and is a member of the Small Island Developing States (SIDS). One of the many challenges identified for SIDS, including Curaçao, is the management of waste (The Ministry of Health, Environment & Nature of Curaçao, 2014). According to the Business Dictionary (n.d.) waste management entails the collection, transportation and disposal of garbage, sewage and other waste products. Waste management entails the management of procedures and resources for appropriate treatment of waste products, from maintenance of garbage trucks and disposal facilities, to compliance with health codes and environmental regulations. This is currently regarded as an environmental concern where waste is often a resource as well as an issue.

The inhabitants of the island produce approximately 2.5 kilograms of waste per day per capita (The TUI Care Foundation, 2016). The government owned company responsible for municipal solid waste (MSW) management, Selikor N.V. is currently mainly practicing waste dump on the island, in what the company reports to be a sanitary landfill. A sanitary landfill differs from a landfill (open dump) in the sense that it can be regarded as a securer and more structured system of waste management. This site is regulated by the government and must stringently follow waste laws processing regulations for waste management (Help Save Nature, 2017). Although considered a cheap alternative, landfilling occupies a significant share of land and disorders the beautiful environment that most islands are known for. Through the current unsustainable waste management practices, landfilling carries risks for national health, the environment and the economic development. Curaçao should therefore consider the adverse impacts negative publicity on the waste management practices can have on the tourism industry, and by extension, the correlation to the island's economic development. Moreover, Curaçao needs to be conscious of the fact that the current growth model based on capital formation and significant environmental degradation, meaning poor waste disposal methods and severe dependence on fossil fuels, is not sustainable (TAC Economics, 2013).

Additionally, this sanitary landfill, known as Malpais Landfill, is almost full with a remaining lifecycle estimated to be only 10 to 15 years (The Ministry of Health, Environment & Nature of Curaçao, 2014). The prevailing mentality is the "grow dirty now and clean up later" mentality, which means that the island is too focused on economic developmental pathways that are unsustainable, that in turn cause irreversible environmental damage (TAC Economics, 2013). These are indications that alternatives are needed for the waste management system on the island.

Furthermore, the island is battling illegal dumping of wastes by inhabitants, and is dealing with a severe case of littering because of inadequate solid waste collection. Products of littering on Curaçao are often small beverage bottles (e.g. soda bottles), beer cans (aluminum cans), single-use plastic bags, and foam food containers. Causes of littering can be for example, since take-out is often consumed in the car, and the waste is thrown out of the window (Profas & Ras, n.d.). After becoming an autonomous country within the Kingdom of the Netherlands on 10 October 2010, there has been a rise in illegal dumping. The government has not been imposing fines for wastes illegally dumped, since these licenses expired when Curaçao became an autonomous country. This has led to more people simply disposing of their household wastes on the sides of the roads and in forests, as people notice that there are not any sanctions for their actions (Koek, 2013). In other words, there are currently insufficient measures to guarantee that polluters pay the full cost for polluting actions (TAC Economics, 2013). The aforementioned translates into Curaçao dealing with a lack of regulation and/or inadequate enforcement. Therefore, the focus of this research will be the applicability of a more sustainable waste management system for the country of Curaçao, with the significance of this study being the safeguarding of national health and the environment.

To provide a solution to the issue of waste management, a multi-stakeholder approach is taken. The reason for this is because there are several stakeholders involved that collectively generate waste on the island. In order to research the possible solutions for Curaçao's waste management issue, the central research question: "**How can Curaçao transform its current landfilling waste management system into a more sustainable waste management system?"** is established. To answer the central research question, the following sub-questions have been established:

1. What is Curaçao's current situation for solid waste management?
2. Which sustainable practices are best suitable for Curaçao?
3. Which sustainable waste management practices on islands can be applied in Curaçao?

This report is divided into 8 chapters. First, the theories used during this research are explained. This is done by first providing an explanation on the general theory of municipal solid waste management (MSWM), followed by an explanation of several waste management methods. Additionally, the methodology is described, providing an in-depth explanation for the chosen research methods. Third, a description and analysis of the current situation of MSWM practices in Curaçao is provided. This is based on the waste hierarchy. Subsequently, the best practices, also according to the waste hierarchy, when it comes to MSWM are described and will be analyzed to see which practices can best be implemented in Curaçao. Finally, waste management methods on islands are analyzed, to determine possibilities for Curaçao. To conclude on the report, conclusions on the best practices are provided, and if needed recommendations are given for MSWM in Curaçao.

1.2. Scope & Limitations

The scope of this report is limited to identifying and researching more sustainable methods for waste management of MSW on the island of Curaçao. For this report, solid waste is defined as non-liquid material that no longer has any value to the person who is responsible for it. Any solid material in the material flow pattern that is rejected by society is called solid waste. Furthermore, researching the product design and product lifecycle are outside the scope of this report, and will be discussed to a certain extent in the theoretical framework section. Due to time constraints (this research being a four-month research project) it is not possible to go too in depth on the matter. Moreover, this report is limited to only desk research. A limitation of this desk research is that waste statistics are limited, unreliable or not continuously updated or available via public media.

Chapter 2: Theoretical Framework

In this chapter, the theory considering waste management used in the report is explained. First, a description of municipal solid waste management is provided. Following, relevant theories on waste management are described. Among the theories are the Waste Hierarchy, the Integrated Solid Waste Management System, the Cradle-to-Cradle concept and the Circular Economy.

2.1. Municipal Solid Waste Management

Waste is defined by several instances. For example, the European Union (EU) defines waste as "any substance or object which the holder discards or intends or is required to discard" (European Parliament & Council of the European Union, 2008). The United Nations Statistics Division (UNSD) and the Glossary of Statistical Terms of the OECD (2001) define waste as "materials that are not prime products (that is, products produced for the market) for which the generator has no further use in terms of his/her own purpose of production, transformation or consumption, and of which he/she wants to dispose" (OECD, 2001a).

According to the United States Environmental Protection Agency (US EPA), municipal solid waste (MSW), generally identified as 'trash', consists of everyday items people use and then discard. It thus refers to solid waste from houses, streets and public places, businesses, schools and hospitals (US EPA, 2016). Solid waste management from these sources is frequently the responsibility of municipal or other governmental authorities. Street waste, a major factor of MSW, contains a mixture of waste from many sources, seeing that streets are used as dumping grounds by all waste generators. Municipal solid waste management (MSWM) refers to the control of waste generation, its storage, collection, transfer and transport, processing and disposal by means that is in accordance with the best principles of public health, while considering other environmental matters. As a system, MSWM should simplify the collection, transportation, treatment and disposal of solid waste in the community at minimal costs, with minimum damage to public health and environment (Ajith, 2014). According to Pongrácz, Phillips, & Keiski (2004), the waste management theory is constructed on the expectation that waste management is meant to prevent waste from causing damage to both human health and the environment. In addition, the theory is based on the thought that the application of waste management leads to conservation of resources.

2.2. Methods of Sustainable Waste Management

2.2.1. The Waste Hierarchy

There are several ways to manage waste, with some being more favorable than others. The main theory chosen and described for this report is the waste hierarchy (in Dutch: de Ladder van Lansink). The waste management hierarchy indicates an order of preference for action to reduce and manage waste from most favorable to least favorable actions. The hierarchy, as illustrated in *Figure 1*, identifies five tiers of waste management options to reduce and manage waste, and to maximize the efficient use of natural resources. Prevention and minimization of waste are the top priority (avoidance). Recycling and high-quality energy recovery are the second priority (recovery), with the least preferred options being burning waste and dumping waste on landfills (disposing) (United Nations Environment Program, 2013).

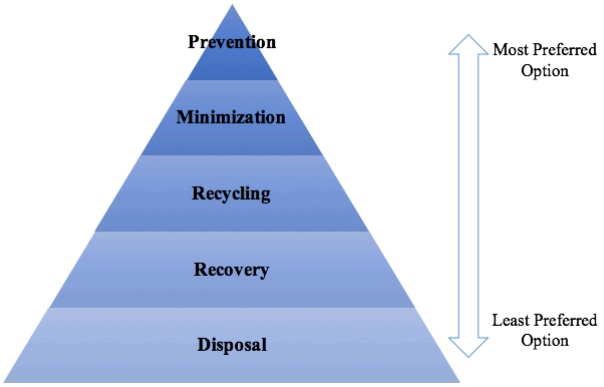
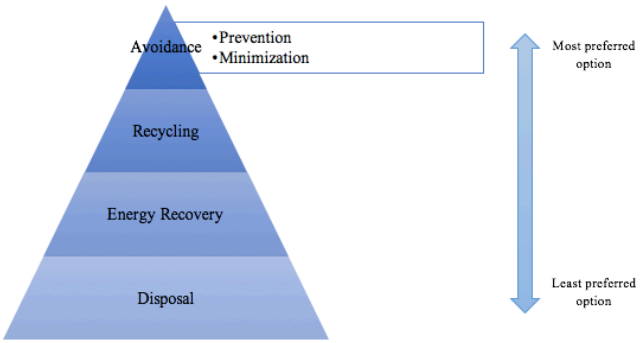


Figure 1. The Waste Hierarchy

Therefore, the waste hierarchy is a preferential order of waste treatment options that aims to reduce environmental impacts by prioritizing prevention, minimization, recycling and energy recovery, with landfilling being the last resort. It is commonly described as a priority order for (at least three) waste management options, based on assumed environmental impacts (van Ewijk & Stegemann, 2014). The hierarchy is widely used in the European Union (due to EU legislation), and is also applied in several countries around the world as a tool for sustainable waste management.

However, in order to obtain relevant information, the waste hierarchy is adapted. Since the EC often uses prevention and minimization in the same sentence, and considering that when researching waste prevention and minimization methods the information is mixed; the top of the waste hierarchy is renamed to avoidance, combining both waste minimization and waste prevention. This allows for the model to be as follows:

Figure 2. Adapted Waste Hierarchy



1. Avoidance

Prevention is the most desirable waste management option, since it eliminates the need for handling, transporting, recycling or disposing of waste. Waste prevention represents the most efficient and sustainable use of resources (European Commission, 2012), providing the highest level of environmental safeguarding by removing a possible source of pollution (Ecological Recycling Society, 2015). Reducing the amount of waste generated at the source and reducing the hazardous content of that waste is considered as the highest priority according to the waste hierarchy (European Commission, n.d.a). It generally suggests preventing pollution at its source, meaning before waste is generated. Prevention involves any measure that reduces the quantity and/or toxicity of contaminants entering the waste stream prior to recycling, treatment, or disposal (EPA, 2016). In other words, waste prevention contains measures to reduce the adverse impacts of the generated waste on the environment and human health. Additionally, waste prevention by limiting unnecessary consumption and consumption of products that generate less waste are forms of strict avoidance of waste (European Commission, 2012). Waste prevention is becoming more and more important as the global population increases and the finite supply of natural resources is being consumed.

Furthermore, according to the EPA's official definition, prevention means 'source reduction' as defined in the Pollution Prevention Act. Prevention also includes: "other practices that reduce or eliminate the creation of pollutants through increased efficiency in the use of raw materials, energy, water or other resources, or protection of natural resources by conservation" (US EPA, 1992). Thus, next to waste reduction at the source, prevention also refers to any practice that reduces the use of hazardous materials in production processes. In the general sense, examples for prevention include equipment or technology alterations, redesign of productions, maintenance, replacement of less toxic raw materials, and more (EPA, 2016).

There is a distinction between three types of waste prevention: process oriented waste prevention, product oriented waste prevention and consumer oriented waste prevention. Process oriented waste prevention involves introducing supplementary materials and using more efficient and innovative technologies. In product oriented waste prevention, eco-design principles are applied to achieve products which are causing smaller amounts of waste and less hazardous waste. Finally, consumer oriented waste prevention involves a change in consumption patterns of consumers. Patterns identified that can contribute to waste prevention are: consumption meeting the demand of eco-efficient products and services, purchase of reusable products, utilization reusable packaging, and more (Ecological Recycling Society, 2015).

The current linear 'take, make, dispose' economy model relies on large quantities of cheap, easily accessible materials and energy, and is a model that is reaching its physical limits. Preventing

products and materials from becoming waste for as long as possible, and turning inevitable waste into supplies are key steps to achieve a greener, more circular economy (European Commission, 2017). In a circular economy, products and the materials they contain are highly valued. This suggests a need for reducing waste to a minimum as well as re-using, repairing, refurbishing and recycling existing materials and products. Thus, circular economy is an industrial model where waste is designed out, by concentrating on and changing how products are supplied and constructed, meaning that waste becomes a resource. This concept requires a change in consumption behaviors to support the transformation from a linear to a circular model (Persson, 2015). See *chapter 2.2.4. The Circular Economy* for the extended theory on the circular economy.

Furthermore, modern waste management strategies emphasize proactive (preventive) rather than reactive (end-of-pipe treatment and disposal) measures. This leads to the 'zero waste' theory. The aim of zero waste is to eradicate waste, rather than to manage it. It is a holistic system approach that aims for a major change in the way materials flow through society, resulting in no waste. Thus, this system is a solution for the final stages of waste management which encourages waste diversion through recycling and resource recovery. This means that it can be considered as a way of cradle-to-cradle thinking (see chapter 2.2.3. Cradle-to-Cradle Theory). Additionally, zero waste is a mindset for the elimination of waste at the source and at all points down the supply chain. However, zero waste can best be considered as a goal, as a way to change industries and the society, rather than a hard target. It is important not to get too distracted by the term zero, because no system is 100 percent efficient. It is simply a method to focus on ways to improve waste management systems (Zero Waste New Zealand Trust, n.d.).

It can be difficult to discuss the difference between the terms 'prevention' and 'minimization', since these two terms are mostly used in the same sentence. Minimization includes activities that avoid, reduce or eliminate waste at its source or results in reuse or recycling (Ecological Recycling Society, 2015). Through waste minimization it is attempted to limit the amount of waste generated, thereby facilitating the elimination of persistent and harmful wastes, while beneficially supporting attempts to promote a sustainable society. Thus, waste minimization encompasses a shift in societal patterns that relate to the production and consumption to eliminate the generation of waste (Lawson, n.d.). Similar to prevention, minimization refers to waste reduction at source and/or environment friendly recycling methods prior to energy recovery, treatment, or disposal of wastes. Moreover, waste minimization does not include waste treatment, that is, any process designed to change the physical, chemical, or biological composition of waste streams (EPA, 2016). The minimization of waste includes the 3Rs, which can be summarized as reduce, reuse and recycle (Lawson, n.d.).

Considering consumption, the aim of waste minimization strategies is to reinforce awareness and encourage environmentally conscious consumption patterns and consumer responsibility to minimize the general levels of waste generation (United Nations Environment Program, n.d.). Waste minimization at individual and household level is difficult to have, because at these levels, waste minimization activities often is accompanied by the lifestyle of the individuals. Current consumer behavior patterns generate more waste seeing that new products are bought when there are already useable but older products available (Lawson, n.d.). It is suggested that waste minimization actions can and should be undertaken by all, from governments to individuals. All consumers are collectively accountable for their waste production, and should therefore reduce, both quantitatively (volume of waste generated) and qualitatively (the amount of harm waste can cost), their waste, by for example purchasing longer life goods (United Nations Environment Program, 2002).

Hence, an approach to minimizing waste is through reusing products. As mentioned, purchasing longer life goods provides the opportunity to reuse products. Reuse involves the repeated use of products and components for the same purpose for which they were created, without the need for reprocessing. Reuse avoids disposal of materials to a waste stream when its initial usage has concluded (Ecological Recycling Society, 2015). The reuse of materials or products such as clothes and furniture that would otherwise become waste has social, economic and environmental benefits, creating jobs and making products available to consumers who could not necessarily afford to purchase them new (European Commission, 2010).

2. Recycling

Much of the waste that is being disposed of can be recycled. Recycling, the most widely recognized form of source reduction, can be defined as a process by which materials meant for disposal are collected, reprocessed or remanufactured and are reused. Thus, recycling reduces the amount of waste that ends up in landfill sites, while cutting down on the amount of material needed from the natural environment (European Commission, 2010). The significance of recycling is threefold, that is, economic (reduces the disposal cost attached to managing waste), environmental (improves environmental sanitation and conserves natural resources), and health and social (promote social esteem of waste workers) (Ajith, 2014).

Recycling of MSW removes from the waste stream items made of recyclable materials, such as glass, metal, plastics, and paper, before the wastes are disposed of. In many communities, residents sort recyclables in special garbage bins before putting them out to be collected; in other communities, recyclables are not sorted. The latter is known as single stream recycling. In this situation, materials collected are processed at material recovery facilities, where items are sorted using varying degrees of automation. For example, a series of tumblers perforated with larger and larger holes can be used

to sort objects by size; a water bath can separate materials that float (such as food or plastic) from those that sink (such as metals); and magnets can be used to separate out ferrous metals. Additionally, a range of organic materials can also be removed from the solid waste stream for composting. It is possible to do composting at home, separated by the resident prior to collection. However, from a municipal viewpoint, this practice is considered as waste prevention rather than recycling, because it prevents waste from entering the municipal waste stream (Maxwell, 2010).

Furthermore, there are methods to promote recycling. One of these methods is the deposit-refund system (DRS). The Glossary of Statistical Terms of the OECD (2001) provides the following definition of the DRS: "A deposit-refund system is the surcharge on the price of potentially polluting products. When pollution is avoided by returning the products or their residuals, a refund of the surcharge is granted" (OECD, 2001b). This method is considered as an economic incentive to promote recycling, and for consumers to take an active part in waste collection. Aside from promoting recycling, the DRS can also help reduce litter. Around the world, DRS has been applied to beverage containers, used motor oil, batteries, and more. During a comparison study conducted in the past it was found that, when comparing deposit systems and curbside recycling programs, deposits generally resulted in higher percentages of materials returned and less contamination of collected materials ("Deposit-Refund Systems," 2001).

3. Energy Recovery

Waste-to-Energy (WTE) incineration serves the dual purpose of disposing of MSW and generating energy by recovering valuable resources, either in the form of electricity or as steam to be used in an industrial process (Maxwell, 2010). This is the case when waste cannot be prevented or recycled, recovering its energy content is usually better than landfilling it (European Commission, 2017). Many of the combustible components of MSW are recyclable and, thus, can serve as substrates for biological conversion to a fuel gas that is immediately converted into energy (i.e. direct conversion into heat energy), or that can be stored or transported for later conversion (i.e. indirect conversion).

Energy produced by a MSW incinerator reduced the demand for energy from traditional sources, such as fossil or nuclear fuels, as these are only available to a limited extend. In addition, when garbage is reduced to ash by burning, its volume is decreased by 80 to 90 percent (Maxwell, 2010). WTE is a vital part of sustainable waste management and is fully complementary to recycling (Babcock & Wilcox Vølund A/S , n.d.). However, the energy potential of all urban wastes is not the same, meaning that they differ both in energy content and in the ease with which the energy can be 'extracted'.

An example of WTE is anaerobic digestion (AD). This method is applicable for the organic fraction of MSW. This is a natural biological process that converts biomass into energy (biogas) in the absence of oxygen. Biogas can be used be used as a renewable energy source for cooking, lighting or to generate electricity, thereby replacing other fuel sources (Zurbrügg, n.d.). AD systems have large potential and can range from low to high technology, therefore they can service communities of all income levels (Roth, n.d.). While AD of organic household waste in centralized high-tech plants in industrialized countries has become increasingly popular in recent years, most regions of developing countries still lack appropriate low-tech options (Zurbrügg, n.d.).

4. Disposal

Disposal through landfill is the least preferred option for waste management. Landfilling is the oldest form of waste treatment and the least desirable option because of the many potential adverse impacts it can have, and should therefore be limited to the necessary minimum. The collected MSW that is not recycled is most likely sent to landfills: planned areas of land where waste is dumped, compressed, and covered with soil (US EPA, 2014). Different from other methods such as incineration, landfilling can be considered as the cheapest method, since landfilling requires fewer advanced technologies to be able to function (Malek & Shaaban, 2008). Despite being the cheapest method of waste disposal, landfilling remains the most undesirable method for waste management considering the loss of waste products that can potentially be re-used (recyclables) (Mohee, et al., 2015).

2.2.2. The Integrated Waste Management System

Improper management of solid waste through unsustainable practices pose risks to both human health and the environment. With the evolution of solid waste management, an interconnected series of options targeting waste source reduction, recycling, treatment and final disposal is now being considered. This is done through the waste hierarchy. The EPA defined Integrated Solid Waste Management (ISWM) as a comprehensive waste prevention, recycling, composting, and disposal program (US EPA, 2002), while the United Nations (2005, p. 7) defined ISWM as:

> A frame of reference for designing and implementing new waste management systems and for analyzing and optimizing existing systems. Integrated waste management is based on the concept that all aspects of a waste management system should be analyzed together, since they are in fact interrelated and developments in one area frequently affect practices or activities in another area.

When considering the many options available for solid waste management, a system investigation approach is essential. The system model is essential because of the connections of many aspects within the waste management system. Within the system approach, the issues are multidimensional

and multidisciplinary, meaning that the solutions provided or recommended to tackle the issues must reflect this complexity (Ramachandra, 2011). Here, all actors have their specific role, which in turn allows for the participation of the public, private, and informal sector (United Nations Environment Program, 2005). In other words, since there is an interconnection within the operations of waste management systems, the employment of the collection and sorting methods within a system will affect the ability to efficiently recover materials (McDougall, White, Franke, & Hindle, 2001).

Furthermore, an effective ISWM system considers how to prevent, recycle, and manage solid waste in ways that most effectively protect human health and the environment. This includes assessing local needs and conditions, and subsequently selecting and combining the most suitable waste management actions for those situations. The waste hierarchy is a key element in the major ISWM activities, and therefore includes waste prevention, recycling, incineration and the disposal of waste in properly designed, built, and managed landfills (US EPA, 2002).

Distinctive from the waste hierarchy, the ISWM approach does not forecast what would be the 'best' general management system, since according to this approach there is no prevalent 'best' system. This is because both the composition of waste and the amount of waste generated differ according to geographies. Comparably, the accessibility of waste management options, such as a landfill, and the market size for materials derived from waste management systems also differ according to geographies. Additionally, the cost of using diverse waste management options is reflected through the existing infrastructure. What plays a role is if the waste management plant already exists or if it still needs to be built. The ISWM approach allows for the different waste management systems in the different regions to be compared with each other, providing the opportunity for the 'best' suitable system in the region to be determined locally (McDougall, White, Franke, & Hindle, 2001).

2.2.3. Cradle-to-Cradle Theory

The current consumption-driven society produces an enormous volume of waste every day. Because of the current cradle-to-grave method of consumption, the world is dealing with continuous depletion of depletable resources by urban populations, leading to an uncertain future. Therefore, to prevent further depletion of global resources, sustainable consumption and a strategic waste management system is required (Zaman & Lehmann, 2011). From these thoughts, the cradle-to-cradle concept (C2C) emanates. The idea behind the C2C concept is production without waste, leading to zero waste. The C2C model begins with a design that considers the lifecycle of the product. By revising the current method of production, it provides the opportunity to make products consisting of biological (plant-based and biodegradable materials) or technical (metals and some polymers) nutrients that will not produce waste during production or after the product's existence (Lie, 2010).

C2C considers the transition from the current cradle-to-grave model, being one that 'takes, makes and pollutes', to a system whose materials stay in cycles. This model requires a shift from ownership to 'user-ship' for products that are made of technical nutrients. With this is meant that products are used by consumers only for the time needed, and afterwards, when they are done using the products, returning it to the remanufacturing chain (Stouthuysen & le Roy, 2010). Producers start production of their products. When a product reaches the end of its lifecycle, consumers who have purchased the product will need to dispose of it. Following the C2C concept, disposal can be done through the biological cycle, where products become a 100 percent nutrient for nature as they are renewable, or the technical cycle, where products are brought back to producers to be recycled or upcycled since the materials used are depletable resources. In this process, the disposed of product is used in a new product of at least the same quality (recycled) or a better quality (upcycled) (Lie, 2010).

If a product is designed according to the C2C concept, materials can be reused or recycled, meaning that no wastes get produced. Accordingly, there will be no negative impacts caused on the environment within the closed cycle of the product lifecycle (see *Figure 3*). This can be achieved by having industries modify their products from having a cradle-to-grave design where the product will ultimately get disposed of in a landfill at the end of its lifecycle, to a C2C designed product where the materials will circulate in a closed circle without losing any natural resources. In this sense, the C2C concept promotes sustainable development (El-Haggar, 2007).

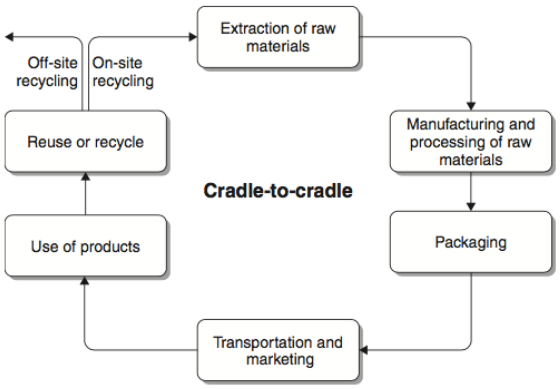


Figure 3. Product Lifecycle Analysis based on the C2C concept (Source: El-Haggar, 2007)

To conclude, the C2C framework deals mainly with the production cycle of goods, and through sustainable production and efficient methods earlier in the production chain, preventing end-of-life products from entering the waste stream. Thus, C2C indicates that the production chain and materials should be adapted to a more sustainable method. With Curaçao being an island, not much is domestically made with most products consumed being imported. This fact makes it harder to address the issue of how consumer goods are produced, as they are being manufactured in another country. It is evident that there are some aspects of the waste hierarchy incorporated in this concept,

such as recycling, prevention and reuse. However, addressing the issue of product manufacturing is outside the scope of this report, and, therefore, shall not be further discussed. Consequently, the focus will still be set on the waste hierarchy.

2.2.4. The Circular Economy

Modern consumption and growth patterns characterized by natural resources being highly misused, cumulative emissions and an unpredictable economy, has put civilization on an unsustainable pathway (Persson, 2015). It is argued that the current society is living according to the linear economy concept, which is similar to the cradle-to-grave concept introduced in the C2C section. Characteristics of the linear economy concept is that waste, being an inevitable consequence of the manufacturing process, is discarded in the environment. The concept is based on the principle: "take, produce, consume, dispose", while using an unlimited quantity of - and easily accessible depletable resources (Drljača, 2015). The tendency is to accumulate waste and not take recycling and reusing into account.

Therefore, a shift in society is needed to a more circular economy. The circular economy is based on the C2C concept, with the difference being that C2C is a concept of total recycling through design. The circular economy is a concept with the intention of restoration and regeneration. Products and the materials they contain are highly valued, unlike the traditional linear economy concept which involves significant resource loss. Thus, central to the circular economy concept is the view that the value of materials and products is kept as high as possible for as long as possible. This helps to reduce the need for the input of new material and energy, which in turn reduces the environmental burden linked to product lifecycle. This takes into consideration the resource extraction, production and use, and eventually the product's end-of-life (Lee, et al., 2017).

The circular economy is based on three components. First, there is a need to design out waste, meaning that waste does not exist. Products are designed and optimized for a cycle of disassembly and reuse (World Economic Forum, 2014). Second, the concept indicates a distinction between the consumption and the use (meaning the durability) of materials. The circular economy promotes the need for an effective service model in which manufacturers and/or retailers retain the ownership of their products and, where possible, act as service providers – selling products that are durable, instead of selling products for one-way consumption. In this sense, the circular economy relates to the C2C concept which advocates a shift from ownership to 'user-ship' (The Ellen MacArthur Foundation, 2013). Consumables in the circular economy are, comparable to C2C, largely made of biological nutrients that can safely be returned to the biosphere; this involves the flow of renewable materials. Durables are made of technical nutrients unsuitable for the biosphere; this involves the stocks of depletable materials. Finally, the energy essential to produce this cycle should be renewable by

nature, again to decrease resource dependence and increase system flexibility (World Economic Forum, 2014). Thus, circular economy replaces the end-of-life concept of products with regeneration. *Figure 4* presents an example of the circular economy concept.

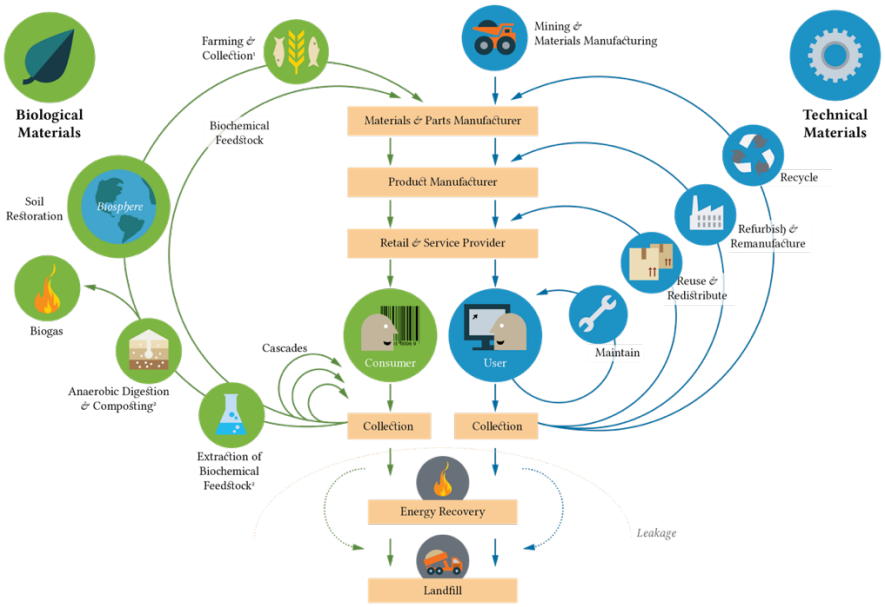


Figure 4. The Circular Economy Concept (Source: The Ellen MacArthur Foundation)

The circular economy calls for systematic thinking. This means that all actors (being people, businesses, etc.) are part of a complex system in which the actions of one actor can have an impact on other actors. In decision-making procedures, these potential impacts are taken into consideration by considering both the short- and long-term consequences of a decision, while working towards the creation of a more resilient system which is effective at every scale (The Ellen MacArthur Foundation, 2015). Therefore, considering this concept for Curaçao might be a large step, since the current waste management system is too outdated. Implementing the circular economy can be considered as too drastic, considering all this theory entails and the situation Curaçao is currently in. Perhaps some elements of the circular economy can be used, but the whole concept cannot be implemented at the moment. Therefore, the focus is set back on the waste hierarchy.

2.3. Waste Management in SIDS

Islands differ in their socioeconomic and physical characteristics, but they all share one common characteristic: they are physically separated from other land masses. Being physically separated from other land masses can create several barriers. In this case, it limits the islands' ability to outsource their issues, with the most important issue being contemporary waste management methods. From the many challenges islands face, it is notable that the challenge and issue of solid waste management is since products are being imported from the global market, whereas islands must manage the waste produced from these imported products domestically (Eckelman, 2014). The ongoing issue of SWM is also considered to be affected by the continuous increase in waste generation and the lack of

effective and sustainable waste management strategies. It can be argued that the issue in SIDS is the lack of knowhow, abilities and expertise in the field of waste management (Mohee, et al., 2015).

As mentioned, landfilling is the least preferred method according to the waste hierarchy. Nevertheless, this is highly practiced in many SIDS. The reason for high landfilling in SIDS is the absence of other waste management techniques in addition to the fact that landfilling is relatively cheap compared to other waste management options (Mohee, et al., 2015). Thus, the wastes are disposed of in landfills due to the deficiency of other sustainable waste management tools. Some factors that hinder the practice of recycling in SIDS were identified. These factors include (Mohee, et al., 2015):

- The considerably smaller population and economic development;
- The lack of education and stimulation of the community and decision makers on such matters amplifying the difficulties already present in SWM in SIDS;
- The high costs involved in collecting and transporting recyclables to recycling centers which outweigh the income that could be derived from the sale of the recyclables;
- The barriers to technology transfer;
- Limited economies of scale for treatment of waste streams.

Moreover, institutional and financial challenges were also identified. These challenges include (Mohee, et al., 2015):

- The lack of policies and strategies on behalf of the government to promote SWM approaches. This includes the absence of formal procedures, policies and appropriate regulations pertaining to waste generation and management.
- The lack of sufficient funds to develop and implement SWM systems.

Regardless of certain existing legislation in SIDS, these are not acknowledged by citizens since they are either uninformed of the existing legislation or they are not properly implemented making them ineffective. Considering the financial challenges, the efficiency of SWM depends on government priority and willingness to invest. Seeing that SWM is not a priority for many governments, the amount of funding available for waste management is not sufficient considering the cumulative amount of waste generated. The consequence is a poor SWM system in SIDS (Mohee, et al., 2015).

One factor that is common for many Caribbean islands is the lack of waste separation at the source. Products discarded into waste streams are mixed or contaminated with toxic components, since there is limited knowledge on the different ways waste can be separated for collection, and how much it costs to collect and properly manage waste. The fact that all is mixed limits the options for reusing, recycling and waste recovery, increases the costs, and makes the functioning of already accessible

waste treatment tools and technologies inefficient. Considering this factor, along with the inefficient use of waste treatment technologies, it is challenging to promote recycling, raising the overall cost of waste disposal (de Cuba, Burgos, & Contreras-Lisperguer, 2008). The lack of knowledge on diverse waste management technologies represents a challenge in the case that future waste management technologies are to be implemented (Mohee, et al., 2015). This explains why many islands in the Caribbean region, apply the least preferred and least expensive waste management option according to the waste hierarchy, which is landfilling (de Cuba, Burgos, & Contreras-Lisperguer, 2008).

2.4. The Conceptual Framework

The conceptual framework provides an outline of how the research conducted is planned, and displays the main factors, concepts or variables to be studied. The framework serves as a guide to ensure that the research goes according to the plan. The steps of the framework are all related to the central question and the sub-questions.

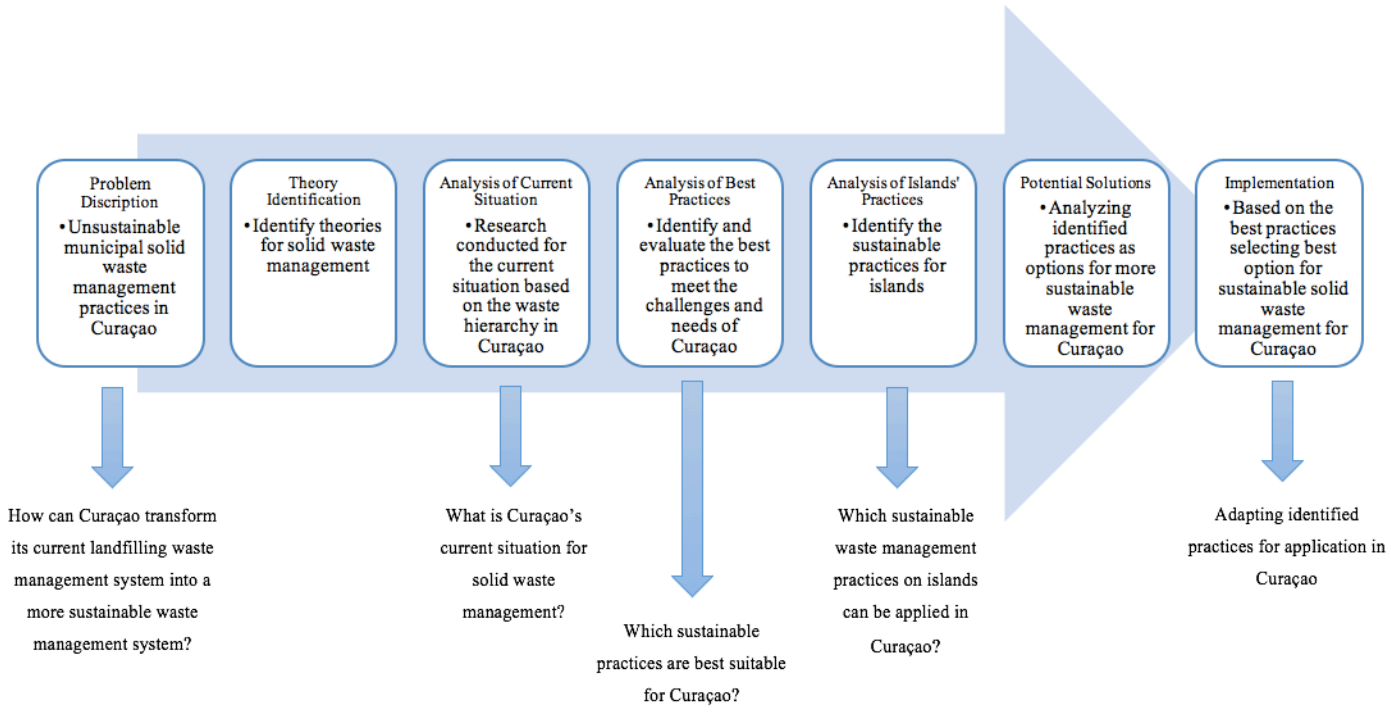


Figure 5. The Conceptual Framework

Chapter 3: Methodology

This chapter explains the research methods. The methodology provides a discussion regarding the specific methods chosen and how these methods are used in this research report to answer the sub-questions, and subsequently the central research question.

3.1. Research Design

Since municipal waste mismanagement and its potential impacts on the environment is a growing concern among many, and since there is a need for the implementation of better waste management practices, approaches to the management of waste are consulted and analyzed. With the central research question: "**How can Curaçao transform its current landfilling waste management system into a more sustainable waste management system?"**, this study focuses on the waste management methods practiced in countries worldwide, and considers which of these practices would be best suitable for the country of Curaçao, considering the country's conditions.

First, an explanation on the term waste was provided, followed by the general theory of municipal solid waste management (MSWM). The theory on MSWM was studied to understand what waste management entails. Moreover, existing theories on solid waste management were studied, focusing on the waste hierarchy theory. The waste hierarchy is a widely-used method of waste management and provides an in-depth analysis as for the possible methods for waste management in Curaçao, and is therefore extensively explained. Furthermore, other theories studied include the Integrated Solid Waste Management (ISWM) system, the Cradle-to-Cradle (C2C) concept, and the Circular Economy concept. However, seeing that the current practices in Curaçao are outdated, the implementation of these practices are currently not considered, since implementing these can be a drastic change for the island, meaning that too much will need to be altered at once. Therefore, the focus was set on the waste hierarchy. Furthermore, for this research, the quantitative research method was used, with information gathered through desk research. The desk research conducted was based on factual research information publicly available on the internet.

For the theory on the waste hierarchy, sources used include reports from the European Union, the United Nations, and journals. As to the credibility of the sources, when doing preliminary research on the theories on waste management, many of the results that came up were in accordance with the waste hierarchy. Most of the literature consulted were from published academic journals on solid waste management strategies and books on waste management. Journals are credible, because they have been approved by a group with expertise in the field under discussion (Yale University, n.d.). Among the several results that came up during the preliminary research, there were reports on the waste hierarchy by the United Nations Environment Program (UNEP) and the European Commission (EC). The waste hierarchy is entrenched in European legislation, and is therefore

widely applied in the European Union member states when it comes to sustainability and the environment.

3.1.1. What is Curaçao's current situation for solid waste management?

For this sub-question, the current waste management practices in Curaçao were studied. To be able to provide a solution to Curaçao's waste management issue, how waste is currently managed needed to be analyzed. The current practices were analyzed according to the waste hierarchy, meaning that each tier of the waste hierarchy was studied to see what is currently being done in the waste management practices of the island. This information was obtained through desk research. The study of the current practices helped to develop a full understanding of the current issue. This was done to review Curaçao's waste management system and compare it to countries' policies/initiatives to inform the indication of actions to improve Curaçao's waste management system. Thus, the current practices were studied to determine which areas are best to be first dealt with in improving the island's waste management methods. Moreover, local companies and organizations were approached for additional information on the waste management practices in Curaçao.

The information gathered for the current practices was based on previously conducted research and national research reports provided for by the government or governmental agencies, and from publications publicly available on the internet. The information was gathered from the Environmental Policy Plan Curaçao 2016-2021, the national SIDS report, Selikor's annual report and website, and Green Force's website. Other sources included news articles on the issue of waste management in Curaçao. The information obtained from these sources corresponded with each other on the current waste management practices in Curaçao; there was more than one source that provided the same information on the topic. Considering the credibility of these sources, they can be considered as credible, seeing that they are provided for by the local government itself, or from third parties that conducted a national research on behalf of or in collaboration with the local government. From Selikor's annual report, first-hand information was gathered from the island's main waste management company, making the information credible.

3.1.2. Which sustainable practices are best suitable for Curaçao?

For this sub-question, a benchmark approach was taken. Benchmarking is defined as "the process of continuously measuring and comparing one's business processes against comparable processes in leading organization to obtain information that will help the organization identify and implement improvements" (Andersen, n.d.). Another definition of benchmarking is that of Robert Camp, who defined benchmarking as "the search for those best practices that will lead to the superior performance" (Camp, 1989). Benchmarks can be beneficial as they provide reference points that give organizations the opportunity to evaluate their performance and practices in relation to the best

practice (BioIntelligence Service S.A.S., 2012). This concentrates on the improvement of performances by taking advantage of best practices, instead of just determining the best performance in the field. Benchmarking is focused on identifying, studying, analyzing, adapting the best practices, and implementing the results (Kelessidis, 2000). Thus, the purposes of benchmarking are to determine what and where improvements are needed, to analyze how other organizations achieve their best practices, and to use this information to improve own performance and practices (Pierson & Brandley, 2013).

In this report, waste management practices in the top five performing countries were analyzed. For this analysis, each tier of the waste hierarchy was studied, looking for best practices. The best practices are a set of guidelines, methodologies and techniques developed through experience and research indicating effectiveness, which can lead to improvements or achieving desired outcomes ("Best Practice," n.d.). However, it must be mentioned that the five countries analyzed may differ according to each tier of the hierarchy. Based on the indicators of the waste hierarchy from the five analyzed countries, it was possible to establish a milestone or a target for Curaçao's waste management situation. This information was based on their recycling, energy recovery and disposal ranking according to the OECD, Eurostat and, when it came to avoidance, the EC. For waste avoidance, the countries analyzed were selected based on their approach to MSW and all types of waste, mainly targeting consumers and businesses, since they were considered the main generators of MSW.

Furthermore, to determine the practices of each country, case studies were analyzed. The information gathered from these case studies were publicly available on the internet. The reason for the use of case studies was because case studies allow for a comprehensive, versatile assessment of complex issues in their real-life settings (Zainal, 2007). The practices of each identified country were stated and subsequently explained and analyzed. This table helps to identify the practices that were commonly used and will show patterns. The practices that were not common for all countries will stand out, illustrating differences in waste management practices in the top performing countries. For the specific practices themselves, several sources were consulted, including reports published by the United Nations (UN), the European Environment Agency (EEA), and journal articles. Furthermore, the sources consulted are considered reliable, since these are official publications (factsheets and reports) from the EC, UN and the EEA, from national governments, or country information websites. However, it is important to note that the choice for implementation will be based on specific local conditions that is best suitable for Curaçao, seeing that methods implemented in some countries, cannot be implemented without some adaptations to these local conditions. Therefore, there is the third sub-question.

3.1.3. Which sustainable waste management practices on islands can be applied in Curaçao?

To answer this sub-question, four islands were analyzed to gain insight on their sustainable waste management practices. Finding information for this section proved to be more difficult, seeing that there were no official indicators or extensive research on waste management sustainability on islands. Therefore, since most islands' main waste management method is landfilling, the four islands analyzed were identified as having practices other than only landfilling as a method for managing waste. The reason for this analysis was to identify islands with different practices to prove that islands too can sustainably manage waste, and to have an overall image of waste management practices on islands. Additionally, these practices might be more suitable to implement in Curaçao considering the scale of generated waste. For this section, information was used from national reports and case studies on the islands' practices. These sources were credible since they were first-hand information on the practices from the islands themselves, several theses documents, news articles and Zero Waste Europe: an official organization targeting the elimination of waste in societies.

3.2. Scope & Limitations

As mentioned, local companies were approached for information in order to assess the island's current waste management practices. Regarding this aspect, this led to some limitations during the research, mainly in obtaining information from these companies. For example, local recycling company Green Force was approached for information; however, limited information was obtained since a majority of the information is kept confidential as it can fall into competitor's hands. The advice received from them was to search for information on their website. It should also be mentioned that waste statistics for Curaçao are limited, unreliable or not continuously updated or available via public media, making it a bit more difficult to find relevant information on current waste management practices. Furthermore, information regarding waste management practices in the countries analyzed also had some limitations, mainly in the websites not being updated or serves does not exist anymore, or in the languages the information is being provided. Some information is only provided in the native language, and not in English.

Considering the other theories: C2C, ISWM, and the Circular Economy concept, their analysis is outside the scope of this report. Before Curaçao can implement these sustainable practices, the island should consider properly implementing the waste hierarchy first. After, it may be possible to gradually transition to one of these practices. Additionally, considering that Curaçao is an island and most goods are imported, and seeing that, for example, according to C2C all changes must start with the manufacturing of goods, it requires collaborations with manufacturers and producers to achieve the sustainable goals. For this research, researching this aspect is outside the scope of the report.

Chapter 4: Assessment of Current Practices in Curaçao

This chapter will discuss how Curaçao is currently managing the waste generated by inhabitants. This is done based on the waste hierarchy discussed in *chapter 2*. A careful look is taken into each tier of the waste hierarchy, to see how waste is currently being managed on the island.

Selikor N.V., the local waste management company, claims to work according to the waste hierarchy, following the prevention, reusing and recycling scheme, arguing that it is an aspect of major importance within the company (Selikor N.V., 2013). At the same time, several national research reports conducted by third parties on sustainability in Curaçao suggest that there is a need for the development and enforcement of a long-term waste management plan. It states that Curaçao has devoted time and resources on developing regulations. However, studies show that regulations have not always been effective since the island is dealing with inadequate institutional and human resource capacities to enforce these regulations. There are currently limited incentives to prevent, minimize and recycle waste. Nevertheless, in recent years, considerable developments have taken place regarding proper waste collection and waste transportation. Yet, the minimization of waste intended for final disposal and appropriate final disposal itself have not been improved (The Ministry of Health, Environment & Nature of Curaçao, 2014).

4.1. Application of the Waste Hierarchy in Curaçao

This section provides the results of the assessment of how the adapted version of the waste hierarchy is applied in Curaçao. This is followed by an analysis of the results, and after a conclusion on the section is provided.

4.1.1. Results

The results in this section are shown in the form of an inverted pyramid, considering the fact that disposal is Curaçao's main method of waste management, with avoidance being what is practiced less on the island. This is displayed in order of preference, from least preferred to most preferred method.

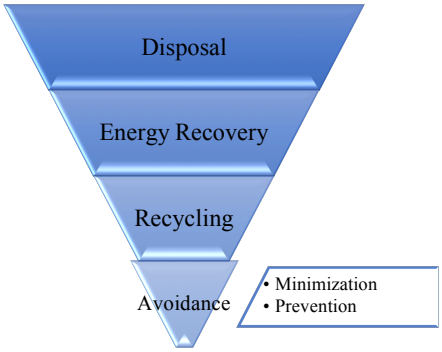


Figure 6. The Inverted Waste Pyramid

4.1.1.1. Disposal

Without an effective recycling system and laws for solid waste management, over 95 percent of the waste currently collected ends up in landfill (The TUI Care Foundation, 2016). Waste separation at the source, as practiced in the Netherlands and several other countries, is not practiced in Curaçao, meaning that all waste is mixed ("Selikor en Afvalverwerking," 2012). The household waste is collected through curbside collection at the source, and for every household a free garbage container (a kliko) is provided. According to Selikor N.V., this makes it easier for consumers to collect their waste and safely put it curbside for a weekly pick-up (Selikor N.V., n.d.a). As Selikor N.V. has opted for the landfill as the waste disposal method, all collected waste is taken directly from the source to a transfer station or Malpais landfill. Depending on where one lives on the island, the waste is first transferred to a transfer station. If one lives on the east side of the island, waste is collected and stored at Selikor's Koraal Specht transfer station, prior to final disposal at Malpais landfill. If one lives on the west side of the island, the collected waste is directly taken to Malpais landfill for final disposal (Con, 1994).

4.1.1.2. Energy Recovery

Energy recovery from waste is one tier of the waste hierarchy that is currently not practiced on the island, seeing that there are no thermal treatment facilities on the island. Aqualectra (Curaçao's utility company) and Selikor N.V. have signed an agreement for the investigation of a waste-to-energy (WTE) plant. Aqualectra finds that this is an efficient way of producing energy, and to be less dependent on fossil fuels (Aqualectra Holdings, n.d.). however, Selikor N.V. finds that the costs of a large facility are beyond the company's means. The current focus is set on breaking even in costs. Instead, the short-term priorities include an incinerator for hazardous waste processing, expanding landfill capacity, upgrading recycling processing, and introducing an additional waste drop off center in the east end (Gobièrnu di Kòrsou, 2015). Furthermore, local investor group Ensol and international investment groups Venergy Group and Green 3Power have shown interest in constructing a WTE plant at the Malpais complex. The construction of the WTE plant should be a joint-venture between these groups and Selikor N.V. However, the local government must take the necessary steps to give these groups the proper attention and so to deal with Curaçao's waste problem (Mc William, 2016). Other parties also support the construction of a WTE plant on the island. Political party 'Un Kòrsou Hustu' states that a WTE plant can help solve Curaçao's waste problem, while dealing with the island's lack of energy production, since the abundance of waste can be processed into energy (Un Kòrsou Hustu, n.d.).

4.1.1.3. Recycling

Selikor N.V. practices recycling on the island; however, this is done on a limited scale. In 2010 Selikor opened the 'Milieustraat' (the Environment Street) at the Malpais waste disposal complex.

At the Milieustraat the following waste streams can be received separately: batteries, plastic, aluminum, tires, electronic equipment, glass, metal, old iron and white goods. Additionally, Selikor N.V. is encouraging inhabitants to recycle more, by incorporating and utilizing the Fun Miles loyalty program into their program. Inhabitants are encouraged to bring certain types of waste, such as those mentioned above, to the Milieustraat. The mentioned recyclable waste is processed by Selikor N.V. itself or by other local companies, and after processing, the material is transported to foreign companies for final processing. Car wrecks, old iron and steel are also kept separate, and are collected and processed by other local companies on behalf of Selikor N.V. Through Selikor N.V.'s subsidiary Caribbean Recycling Company (CRC), asphalt, construction and demolition waste are processed into raw materials for the original purpose of the material or for other purposes in a production process (Selikor N.V., 2013). However, the National Report of Curaçao for the Third International Conference on Small Island Developing States suggests that recycled materials consist mainly, by more than 98%, of building materials, and do not mention any other activities for recycling. Recycling is done on a small scale, seeing that there are some facilities available at the Malpais complex, such as the Milieustraat, and other locations to separate waste and to drop off already separated waste (The Ministry of Health, Environment & Nature of Curaçao, 2014).

Furthermore, community recycling is done by Green Force (GF), an independent recycling company owned by Mr. Timo Brouwer. GF recycles both household and industrial waste. From household waste aluminum cans and plastic PET bottles are collected, and from industrial waste plastic LDPE shrink wrap, old corrugated cardboard and plastic HDPE bottles are collected (Brouwer, n.d.). According to Mr. Brouwer (personal communication, October 16, 2017), after collection, the waste gets processed at the GF factory where secondary material that will fulfill the needs of GF's customers or buyers is made. This material is then shipped abroad to several different countries and continents, and abroad the material is washed, melted and reused into new products or packaging. GF has also established recycling centers situated in three locations (Albert Heijn Zeelandia, Centrum Supermarket Piscadera and Mangusa Hypermarket) on the island to promote recycling among consumers (Green Force, n.d.).

4.1.1.4. Avoidance – Prevention & Minimization

Considering waste prevention, Selikor N.V. states that it strives to educate the community on waste generation and to create awareness about the importance of waste reduction and prevention. This is done in collaboration with organizations on the island, such as Fundashon Kòrsou Limpi Bunita (FKLB). Selikor N.V. and partners give talks and presentations at local schools, community centers and other organizations on the topic of waste prevention, and what consumers can do to help combat waste challenges (Selikor N.V., n.d.b). FKLB more specifically works towards combatting litter on the island. This is done through stimulating public opinion, promoting awareness and influencing

behavior of people through information and education on their consumption patterns and the prevention of waste. Furthermore, FKLB works to encourage public bodies, agencies, private institutions and organizations to take the necessary measures to prevent and control waste (FKLB, n.d.).

Furthermore, several public awareness programs were developed and waste drop-off centers were established to encourage the minimization of waste among consumers. It can be argued, however, that many of these programs were/are not functioning efficiently. Since there has been a lack in the effectiveness and consistency of policies for the prevention, minimization and recycling of waste in the past, there has been a continuous growth in the volume of waste (The Governments of Curaçao & Sint Maarten, 2011). There was a breakthrough at one point in time, when the island's large supermarkets joined a national campaign that required customers to bring their own grocery bags, and voluntarily agreed to stop using and providing plastic bags to consumers at the checkout. However, the supermarkets still had large and small paper bags available for purchase for customers who did not have their individual grocery bags (The Ministry of Health, Environment & Nature of Curaçao, 2014). Furthermore, considering the fact that Green Force, The Curaçao Clean Up and Sea Turtle Conservation Curaçao have recently started a petition for the national government to ban the use plastic bags in Curaçao, it can be argued that this campaign did not last long, and plastic bags are still provided to consumers ("Oproep Voor Verbod op Plastic Tasjes Curaçao," 2017). Therefore, the supermarket campaign was not considered as taking preventative measures against waste generation, but rather as an effort to reduce plastic waste on the island.

4.2.2. Analysis of Results

There is limited information on the current practices available online, making it difficult to fully determine if the waste management policies are well-designed and poorly executed, or just poorly executed. The research suggests that a majority of the policies are poorly designed, despite having invested a significant amount of time and effort in designing the policies. In addition, existing policies are also poorly executed because of inadequate institutional and human resource capacity to enforce these regulations. Without proper design and implementation of waste management policies, it is difficult to be more sustainable. The attempts to promote waste avoidance are inconsistent and on a limited scale, meaning that they do not actually have an impact on the community, and thus need to be adapted and strictly implemented for efficiency. Furthermore, for waste prevention to be more effective, there is a need for more awareness education campaigns to make people conscious of the waste challenges Curaçao faces, and how consumers can alter their consumption patterns to meet sustainable objectives. Waste separation at the source is considered an important aspect of waste management, and since this is not practiced on the island, it also makes it harder to work towards a more sustainable Curaçao. Additionally, seeing that recycling is done on a small scale,

and mostly consists of building materials, the recycling efforts for other materials will have to be induced.

4.3. Overview of Curaçao's Waste Management Performance

Curaçao's approach to waste management is based on the waste hierarchy, focusing on prevention, reusing and recycling. The waste management hierarchy indicates an order of preference for action to reduce and manage waste from most favorable to least favorable actions, with prevention being the most favorable, and disposal the least favorable option. The table below provides an overview of Curaçao's current practices according to the waste hierarchy.

 **Avoidance**	 **Recycling**	 **Energy Recovery**	 **Disposal**
• Awareness campaigns and education by Selikor N.V. and FKLB • National campaign for own grocery bags in large supermarkets • Drop-off centers as encouragement for waste minimization	• Recycling on a **small scale** by Selikor N.V. & Green Force • Milieustraat: promoting waste separation for recycling • Promotion of recycling by organizations	• **No thermal treatment facilities for MSW** available on the island • Signed agreement for research of possibilities for a WTE plant • Third parties have shown interest in constructing a WTE plant	• Very **high dependence** on disposal in a landfill • Cheapest option for local government

Table 1. Overview of Curaçao's Waste Management Practices

The arrows indicate the impact of what is currently practiced on the island in regard to managing waste. The larger the arrow, the larger the action to manage waste. As indicated in the table by the largest arrow, Curaçao's main waste management method is waste disposal. Considering the fact that there are currently no thermal treatment facilities for MSW, this is indicated with an 'X'.

Chapter 5: Case Studies

In this chapter, the best practices for waste management are analyzed. For this, the benchmarking approach is taken. Benchmarking is done based on case studies research on the waste management practices in the top performing countries. First, an introduction of the benchmarking tool used during the research is provided. After, the best practices in waste management are analyzed and discussed.

5.1. The Waste Hierarchy as Benchmarking Tool

For this research, the waste hierarchy is used as the benchmarking tool to determine and to analyze the waste management practices of the top performing countries identified. As mentioned, the adapted waste hierarchy identifies four tiers of waste management options to reduce and manage waste, and to maximize the efficient use of natural resources. Waste avoidance is the top priority. Recycling and high-quality energy recovery are the second priority (recovery), with the least preferred options being burning waste and dumping waste on landfills (disposing) (United Nations Environment Program, 2013). For this benchmark, waste avoidance, recycling, energy recovery and disposal are analyzed.

5.2. Best Practices in Waste Management

In this section, the best practices in waste management are discussed. Waste management is an area of environmental concern to many countries. Regardless of the significance of solid waste management in the urban environment, the measures taken by societies around the world to manage the issue show that there can be advancements made in this area (Filho, Brandli, Moora, Kruopiene, & Stenmarck, 2016). Therefore, based on the waste hierarchy, the best practices in waste management are to be identified, studied, analyzed, adapted and the possibilities of their implementation are discussed to illustrate advancements made around the world.

5.2.1. Results

The results as described in this section are stated according to two specific criteria: replicable and effective (European Commission, 2016c).

- Replicable: Practices can be easily reproduced and are similarly relevant in regions across Europe.
- Effective: Practices have clearly defined objectives and measurable results.

The information on the country's ranking in recycling, energy recovery and disposal are obtained from the Environment at a Glance 2015: OECD Indicators (2015) report published by the Organization for Economic Cooperation and Development (OECD). For each of these tiers, the top five performing countries are analyzed. The countries differ according to each tier of the waste hierarchy.

5.2.1.1. Avoidance

Several countries have prevention programs in their waste management systems. Therefore, there are some effective strategies available to promote public awareness of waste prevention and to reduce the generation of waste in the European Union and abroad. The practices mentioned are evidence of informational, promotional and regulatory measures to encourage waste avoidance (European Commission, 2016c). These practices are considered as best practices by the EC. The current focus is set on factsheets that provide information for all types of wastes and household waste. Since the EC does not have a ranking system for best waste avoidance, the five countries identified and to be analyzed were not selected according to a specific ranking, and are placed in alphabetical order instead. The five identified countries are:

1. **Belgium** (Gentil, 2013; European Environment Agency, 2016a; Waste Management - General Information, n.d.; European Commission, 2009a; European Commission, 2009b)
2. **Finland** (European Environment Agency, 2016b; European Commission, 2009c)
3. **Ireland** (European Environment Agency, 2016c; Friends of the Eart Japan & Institute for Global Environmental Strategies, 2013)
4. **Luxembourg** (European Environment Agency, 2016d; European Commission, n.d.b; European Commission, n.d.c)
5. **Portugal** (European Environment Agency, 2016e; European Commission, 2009d)

Belgium	Finland	Ireland	Luxembourg	Portugal
• A holistic approach to managing waste • Incentives with obligations to act • Promotion of reuse or recycling of products through Kringloop centers • Communication campaigns • Financial support for municipalities that launch waste prevention initiatives • Clear waste reduction targets	• Use of eco-efficient products and services • Best practice dissemination • Information campaigns • Promoting reusable, reparable and updatable products	• Collaborative approach within national context • Taxation to shopping bags • Avoidance of single use disposable items • Awareness campaigns and informational websites for consumers	• Replacement of disposable shopping bags with sustainable options • A holistic system based on re-consumption • Awareness raising for the use of multi-use products • Educational campaigns and establishment of reuse and repair centers	• Awareness campaigns as preventative measure • Integrative measures to challenge behavioral change • Promotion of use of traditional shopping bags while phasing out plastic bags • Promotion of reuse and repair where possible

Table 2. Practices in Waste Avoidance per Country

5.2.1.2. Recycling

According to the European Waste Framework Directive (Directive 2008/98/EC), 50 percent of municipal waste must be recycled by 2020. The three European Union member states analyzed, namely Germany, Belgium, and the Netherlands, have already achieved this target (Leysen & Preillon, 2014). The other two countries analyzed are not member states of the European Union, but do rank high in recycling according to the OECD, thus also exceeding this Directive's target.

The five top performing countries for recycling are, in order of ranking:

1. **Germany** (Brassaw, 2017; Federal Ministry for the Environment, Nature Conservation and Nuclear Safety, 2011)
2. **South Korea** ("South Korea Legislates Towards a Zero Waste Society," 2015; "Waste Treatment Policy and Measures in South Korea Background Information," n.d.; "Waste Disposal and Recycling in South Korea," n.d.)
3. **Belgium** (Allen, 2012; "Waste Management - General Information," n.d.)
4. **Switzerland** (Skjellaug, 2016; "Swiss are Stuck on Their Rubbish Bag Tax," 2003)
5. **The Netherlands** (Rijkswaterstaat Environment, n.d.; Dijkgraaf & Gradus, 2014)

5.2.1.3. Energy Recovery

In this report, energy recovery stands for waste to energy (WTE), meaning that waste is incinerated to recover the energy it produces, which is subsequently turned into electricity or heat. Considering energy recovery, the top five performing countries as derived from OECD's ranking are (in order of ranking):

1. **Japan** (Japan Environmental Sanitation Center, 2012; Kim & Jeong, 2017)
2. **Norway** (Clark, 2012; Wilts, Galinski, Marin, Paleari, & Zoboli, 2017)
3. **Denmark** (Meisen & Phipps-Morgan, 2010)
4. **Sweden** (Freden, 2017; Sheffield, 2016; Clark, 2012; "Making Waste a Valuable Resource - Sweden's Take on Waste," n.d.)
5. **Switzerland** (The Swiss Confederation, n.d.)

5.2.1.4. Disposal

In this section, an analysis of disposal through landfills is provided. The information is interpreted as these practices having contributed to the reduction of the use of landfills, with currently virtually no waste being sent to landfills, meaning that zero to one percent of waste is currently landfilled. The EU Landfill Directive (Directive 1999/31/EC) played a significant role in the reduction of the use of landfills as a method for waste management. The objective of the Directive is to prevent or reduce as far as possible negative effects on the environment from the landfilling of waste by introducing strict technical requirements for waste and landfills (European Commission, 2016b). The five top performing countries are:

1. **Germany** (Department for Environment, Food and Rural Affairs, n.d.; Fischer, 2013)
2. **Switzerland** (The Swiss Confederation, n.d.; Herczeg, 2013)
3. **Sweden** (Milios, 2013)
4. **Belgium** ("Waste Management - General Information," n.d.; Vijayaraghavan, 2011)
5. **The Netherlands** (Scharff, 2014).

	Germany	South Korea	Belgium	Switzerland	Netherlands	Japan	Norway	Denmark	Sweden
% Recycled	65%	59%	55%	51%	50%	-	-	-	-
Recycling	• Extended Producer Responsibility • Polluter Pays Principle • Color-coded recycling bins • Waste separation at source • Deposit Refund System	• Volume based waste fee system • Color-coded waste bags (with tax) • Waste separation at source • Strict regulations with penalty for non-compliance	• Extended Producer Responsibility • Decentralization of waste • Polluter Pays Principle • Color-coded waste containers • Source separation • Targets for per capita household waste generation	• Color-coded garbage bags (with tax) • Polluter Pays Principle • Extended Producer Responsibility • Separate waste collection	• Extended Producer Responsibility • Separate waste collection • Volume based waste fee system or Pay as you throw system • Deposit Refund Systems	-	-	-	-
% of WTE	-	-	-	49%	-	71%	57%	54%	50%
Energy Recovery				• Second most used method for waste treatment • Only for non-recycled combustible wastes		• Main method of waste management • Advanced waste incineration facilities for WTE • Several methods for waste incineration	• Waste exported to Sweden for incineration • Main method of waste treatment next to recycling • Mixed MSW treatment method	• Waste is imported from neighboring countries • Only for combustible waste • Recyclable materials from bottom ash are recycled • Incineration tax promoting recycling	• Waste is imported from neighboring countries for incineration • Disposal bans of combustible waste • Residuals from burned waste are separated and recycled or reused
% landfilled	0%	-	1%	0%	1%	-	-	-	1%
Disposal	• Ban on un-pretreated MSW • Strict landfill admission criteria for residual MSW • Landfill operators are responsible for complying with the ban • Only for wastes that cannot be recovered	-	• Landfill mining • Landfill ban for selectively collected wastes that can be recycled or combustible wastes • Smart taxes for landfills	• Stringent laws for waste to be landfilled • VASA landfill tax • Ban landfilling of combustible waste • Treat non-recyclable waste for disposal in landfills • Three different landfill sites	• Landfill ban for 64 waste categories • Strictly for non-combustible waste that cannot be recycled • Landfill tax (abolished in 2012) • Remediation of old landfill sites	-	-	-	• Ban on landfilling of sorted combustible waste and organic waste • Landfill taxes

Table 3. Practices in Countries per Tier of Waste Hierarchy

5.2.2. Analysis of Results

This section provides an overview of the results, illustrating the most common practices in the countries analyzed. These results are also further analyzed to get a better understanding of how the practices function.

Avoidance	Recycling	Energy Recovery	Landfilling
• Awareness and education campaigns • Promoting the reuse and repair of products • Avoidance of single use disposable products • Replacing plastic bags	• Extended Producer Responsibility * • Polluter Pays Principle * • Waste separation at the source with color-coded waste containers	• Waste is exported to other countries • Only for combustible waste that cannot be recycled • Residuals from burned waste is recycled or reused	• Ban on combustible wastes • Landfill taxes • Remediation of old landfill sites (landfill mining) *

Table 4. The Common Practices in Best Performing Countries

"*" Indicates that a definition is provided for the term.

Definitions of some terms:

- *Extended Producer Responsibility (EPR):* EPR is a policy approach under which producers are given a significant responsibility – financial and/or physical – for the treatment or disposal of post-consumer products. Assigning such responsibility could in principle provide incentives to prevent waste at the source, promote product design for the environment and support the achievement of public recycling and materials management goals (OECD, n.d.).
- *The Polluter Pays Principle (PPP):* According to the Glossary of Statistical Terms of the OECD (2001c), the definition of PPP is: "the principle according to which the polluter should bear the cost of measures to reduce pollution according to the extent of either the damage done to society or the exceeding of an acceptable level (standard) of pollution" (OECD, 2001c).
- *Landfill mining:* The overall aim is for disposed resources to be recovered and reintroduced into material cycles as secondary raw materials, acting as a source of materials for primary production in the face of finite resources. The extraction of deposited materials may also be integrated with remediation and aftercare measures to handle the environmental consequences of landfilling. This can also facilitate energy recovery and the recovery of land space for urban development (Smart Ground, n.d.).

Considering waste avoidance, there were some similarities identified between the countries analyzed. For most, there is a holistic system, meaning that people and the environment are considered to be one, and that there is a need for collaboration between all actors. The promotion of re-consumption and reuse of products is practiced in all countries analyzed, through various means. These means include communications and information campaigns. This implies that raising

awareness of waste issues is of importance to encourage change. Additionally, single use disposable plastic bags are replaced with sustainable options to further work towards sustainable practices. These methods have been effective for the five countries analyzed, which has led to these countries having the best practices regarding waste avoidance.

The amount of reliable data available on MSW provides an accurate image of the current treatment solutions in the countries analyzed. The analysis of the data indicates that countries combine practices to be able to divert from landfills. For example, landfilling rates decline faster than the growth in recycling, as waste management strategies transition from landfilling to a combination of recycling and incineration, since what cannot be recycled will be incinerated for energy recovery. Thus, high recycling is combined with high WTE and low landfill reliance. Additionally, since countries recycle at the high rate currently done, it can be implied that there are effective regulations in place with efficient infrastructures.

Furthermore, similarities between countries indicate that in order to recycle successfully, there is a need for waste separation at the source, while providing color-coded waste containers for the separated waste. PPP is also closely related to waste separation at source. The countries analyzed indicate to implement unit-based systems of PPP, such as the volume-based fee system (VBFS) and pay-as-you-throw (PAYT). These systems are simply named differently, but do not differ as much in the concept. For example, Switzerland and South Korea both have specific waste bags indicating streams for recycling. These are methods for inhabitants to pay taxes for waste services (PAYT), instead of paying for waste disposal through local authority taxes. This analysis suggests that countries that implement such tactics perform better in waste management than countries where waste collection fees are based on household sizes.

In many of the countries analyzed EPR plays a significant role in reducing pollution. Along with PPP, EPR has helped with improving recycling rates. In addition, landfill fees in combination with these two practices encourage landfill diversion. Furthermore, deposit refund systems (DRS) for recycling are also implemented in some countries of the countries analyzed to further promote recycling activities, and have proven to be effective. This can be assumed from the high recycling rates the countries currently have.

To conclude on this section, it was found that there are several methods to sustainably manage waste. The practices are considered to be interrelated, seeing that the diversion from one practice leads to the enhanced practice of another, such is the case with landfilling, recycling and incineration for energy recovery. Thus, in the countries analyzed there is a clear indication of a shift up the waste hierarchy.

Chapter 6: Sustainable Practices by Other Islands

This chapter analyzes waste management practices on other islands. With Curaçao being an island, it is essential to identify sustainable waste management practices by other islands to properly analyze future possibilities for Curaçao.

Considering the fact that Curaçao is a relatively small island when compared to other islands, one parameter is not having over one million inhabitants. Two islands with approximately 100,000 inhabitants and two islands with approximately 900,000 inhabitants were analyzed, to see differences and similarities in waste management practices. This is done to establish if the scale plays a major role in achieving waste management goals. Additionally, these islands are self-governing or autonomous within a Kingdom, or a state.

6.1. Results

As for most islands waste is being disposed of in a landfill, research was conducted for islands that practice other methods than landfilling to manage generated waste. Once these islands were identified, their practices were analyzed. Four islands were chosen to illustrate different waste management practices for islands. The four islands identified are:

1. **Aruba**, Dutch autonomous country in Caribbean (Bultrini, 2017; Data ES, n.d.; PriceWaterhouseCoopers Aruba, 2014)
2. **Mallorca**, Spain (Simon, 2012; Stewart, 2014; Villanueva, 2014)
3. **Isle of Man**, self-governing Crown dependency of the United Kingdom ("Recycling Locations," n.d.; Isle of Man Government, n.d.)
4. **Oahu**, Hawaii ("Recycling and Disposal Guide for Oahu," n.d.)

Aruba	Mallorca	Isle of Man	Oahu

• WastAway Technology used for small scale recycling
• Community based initiatives:
  • Crowdsourced plastic recycling center
  • Awareness building and mentality change
• Waste to Energy from biogas on a small scale
	• Incineration with energy recovery with reduction of waste volume (62%)
	• Importing waste for incineration from neighboring countries and Spanish provinces
	• Door-to-door waste separation schemes
	• Recycling and Material recovery:
	  • Packaging, Anaerobic Digestion, Composting and Bottom ashes treatment
	• Zero waste discharged into landfills goal
	• Public awareness program promoting reduction, reuse, recycling and recovery of waste
	• Incineration fee for unsorted waste
		• Certain waste is exported to UK for recycling
		• Transfer stations for sorting and separation
		• Waste is recycled (50%)
		• Waste is recovered for energy production, with incinerator available on the island (25%)
		• Mainly inert waste is landfilled (25%)
		• Civic amenity sites for bulky household waste with separate reuse area
		• Public recycling sites promoting waste separation
			• Recycling
			  • Sorting waste at source for collection
			  • Providing drop off centers
			• Incineration with energy recovery
			• The use of educational tools

Table 5. Identified Practices for Chosen Islands

6.2. Analysis of Results

The data for this section indicates that islands too follow the waste hierarchy to an extent; there are attempts to avoid waste, to recycle, to incinerate waste with energy recovery and to landfill on all four islands analyzed. Considering limitations islands face to outsource their waste management issues, it is understandable not being able to completely follow and implement this strategy. However, as mentioned, the tiers are followed to an extent.

Avoidance.

Considering avoidance methods on the islands analyzed, similarities in practices were identified. The islands use public awareness programs promoting reduction, reuse, recycling and recovery. Additionally, educational tools are used to teach the community about waste issues and how to tackle these issues. Another method practiced is awareness building in the community with the aim of changing the mentality on waste issues of the community. These are mainly achieved through public initiatives and public encouragement to effectively achieve sustainable goals. Since these methods have been effective for these islands, they are considered as possible solutions to Curaçao's issue.

Recycling, Energy Recovery and Disposal.

Seeing that these three practices are somewhat linked to each other when it comes to waste management, they have been combined in this section for a more efficient analysis. First, the data indicates that separating waste at the source, and having drop off centers may be necessary for efficient waste recycling and incineration with energy recovery. This practice is in combination with effective regulations, such as an incineration fee for unsorted waste, to enhance the sustainable practice of the methods. The data for these islands indicate similarities with the countries analyzed in chapter *5.2.1. Results*. According to the theory consulted, waste separation is not practiced on many islands, with the majority of the waste being landfilled, due to limited knowledge on sustainability and how to manage generated waste (de Cuba, Burgos, & Contreras-Lisperguer, 2008). These islands show that some islands do have the knowledge to sustainably manage waste, and thus serve as examples. This practice may differ according to the island (or country in general), seeing that there can be different methods to implement waste separation at source, and different ways to collect this separated waste, such as curbside collection and drop-off centers.

Furthermore, as the theory suggests, the reason for the high landfilling rate on islands (and SIDS) is due to the absence of other waste management procedures. In addition, landfilling is relatively cheap compared to other waste management options (Malek & Shaaban, 2008). However, as the islands in the results section indicate, it is possible for islands to divert from landfilling, as it is realized that landfilling is not a sustainable waste management method. To some extent recycling is combined with incineration for energy recovery, thus diverting from landfilling. Albeit on a possibly small

scale, these are currently practiced on the islands analyzed, indicating being a future possibility for other islands in need of more sustainable alternatives. Incineration with energy recovery may be practiced on a small scale, and has the dual purpose of generating energy while reducing waste volume, as indicated by Mallorca. The islands analyzed have an incinerator or recycling plant present on the island itself, which makes it easier to recycle and to recover energy.

Furthermore, the data indicates that it is possible for islands to export waste to main lands or neighboring countries for disposal, in case of not being able to reach economies of scale to reach recycling or incineration targets, thus being an effective method for reducing waste on the island. For example, Mallorca imports waste from Catalonia, Spain and Ireland to feed the incinerator (Stewart, 2014), while Isle of Man exports certain wastes to the UK for recycling (Street, 2013). Importing and exporting waste is also done in some of the countries analyzed in the previous chapter. This practice implies that it is possible to collaborate with other countries to reduce waste generated.

6.3. Conclusion

To conclude, this section shows that islands are also shifting up the waste hierarchy. More waste is recycled or incinerated, and less waste is disposed of in landfills. It can be argued that scale plays a role to a certain extent, because all islands recycle, albeit on a small scale. However, if Aruba and Isle of Man, both having less inhabitants than Curaçao, can recycle, recycling should also be a possibility for Curaçao if resources are invested. This data shows that islands are becoming more informed about sustainable waste management practices, and alternatives were researched for them to shift up the waste hierarchy.

Chapter 7. Discussion of Possibilities for Curaçao

This chapter discusses the feasibility of benchmarking the practices identified in the analysis in the previous chapters, and how they should be adapted to be effective in Curaçao.

7.1. Results of Possibilities

The best performing countries and islands analyzed all provide some solutions that can be applied in Curaçao to solve the current waste management issue. As indicated in the analysis section in chapter 5 and 6, the best performing countries and identified islands apply several methods to manage waste. Not all methods are viable solutions to Curaçao's issue, but some methods have the potential to be successful and may improve the current state in the long term. Possible solutions include:

- A holistic approach
- Avoidance of disposable bags
- Awareness programs and community based initiatives focusing on behavioral changes
- The extended producer responsibility (EPR)
- The polluter pays principle (PPP)
- Waste separation at the source with color-coded bags
- Incineration with energy recovery
- Waste exportation to neighboring countries for recycling and/or incineration
- Landfill taxes and bans on combustible waste

7.2. Analysis of Possibilities

A holistic approach proved to be efficient for many countries, since this requires all actors to collaborate. Based on the theory consulted, this can be related to the integrated waste management system. However, the systems all differ, and cannot simply be 'copied and pasted' in Curaçao. This meant that local needs and conditions needed to be assessed, and subsequently the most suitable waste management actions for the situation identified are selected and combined, and then adapted to find a system more suitable to Curaçao's conditions.

The theory on waste management in SIDS suggests that these countries face many challenges, including lack of policies and strategies on behalf of the government to promote SWM approaches. This theory was confirmed during the research. According to the research conducted, waste avoidance programs in Curaçao are ineffective and circulate without the full support of the local government. A possible solution is to take the example of neighboring island Aruba and encourage the implementation of similar initiatives in Curaçao. Aruba has community based initiatives to promote recycling, to raise awareness, to change consumer behavior, and to reuse products. Aruba's

community based initiatives show innovation and inventiveness, and are therefore considered as examples for the improvement of SWM. Additionally, regular awareness programs and campaigns provided by the government and governmental bodies can also be effective in promoting waste avoidance, as indicated by the best performing countries. Furthermore, seeing that large supermarkets in Curaçao had previously required customers to bring their own grocery bags (this has since stopped), it is possible to re-implement this initiative to encourage waste avoidance and reduce plastic waste. The stated purpose should be to avoid the use of single use disposable products. To effectively encourage locals to bring their own grocery bags and to support this initiative, it may be necessary to charge consumers for plastic bags when not having their own bags at the check-out. This has proven to be effective in countries such as Finland, Ireland and Luxembourg to reduce the use of disposable bags (European Commission, 2016a).

Moreover, the theory suggests that the effectiveness of a SWM system can be effected by social risks due to insufficient public participation (Mohee, et al., 2015). Curaçao has a lack of community participation. Thus, the community needs to be educated on the issues Curaçao faces, and should tackle these by encouraging them to alter their consumer behavior. Local citizens must be made aware of existing regulations that will discourage them from turning to practices such as illegal dumping. Educating citizens about the consequences or benefits of their actions can have a positive effect on their participation and perception towards waste management (Davidson, 2011). However, these initiatives alone may not be enough to significantly alter the waste management system in Curaçao. These initiatives have the potential to be successful if the local government would develop, collaborate and support (community based) SWM projects, since community participation can be effective in solving MSW issues in Curaçao.

Furthermore, recycling is done on a small scale in Curaçao by Selikor N.V. and Green Force. Selikor N.V. mainly recycles building materials, while Green Force collects plastic bottles for recycling on a small scale. Milieustraat provides the opportunity for locals to drop-off specific streams of waste, though this has not been very effective. Therefore, to make recycling more effective and efficient, and to be able to recycle on a large scale, it may be necessary to implement waste separation at the source. With this is meant waste separation in households. This can be achieved by taking the example of Switzerland or South Korea, where there are color-coded waste bags and color-coded recycling bins in place for efficient recycling. However, for this practice to be effective in Curaçao, there is a need for investment for the transition to this practice by the government and this practice will need to be entrenched in the local policies and has to be strictly enforced. Further research is needed concerning PPP and the ways to implement it (PAYT and VBFS), for its feasibility in Curaçao. Conversely, this may bring side-effects such as backyard waste incineration or making the case of littering on the island more severe. Therefore, more research is needed on the feasibility of

large scale recycling for Curaçao. If upon further research it is not feasible to recycle on a large scale, the practice of waste separation may still help with efficiently exporting waste to neighboring countries that do recycle or incinerate.

As the analysis in chapter 5 indicates, extended producer responsibility plays a significant role in reducing the amount of waste disposed of in landfills. However, this concept may not be as feasible to introduce seeing that consumer products are mainly imported in Curaçao, and EPR entails putting responsibility on manufacturers for the treatment or disposal of post-consumer products. What can be feasible is altering this concept of EPR, shifting the responsibilities to large supermarkets to re-collect plastic PET bottles, glass bottles and aluminum cans for the safe disposal of these products, to encourage recycling, and to reduce the amount of waste disposed in landfills. A deposit-refund system (DRS), as implemented in the Netherlands and Germany, is compatible with the EPR concept, and may be a viable solution for Curaçao. In many programs, an up-front fee is assessed on product sales and the earnings are used to fund collection and recycling programs. DRS is considered as an economic incentive to promote recycling. This concept has potential to be effective in Curaçao if implemented correctly by the government and supermarkets. Through DRS, it may be possible to achieve short-term success in altering consumer behavior by implementing such incentive system and encourage public participation. However, it should be considered that alterations brought about by such systems are not maintained in the long-term if the incentive system is removed (Davidson, 2011).

Moreover, the theory on ISWM suggests that the cost of using diverse waste management options is reflected through the existing infrastructure (McDougall, White, Franke, & Hindle, 2001). Considering the fact that there is no incineration facility present in Curaçao, incineration with energy recovery is not yet possible. There was research conducted by Selikor N.V. and Aqualectra on the possibilities of an incinerator for the island, but this has since been halted. Third parties have also shown interest in building an incinerator for the island, but do not have the support of the government. This could indicate that building an incinerator may not be feasible for Curaçao, seeing that it would require a large investment while considering how small of an island Curaçao is. Factors affecting this decision can include reaching economies of scale with viable material to be able to feed the incinerator. Therefore, exporting waste to countries in the region is considered. This practice can be achieved by exporting waste to countries that currently do recycle and/or incinerate. For example, by creating collaboration schemes it is possible to cooperate with Aruba to reach economies of scale to be able to execute recycling for the islands, seeing that Aruba currently has the equipment that is capable of completing the task. This can create inter-regional collaboration.

Furthermore, when researching other countries in the region with capabilities to recycle or to incinerate with energy recovery, all data indicate that research is being conducted on the feasibility of these practices. For example, in Caribbean islands Anguilla and Saint Kitts, pyrolysis was proposed as a renewable energy alternative, and its feasibility is being researched (Mohee, et al., 2015). Pyrolysis is the thermochemical decomposition of organic material at high temperature and in the absence of oxygen or in an atmosphere of inert gasses (Czajczynska, et al., 2017), making it a form of incineration. Additionally, it may be possible to export to Venezuela in the future, since the WTE market has seen a significant growth (Mordor Intelligence, 2016). However, further research is needed to identify the possibilities for collaboration to achieve this practice.

Moreover, there are some factors that need to be taken into consideration when considering exporting waste, such as regulations in countries in the region. For example, in Puerto Rico there is no incineration facility since all the wastes are either recycled or landfilled owing to the regulation prohibiting waste disposal by incineration (Mohee, et al., 2015). This indicates that exporting waste to Puerto Rico for incineration is not a possibility, but exportation for recycling may be possible, seeing that recycling may be done on a small scale (Gabriel, 2011). Another factor to be taken into consideration includes feasibility of materials to be incinerated. For example, in Suriname, incineration of domestic waste is currently not feasible due to high capital investment and the low energy output associated with the high moisture content of domestic waste, meaning that the waste is not combustible (Mohee, et al., 2015). Therefore, further research is needed into the composition of waste to determine feasibility of incineration. This research also shows Suriname is not a suitable collaborator considering waste exportation for incineration with energy recovery.

7.2. Conclusion on Possibilities

In conclusion, considering the fact that landfilling is the main method of waste disposal in Curaçao, it may not possible or feasible to abruptly switch from this practice to recycling or incineration. There is a need for more research on these practices and investment from the government to gradually divert from landfilling and to transition towards more recycling and, if possible and feasible, waste exportation. If Curaçao were to consider the aforementioned possible solutions, it may be possible to transition to more sustainable practices for waste management.

Chapter 8: Conclusion

The objective of this research was to identify the best practices and provide an analysis of these practices to determine possibilities for a more sustainable waste management system for the country of Curaçao. After the desk research conducted, conclusions can be drawn to answer the central question: **"How can Curaçao transform its current landfilling waste management system into a more sustainable waste management system?"**.

The current state of municipal solid waste in Curaçao indicates a failure of the government to solve the issues concerning waste management on the island. The laws and policies on waste management are limited and poorly designed, and are therefore ineffective. Additionally, there are inadequate institutional and limited human resource capacities to enforce these regulations. Issues that arise from these inefficiencies can worsen if the official bodies are not provided with the proper tools to implement solid waste solutions. Curaçao needs to focus more on the waste hierarchy, and work towards shifting up the ladder. Therefore, different approaches can be implemented to help solve the waste management issues in Curaçao.

After benchmarking the practices of the five best performing countries and four islands that have been identified to have waste management practices other than landfilling, conclusions can be drawn. There are several possibilities identified that have potential to be successful and to help with Curaçao's waste management issue, if altered to the island's conditions. It was found that:

- The local government should invest in the waste management system to transition to a more sustainable practice. This can be achieved by implementing an integrated waste management system, focusing on moving up the waste hierarchy ladder.
- The government should introduce and support (community based) initiatives encouraging a more sustainable island, with consistency in implementing waste avoidance and awareness programs.
- The community needs to be educated on the effects their actions have on the waste management system, encouraging consumer behavior alterations and community participation.
- There is a need for waste separation at the source, preferably with color-coded bags, for efficient recycling. Additionally, further research is needed into PPP and its implementation in Curaçao.
- A deposit-refund system, compatible with the EPR concept, can be implemented by large supermarkets to enhance recycling activities, since EPR will not be effective for an island that imports a majority of its products.

- If it is not possible to recycle on a large scale, it may be more feasible to export waste to neighboring countries to try to solve the current issue, creating the opportunity for inter-regional collaboration.
- Curaçao does not have an incineration facility. However, considering factors such as reaching economies of scale and the large investment needed, building an incinerator may not be feasible for an island as small as Curaçao. Therefore, it may be more feasible to collaborate with and to export to countries in the region that do recycle or incinerate.

Even by considering the implementation of these alternatives, Curaçao's waste management issues will not completely be solved, but it may be possible for the island to divert from landfilling and gradually transition to more sustainable practices such as recycling, incineration or waste exportation. Therefore, it is recommended to conduct further research into practices more feasible for islands. Additionally, it is recommended to further research possibilities for collaboration with countries in the region, such as Aruba, Venezuela and Saint Kitts, since there are not many countries in the region that currently recycle or incinerate, but show promise that they may do so in the future.

References

Ajith, P. (2014). *A Study on the Effectiveness of Solid Waste Management of Municipalities in Kerala.* Thesis, Mahatma Gandhi University, School of PedagogicalSciences.

Allen, C. (2012). *Flanders, Belgium: Europe's Best Recycling and Prevention Program.* Global Alliance for Incinerator Alternatives.

Andersen, B. (n.d.). *Industrial Benchmarking for Competitive Advantage.* Norwegian University of Science and Technology, Department of Production and Quality Engineering.

Aqualectra Holdings. (n.d.). *Aqualectra and Selikor Sign Agreement for Waste Treatment*. Retrieved November 13, 2017, from Aqualectra Holdings website: http://www.aqualectra.com/en/news/aqualectra-corporate-news/aqualectra-and-selikor-sign-agreement-for-waste-treatment/#

Babcock & Wilcox Vølund A/S . (n.d.). *How Waste to Energy Works*. Retrieved October 22, 2017, from Volund.dk: http://www.volund.dk/Waste_to_Energy/How_it_works

Best Practice. (n.d.). Retrieved October 31, 2017, from http://searchsoftwarequality.techtarget.com/definition/best-practice

BioIntelligence Service S.A.S. (2012). *Preparing a Waste Prevention Programme: Guidance Document.* Paris.

Brassaw, B. (2017, July 11). *Germany: A Recycling Program That Actually Works*. Retrieved November 20, 2017, from http://earth911.com/business-policy/recycling-in-germany/

Brouwer, T. (n.d.). *Goals*. Retrieved November 12, 2017, from Green Force Curacao Website: http://greenforcecuracao.com/Goals/goals.html

Bultrini, B. (2017). *Community Participation in Solid Waste Management in Aruba.* University of Aruba.

Business Dictionary. (n.d.). *Waste Management*. Retrieved from businessdictionary.com: http://www.businessdictionary.com/definition/waste-management.html

Camp, R. (1989). *Benchmarking: The Search for Industry Best Practices That Lead to Superior Performance* (Illustrated ed.). Taylor & Francis.

Clark, L. (2012, October 29). *Sweden to import 800,000 tonnes of trash to burn for energy*. Retrieved November 27, 2017, from http://www.wired.co.uk/article/sweden-imports-garbage-for-energy

Con, A. (1994). *De Toekomst van de Huidige Afvalverwerking op Curaçao.* Thesis, TU Delft, Faculteit der Civiele Techniek, Delft.

Czajczynska, D., Anguilano, L., Ghazal, H., Krzyzynska, R., Reynolds, A., Spencer, N., & Jouhara, H. (2017, September). Potential of Pyrolysis Processes in The Waste Management Sector. *Thermal Science and Engineering Progress, 3*, 172.

Data ES. (n.d.). *Energy Snapshot Aruba.* Retrieved December 4, 2017, from https://www.nrel.gov/docs/fy15osti/62709.pdf

Davidson, G. (2011). *Waste Management Practices: Literature Review.* Dalhousie University.

de Cuba, K., Burgos, F., & Contreras-Lisperguer, R. (2008). *Integrated Waste Management Including Renewable Energy Limits and Potential for Waste Management to Energy Generation in the Caribbean.* Organization of American States, Department of Sustainable Development, Washington D.C.

Department for Environment, Food and Rural Affairs. (n.d.). *Germany.*

Deposit-Refund Systems. (2001, January). Retrieved October 22, 2017, from yosemite.epa.gov: https://yosemite.epa.gov/ee/epa/eerm.nsf/vwAN/EE-0216B-06.pdf/$file/EE-0216B-06.pdf

Dijkgraaf, E., & Gradus, R. (2014). *The Effectiveness of Dutch Municipal Recycling Policies.* Tinbergen Institute. Tinbergen Institute.

Drljača, M. (2015). Proceedings Book: Quality System Condition for Successful Business and Competitiveness. *The Transition for Linear to Circular Economy (Concept of Efficient Waste Management)*, 35-44. Vrnjačka Banja, Serbia.

Eckelman, M. (2014). Island Waste Management Systems. (R. Lifset, Ed.) *Journal of Industrial Ecology, 18*(2).

Ecological Recycling Society. (2015). *Waste Prevention Guide.* Athens: ERS.

El-Haggar, S. (2007). *Sustainable Industrial Design and Waste Management.* United States of America: Elsevier Academic Press.

EPA. (2016, February 22). *Frequent Questions*. Retrieved October 22, 2017, from EPA Archive website: https://archive.epa.gov/epawaste/hazard/wastemin/web/html/faqs.html

European Commission. (2009a). *Waste Prevention & Management Plan (Flanders).* Best Practice Factsheet.

European Commission. (2009b). *Kringloop Reuse Centres (Flanders).* European Commission.

European Commission. (2009c). *It's Smart with Less Waste (Helsinki, Finland).* European Commission.

European Commission. (2009d). *Eu Nao Faço Lixo (Portugal).* European Commission.

European Commission. (2010). Being Wise with Waste: The EU's Approach to Waste Management. Luxembourg: Publications Office of the European Union.

European Commission. (2012, October). *Preparing a Waste Prevention Programme*. Retrieved October 21, 2017, from http://ec.europa.eu/environment/waste/prevention/pdf/Waste%20prevention%20guidelines.pdf

European Commission. (2016a). *EU Countries Have to Drastically Reduce Consumption of Lightweight Plastic Carrier Bags.* European Commission.

European Commission. (2016b, June 8). *Waste*. Retrieved November 28, 2017, from The European Commision website: http://ec.europa.eu/environment/waste/landfill_index.htm

European Commission. (2016c, June 8). *Waste Prevention - Best Practices*. Retrieved November 14, 2017, from Europa.eu: http://ec.europa.eu/environment/waste/prevention/practices.htm

European Commission. (2017, August 24). *Waste Prevention and Management*. Retrieved October 21, 2017, from The European Commission Environment Website: http://ec.europa.eu/environment/green-growth/waste-prevention-and-management/index_en.htm

European Commission. (n.d.a). *Waste Prevention*. Retrieved October 21, 2017, from The European Commision Environment Website: http://ec.europa.eu/environment/waste/prevention/index.htm

European Commission. (n.d.b). *Reusable Shopping Bag "Eco-Sac".* European Commission.

European Commission. (n.d.c). *SuperDrecksKëscht.* European Commission.

European Environment Agency. (2016a). *Overview of National Waste Prevention Programmes in Europe - Belgium - Brussels.* European Environment Agency.

European Environment Agency. (2016b). *Overview of national waste prevention programmes in Europe - Finland.* European Environment Agency.

European Environment Agency. (2016c). *Overview of national waste prevention programmes in Europe - Ireland.* European Environment Agency.

European Environment Agency. (2016d). *Overview of national waste prevention programmes in Europe - Luxembourg.* European Environment Agency.

European Environment Agency. (2016e). *Overview of national waste prevention programmes in Europe - Portuga;.* European Environment Agency.

European Parliament & Council of the European Union. (2008). *Directive 2008/98/EC of the European Parliament and of the Council of 19 November 2008 on waste and repealing certain Directives.* EU Directive. Retrieved from Eurostat Statistics Explained: http://ec.europa.eu/eurostat/statistics-explained/index.php/Waste_statistics

Federal Ministry for the Environment, Nature Conservation and Nuclear Safety (BMU). (2011). *Closed-loop Waste Management: Recovering Wastes - Conserving Resources.* Public Relations Division. Berlin: Federal Ministry for the Environment, Nature Conservation and Nuclear Safety (BMU).

Filho, W. L., Brandli, L., Moora, H., Kruopiene, J., & Stenmarck, A. (2016, January 20). Benchmarking Approaches and Methods in the Field of Urban Waste Management. *Journal of Cleaner Production, 112*(5), 4377-4386.

Fischer, C. (2013). *Municipal waste management in Germany.* European Environment Agency.

FKLB. (n.d.). *Welcome to FKLB*. Retrieved November 13, 2017, from FLKB website: http://www.fklb.org/index.php?option=com_content&view=article&id=6&Itemid=8

Freden, J. (2017, March 29). *The Swedish Recycling Revolution*. Retrieved November 30, 2017, from https://sweden.se/nature/the-swedish-recycling-revolution/

Friends of the Eart Japan; Institute for Global Environmental Strategies. (2013). *Best Practices and Recommendations for Waste Reduction: Towards Sustainable Consumption.* Discussion Paper.

Gabriel, W. (2011, July 11). *Recycling Issues in Puerto Rico*. Retrieved November 24, 2017, from Recycle Nation website: https://recyclenation.com/2011/07/recycling-issues-puerto-rico/

Gentil, E. C. (2013). *Municipal Waste Management in Belgium.* European Environment Agency.

Gobièrnu di Kòrsou. (2015). *Curacao National Development Plan.*

Green Force. (n.d.). *Where Can You Bring Your Recyclables?* Retrieved November 13, 2017, from Green Force Curacao Website: http://www.greenforcecuracao.com/Recycling/Where-can-I-recycle-on-Curacao/where-can-i-recycle-on-curacao-through-green-force-.html

Help Save Nature. (2017). *Difference Between Sanitary Landfills and Open Dumps You Must Know*. Retrieved from helpsavenature.com: https://helpsavenature.com/difference-between-sanitary-landfills-open-dumps

Herczeg, M. (2013). *Municipal waste management in Switzerland.* European Environment Agency.

Isle of Man Government. (n.d.). *Department of Infrastructure Waste Policy and Strategy 2012 to 2022.* Isle of Man Government.

Japan Environmental Sanitation Center. (2012). *Solid Waste Management and Recycling Technology of Japan.* Ministry of the Environment.

Kelessidis, V. (2000). *INNOREGIO: Dissemination of Innovation Management and Knowledge Techniques.* Project Report.

Kim, J., & Jeong, S. (2017). *Economic and Environmental Cost Analysis of Incineration and Recovery Alternatives for Flammable Industrial Waste: The Case of South Korea.*

Koek, E. (2013, August 6). *Curaçao heeft geen actieve wet Illegale Vuilstort meer*. Retrieved from caribischnetwerk.ntr.nl: http://caribischnetwerk.ntr.nl/2013/08/06/curacao-heeft-geen-wet-illegale-vuilstort-mee/

Lawson, E. (n.d.). *What is the Process of Minimizing Waste?* Retrieved October 22, 2017, from Conserve Energy Future: https://www.conserve-energy-future.com/what-is-the-process-of-minimizing-waste.php

Lee, P., Sims, E., Bertham, O., Symington, H., Bell, N., Pfaltzgraff, L., & Sjogren, P. (2017). *Towards a Circular Economy - Waste Management in the EU.* Wuppertal Institute. Brussels: Science and Technology Options Assessment.

Leysen, A., & Preillon, N. (2014). *Belgian Waste and Recycling Solutions.* Belgian Foreign Trade Agency.

Lie, K. T. (2010). *Cradle to Cradle: Incorporating closed-loop material chains in the industry.* Master Thesis, RSM Erasmus University Rotterdam, Decision and Information Sciences.

Making Waste a Valuable Resource - Sweden's Take on Waste. (n.d.). Retrieved December 4, 2017, from http://www.envirosweden.se/thematic-areas/waste-to-energy/

Malek, M. A., & Shaaban, M. (2008). Landfill Common Method and Practices of Solid Wastes Disposal in Malaysia.

Maxwell, N. I. (2010). *Understanding Environmental Health: How We Live In The World.* Jones & Bartlett Learning.

Mc William, G. (2016, March 8). *Grupo Di Inversh onista Kla Pa Konstrui Planta Di "Waste Energy" Na Malpais*. Retrieved November 13, 2017, from Caribseek News website: http://news.caribseek.com/23613-grupo-di-invershonista-kla-pa-konstrui-planta-di-waste-energy-na-malpais-curacao

McDougall, F., White, P., Franke, M., & Hindle, P. (2001). *Integrated Solid Waste Management: A Life Cycle Inventory* (2nd ed.). Blackwell Science Ltd.

Meisen, P., & Phipps-Morgan, I. (2010). *Waste to Energy Plants.* Global Energy Network Institute.

Milios, L. (2013). *Municipal waste management in Sweden.* European Environment Agency.

Mohee, R., Mauthoor, S., Bundhoo, Z., Somaroo, G., Soobhany, N., & Gunasee, S. (2015, September). Current Status of Solid Waste Management in Small Island Developing States: A Review. *Waste Management, 43*, 539-549.

Montevecchi, F. (2016). *Policy Mixes to Achieve Absolute Decoupling: A Case Study of Municipal Waste Management.* Institute for Managing Sustainability, Vienna University of Economics and Business.

Mordor Intelligence. (2016, August). *Venezuela Waste-to-Energy Market Analysis to 2020 – Market Analysis by Technology (Physical, Thermal, Biological), Competitive Landscape, Key Company Information - Growth Trends and Forecasts.* Retrieved December 16, 2017, from The Mordor Intelligence Website: https://www.mordorintelligence.com/industry-reports/venezuela-waste-to-energy-market-industry

OECD. (2001a, September 25). *Waste*. Retrieved November 29, 2017, from Glossary of Statistical Terms Website: https://stats.oecd.org/glossary/detail.asp?ID=2896

OECD. (2001b, November 5). *DEPOSIT-REFUND SYSTEM*. Retrieved October 22, 2017, from The OECD Statistical Terms Glossary: https://stats.oecd.org/glossary/detail.asp?ID=594

OECD. (2001c, December 11). *POLLUTER-PAYS-PRINCIPLE*. Retrieved November 20, 2017, from OECD Statistical Terms Glossary: https://stats.oecd.org/glossary/detail.asp?ID=2074

OECD. (2015). *Environment at a Glance 2015: OECD Indicators.* Paris: OECD Publishing.

OECD. (n.d.). *Extended producer responsibility*. Retrieved November 29, 2017, from OECD website: http://www.oecd.org/env/tools-evaluation/extendedproducerresponsibility.htm

Oproep Voor Verbod op Plastic Tasjes Curaçao. (2017, August 10). Retrieved November 20, 2017, from duiken.nl: http://www.duiken.nl/nieuws/10/augustus/oproep-voor-verbod-op-plastic-tasjes-curacao/

Persson, O. (2015). *What is Circular Economy? - The Discourse of Circular Economy in the Swedish Public Sector.* Uppsala University, The Department of Earth Sciences. Department of Earth Sciences.

Pierson, G., & Brandley, S. (2013). *The Trust Factor.* eBookIt.com.

Pongrácz, E., Phillips, P. S., & Keiski, R. L. (2004). Evolving the Theory of Waste Management – Implications to waste minimization. *Waste Minimization and Resources Use Optimization Conference* (pp. 61-67). Finland: Oulu University Press.

PricewaterhouseCoopers Aruba. (2014). *Environmental Sustainability Ranking.* Oranjestad: PWC Aruba.

Profas, C., & Ras, J. (n.d.). *Environmental Policy Plan Curaçao 2016-2021.* GMN, E.C. Newton with Environmental Policy Division. Willemstad: The Government of Curaçao.

Ramachandra, T. V. (2011). Chapter 30: Integrated Management of Municipal Solid Waste. In S. R. Garg (Ed.), *Environmental Security: Human and Animal Health* (p. 466). Bangalore, India: IBDC Publishers.

Recycling and Disposal Guide for Oahu. (n.d.). Retrieved December 4, 2017, from http://www.opala.org/solid_waste/pdfs/Rec_Disp_Guide.pdf

Recycling Locations. (n.d.). Retrieved November 30, 2017, from Isle of Man Government Website: https://www.gov.im/categories/home-and-neighbourhood/recycling/recycling-locations/

Rijkswaterstaat Environment. (n.d.). *Elements of Dutch waste management*. Retrieved November 20, 2017, from Rijkswaterstaat Environment Website: https://rwsenvironment.eu/subjects/from-waste-resources/elements-dutch-waste/

Roth, A. (n.d.). *Waste To Energy*. Retrieved October 22, 2017, from Student Energy: https://www.studentenergy.org/topics/waste-to-energy

Scharff, H. (2014). Landfill Reduction Experience in the Netherlands. *Waste Management, 34*(11), 2218-2224.

Selikor en Afvalverwerking. (2012, February 13). Retrieved November 20, 2017, from Antilliaans Dagblad website: http://antilliaansdagblad.com/nieuws-menu/lezers/4504-selikor-en-afvalverwerking

Selikor N.V. (2013). *Annual Report 2013.* Willemstad: Selikor N.V.

Selikor N.V. (n.d.a). *Residential Curbside Collection*. Retrieved November 20, 2017, from Selikor N.V. Website: http://www.selikor.com/residential-links/289-10-residential-curbside-collection

Selikor N.V. (n.d.b). *Phase 1: Prevention*. Retrieved November 13, 2017, from Selikor N.V. website: http://www.selikor.com/learning-center-links/183-phase-1-prevention

Sheffield, H. (2016, December 8). *Sweden's recycling is so Revolutionary, the Country Has Run Out of Rubbish* . Retrieved November 26, 2017, from

http://www.independent.co.uk/environment/sweden-s-recycling-is-so-revolutionary-the-country-has-run-out-of-rubbish-a7462976.html

Simon, J. M. (2012). *Mallorca; Sun & Waste*. Retrieved December 5, 2017, from Zero Waste Europe Website: https://zerowasteeurope.eu/2012/11/mallorca-sun-waste-the-sunny-and-shady-sides-of-zero-waste/

Skjellaug, A. (2016, September 6). *Comment la Suisse transforme ses déchets en or*. Retrieved November 26, 2017, from https://www.letemps.ch/suisse/2016/09/06/suisse-transforme-dechets-or

Smart Ground. (n.d.). *Enhanced Landfill Mining Toolkit for Municipal Solid Waste Streams.* Retrieved November 30, 2017, from Smart Ground Website: http://www.smart-ground.eu/download/MSW_LFM%20toolkit_pdf_final.pdf

South Korea Legislates Towards a Zero Waste Society. (2015, July 17). Retrieved November 20, 2017, from Waste Management Review website: http://wastemanagementreview.com.au/south-korea-legislates-towards-a-zero-waste-society/

Stewart, L. (2014, May 31). *Fury Over Export of Our Waste to Island*. Retrieved December 5, 2017, from Belfast Telegraph Website: https://www.belfasttelegraph.co.uk/news/northern-ireland/fury-over-export-of-our-waste-to-island-30318189.html

Stouthuysen, P., & le Roy, D. (2010). *Cradle to Cradle: Theoretical Framework.*

Street, A. (2013, February 1). *The Answer for Remote Islands*. Retrieved December 5, 2017, from Waste Management World Website: https://waste-management-world.com/a/the-answer-for-remote-islands

Swiss are Stuck on Their Rubbish Bag Tax. (2003, August 7). Retrieved November 26, 2017, from https://www.swissinfo.ch/eng/swiss-are-stuck-on-their-rubbish-bag-tax/3448786

TAC Economics. (2013). *Strategies for Sustainable Long Term Economic Development in Curacao.*

The Central Intelligence Agency. (2017, July). *The World Factbook*. Retrieved from cia.gov: https://www.cia.gov/library/publications/resources/the-world-factbook/geos/cc.html

The Ellen MacArthur Foundation. (2013). *Towards the Circular Economy.* The Ellen MacArthur Foundation .

The Ellen MacArthur Foundation. (2015). *Towards a Circular Economy: Business Rationale for an Accelerated Transition.* The Ellen MacArthur Foundation.

The Governments of Curaçao & Sint Maarten. (2011). *First Millennium Development Goals Report.* Status Reclamestudio.

The Ministry of Health, Environment & Nature of Curaçao. (2014). *National Report of Curacao for the Third International Conference on Small Island Developing States.* The Government of Curacao.

The Swiss Confederation. (n.d.). *National Reporting to CSD 18/19 by Switzerland.* The Swiss Confederation.

The TUI Care Foundation. (2016, December 19). *Curacao - A Recycling Project in the Caribbean*. Retrieved from tui-policylounge.com: http://www.tui-policylounge.com/en/policy-blog/2016/december/recycling-project

Un Kòrsou Hustu. (n.d.). *Un Kòrsou Hustu, Curacao Goes Blue.* Willemstad: Un Kòrsou Hustu.

United Nations Environment Program. (2002). *Training Resource Pack for Hazardous Waste Management in Developing Economies.*

United Nations Environment Program. (2005). *Solid Waste Management.* United Nations Environmental Programme.

United Nations Environment Program. (2013). *Guidelines for National Waste Management Strategies Moving from Challenges to Opportunities.* United Nations Environment Program.

United Nations Environment Program. (n.d.). *Waste Minimization*. Retrieved October 22, 2017, from unep.org: https://www.unep.org/gpwm/what-we-do/waste-minimization

US EPA. (1992, May 28). *EPA Definition of 'Pollution Prevention'.* Memorandum, Office of the Administrator, Washington D.C. Retrieved November 18, 2017, from US EPA Website: https://www.epa.gov/sites/production/files/2014-09/documents/pollprev.pdf

US EPA. (2002). *What is Integrated Solid Waste Management?* Retrieved November 5, 2017, from National Service Center for Environmental Publications: https://nepis.epa.gov/Exe/ZyNET.exe/P1000L3W.TXT?ZyActionD=ZyDocument&Client=EPA&Index=2000+Thru+2005&Docs=&Query=&Time=&EndTime=&SearchMethod=1&TocRestrict=n&Toc=&TocEntry=&QField=&QFieldYear=&QFieldMonth=&QFieldDay=&IntQFieldOp=0&ExtQFieldOp=0&XmlQuery=&File=D%3A%5Czyfiles%5CIndex%20Data%5C00thru05%5CTxt%5C00000014%5CP1000L3W.txt&User=ANONYMOUS&Password=anonymous&SortMethod=h%7C-&MaximumDocuments=1&FuzzyDegree=0&ImageQuality=r75g8/r75g8/x150y150g16/i425&Display=hpfr&DefSeekPage=x&SearchBack=ZyActionL&Back=ZyActionS&BackDesc=Results%20page&MaximumPages=1&ZyEntry=1&SeekPage=x&ZyPURL

US EPA. (2014). *Municipal Solid Waste Landfills: Economic Impact Analysis for the Proposed New Subpart to the New Source Performance Standards.* Office of Air Quality Planning and Standards. North Carolina: US EPA.

US EPA. (2016, March 29). *Municipal Solid Waste*. Retrieved November 18, 2017, from EPA Archive website: https://archive.epa.gov/epawaste/nonhaz/municipal/web/html/

van Ewijk, S., & Stegemann, J. A. (2014, December 2). Limitations of the waste hierarchy for achieving absolute reductions in material throughput. *Journal of Cleaner Production, 132*, 122-128.

Vijayaraghavan, A. (2011, September 16). *Belgian Company Leads the Way in Landfill Mining*. Retrieved November 27, 2017, from https://www.triplepundit.com/2011/09/belgian-company-leads-landfill-mining/

Villanueva, I. R. (2014). *The Economics of Municipal Solid Waste Management in Tourism Destinations: The Case of Mallorca.* Doctoral Thesis, University of the Balearic Islands, Department of Applied Economics.

Waste Disposal and Recycling in South Korea. (n.d.). Retrieved November 20, 2017, from https://www.angloinfo.com/how-to/south-korea/housing/setting-up-home/waste-recycling

Waste Management - General Information. (n.d.). Retrieved December 4, 2017, from The United Nations Website: http://www.un.org/esa/dsd/dsd_aofw_ni/ni_pdfs/NationalReports/belgium/WasteManagement.pdf

Waste Treatment Policy and Measures in South Korea Background Information. (n.d.). Retrieved November 20, 2017, from http://www.legco.gov.hk/yr12-13/english/panels/ea/duty_v/eavp1304-3-e.pdf

Wilts, H., Galinski, L., Marin, G., Paleari, S., & Zoboli, R. (2017). *Assessment of Waste Incineration Capacity and Waste Shipments in Europe.* European Topic Centre on Waste and Materials in a Green Economy.

World Economic Forum. (2014). *Towards the Circular Economy: Accelerating the Scale-up Across Global Supply Chains.* Geneva: World Economic Forum.

Yale University. (n.d.). *Scholarly vs. Popular Sources*. Retrieved October 25, 2017, from Yale University Website: http://ctl.yale.edu/writing/using-sources/scholarly-vs-popular-sources

Zainal, Z. (2007). *Case Study as a Research Method.* Universiti Teknologi Malaysia, Faculty of Management and Human Resource Development.

Zaman, A. U., & Lehmann, S. (2011). Challenges and Opportunities in Transforming a City into a "Zero Waste City". *Challenges*, 73-93.

Zero Waste New Zealand Trust. (n.d.). *The End of Waste: Zero Waste by 2020.* Retrieved from http://www.unep.or.jp/ietc/Focus/An%20End%20to%20Waste.pdf

Zurbrügg, C. (n.d.). *Anaerobic Digestion of Organic Solid Waste*. Retrieved October 22, 2017, from Eawag.ch: http://www.eawag.ch/en/department/sandec/projects/mswm/anaerobic-digestion-of-organic-solid-waste/