IIIEE Theses 2022:05

Rethinking organic municipal solid waste management in Kenyan urban areas

Lessons from Bangladesh and Sri Lanka on circular approaches

Elaine M'Nkubitu

Supervisor

Naoko Tojo

Thesis for the fulfilment of the
Master of Science in Environmental Management and Policy
Lund, Sweden, May 2022

Published in 2022 by IIIEE, Lund University, P.O. Box 196, S-221 00 LUND, Sweden,
Tel: +46 – 46 222 00 00, Fax: +46 – 46 222 02 10, e-mail: iiiee@iiiee.lu.se.

ISSN 1401-9191

Acknowledgements

I would like to extend my sincerest gratitude to Naoko Tojo who has been a wonderful supervisor throughout the thesis period. Your guidance and continuous feedback were instrumental in shaping the final output of this research. Your assurance also helped me remain calm even when it felt daunting. I would also like to thank Thomas Lindhqvist and Leonidas Milios who helped in the formulation of my thesis ideas at the onset of AR and RDM courses. Additionally, many thanks to Luis Mundaca, Per Mickwitz, and my peers who provided feedback to my proposal that helped me refocus my thesis topic.

I would like to express immense gratitude to all the people and organizations who contributed to this research through interviews. Your time and input were much appreciated, and without your help, this thesis would be incomplete.

I would also like to thank all the staff of IIIEE who have taught me so much over the past two years. The amount of knowledge I have acquired throughout this program has exposed me to so many interesting areas and equally challenged me. Systems thinking and applying a critical eye to issues will remain with me for a long time! Apart from academics, the IIIEE family made the Insti feel homely, even amidst the Covid-19 pandemic. Special thanks to Naoko, Patricia, and Birgitta for all the support you have offered us.

So many thanks to B27 for an amazing 2 years. It was a wonderful experience sharing this journey with each one of you! You are all smart and inspiring and I cannot wait to see the great journeys we all set out on! Special thanks to the Food Gang; for great food, laughter, games, and conversations. You have made this journey so much more beautiful and memorable! You will always be in my heart.

Lastly, I want to thank my loved ones; family, and friends who offered me support in numerous ways and kept me focused and motivated. Despite the thousands of miles that separated us, your love and support were ever-present. Thank you for always believing in me, pushing me, and being an unfaltering support system!

Abstract

Organic waste forms a big share of municipal solid waste, especially in developing countries. Its management is however faced with many challenges ranging from limited financial and technical capacity to lack of, or weak policy enforcement. This causes poor management of the waste leading to open dumping and disposal in un-engineered landfills. Such practices have adverse effects on both the environment and the people. To improve the situation, actors in different locations have been applying circular economy approaches to manage organic waste better and recover resources from it. Such two cases are Waste Concern, a social enterprise in Bangladesh, and the Sri Lankan government through the National 'Pilisaru' Waste Management Project. These examples can provide a learning opportunity for other actors who might want to implement similar approaches. By using the Integrated Solid Waste Management (ISWM) model and applying an extrapolation-based case research framework, this thesis aims to determine what lessons can be learned from the two case studies, and how Kenya can establish similar approaches to address the challenges facing organic waste management in the country. The findings show that the adoption of simple, low-cost but labour-intensive technology is a key element of these approaches. Apart from this, there are other crucial features such as having marketing strategies for the product, forming strategic partnerships, and promoting waste separation.

Keywords: Organic waste management, circular economy, extrapolation, stakeholders, influencing factors.

Executive Summary

Problem definition

The urban population in many countries around the world is growing and this is contributing to high volumes of waste. Unsurprisingly, municipal solid waste (MSW) management is becoming an issue of concern globally. Especially developing countries are experiencing more difficulties managing the large amounts of waste generated as they are faced with multiple challenges. These include lack of financial capacity, underdeveloped infrastructure, lack of, or weak enforcement of policies, and limited technical skills. As a result, waste is managed poorly and, in most cases, is collected and dumped in un-engineered landfills and open spaces. This poor management of waste has adverse effects not only on the environment but also on the people.

The application of circular economy (CE) in waste management is becoming widespread in many places globally. While CE can be used to manage different waste streams, the organic fraction presents different paths of recovering nutrients and energy through processes such as composting, anaerobic digestion, and incineration. The use of CE to manage organic waste is attractive to many developing countries where the organic fraction forms the biggest share of MSW by weight, ranging between 40% and 70% (Storey et al., 2015; Sibanda et al., 2017). To improve the overall state of waste management, some countries have adopted circular approaches to deal with the organic share of MSW. Other countries, such as Kenya, that are facing challenges with organic waste management, can borrow lessons from the countries already implementing circular approaches.

Aim and research questions

This thesis aims to assess the possibility of transferring the circular approaches being used in other countries to Kenya. Two case studies from Bangladesh and Sri Lanka were chosen given similarities between the two countries and Kenya, such as challenges experienced in waste management and the high percentage of organic waste. The study was guided by the following research questions:

> **RQ1.** What are the experiences of specific aspects of circular organic waste management in Bangladesh and Sri Lanka?
>
> **RQ2.** What is the current state of organic waste management in Kenya?
>
> **RQ3.** How can the circular approaches in the two countries be transferred to the Kenyan context?

Research Design and Methodology

To understand if, and how, such approaches can be transferred to Kenya, the first step is to understand how the approaches were implemented in the two cases. This is done by using the Integrated Solid Waste Management (ISWM) model to establish aspects such as stakeholders involved and their roles, the interventions made at various stages of the waste management cycle, and the factors that influenced the outcomes. The second step is the analysis of the Kenyan context to understand the current state of organic waste management in the country. The last step is assessing the transferability of the approaches.

To determine if the approaches are suitable for the Kenyan context, an extrapolation-oriented case study design is employed. As part of extrapolation, theory-driven evaluation is used to reconstruct the mechanisms through which the two cases achieved the observed outcomes. The key features needed for the implementation of circular approaches are determined by consolidating information from the two cases. These features are then compared to the current state in Kenya to understand what adaptations might be needed, especially for resources or aspects that are different from the case studies. This information is then used to design a potential circular approach for organic waste management in Kenya.

Main findings

While the circular approaches in the two cases were implemented differently, the findings show that there was one common feature that was chosen due to the social-economic context of the two countries. The use of a simple low-cost technique for composting was suitable in both countries to avoid financial limitations that could be involved in purchasing advanced equipment. The use of such a simple but labour-intensive method also takes advantage of the affordable workforce and is not limited by the availability of advanced technical skills. Other features were crucial for the initiatives to achieve the intended outcomes. Waste separation was critical as this affected the amount of labour at the composting facilities, but more importantly, it affected the quality of compost produced. Presence of a market for the compost and having clear marketing strategies were also very critical. Other factors identified include the need for relevant policies and their strong implementation, creating strategic partnerships, and the use of awareness campaigns.

Overall, the findings show that by addressing the gaps identified in the Kenyan context, these approaches can be adopted. The similarities between the countries allow for Kenya to rely on the same level of technologies since it also has an affordable workforce and faces limited financial capacity. However, issues such as waste separation and having a marketing strategy for the compost must be addressed. Given the absence of relevant policies in this area, pragmatic policies will need to be developed and enforced. The use of circular approaches in organic waste management would however not be new to Kenya as there are companies already doing it. Such companies could be used to lead the transition to circular approaches at a national level.

Table of Contents

List of Figures

List of Tables

Abbreviations

CBO	-	Community-Based Organizations
CE	-	Circular Economy
CEA	-	Central Environment Agency
EMF	-	Ellen MacArthur Foundation
ISWM	-	Integrated Solid Waste Management
SWM	-	Solid Waste Management
NEMA	-	National Environment Management Authority
NGO	-	Non-Governmental Organization
MSW	-	Municipal Solid Waste

WC	-	Waste Concern
WtE	-	Waste-to-Energy

1 Introduction

The increase in world population coupled with growing urbanization rates has led to the production of high volumes of waste (Das et al., 2019) making municipal solid waste (MSW) an issue of concern globally (Leal Filho et al., 2016). The generation rate of MSW was estimated to be between 1.3 - 1.9 billion tonnes per year in 2012 (1.2 kg/capita/day) and is expected to reach 2.2 billion tons per year (1.42kg/capita/day) by 2025 worldwide (Batista et al., 2021; Hoornweg & Bhada-Tata, 2012, Kaza et al., 2018). Despite the individual waste generation rate (WGR) being higher in developed countries (Welivita et al., 2015), it is estimated that developing countries contribute about 56% of the world's total solid waste generated (Alam & Qiao, 2020).

The challenges of MSW are particularly dire in developing countries which face multiple inadequacies when it comes to waste management (Guerrero et al., 2013; Paes et al., 2019; Sibanda et al., 2017; Tukahirwa et al., 2011). The challenges include but are not limited to inadequate capacity, improper technology, limited capital, lack of infrastructure, and minimal participation from stakeholders (EPA, 2020; Guerrero et al., 2013; Sibanda et al., 2017). As a result, the rates of waste collection are very low and most of the waste that is collected is disposed of in open landfills and undesignated spaces (Guerrero et al., 2013; Sibanda et al., 2017).

Poor management of waste has extensive negative impacts on both the public and the environment (Monyoncho, 2013). Disposal of waste in open spaces or water bodies can create unhygienic conditions that lead to the spread of disease-causing vectors. Improper disposal can also lead to soil and water pollution. This is common with un-engineered landfills that lack the proper technology to prevent leachate from seeping into underground water sources or getting into contact with the soil. Another negative impact of poor waste disposal is the contribution to climate change from the release of greenhouse gases such as methane which is released during waste decomposition (Mosler et al., 2006). Moreover, dumpsites produce bad odours and ruin the aesthetics of the surroundings (Wilson et al., 2006).

MSW comprises various fractions that include organic waste, plastics and rubber, textiles, metals, glass, and cardboard among others (Xing et al., 2013). In many developing countries, organic waste comprises a big percentage of MSW. For example, in Asian countries, it makes up about 40-70% of MSW (Storey et al., 2015) while in East African urban areas it forms about 65-70% (Sibanda et al., 2017) by weight. The focus of many resource-recovery initiatives is on recyclables like glass, plastics, and papers (Ferronato et al., 2019) while most organic waste ends up in landfills (Guerrero et al., 2013). Given the huge share of MSW that organic waste comprises, it is necessary to find better pathways for its management to not only prevent the negative effect it has but also recover value from it.

To recover value from waste, the concept of circular economy (CE) has become popular in waste management. Kirchherr et al. (2017) describe CE as "an economic system that is based on business models which replace the 'end-of-life' concept with reducing, alternatively reusing, recycling, and recovering materials in production/distribution and consumption processes to accomplish sustainable development". Application of CE is not only limited to recyclables but is also suitable for organic waste. As stated by Ddiba et al. (2020), "applying circular models for organic waste streams which form the "biological material cycle" (Ellen MacArthur Foundation 2017), can help recover different resources such as water, nutrients, and energy". The introduction of circularity in organic waste management thus presents numerous benefits

including mitigating greenhouse gas emissions, securing food and water, providing energy, and creating employment opportunities (Ddiba et al., 2020).

The use of CE in organic waste management is widespread globally with various resource recovery models being employed in different locations. Bangladesh and Sri Lanka are examples of countries where circular approaches have been implemented to deal with this waste fraction. The two case studies used for this thesis research are based in these countries. From Bangladesh, Waste Concern will be used to showcase a resource recovery initiative by a private actor. Waste Concern, originally a non-governmental organization, is a social enterprise, that works with waste and provides other environmental services (Yedla, 2012). Their waste management model which was started in Dhaka city became a huge success and was replicated in other cities in Bangladesh and other Asian countries like Vietnam and Sri Lanka. A detailed analysis of Waste Concern's approach is presented in section 4.1. For Sri Lanka, a case study of the National Solid 'Pilisaru' Waste Management Project, also known as the Pilisaru Project is discussed in section 4.2. This was an initiative by the government to promote better waste management among the local authorities by providing funding and technical support for resource recovery programs.

These two cases present an opportunity to learn how the approaches used can be adapted to Kenya, a country that shares similar contextual characteristics such as challenges with waste management, the large share of organic share in MSW, and a comparable level of economic development. This thesis is therefore designed to analyse aspects like interventions that were made in the waste management cycle, stakeholders and partnerships among them, and factors that influenced the outcomes of the two cases. These aspects will subsequently be used to assess the feasibility of transferring the same or similar approaches to the Kenyan context. This is done by establishing what the status quo for organic waste management is and the adaptations that need to be done for the adoption of the approaches studied.

1.1 Problem Definition

Like many African countries, the Kenyan population has been growing at an increasing rate with the current population of the country being around 53.8 million people. Of this, 15 million (28%) of them were living in urban areas as of 2020 (Statista, 2022) and this number is expected to continue growing and is estimated that it will be 40 million by 2050 (blog.worldbank.org, 2016). The high population in urban areas contributes to high volumes of waste. However, waste management in Kenya faces numerous challenges which leads to low collection rates and poor or improper disposal of waste (Tukahirwa et al., 2013). Recycling, which is also minimal, targets materials like plastics and paper, which have a direct market value. Organic waste, which forms the biggest share of MSW is rarely used as a resource except in small-scale cases of composting (Monyoncho, 2013). This linear flow of the organic material presents an opportunity for resource recovery as well as a solution to the negative impacts of poor waste management.

A lot of research has been conducted in the area of solid waste management in developing countries (Diener et al., 2014; Otoo & Drechsel, 2018; Tukahirwa et al., 2013). The focus of these studies has ranged from policy interventions, the role of different stakeholders or drivers and barriers to sustainable waste management (Ezeah & Roberts, 2012). When it comes to organic waste, there has been a great focus on the technical aspects, looking into different technologies that can be used in resource recovery from organic waste (Cofie et al., 2009; Diener et al., 2014; Wainaina et al., 2020).

However, as discussed in section 2.4, research at the intersection of CE and organic waste management is minimal overall (Paes et al., 2019). This is more so the case in Kenya where until 2017 there were very few publications on CE. Knowledge and awareness about the potential of using CE models for organic waste management in Kenya need to be developed. Furthermore, since there are other countries already using circular approaches for organic waste management, there is an opportunity to determine if similar approaches would be suitable in Kenya. On a related note, despite there being a fair amount of research on stakeholder engagement for MSW, analysis of stakeholder engagement and partnerships for circular models is minimal. There are several stakeholders involved in waste management in Kenya and to determine how circular approaches can be adopted, it is crucial to understand the roles of these stakeholders and explore how partnerships between them can be developed to facilitate the adoption of circular approaches.

1.2 Aim of Research

The overarching aim of this thesis research is to explore the feasibility of transferring the circular approaches being used in organic waste management in Bangladesh and Sri Lanka to the Kenyan context. The research fulfils this aim in three ways.

First, the systems being used in Bangladesh and Sri Lanka will be studied using a case study in each country to uncover the approaches being used to recover resources from organic waste. The research aims to identify aspects such as interventions that were made to the previously existing waste management system, the stakeholders involved and their responsibilities, and the factors that have influenced the outcomes of these approaches. Secondly, the Kenyan context will be analysed to establish the status quo and to provide a basis for assessing the possibility of adopting similar approaches. Lastly, after the state of organic waste management in Kenya and the influencing factors have been established, the considerations and adaptations needed to facilitate the adoption of the circular approaches from the case studies will be evaluated.

1.3 Research Questions

The following research questions and sub-questions will be used to meet the objectives of the research.

Understanding the circular approaches in Bangladesh and Sri Lanka

RQ1. What are the experiences of specific aspects of circular organic waste management in Bangladesh and Sri Lanka?

a. What interventions have been introduced between waste generation to waste 'disposal' and how have they been implemented?
b. Who are the key stakeholders and what are their roles?
c. What are the outcomes (intended and unintended) of adopting circular approaches?
d. What have been the main influencing factors for the implementation of these approaches?

Analysing the Kenyan context

RQ2. What is the current state of organic waste management in Kenya?

a) What are the common practices used to manage organic waste?
b) Who are the stakeholders involved and what are their responsibilities?
c) Are there any stakeholder partnerships that currently exist for organic waste management and if so, what do they look like?

Assessing transferability

RQ3. How can the circular approaches in the two countries be transferred to the Kenyan context?

d) What adaptations need to be done to the approaches in Bangladesh and Sri Lanka to fit the Kenyan context?
e) What would be the main influencing factors for the adoption of these circular approaches in Kenya?

1.4 Overview of Methodology

This section gives a brief introduction of the methodology. More details are discussed in Chapter 3.

The main research methodology is centred around two case studies where circular approaches were used in organic waste management, and an evaluation of their transferability to the Kenyan context. Yin (2003) states that case study design is appropriate when trying to cover contextual conditions which are relevant to the event under study. For this study, the Integrated Solid Waste Management (ISWM) model was used in assessing the waste management aspects of the three contexts. The model guided data collection and analysis by grouping data into the three dimensions of ISWM: the stages of waste (generation to disposal), the stakeholders involved, and the influencing factors. Furthermore, triangulation was exercised in data collection to enhance the validity of the findings (6 & Bellamy, 2013). This was done by relying on different data sources which included literature review, interviews, and observations. A summary of the methodology is presented in Table 1-1.

1.4.1 Data collection methods

To answer the research questions, different data collection methods were used. A literature review of scientific papers, company documents, and other documents was done throughout the research. A total of 13 interviews were conducted with experts and other stakeholders from Sri Lanka and Kenya. Lastly, field visits were conducted in three urban areas in Kenya.

1.4.2 Data analysis

The computer software NVIVO was used in data analysis. It was used in classifying the different literature sources as in structuring coding themes. The Integrated Sustainable Waste Management Model (ISWM) was then used to analyse the findings from literature reviews and interviews. The ISWM model provided the three overarching themes around which the findings are examined. An extrapolation-oriented case research design was used to analyse the transferability aspects of the case studies.

Table 1-1. An overview of the research methodology

Research Question	Data collection method	Data sources
RQ1. What are the experiences of specific aspects of circular organic waste management in Bangladesh and Sri Lanka?	Literature review Interviews	Scientific papers, organizations' documents, experts from organizations and academia, residents, government officials
RQ2: What is the current state of organic waste management in Kenya?	Literature review Interviews Observations	Scientific papers, organization documents, experts from organizations and academia, private companies dealing with waste, field visits
RQ3: How can the circular approaches in the two countries be transferred to the Kenyan context?	Literature review Interviews	Scientific papers, organization documents, experts from organizations and academia, private companies dealing with waste

1.5 Scope and limitations

The primary geographical focus of the study was Kenya, but the scope was extended to include, include Bangladesh and Sri Lanka, where the two case studies are based. After looking at a few cases of initiatives applying circular approaches to organic waste management, Waste Concern and the Pilisaru Project were chosen. One case in São Paolo and another in Costa Rica were not selected as most of the literature on them was not in English. Another potential case, A1Organics in Colorado, USA was not chosen due to limited literature and the huge difference in contexts between the US and Kenya. The two cases were chosen because of the contextual similarities between these countries and Kenya, for instance in terms of composition of MSW, the challenges facing waste management and level of economic development (Storey, 2012; Tukahirwa et al., 2013). For Bangladesh, the case study is limited to Waste Concern's activities. Given that their model was replicated throughout the country, the scope of study is not limited to Dhaka City where the project started but extends to the whole of Bangladesh. For Sri Lanka, the Pilisaru Project was implemented by local authorities throughout the country, so the geographical scope is the entire country. The two cases were also chosen as they offer different approaches, one being a top-down initiative from the government and the other from a private actor.

The initial Waste Concern project was started in Dhaka City in 1995 but the operations of the organization have since expanded to other regions. Given the long duration between the start of their organization and now, this thesis focused on the early years, up to 2010. Analysis of Pilisaru Project focused on the period between 2008-2015, which marks the duration between the launch of the project to when funding from the government ended However, a brief overview of the current state of things for both cases has been provided.

The organic waste stream of MSW was chosen for this research as it forms a big percentage of MSW not only in Kenya but in many developing countries. Moreover, there is limited research focusing on the intersection between organic waste management and circularity in Kenya.

However, given the lack of, or very minimal, waste segregation in Kenya, the analysis of the status quo in Kenya looks at the whole MSW.

The criterion for evaluating the case studies will solely be their transferability to Kenya. This will however entail understanding the contextual characteristics of the three locations such as economic, social, and environmental aspects.

Lastly, while this thesis falls under the policy track, it does not involve analysis of any legal texts or evaluation of a particular policy. It looks holistically at organic waste management, which includes looking at any policies or legal factors that were influential in the case studies, and those that could be applicable to Kenya.

1.6 Ethical considerations

This research project was conducted in line with all ethical practices to promote integrity, credibility, and respect for all participants. All the interviewees were made aware of the purpose of the research and gave consent prior to the interviews. Confidentiality of any personal and sensitive data was observed where all the data collected was stored safely in a password protected personal computer and backed up in an encrypted hard drive. All findings from the research have been reported honestly to the best of the author's knowledge and attributed to the correct sources.

This research is not guided or funded by an external institution that could influence the nature or outcomes of the research. It is also conducted solely by the author hence there are no external influences on the author's analysis and conclusions. Lastly, this research presents no conflict of interest.

1.7 Disposition

The rest of this thesis is structured as follows:

Chapter 2 provides the literature on circular economy, stakeholders involved in organic waste management and introduces some methods of resource recovery from organic waste.

Chapter 3 presents the research design and the methods used for data collection and analysis. It also discusses the analytical framework used for this research.

Chapter 4 unravels the experiences of the two case studies with circular approaches for organic waste management. This is structured using the Integrated Solid Waste Management (ISWM) model dimensions.

Chapter 5 provides a current context analysis of organic waste management in Kenya. The data is also presented using the ISWM model dimensions. The chapter also discusses the conceptualization of circular economy in Kenya.

Chapter 6 presents the analysis based on the findings from Chapters 4 & 5. It recreates the logic models for the two case studies and creates a potential logic model for an organic waste management system for Kenya.

Chapter 7 critically discusses the findings and analysis from Chapters 4, 5, & 6, and the implications of those findings and analysis. It also provides a brief analysis of the research methodology

Chapter 8 provides the major conclusions and provides answers to the research questions It also presents recommendations for further research.

2 Circular economy and (organic) solid waste management: Theory and practice

This chapter provides an overview of the concept of circular economy including its origin and its conceptualization. The issue of solid waste management is also introduced and the challenges of solid waste management (SWM), especially in developing countries, are discussed. Additionally, a review of the main stakeholders involved in waste management has been done. The chapter then discusses the intersection of CE and organic waste management and briefly introduces some of the methods used for resource recovery.

2.1 Circular Economy

The concept of circular economy (CE) has spread globally through various academic disciplines and fields of study. It is mainly rooted in ecological, and environmental economics and industrial ecology (Ghisellini et al., 2016). References to circular economy can be found as early as 1976, albeit under varying guises such as industrial symbiosis, industrial ecology, or closed-loop economy (Turing, 2021). However, it was only in 2011 that the term became mainstream (Nissen, 2015 as cited by Turing, 2021). Some studies cite the origin of the concept of circular economy to be political economists like Ricardo or Adam Smith who viewed the production and consumption system as a circular process. Others believe Kenneth Boulding's paper from 1966, "The economics of the coming spaceship to earth", to be one of the antecedents of the concept (Schröder et al., 2019 p. 4). In the paper, the author advocated for a transition from a 'linear cowboy economic model of take-make-dispose to a closed cyclic system' (Ddiba, 2020, Rizos et al., 2016).

The concept lacks a single definition as discussed by Kircherr et al. (2017) who found at least 114 definitions by different stakeholders. Murray et al. (2017) attribute this lack of a single definition to the fact that the concept originated from policies and legislation rather than from academia (Donner et al., 2020), while Ghisellini et al. (2016) attribute it to the fact that the concept came from different schools of thought with diverse disciplinary backgrounds. The various definitions of CE can be seen to integrate different ideas and concepts such as cradle-to-cradle, biomimicry, and performance or sharing economy (Schröder et al., 2019, p. 4). Whilst the concept can be traced back to academia, the Ellen MacArthur Foundation (EMF) has led to its widespread adoption and is frequently understood within the conceptualization put forward by the foundation (Turing, 2021). While is it not universally agreed upon and is criticized for not being comprehensive (Turing, 2021), the EMF offers one of the most cited definitions (Ddiba, 2020) of CE which is as follows:

> *"… an industrial system that is restorative or regenerative by intention and design. It replaces the 'end-of-life' concept with restoration, shifts towards the use of renewable energy, eliminates the use of toxic chemicals, which impair reuse, and aims for elimination of waste through superior design of materials, products, systems, and, within this, business models" (EMF, 2012)*

The EMF uses the butterfly diagram, see Figure 2-1 below, adopted from McDonough cradle to cradle concept to demonstrate CE (McDonough & Braungart, 2002). In the diagram, the material flows are divided into two categories based on McDonough and Braungart (2002) description of the two cycles as follows: 'Biological nutrients, designed to re-enter the biosphere safely and build natural capital, and technical nutrients, which are designed to circulate at high quality without entering the biosphere' (EMF, 2015). CE aims at enhancing the continuous flow of these materials in the value circle while keeping products, components, and materials at their highest utility and value at all times and reducing waste to a minimum (EMF, 2013). This thesis

project will focus on the biological cycle since it looks at resource recovery from organic solid waste.

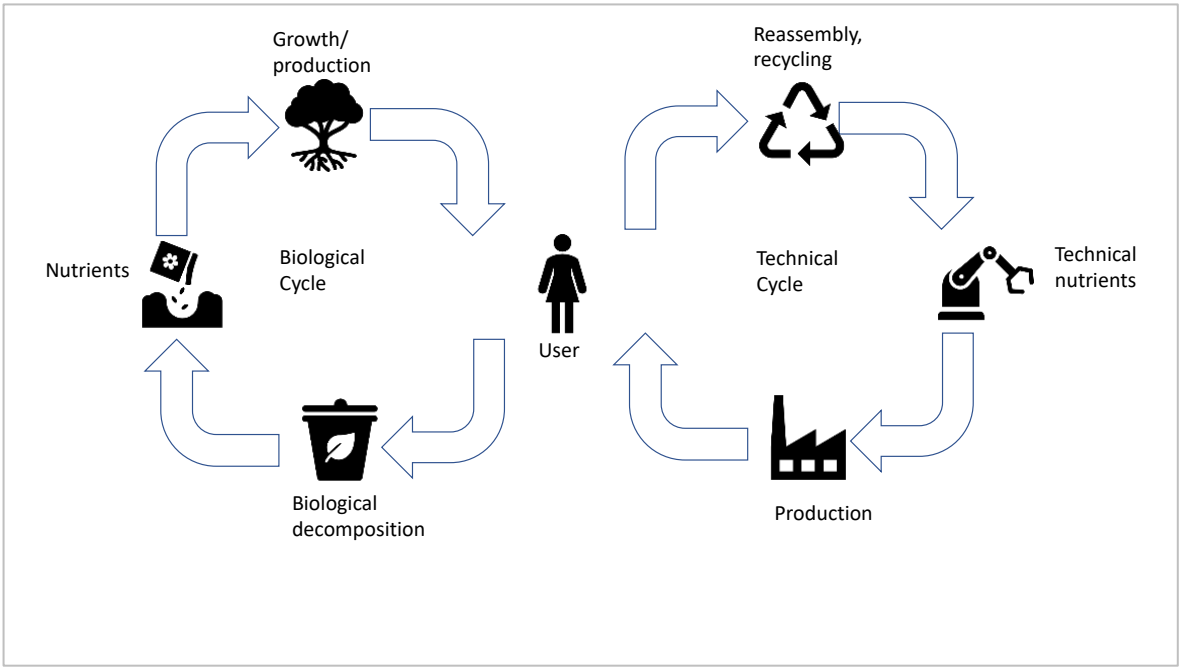

Figure 2-1. An illustration of material flows in the biological and technological cycles (Adapted from mcdonough.com)

CE has been shown to bring numerous benefits, not only economically but also to the environment and people. The three principles of CE, eliminating waste and pollution, circulating products and materials, and regenerating nature aim, at efficient resource use by transitioning from the 'take-make-dispose' model to circular models (EMF, 2013). Creation and retention of value of materials by enhancing circular flows that regenerate and restore this value can bring greater economic value while reducing environmental impacts. For example, the World Economic Forum estimated that the global biomass value chain had revenues that could reach US $295 billion by 2020 (Paes et al., 2019). To create a system that is restorative and regenerative, a shift from existing linear models is needed where energy and materials are redirected and transformed from being waste into valuable inputs for other processes and in the process reduce pollution, greenhouse gases, and other negative environmental impacts (Schröder et al., 2019 p. 3).

However, it is important to note that CE is not the panacea solution for solving all environmental issues and has its own limitations. (Schröder et al., 2019, p. 9). Korhonen et al., (2018) discuss some of these limitations. They include: 1) limitations imposed by laws of thermodynamics where it is impossible to have 100% efficiency in resource use and elimination of waste, 2) limits from system boundaries where spatially, problems are either shifted along the product life cycle while CE solutions might not know the long-term effects of the systems put in place today, 3) limits from physical economic growth such as Jevon's paradox/rebound effects and boomerang effect, 4) CE is affected by, and could also lead to, path dependency and lock-ins. 5) there are limits of governance and management due to inter-sectoral and inter-organizational management and physical flow of materials and lastly, 6) limits of social and cultural definitions.

CE also faces numerous implementation challenges. Adoption of circular models requires a lot of effort at micro, meso, and macro levels (Ferronato et al., 2019). It also requires capital investment, the right business models, advancement in policy coherence, coordination, and collaboration among stakeholders in different sectors and governance levels (Ddiba et al., 2020). These are some of the inhibitions to the adoption of circular approaches, especially in many developing countries that are already experiencing challenges like inadequate capital and weak policy development and enforcement.

Nevertheless, developing countries are beginning to see the opportunities that CE could bring especially when it comes to green industrial development (Schröder et al., 2019, p. 9). Despite the limited research on the demand for and opportunities for CE approaches by the stakeholders in these countries (Schröder et al., 2019, p. 10), the studies conducted have shown that many benefits could result from the adoption of CE. Halog and Anieke (2021) discuss a three-way win that could result from CE as it can lead to enhanced productivity and economic growth, it can improve quality and quantity of employment, and lastly, it can save lives by reducing environmental impacts such as climate change and pollution. CE can be applied to many sectors, but Halog and Anieke (2021) identified three major sectors where it can be effectively implemented. These are bioeconomy, mineral extraction and mining, and municipal waste management. They state that circular economy can promote the development of advanced cooperative models that include the hidden sectors of waste management.

2.2 Urbanization and challenges of (organic) solid waste management

As of 2018, more than 50% of the world population was living in cities and that number was set to increase to more than 65% by 2050. Out of this, 90% of this transition would be occurring in low- and middle-income countries (Ddiba et al., 2022). This huge urban population translates to growing quantities of waste with over 1.6 million tonnes of organic solid waste being generated daily, equating to about 1.3kg per person per day (Kaza et. al 2018). The situation of solid waste management is, however, not able to improve at the same rate that the population is growing, and the state of solid waste management (SWM) is dire in many countries, but especially the developing ones (Ezeah & Roberts, 2012). While local authorities in these countries spend about 20-50% of their budget on SWM, the services cover less than 50% of the population in cities. Additionally, 80-95% of the expenditure on waste management is on collection alone, a big contrast to less than 10% in developed countries (Harir et al., 2015). Given the lack of better waste management techniques, waste disposal in landfills and open dumpsites is also considered the most economical and common method of disposal. This model only transfers the environmental pressures downstream with negative implications for human health and the environment (Ddiba et al., 2022).

The poor state of SWM is caused by challenges coming from the economic, political, and social spheres. At the first stage of waste cycle, there is minimal awareness about waste separation at source. This is exacerbated by the absence of separate waste collection bins for various waste streams (Monyoncho, 2013; Sibanda et al., 2017), which makes separation of waste at the household level pointless since it would get mixed again at the collection stage. Collection and transportation are impacted by inadequate or underdeveloped infrastructure. For example, in Nairobi where the population is more than 8 million, there were only less than 70 garbage collection trucks provided by the Nairobi City Council (Henry et al., 2006). Supporting infrastructures like roads are also underdeveloped making some areas inaccessible especially in slums. Lastly, waste disposal is undermined by underdeveloped infrastructure, lack of technical skills, and inadequate or weakly enforced policies. Without facilities for waste recycling, reuse, or other resource recovery methods, or the technical skills needed to manage these activities,

the only alternative for disposal is landfilling. For the local authorities that are responsible for waste management, their budgets are often constrained and are consequently limited in terms of personnel and overall capacity (Paes et al., 2019; Sibanda et al., 2017, Storey et al., 2015).

This suboptimal state of waste management comes with numerous negative impacts that proliferate the economic, environmental, and social spheres. This includes greenhouse gases that are released into the atmosphere during decomposition, water and soil pollution from leachate, unhygienic conditions that lead to spread of diseases and bad odour (Kaza et al., 2018; Otoo & Drechsel, 2018). It is therefore critical that better systems are put in place to reduce all the adverse effects as well as to harness benefits that could result from better waste management approaches.

2.3 Stakeholder analysis in (organic) waste management

Solid Waste Management (SWM) is a complex system that involves a lot of stakeholders. In many places around the world, the municipalities, or the equivalent units, are the main stakeholders responsible for waste collection and disposal. However, other stakeholders such as private companies, community-based organizations (CBOs), research institutions, and the residents are also involved. The informal sector also plays a major role in waste management, especially in developing countries. The roles and responsibilities of each stakeholder might vary from one location to another. The term governance is usually used to describe the relationship between such actors. As cited in Wiesmann et al. (2011) Hufty defines governance as "Processes of interaction and decision-making among the actors involved in a collective problem that lead to the creation, reinforcement, or reproduction of social norms and institutions" (p. 405).

The governance of waste in many developing countries is affected by a lack of coordination among the stakeholders involved. This is especially the case as service provision is shared between multiple actors, but the responsibilities for each of them are not well defined. Tukahirwa (2013) explores this institutional fragmentation in East African metropolis where waste management is done by local government, private companies, and CBOs. Since the mandate for each of them is not clearly established, it makes it difficult to determine the party responsible for any area (Tukahirwa et al., 2013). Given that the capacities of these actors also vary by big margins, waste is handled very differently by each one of them. This fragmentation makes it difficult to have uniform practices around waste management. Lack of coordination also results from a lack of information sharing between the actors (Ma & Hipel, 2016; Paes et al., 2019; Storey et al., 2015).

When shifting to circular approaches in organic waste management, it is important to re-evaluate the stakeholders involved and their interactions. Circular models need to address issues such as the risks involved and which actor(s) bears those, how the gains are distributed, how problems can be identified and how all the actors can collaborate despite having different values and interests (Ddiba, 2020). Moreover, CE requires a transition from intra- to inter-sector management. The siloed model of looking at organic waste management would not be suitable as CE needs involves collaborating with multi-sectoral actors who are not currently linked to waste management (Ferronato et al., 2019) For example, implementation of resource recovery project where energy or fertilizer were the recovered would require working with the energy or farming sector to streamline the whole value chain.

2.4 CE in organic waste management

As stated earlier, waste management is one of the three sectors where the application of CE could have many advantages (Halog & Anieke, 2021). The introduction of circular approaches in organic waste management can present numerous benefits including mitigating greenhouse gas emissions, securing food and water, providing energy, and creating employment opportunities (Ddiba et al., 2020). Such benefits might be particularly attractive for countries like Kenya where the share of organic waste is about 65-70% of the MSW (Ferronato et al., 2019). However, the research that has been conducted looking at the intersection of CE and organic waste is limited (Otoo & Drechsel, 2018; Paes et al., 2019). The studies that have been done have, however, shown the potential of CE. Some of the studies have also addressed some of the drivers and barriers, most of which are the same challenges that are being experienced in the current waste management regimes. One of the challenges that is more particular to CE is the lack of widespread knowledge about the concept. While practices like composting or the use of biogas might be common, having a holistic understanding of how to scale and institutionalize these practices is lacking (Ddiba et al., 2022; Rizos et al., 2016) .

CE in organic waste management is implemented through various resource recovery methods. Some of these methods are described in more detail in section 2.5. A key aspect of designing circular models is adapting them to the context based on social, environmental, financial, and political characteristics (Ferronato et al., 2019). A model that works in one country might fail in another one due to such differences. Cultural and behavioural differences also play a big role in the success of circular models especially since people perceive waste differently (Storey et al., 2015). Yedla (2012) conducted a study to determine the strategies for replicating Waste Concern's community-based decentralized composting model in other Asian cities. They point out that a multi-criteria approach can be used, applying criteria such as transferability, longevity, economic viability, and adaptation. Like Ferronato et al. (2019), they state that circular models in countries with limited resources should rely on low-cost technology and local resources and should also be based on committed long-term partnerships (Yedla, 2012).

There are numerous factors that are needed to successfully implement circular models as will be seen from the case studies in Chapter 4. Some of the key factors include presence of waste separation, market/demand for the recovered or upscaled products, and the existence of policies to support these models. Waste separation is particularly critical where resource recovery involves composting as it helps provide quality non-contaminated feedstock (Storey et al., 2015). Waste separation also stabilizes the remaining waste (Otoo & Drechsel, 2018) by reducing harmful effects like decomposition and odor, and leaves the other waste fractions uncontaminated making it easier for inorganic materials to be reused or recycled. Additionally, demand for the recovered resource has to exist to enable the creation of pragmatic value chains (Donner et al., 2020). Demand for recovered resources is closely linked with having marketing strategies to promote the recovered product since many people are not aware of the existence of such products and their benefits, or have a negative perception of them (Ddiba, 2020; Rizos et al., 2016). The presence of policies and their implementation can also contribute to the scaling of resource recovery initiatives and mobilize different stakeholders to participate (Storey et al., 2013).

Currently, all these factors are barriers in many developing countries. Waste separation at the source is very minimal due to a lack of awareness or the infrastructure needed to promote it (Hettiarachchi et al., 2020, p. 18; Monyoncho, 2013). At a time when most waste is also collected for disposal, having waste separation at the source would be counterintuitive as the waste would be mixed again during disposal. Regarding the market for the products of CE, first, there is a

lack of awareness about such products. Secondly, due to the attitude that people have towards waste, they might prefer products made from virgin materials. Thirdly, the willingness to pay for these products is significantly lower than for other products in the market making them economically unviable (Ddiba, 2020; Sabki Mirza Hussein et al., 2018). Policies targeting CE are also either missing or are not strongly implemented (Monyoncho, 2013; Storey et al., 2015).

2.5 CE resource recovery methods

As stated above, there are several methods that can be used for resource recovery from organic waste. The choice of the method is dependent on factors such as input availability, demand for the recovered product, the capital investment needed, scalability, technology level, etc. The main resources recovered from organic waste include nutrients (including through feedstock) and energy.

Whilst the two case studies chosen are mostly focused on composting, this section covers other methods to provide the reader with a broader sense of resource recovery alternatives from organic waste.

2.5.1 Nutrient and organic matter recovery

The need for nutrient recovery is highly driven by the need to feed a growing global population with limited resources and under the pressure and risks of climate change. It is also enhanced by the high fertilizer prices and increasing regulations on the need to safeguard the environment against pollution. One of the compounds that has been of high concern is phosphorous, which is constantly lost to water bodies and is very expensive to recover to be used for agricultural purposes (Otoo & Drechsel, 2018). Nutrient recovery is especially important in urban areas which currently act as major nutrient sinks. In addition, nutrient recovery can present economic benefits through viable models of waste valorisation. One of the main methods used for nutrient recovery is composting. However, nutrients can also be recovered at the intermediate and end stages of other resource recovery methods as illustrated in Figure 2-2.

2.5.1.1 Composting

Composting is a controlled biological process that uses natural aerobic processes to increase the rate of biological decomposition of organic materials (Harir et al., 2015). It involves piling organic materials under suitable temperature and moisture conditions for them to be broken down by naturally occurring microorganisms such as bacteria, fungi, and earthworms (EMF, 2013). The conditions of composting must be right to prevent other issues like odour or dust (Harir et al., 2015). Composting is an especially favourable approach as it is considered the lowest-costing and low-technology method. However, composting needs high-quality feedstock to produce quality compost, and this could be challenging for MSW as the quality of waste is often difficult to control.

2.5.1.2 Fly larvae production

Black Soldier Fly (BSF) production is gaining popularity as another way of recovering waste and a faster way of breaking down organic waste (Hettiarachchi et al., 2020, p. 216). This is because of fluctuating supply of protein used in animal feed. The BSFs can consume huge volumes of organic waste and turn it into protein during the larvae stage. These larvae are then fed directly to animals like chicken or mixed with other substances to make protein-rich animal feed (Ddiba et al., 2022).

2.5.2 Energy recovery

Access to affordable and sustainable energy is crucial for economic growth and a better standard of living (Otoo & Drechsel, 2018). Among the Sustainable Development Goals (SDGs), SDG 7 is dedicated to achieving sustainable, reliable, and affordable energy, with target 7.2 aiming to increase the share of renewable energy including energy derived from organic waste. Given that many people in developing countries rely on solid fuels like firewood, charcoal, and dung which have negative effects on the people and the environment, better and cleaner energy sources from organic waste conversion might be an attractive alternative. For example, energy demand in Africa is mostly for cooking unlike in other places where it is used for electricity (Ddiba, 2020). Energy recovery can take various forms, but the most popular ones are the production of biogas and solid fuels such as briquettes.

2.5.2.1 Anaerobic digestion (biogas production)

Unlike composting, anaerobic digestion (AD) is a process in which microorganisms break down organic materials in the absence of oxygen. AD produces biogas and a solid residual. Biogas, which is made primarily of methane and carbon dioxide, can be used as a source of energy like natural gas. The solid residual can be composted further or applied to the soil directly (EMF, 2013). AD is practiced at different scales starting at the household level all the way to the industrial level. The biogas industry has been growing steadily and its market is expected to reach $50 billion in 2026 (Wainaina et al., 2020).

2.5.2.2 Drying and densification to generate solid fuel

A direct way of recovering energy is converting the organic fraction of municipal solid waste into briquette fuel. Briquettes are a form of solid fuel produced by compacting loose biomass residues into solid blocks that can be burned for heat energy and can substitute traditional biomass-based energy sources such as charcoal and firewood for domestic or institutional cooking, as well as for industrial heating processes (Otoo & Drechsel, 2018).

2.5.2.3 Incineration

Municipal solid waste is normally treated as waste, but it could be a source of energy. The calorific value of solid waste can be used for heating purposes and electricity can be produced from this energy. This method, commonly referred to as Waste-to-Energy (WtE) can solve the problem of MSW disposal with energy recovery from the waste and can improve environmental quality (Halder et al., 2014). However, incineration of organic waste is considered expensive or impractical in many cases. This is due to the high moisture content and low calorific value of the waste (Gunarawan & Gunasekara, 2016). For this reason, the energy recovered is lower that the energy used in the combustion making it economically unviable (Alam & Qiao, 2020).

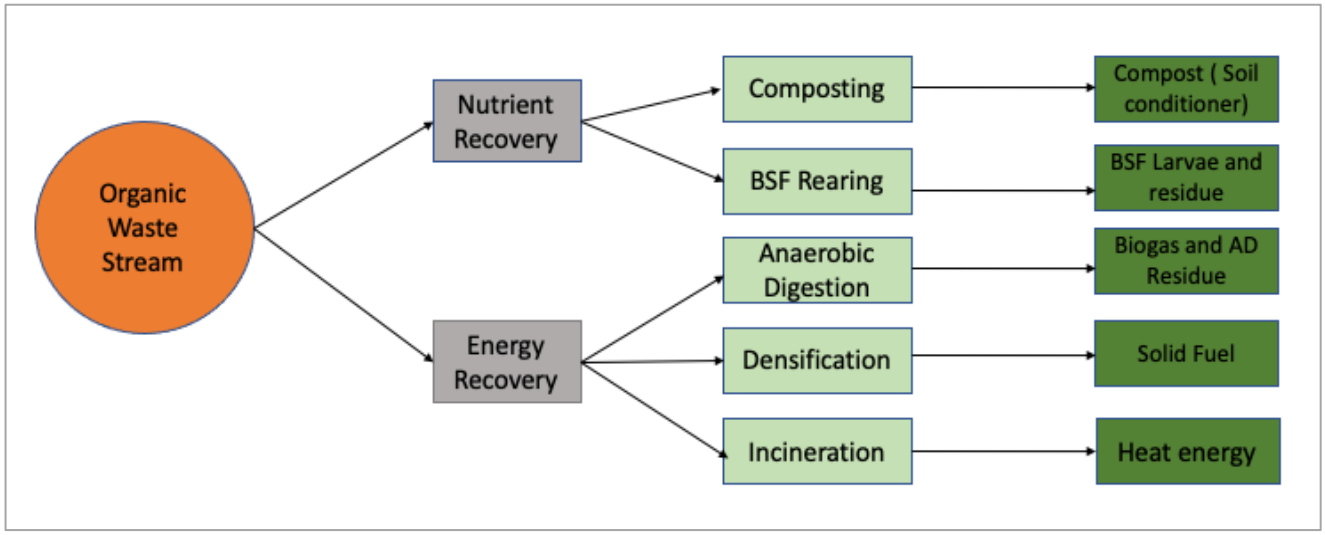

Figure 2-2. Resource recovery methods and output from organic waste (Adapted from Ddiba, 2020)

3 Research Design and Methodology

This chapter describes the methodology used during the research and gives more details about the methods used for data collection and data analysis and the limitations of those methods. The analytical framework used for this research is also presented. Figure 3-3 provides an overview of the methodology used.

The overarching research methodology is framed from a transferability assessment based on two case studies as mentioned in Section 1.4. The methodology used aims to determine how the circular approaches being implemented in Bangladesh and Sri Lanka can be transferred to Kenya to improve the existing regime of organic waste management. While Wang et al. (2006) define transferability as 'the extent to which the measured effectiveness of an applicable intervention could be achieved in another setting", this research better fits the term applicability which they describe as "the extent to which an intervention process could be implemented in another setting". To determine this, the extrapolation-oriented case research, which is discussed in section 3.4.2 is used.

In studying the transferability of sustainable urban mobility measures, Munthe-Kaas et al. (2020) came up with a 10-step framework that has been adopted for this research. For this research, the steps are listed below. The steps have however not been carried out in the same order as numbered below.

1. Diagnostic of the existing organic waste problems in Kenya
2. Characterization of the country
3. Analysis of the country's context and implications of the problems identified
4. Look around for similar contexts
5. Selecting examples of source countries
6. Identify measures with potential for transferring
7. Packaging and dimensioning the measures for transferring
8. Ex-ante assessment of measures to transfer
9. Identify need for adjustment
10. Implement measures and steer results

While steps 8 and 10 are outside the scope of this thesis project, steps 1-7 are discussed in the following sections and chapters: Steps 1-3 are discussed in **Chapter 5** which looks at the state of organic waste management in Kenya. Steps 4 & 5 were completed by looking at different case studies and narrowing them down to the two as discussed in section 1.5. Step 6 is covered in **Chapter 4** which discusses the case studies and lastly, steps 7 & 9 are discussed in **Chapter 7** where the analysis of transferability is presented.

3.1 Methodological approach

3.1.1 Case study methodology

A case study "is an empirical inquiry that investigates a contemporary phenomenon in depth and within its real-world context especially when the boundaries between the phenomenon and the context are not clearly evident" (Yin, 2003). Case studies, unlike other qualitative designs like grounded theory, are open to using theory and concepts to guide research and in data analysis (Meyer, 2001). Additionally, case studies are important for generating context-dependent knowledge (Flyvbjerg, 2006 as cited by Ddiba, 2020), which makes them a crucial part of this thesis methodology. Given the limitations that come with the use of a single-case

study, such as the limitation of generalizability and several information-processing biases (Meyer, 2001), two cases were chosen for this thesis.

The two case study countries, Bangladesh and Sri Lanka are located in South Asia and can be classified as developing or lower-middle-income countries with populations of 164.7 million and 21.92 million inhabitants respectively. Following Yin's (2003) recommendation about setting the boundaries of case studies, the boundaries for this research were limited to looking at organic waste management and the application of circular approaches. As stated in section 1.5, the two countries were selected for the case studies due to the similarities they share with Kenya, the target country, and their interesting experiences. While Bangladesh and Sri Lanka are only two cases and the findings might not be generalizable to other developing countries, they will offer a baseline for creating knowledge that could be transferred to other countries that share similar contexts.

3.2 Methods for data collection

To answer the research questions outlined in section 1.3, a variety of methods were used to gather data as discussed in the following section.

3.2.1 Literature review

Background information about circular economy, organic solid waste management, and governance, as well as country profiles on Bangladesh, Sri Lanka, and Kenya was collected via literature analysis of peer-reviewed journals, articles, and books, as well as from other online sources. Information more pertinent to Waste Concern was obtained from the organization's website where they have published some scientific papers and other grey literature. Most of the literature available was from the early years which made it relevant given the temporal scope of that case study. For Sri Lanka, there were publications from the government as well as other scientific papers. The Central Environmental Agency has also published a few documents and papers about the Pilisaru Project that were very relevant. Other publications by research institutes such as the International Water Management Institute (IWMI) and the Institute for Global Environmental Strategies (IGES) were also consulted.

3.2.2 Interviews with stakeholders

There were several stakeholders interviewed for this research as represented in Table 3-1. For Sri Lanka, five stakeholders were interviewed. A lead expert in the Pilisaru Project, the Director of the Pilisaru Project, the head of an NGO that was an implementing partner for one of the composting projects, and two residents. These stakeholders, having played different roles were able to provide information from different perspectives. The interview questions were structured around the outcomes of the project, the stakeholders involved, and the factors that led to the outcomes.

For Bangladesh, it was difficult getting stakeholders to interview despite numerous attempts. The multiple requests sent to over 30 people in Bangladesh via emails, LinkedIn, and Facebook did not yield any interviews. This was further impacted by the specificity of the case study which limited the people who could provide relevant information. A few people who responded declined to be interviewed as they said they were not very knowledgeable about the operations of the organization. As a result, the information on Waste Concern was based solely on literature which included scientific papers and publications by the organization. The limitations of this are discussed in section 7.2.1.

To understand the status quo in Kenya and determine the transferability of mechanisms identified in the case studies, eight interviews were conducted. The interviewees included two people in academia, one expert in composting, two people from two private companies that conduct waste recovery, two people that lead separate community-based organizations, and one resident from Nakuru.

All the interviews were used to gain further information and helped identify relevant literature and other existing documents. Earlier interviews were useful in improving subsequent interviews, and through the snowballing method, helped identify other people to interview. All the interviews were semi-structured with some pre-defined questions to guide the discussion, which left room for probing. The interview guide can be seen in Appendix 1. The interview questions were also customized based on the person being interviewed to obtain information that was more relevant to the person's experience. Due to the location of the researcher during the research period, all the interviews were conducted virtually via Zoom. The time for the interviews ranged from 45- 90 minutes for all the 13 interviews conducted.

Table 3-1. Types of stakeholders interviewed

Type of Stakeholder	**Institution**
CBO	Kwa Muhia Environmental Group (Kenya) Kibuye Market Group (Kenya)
Academia	Boras University (Sweden) KTH/SEI (Sweden)
Expert/Practitioners	FiBL, World Bank (Switzerland, Sri Lanka)
Private Companies	TakaTaka Solutions (Kenya) Safi Organics (Kenya)
Government	CEA (Sri Lanka)
NGO	SEVANATHA (Sri Lanka)
Citizens	Sri Lanka and Kenya

To preserve the anonymity of the interviewees, information obtained through interviews is presented collectively without attributing it to the specific interviewee. Each section containing information obtained from interviews has been described to let the reader know that some of the information came from interviews.

3.2.3 Observations

Observations were carried out in three urban areas in Kenya between January 18th and February 6th, 2022. These were done in Maua town in Meru county, Kangemi market in Kiambu county,

and Kibuye market in Kisumu city (see Appendix 2). Figure 3-1 below shows their placement on the Kenyan map. The observations were conducted passively in Kangemi, where the author visited the market without interacting with the residents, while in Maua and Kibuye Market, there were interactions with the residents. Residents were asked simple questions regarding the collection of waste and if they knew where the waste collected was disposed of. Observations were done to check consistency with what was reported in the literature review and to identify any information that might be missing. Notes were taken during all the visits and were used for analysis. The three locations were chosen due to their accessibility to the researcher. Whilst there are numerous such urban areas in Kenya, these provided a mixed sample based on size and location in the country. Despite only three locations being observed, urban areas in Kenya tend to be homogenous, hence the three areas offered a good representation of the other urban areas.

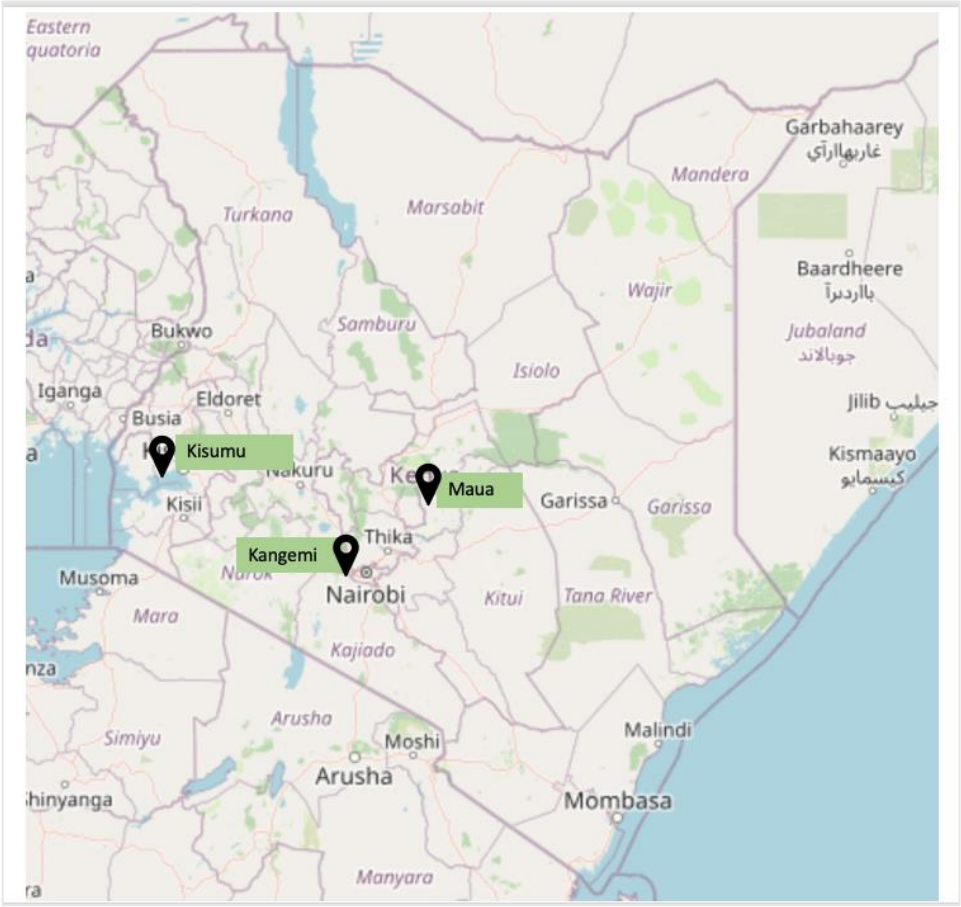

Figure 3-1. Map of Kenya showing locations where observations were conducted (Adapted from Open Maps)

3.3 Methods for data analysis

As briefly mentioned in section 1.4, NVIVO software was used to help in data analysis. The tool helped in classifying literature into different categories and coding around different themes identified in the literature and the interviews. Findings from the case studies and Kenya were organized around the three dimensions of the ISWM model. The codes used in NVIVO were also grouped in these three broad categories, but more granular sub-codes were used under each dimension.

3.4 Analytical framework for the research

The findings and analysis of this thesis are presented using two frameworks: The Integrated Solid Waste Management (ISWM) model and the extrapolation-oriented case research framework. The ISWM model is used to structure the findings from the case studies and finding on the status quo in Kenya. ISMW model provides a comprehensive approach of looking at a waste management system, not only looking at the elements in the waste cycle and the stakeholders but also analysing the factors affecting the system. The model is discussed in more detail in section 3.4.1 below. While it would have been possible to adapt the Governance Capacity Framework (GCF) that is mostly used in analysing water challenges (Koop et al., 2017), the ISWM offered a way of looking at the three dimensions separately instead of only using indicators used in GCF. The extrapolation-oriented approach was chosen over a pure policy evaluation as provides an extra step to policy evaluation. Namely, after establishing the mechanism by which a policy intervention worked in a given place, it looks at the possibility of transferring that practice to a different location. Section 3.4.2 discusses the approach in more detail. The two frameworks are complementary to each other. By identifying elements in the ISWM model of a system, the different actors and inputs that form the mechanism through which the policy intervention works are made clear. Correspondingly, the use of extrapolation to reconstruct the logic models, refer to Section 3.4.2, helps identify elements of the ISMW model that might not have been obvious.

3.4.1 Integrated Solid Waste Management (ISWM) model

The ISWM model allows the study of the complex and multi-dimensional system of waste management. As shown in Figure 3-2, it is structured around three crucial dimensions of waste management; (1) the stakeholders involved in, and affected by waste management, (2) the practical and technical elements of the waste system, and (3), the sustainability aspects of the local context that should be considered when planning or assessing a waste management system (Anschütz et al., 2004). A stakeholder is a person or organization that has an interest in something, in this case, waste management. The stakeholders involved in waste management vary from one location to another, but in many places, the municipalities are the main stakeholder as they are responsible for waste management in many countries (Paes et al., 2019). As introduced in Section 2.3, other stakeholders might include CBOs, residents, institutions, industries, and NGOs. The informal sector is also a major stakeholder, especially in developing countries. All these stakeholders play different roles and have different responsibilities in waste management. The waste system elements constitute the stages that waste goes through from generation, collection to treatment, and disposal. It is in this dimension that the waste hierarchy concept is applied by prioritizing waste prevention, reduction, recycling, and other methods of waste recovery. The last dimension consists of six sustainability aspects through which a waste management system can be assessed. These include technical performance, policy/legal, financial-economic, social-cultural, institutional/organizational, and environmental-health factors (Anschütz et al., 2004).

ISWM assessment applies normative principles outside of the usual evaluation criteria of efficiency and effectiveness. The three additional principles applied are equity, fairness, and sustainability. The inclusion of these principles ensures that a waste system is designed to serve all stakeholders, that the costs and benefits of the system are distributed fairly, and that it can operate at a stable level without losing the ability to do so in the future. For this thesis, the principles of equity and fairness have not been explicitly applied in the assessment of the waste management systems under study. However, since equity refers to the system being able to serve all people irrespective of their social and economic background, and fairness means that the

costs of the system are distributed based on the ability of stakeholders to bear the costs (Anschütz et al., 2004), these aspects are covered when looking at the stakeholders and sustainability aspects dimensions.

The ISMW model will be applied in assessing the two case studies as well as in analysing the Kenyan context.

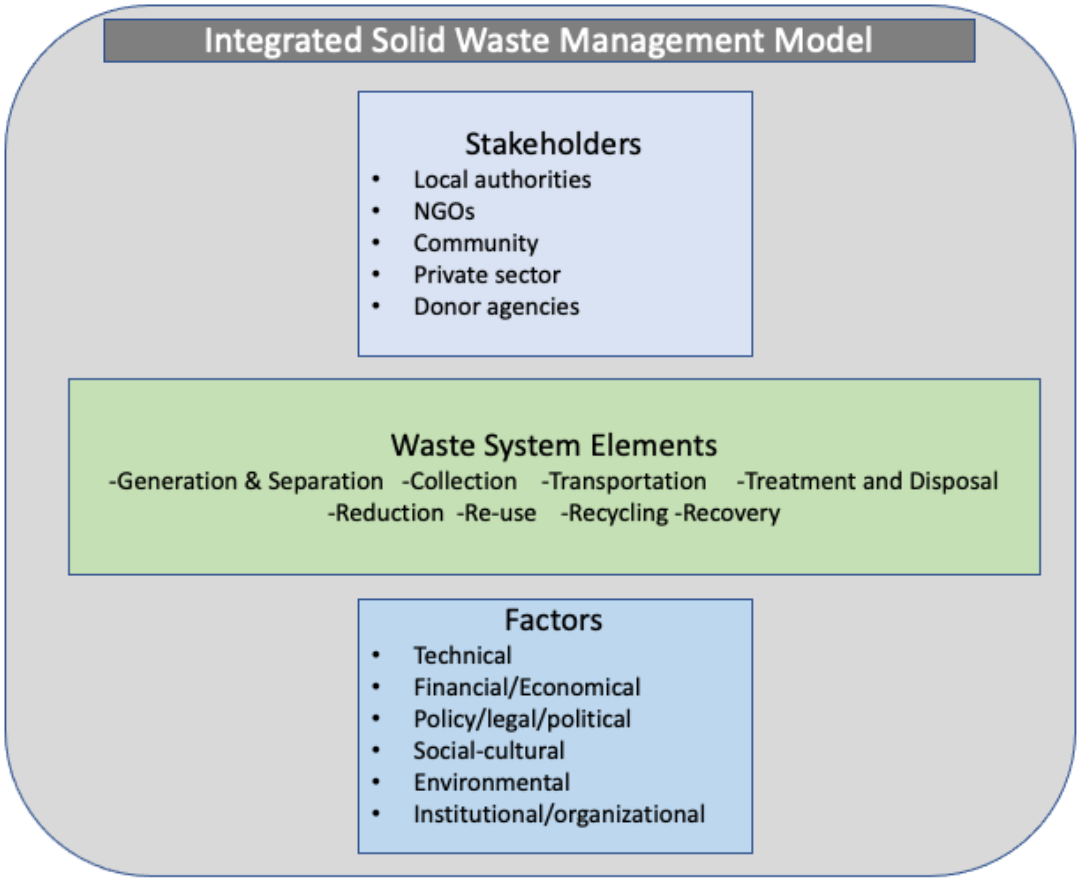

Figure 3-2. The integrated Solid Waste Management (ISWM) model adopted from Halimah Ismail (2015)

3.4.2 Extrapolation-oriented case research

In his presidential address, Bardach (2004) discusses how we can learn from vicarious experiences. The address notes that significant efforts to improve performance in one situation, or target site, involve analysing experience acquired somewhere else, referred to henceforth as the source site (Bardach, 2004). In learning from others' experiences, it is not enough to determine if the practice in the source site was effective but more important is to try to uncover how the observed practice mobilized human action and created significant effects (Barzelay, 2007). The objectives for trying to learn from other's good practice could be the replicate, adapt or experiment with the same practice. This choice is dependent on available resources and alternatives at the target site. Since replication is only possible if the conditions in Kenya were identical to those in Bangladesh and Sri Lanka (Bardach, 2004), the objective of this research is to learn how to adapt the circular approaches given the contextual variations between the countries. These conditions make extrapolation-oriented case research suitable for this study as

explained by Barzelay (2007), that in extrapolation, actors should focus on crafting functionally similar but materially different contrivances. It is also important to note that the case studies used here are not necessarily good exemplars (Barzelay, 2007) but they offer experiences from which lessons can be drawn.

Extrapolation is a two-step process beginning with research on the design exemplar, followed by using the lessons learned from the exemplar as a source of ideas for solving the design problem at hand. In the first step, the researcher explains the performance effects of the exemplar by understanding how it functions (Barzelay, 2007). The causal theory is the most accessible and most reliable method of solving extrapolation problems (Shadish et. al,2001 as cited by Bardach, 2004), although it has its share of limitations. The causal theory is centred around the idea of a mechanism, which serves as an explanatory device between the inputs or interventions and the outcomes. This first step will be applied to the two case studies. The purpose will be to understand the driving elements, which Bardach (2004) describes as a mechanism that has some causal power. The circular approaches will be analysed to uncover the role played by different contrivances and to establish links between different inputs and outcomes.

The second step of extrapolation is using the exemplars as a source of ideas for designing the solution for the target site. This involves decision-making under uncertainty to predict how the causal process in the source site can be produced at the target site with different undertakings (Barzelay, 2007). Lessons from the source site can reduce the uncertainty about whether practices in the source site would have similar effects at the target site. Bardach (2004) offers fortiori analysis as a strategy to reduce uncertainty. This involves comparing the target site and source site on a single resource or a combination of resources and then asking:

1. *"How much trouble did they have, given their level of these resources"?*
2. *Are we better or worse off than they were with respect to these resources"? (Bardach, 2004)*

In analysing the lessons that can be learned to be applied to the Kenyan context, the assessment will follow a fortiori procedure comparing the different resources between Kenya and Bangladesh, and Kenya and Sri Lanka. These include an analysis of the political, economic, and social factors and uncovering the causal connections between the design features, context factors, and the actors involved (Barzelay, 2007). Among these features, some will be implementing features, those that 'directly implement basic mechanisms', and others will be supportive features, 'those that bring implementing features into being' Bardach, 2004). For example, implementing features could be policies aimed at causing behaviour change to promote waste separation while supportive features could be the level of commitment from the stakeholders involved in waste management.

Extrapolation can be likened to enhanced theory-driven evaluation that goes an extra step to determine how the mechanism that worked in one place can be adopted in a different location. A theory-driven evaluation utilises an explicit theory of how a program causes the observed outcomes (Rogers et al., 2000 as cited by Coryn et al., 2007). Simply put, the evaluation determines not if a program works, but how it works (Rogers, 2000). This corresponds to the first step of extrapolation. The first part of the analysis will therefore be partly reconstructing the intervention theories to understand the observed outcomes in the case studies. Theory-driven evaluation can also help identify the reasons a program did not achieve the intended outcomes. This could be due to implementation failure, where the program was not

implemented as intended, or theory failure, where there was a fault in the logic of the underlying mechanism (Rogers, 2000). These two types of failures will be discussed in relation to one of the case studies in Section 6.2.

Another aspect of theory-driven evaluation is determining if the outcomes were produced by the intervention or by other elements external to the intervention (attributability assessment). This assessment is however outside the scope of this thesis so the outcomes will be linked solely to the interventions.

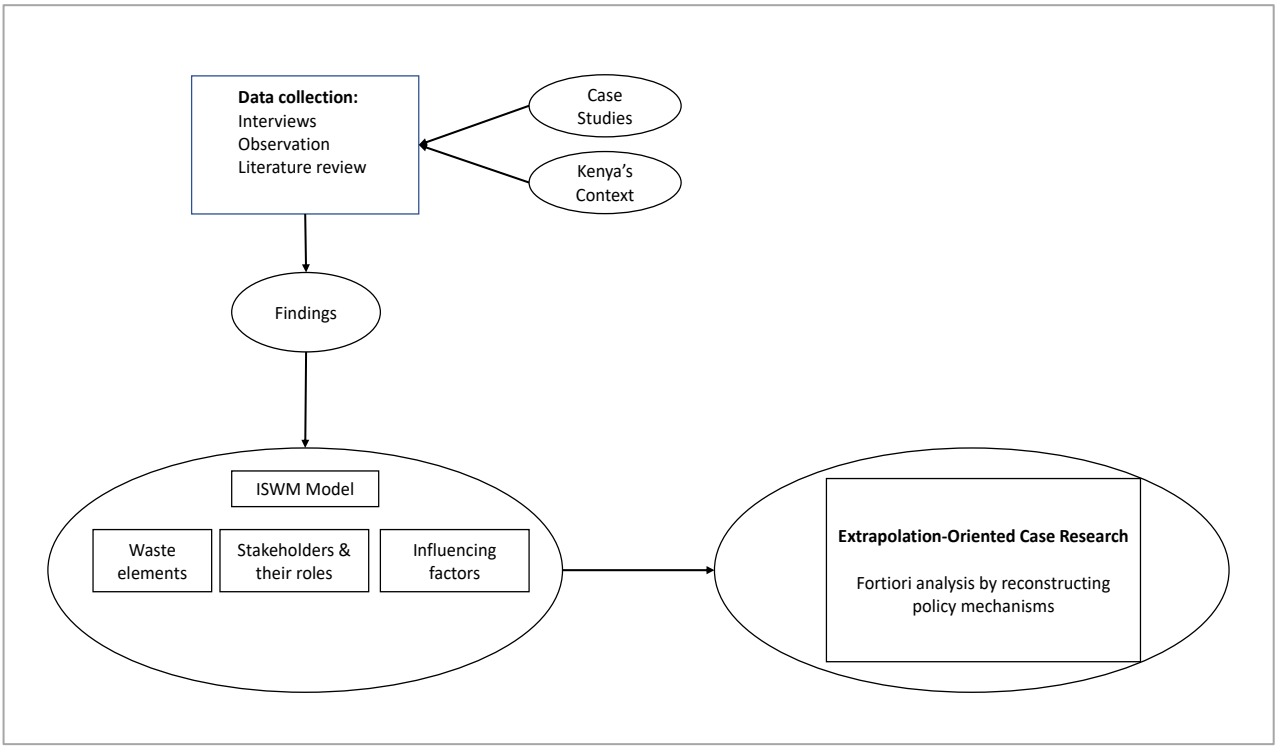

Figure 3-3. An illustration of the methodology

4 Case Studies

This chapter presents the findings and analysis of the two case studies of circular approaches in organic waste management in Bangladesh and Sri Lanka. The findings are presented by looking at the waste cycle elements between waste generation to disposal and the stakeholders involved. Furthermore, the influencing factors are discussed in relation to the success or failures of the case studies.

The information on the case study in Bangladesh is based solely on literature review while the Sri Lanka case study is based on literature review and interviews. The data is presented using the ISWM model.

4.1 Waste Concern's decentralized composting in Bangladesh

4.1.1 Overview of waste management in the Republic of Bangladesh

Bangladesh is a South Asian country that is almost surrounded by the eastern part of India. See Figure 4-1 below. It has a population of more than 160 million people with about 47 million (29.4%) living in urban areas (Alam & Qiao, 2020). It is one of the most densely populated countries in the world with about 1,115 people living per square kilometre (Ashikuzzaman & Howlader, 2020). Administratively, it is divided into eight divisions which are further divided into districts. It has 522 urban hubs (Alam & Qiao, 2020) with the main urban areas being the headquarters of the divisions. These include Dhaka City, Khulna, Chittagong, Rajshahi, Sylhet, Barisal, and Rangpur. Dhaka is the capital city with a population of about 6.73-7.5 million people (Alam & Qiao, 2020) and is made up of five municipalities.

Solid waste management is a big issue for Bangladesh. The average per capita municipal solid waste (MSW) generation varies in different municipalities and ranges between 0.2 to 0.56kg per capita per day. It is estimated that waste generation per capita in urban areas will be 0.75kg/capita/day in 2025 and the total amount of waste from urban areas will reach 21.07 million tons per year. Early waste management in Bangladesh allowed for practices like open dumping and burning, disposal of waste in water bodies, and landfilling (Ashikuzzaman & Howlader, 2020). Over time, however, the waste management approach has shifted as waste was seen as a resource. While recycling and composting of organic waste began in the 1980s and 90s, there are still many challenges experienced in waste management with the average collection rate being about 55% (Islam, 2021) due to lack of financial capacity, technological inadequacy, and low awareness. As shown in Table 4-1 below, the highest share of waste by weight is the organic fraction with an average of 74% across the major cities (Ashikuzzaman & Howlader, 2020).

Bangladesh waste management is conducted by actors that fall under either formal, informal, or community umbrellas (Ashikuzzaman & Howlader, 2020). In the formal sector, the municipalities or city corporations are responsible for all waste-related activities. The informal sector involves a labour force that deals mostly with recycling. The community umbrella comprises NGOs and CBOs who help collect and manage waste especially since the municipalities' capacity is limited (Waste Concern, 2004). Waste Concern (WC), which is covered in this section, falls under the community actors.

Figure 4-1. A map of Bangladesh showing the administrative divisions. Adapted from Mamun & Mascie-Taylor (2019)

Table 4-1. Waste composition in Bangladesh (Adapted from Ashikuzzaman & Howlader, 2020)

Waste stream	**Weight in percentage (average in 6 major cities)**
Food waste	74.5
Paper and paper product	9.1
Polythene and plastics	3.5
Textile & woods	1.9
Leather and rubber	0.8
Metal and tins	1.4
Glass & ceramic	0.8
Dust, ash, & mud products	5.1
Others	2.9

4.1.2 Waste Concern's decentralized composting model

Waste Concern (WC) is a social business enterprise (SBE) based in Bangladesh. It operates in solid waste management and provides other environmental services (Yedla, 2012). In 1995, WC started its first decentralized community composting project, with a 3-ton capacity composting plant in Mirpur in Dhaka (Yedla, 2012). The aim of the project was to develop a low-cost composting technique that was suitable for Dhaka's waste type, social-economic conditions, and climate. The project was also meant to develop public-private-community partnerships and create job opportunities for the urban poor in Dhaka (Zurbrügg et al., 2005).

The first plant was also meant to serve as a demonstration project (Yedla, 2012). The initiative became successful and with government support, it was replicated in other locations in the country and in other Asian countries like Vietnam and Sri Lanka (Storey et al., 2013). The project became the first carbon trading composting project under the Clean Development Mechanism (CDM) of the Kyoto Protocol (Parvin & Begum, 2018).

This case study focuses on the initial model at Mirpur in Dhaka. The following sections look in detail at this community-based composting model and use the ISWM model to analyse the different aspects of the project.

4.1.2.1 Stakeholders

The Waste Concern (WC) initiative had and continues to have various stakeholders involved including the government, private sector, waste generators, and international organisations (Zurbrügg et al., 2005). The waste generators, who are mostly households, were critical as they were the source of the feedstock for composting. At the onset of the initiative, there was not a lot of support from the government but after the successful demonstration at the Mirpur plant, they received government which led to increased funding and provision of land for composting plants. For example, DCC provided land for WC to construct a 5 tons/day capacity plant in Dhaka while the Ministry of Environment and Forest funded the construction of four composting plants under its "Community Based Urban Solid Waste Management Project in Dhaka" (Waste Concern, 2004; Yedla, 2012; Zurbrügg et al., 2005).

As replication of the project spread to other urban areas in Bangladesh, other partnerships developed to support them. For instance, the Swiss Development Cooperation funded the composting plant in Khulna, the third largest city in Bangladesh. In the early 2000s, WC became the first composting project under the Clean Development Mechanism with an initiative for 700 tons/day capacity composting plant and landfill gas recovery at the Matuail landfill in Dhaka City. This was done through WWR, a Dutch company. The approval of the project under the Clean Development Mechanism led to more partnerships and became a source of revenue from trading carbon credits (Parvin & Begum, 2018).

Another key partnership that was crucial for the success of the project was between WC and Map and Alpha Agro Industries, the fertilizer producers. They would buy compost from WC in bulk, enrich it, then sell it to retailers. This provided an easier way to market the product since the fertilizer company already had an existing network of distributors. Retailers and the end-buyers of the fertilizer, who could be both farmers and nursery owners, were also key stakeholders since, without the demand for the product, the economic viability of the project would be impacted (Yedla, 2012).

Table 4-2 below gives an overview of the stakeholders involved, mapped to the various stages of waste management.

Table 4-2. Stakeholders involved in the composting project and their roles

Stage of waste management	**Stakeholder**	**Role**
Generation	Households/community	Provide waste for collection and pay a collection fee
Collection Transportation Treatment	Informal sector + Waste Concern Government/Dhaka City Corporation Government and International institutions	Collection of waste from households, composting the waste Transportation of inorganic waste to landfill Provision of land and funding
Marketing/Recovery 'Disposal'	Map Agro Industries Retailers, Farmers	Buy raw compost and enrich it. Sell it to retailers and other dealers Purchase of enriched compost and its application

4.1.2.2 Waste system elements: Generation to disposal and 4R principles

Municipal solid waste in urban areas in Bangladesh comes mostly from residential, commercial, and industrial sources (Faisal, 2005) each making 52.1%, 21.9% and 18.2% respectively (Alam & Qiao, 2020). When Waste Concern was starting the project, The Dhaka City Corporation (DCC) estimated that there were about 3500 tons of solid waste being generated in Dhaka City, with DCC collecting and dumping about 1800 tons, 900 tons going to backyard and landfilling, and the rest was left by the roadsides or dumped in open spaces (Hai & Faisal, 2005).

To set up their first composting plant, Waste Concern got a piece of vacant land from Lions' Club (Enayetullah, & Sinha, n.d.). They then started house-to-house daily collection of waste by means of rickshaws which had a capacity of 1.8m^3. They employed some people to collect the waste and transport it to the site, and others at the site to manage the composting process (Zurbrügg et al., 2005). The waste that was collected was not separated at source. Sorting took place at the composting site. In 1995, the plant treated about 1.7 tons of MSW per day, a little over half of the plant capacity. By 2001, it was operating at full capacity processing 3 tons of MSW (Zurbrügg et al., 2005). At the plant, the waste was sorted, and the organic matter was set for composting. DCC collected the inert fraction from the site and transported it to the dumpsites while some of the recyclables were sold to other actors (Yedla, 2012). The organic portion was improved by adding substances such as sawdust, urea, cow dung and water. Composting was done using the 'Indonesian Windrow Technique' a non-mechanised aerobic

and thermophilic compositing process (Zurbrügg et al., 2005). This method was chosen over other methods as it had better odour control and produced better quality compost (Yedla, 2012).

Once the compost was ready and had gone through screening procedures, it was ready to be sold. Waste Concern signed a contract with Map and Alpha Agro Industries (Waste Concern, 2004), a private company that makes fertilizer, to sell compost produced in the plant to them (Yedla, 2012). Map and Alpha Agro Industries bought the bulk of the compost then enriched it further to meet the needs of different crops. They were also responsible for selling the enriched product. Through this model, the project was able to promote the principles of 4Rs (Reduce, Re-use, Recycle and Recovery of waste), which was a prime goal of the initiative (Waste Concern, 2004).

4.1.2.3 Influencing factors in Bangladesh

There are several factors that affected the outcome of the Waste Concern project. They are discussed below in order of significance determined by the author.

4.1.2.3.1 Technical factors

The aim of WC was to come up with a low-cost and local technology technique for composting organic waste (Yedla, 2012). The Indonesian Windrow composting required minimal capital and technical skills which allowed job creation for the local community. There was no special equipment or machinery needed since the waste was mixed with the additives and then piled around an aerator track to allow circulation inside the pile. The compost was then left to mature for a period of 53 days (Zurbrügg et al., 2005). Waste Concern also adopted the composting technique for different areas. For example, they realized the decentralized model was not suitable for the population residing in the slum areas of Dhaka City. This was because the slum dwellers were illegally occupying the land and were not served by the city authorities. They also lacked enough land space to have a composting plant. To overcome this challenge, WC modified the Barrel Type Composting model invented by SEVANATHA, an NGO based in Sri Lanka, and with the support from the Local Initiatives Facility for Environment and UNDP, they launched these models in the slums. This type of composting was not only low-cost, but the community could also generate revenue from selling the compost (Waste Concern, 2004).

4.1.2.3.2 Financial/economic factors

Closely linked to the technical aspects of the project was the financial/economic factors. Due to the use of low-cost and locally available technology, the financial requirements to set up the plants were not a limitation. Additionally, the project was designed to make it financially sustainable on its own. The revenue that was generated from collection fees and the sale of compost exceeded the operational costs of the plants. The payback period on the initial investment was only 23 months (Yedla, 2012). Moreover, the project provided economic benefits to the community through creation of employment, especially to the urban poor. Waste Concern's approach also integrated the informal sector by providing jobs in waste collection and working at the compost plant (Zurbrügg et al., 2005). The use of local technology also meant that labour was readily available and affordable. Lastly, by partnering with Map and Alpha Agro Industries, they ensured that there was bulk buying of the compost and that the enriched compost's market was not only limited to the local area but could be sold countrywide through the fertilizer maker's networks (Zurbrügg et al., 2005).

4.1.2.3.3 Social-cultural factors

Before the establishment of the first demonstration plant, Waste Concern had conducted a questionnaire survey among the residents in Section-2 neighbourhood in Mirpur. They wanted to determine the opinion of the community on the state of solid waste management, their willingness to participate in the program, and their willingness to pay a fee for waste collection. The results showed that more than 80% of the residents were dissatisfied with the existing service and they were in support of a door-to-door collection scheme. More than 77% were also willing to pay Tk. 15-60/month (0.2 -0.7 USD) for the service. This information encouraged Waste Concern to start the project as they knew there was a market for waste collection and that there was a willingness to participate from the community (Enayetullah & Sinha, n.d.).

Central to the Waste Concern's model were the multi-stakeholder partnerships that were formed from the beginning. The public-private-community partnerships created an environment that contributed to the success of the project with each actor having specific roles to fulfil (Waste Concern, 2004). The benefits of the program were also shared among the actors making the partnership beneficial for everyone. The community had a cleaner environment and job opportunities, Dhaka City Corporation's (DCC) cost of waste management was reduced due to the reduced volume of waste, Waste Concern got revenue from collection charges and sale of compost, and the Map and Alpha Agro Industries profited from selling enriched compost (Yedla, 2012). With time, WC has been able to foster more partnerships including international agencies, which have further promoted the growth of the organization.

4.1.2.3.4 Institutional/organizational factors

The presence of specific institutions in Bangladesh also played an essential part in the project. For example, Waste Concern had the compost tested by the National Laboratories of Soil Science. The results showed that the compost was of a higher quality than compost on the international market (Yedla, 2012). Similarly, the Bangladesh Agriculture Research Council gave formal approval to the use of the compost product for agricultural purposes (Zurbrügg et al., 2005). These actions guaranteed the quality of the products and increased trust from farmers and other buyers (Yedla, 2012).

4.1.2.4 Waste Concern today

Unfortunately, due to unsuccessful attempts at connecting with anyone currently working with Waste Concern, it was impossible to establish their current operations in organic waste management. From their organization website, however, they have increased the scope of their operations to general solid waste management, recycling, clinical and hazardous waste management, wastewater treatment, as well as organic farming Waste Concern is now a Social Business Enterprise consisting of for-profit and not-for-profit groups (Waste Concern, 2022).

4.2 Pilisaru (Waste Management) Project in Sri Lanka

Information presented in this section was obtained from interviews and literature review.

4.2.1 Overview of Sri Lanka's waste management

Sri Lanka is a low-middle-income country located in the southeast of India separated by the Poak Straits (Jica, 2016). It had a population of 21.4 million in 2020 and a GDP of 4,073 USD (IGES, 2020). Administratively, it is divided into nine provinces and 25 districts. The capital city of Colombo is in the Western province, which is also the most populated among all the provinces.

Improper waste management has been a key environmental problem in Sri Lanka. Lack of organized systems, lack of intermediate disposal, and poorly managed landfills have aggravated the problem in the country (Fernando, n.d.). It is estimated that 5,976 metric tons of MSW are generated per day and is expected to grow 1.2% per annum (IGES, 2020). The local authorities (LAs) have responsibility for all the municipal waste management functions. (Fernando & Silva, 2020; Roy et al., 2021). Given that Sri Lanka uses a centralized approach to SWM (Fernando & Silva, 2020), the national government has taken several initiatives to help improve the situation (Roy et al., 2021). In 1999 the Ministry of Environment and Natural Resources issued the National Strategy for Solid Waste Management. The same ministry introduced the National Waste Management Policy in 2007. This was to ensure integrated, economically viable, and environmental-friendly waste management at national, provincial, and local levels (IGES, 2020). It was as part of this policy that the ministry launched the Pilisaru Project under the chairmanship of the Ministry of Environment and the Central Environmental Authority (CEA) (Fernando, n.d.; IGES, 2020).

4.2.2 The Pilisaru Project

The National 'Pilisaru' Solid Waste Management Project, commonly referred to as the Pilisaru Project, was established in 2008 to address the issue of improper SWM in a nationally coordinated manner (Fernando, n.d.). In the years preceding the launch of the project, NGOs had raised concerns about poor waste management in the country and had gone to court to pressure the CEA to take action. Since there is a law that requires local authorities to provide waste management services, the CEA took a few local authorities to court in return. The mayors who are the head of the local authorities came up with a list of challenges that were causing the poor waste management. These included lack of funding, lack of technical skills, and unavailability of land on which to carry out waste management activities. The court ruled that the government needed to provide these resources to the local authorities to enable them to offer better waste management services. The launch of the Pilisaru Project was therefore aimed to address the challenges that had been raised by the urban councils. Weligama urban council which was already managing its organic waste through composting provided a blueprint for the Pilisaru Project.

There were 5 main objectives under the program:

- Developing a national policy on SWM
- Developing a national strategy on SWM
- Effective education & awareness for all stakeholders
- Facilitating local authorities for implementation of SWM projects
- Legal reforms to strengthen law enforcement

(Fernando, n.d.; Ministry of Environment and Resources, 2012)

The MSW covered in the project included household waste, commercial waste, and industrial waste. Several activities were included in the scope of the project including but not limited to evaluation of project proposals, establishment of waste collection systems, technical support and capacity building, the establishment of composting plants at the municipal level, providing waste handling equipment, and monitoring and evaluation of the projects/programs (Fernando, n.d.). The project aimed to achieve the fourth objective of facilitating the implementation of SWM in four steps: Stabilize waste by composting organic fraction, improve waste collection, improve waste disposal and lastly, start source separation. Source separation was designed as the last step as it would take time for behaviour change, and it was important to begin managing the organic share as this would reduce the pollution potential of the waste.

When the project was established, it was designed for a period of three years with a budget of 5.675 billion LKR (43.6 million USD) from the national treasury (Fernando, n.d.; Sinnathamby et al., 2016) with effect from January 2008. However, it was extended until 2015 (IGES, 2020). The same year the project was launched, the National Solid Waste Management Support Centre was established to offer technical support for local authorities (Sinnathamby et al., 2016).

Since the Pilisaru Project was designed to support project proposals from local authorities, the types of projects that were funded varied in size, activities, and stakeholders involved. While there were projects involving biogas recovery, recycling of glass and plastics, or awareness campaigns, many projects involved composting organic waste. By 2011, about 100 composting facilities had been established through the project. Figure 4-2 shows the number of composting plants between 2005 and 2019 while Figure 4-3 shows the locations of the different composting plants established under the project.

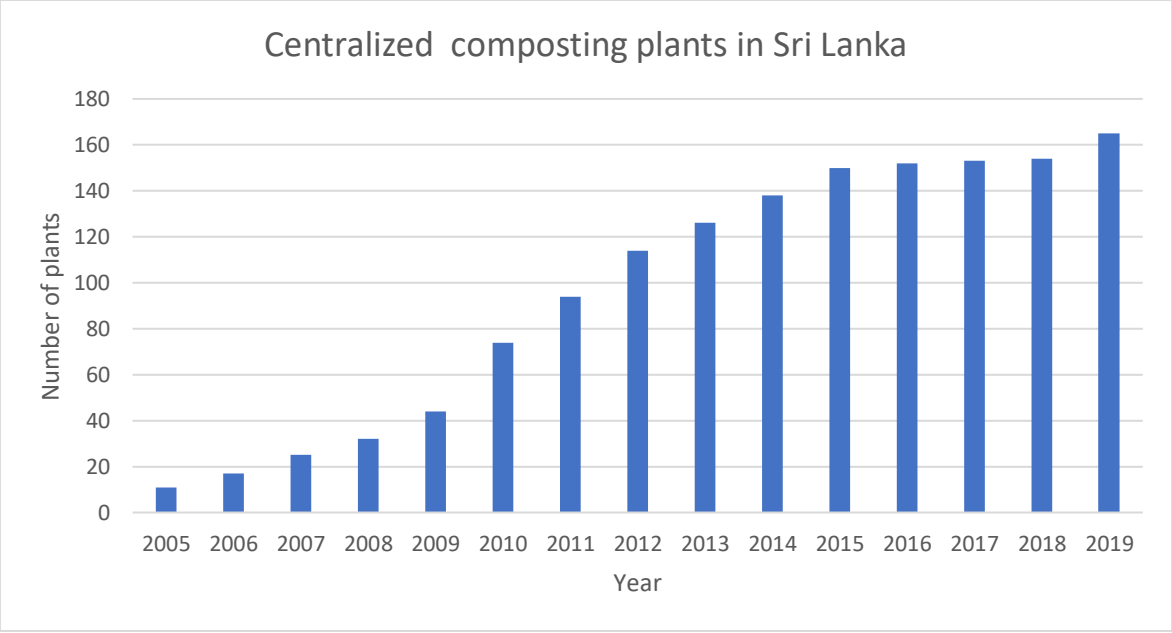

Figure 4-2. Number of centralized composting plants in Sri Lanka (Adapted from IGES, 2020)

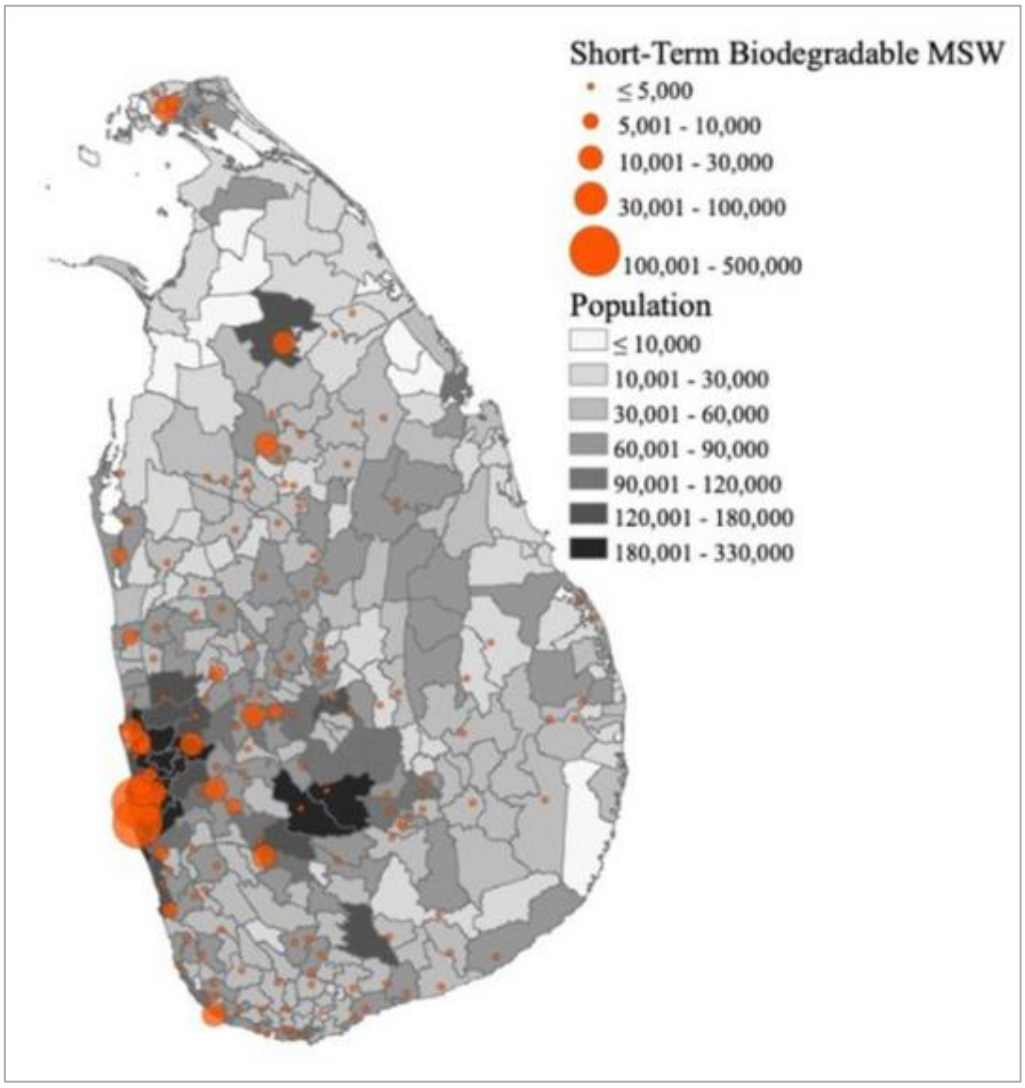

Figure 4-3. Location of composting facilities established through the Pilisaru Program (Source Roy et al., 2021)

The information presented in the following sections is based on different local authorities' projects approved and funded under the Pilisaru Project.

4.2.2.1 Stakeholders involved

The stakeholders involved varied based on the type of project and the local authority. In some cases, there was collaboration between various government authorities, involvement of the residents as well as NGOs. There were also technical expert committees for different themes or waste management methods like composting, biogas, landfilling, and recycling.

This section looks at the stakeholders involved in a project based in Matale, in Central Province, which received support from the Pilisaru project. In Matale, there was an Integrated Resource Recovery Centre (IRCC) that had been established by United Nations Economic and Social Commission for Asia and the Pacific (ESCAP) with technical support from Waste Concern (Storey et al., 2013). ESCAP has started a regional project to promote decentralized IRRCs in secondary cities and small towns in the Asia Pacific to improve MSW. The IRRC model was designed to reduce waste and recover resources from the waste.

ESCAP had partnered with a local NGO, SEVENATHA, to pilot a 2-ton IRRC in 2007. Due to the success of that centre in diverting waste and recovering resources, the Pilisaru project provided funds to establish a second IRRC in 2013. In the same year, ESCAP supported the establishment of a third IRRC, with the three of them having enough capacity to process all the organic waste from Matale. The land on which the IRRCs were constructed was provided by the municipality (Storey et al., 2015). To promote source separation, community development officers from the Public Health Department of the municipality did a door-to-door awareness campaign visiting each household at least once a month. They educated the residents on the importance of source separation by tying it to sustainable SWM as well as improved urban hygiene. These awareness campaigns were further backed by the municipal department, thus increasing their credibility. The IRRC was operated by a partnership between Matale Municipal Council and MEC Pvt, a social business that was formed by SEVANATHA. (Storey et al., 2013)

Figure 4-4 illustrates the stakeholders involved in the project in Matale.

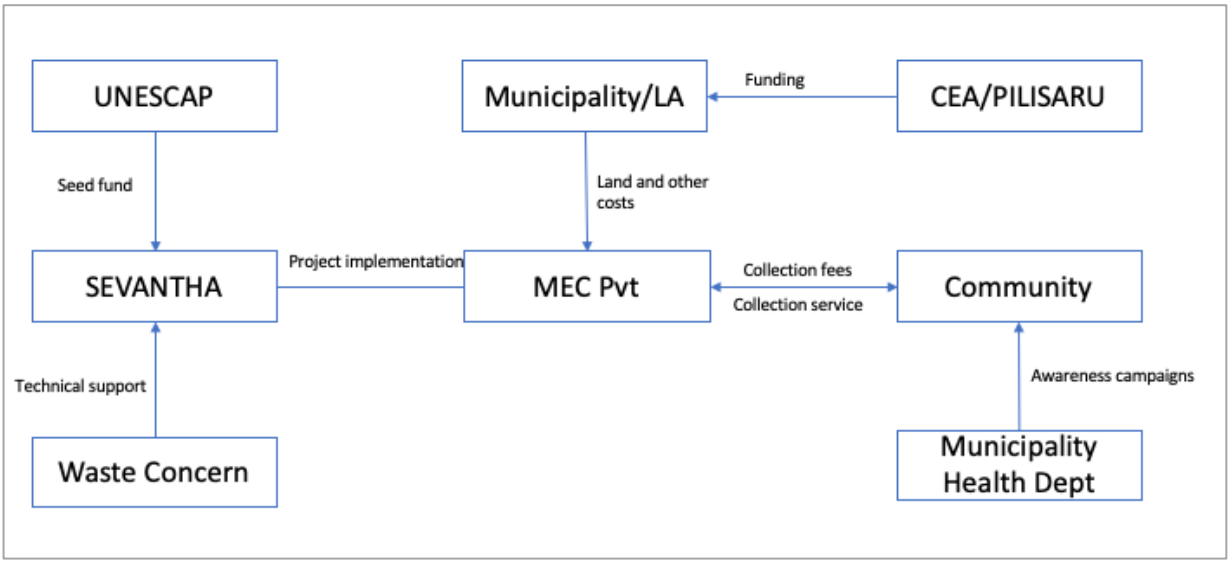

Figure 4-4. Stakeholders involved in IRRC in Matale, Sri Lanka (Source: Developed by author inspired by Storey et al., 2013)

4.2.2.2 Waste system elements: Generation to disposal and resource recovery

Under the Pilisaru Project, the local authorities were still responsible for waste collection, transportation, and disposal (CGIAR, 2019). Local authorities were able to seek support to improve their waste management practices at different stages between waste generation and disposal. For example, the local authority in Moratuwa in Western Province provided green bins to promote the separation of organic waste to all households in Soyasapura Housing Scheme. With source separation, the local authority collected organic waste 5 days a week while on the other two days the recyclable waste was picked up (CGIAR, 2019). For Kuliyapitiya Urban Council (KUC) in North Western province, they faced a huge challenge at the composting facility from receiving unsorted waste through the conventional collection system. This implied they needed a bigger workforce to sort the waste. They changed the approach and employed a vehicle to collect only sorted organic waste. The collection vehicle also announced its presence through music. The waste generators were warned that mixed waste would not be collected and

the workers on the vehicles inspected the waste bins to enforce separation. As a result of the consistency and regularity of the collection service, the residents started adhering to the waste segregation requirements. To reward the KUC for the success achieved in source separation, the Pilisaru Project donated a skid steer loader to support their composting activities (IGES, 2020).

Once waste was brought into the composting facilities, it was sorted further and formed into piles for composting. Mihisaru local authority faced a challenge at the composting facility due to unsegregated waste, which could not be handled at the composting facility due to limited sorting capacity. As a result, in the first two years of operation (2011-2013), waste was dumped outside the facility leading to protests by the residents. Since the Mihisaru facility was shared by many local authorities, the urban councils developed their composting plants and stopped bringing their waste to the Mihisaru facility. Later, the local authorities amended the waste collection policy so that the composting facilities received only source-separated organic waste. Any non-biodegradable waste was later disposed of at landfill facilities (IGES, 2020).

Once the compost had matured, it was packaged and stored for sale. There was a common challenge for many local authorities to maintain and improve the quality of compost while also reducing the amount of waste (IGES, 2020).

4.2.2.3 Influencing factors in Sri Lanka

The outcome of the Pilisaru Project varied a lot from one program to another. Some of the composting facilities became very successful to the point of exporting enriched compost to the Maldives and the Middle East (IGES, 2020), while other projects were shut down shortly after funding ended. The factors that led to the success or failure of the initiatives varied between them; the common ones are discussed below. They are ordered based on their significance to the projects.

4.2.2.3.1 Financial-economic factors

One of the challenges facing waste management in Sri Lanka is the limited budget of the local authorities, which makes it difficult to invest in infrastructure to improve the state of waste management (IGES, 2020). The Pilisaru Project provided the capital costs as a grant to the local authorities which covered for construction of waste management facilities and access roads, equipment needed in the facilities, and training of the staff. However, the operation and maintenance costs were to be borne by the local authorities (Sinnathamby et al., 2016). This meant that the authorities had to look for ways to cover other costs such as salaries for their workers. For some of the authorities, this proved challenging as the sale of the compost could not generate enough revenue. This was also aggravated by a lack of waste separation which meant more labour was needed at the facilities. In the case of Mihisaru facility, the waste management authority (WMA) at the provincial level amended the waste policy so that only organic waste would be accepted at the composting plant. This in turn resulted in the need for fewer workers to sort the waste as well as the better-quality compost that could be sold. They also created a source of revenue by imposing a fee that had to be paid by each urban council that was bringing their waste to the facility (IGES, 2020).

A key requirement for resource recovery initiatives is a market or demand for the recovered product (Rizos et al., 2016). This was one of the shortcomings of the project as it lacked a clear marketing strategy for the compost (Hettiarachchi et al., 2020 p.67; Roy et al., 2021). This was further affected by poor public perception regarding the quality of the compost. Some of the local authorities overcame this by working with laboratories that could test the compost to

ascertain its quality and increase the confidence of the buyers. Some of the facilities also sold the compost in bulk at a cheaper unit price which made it attractive for tea, rubber, and coconut plantation owners and distributors who could repackage and sell it in smaller bags, especially in rural areas (IGES, 2020).

4.2.2.3.2 Political & legal factors

Since Sri Lanka uses a centralized approach to waste management, there are several policies that are aimed at improving the state of waste management in the country. The Ministry of Mahaweli Development and Environment (MoMDE) formulates national policies for waste management while the Ministry of Local Government and Provincial Councils (MoLGPC) is responsible for the implementation and monitoring of local authorities' plans (Fernando & Silva, 2020). The Pilisaru Project was based on the National Waste Management Policy that was introduced in 2007 by the Ministry of Environment. The presence of this policy made it possible for provincial councils to enforce practices like waste separation, which was central to successful composting in Western Province. However, there were no policies that focused on the quality of the compost or its marketing (Roy et al., 2021) and this was a huge setback as some of the facilities could not sell the compost produced, which in turn affected their ability to raise revenue for operations (IGES, 2020). In retrospect, the waste policy introduced in 2007 has been recognized to have failed because of the lack of involvement of local authorities' views on the strategies of the policy (Fernando & Silva, 2020). The National Waste Management Policy was revised in 2018 to promote the involvement of the private sector and accommodate the Polluter Pays Principle (IGES, 2020).

Despite the positive contribution of the policy, the implementation and enforcement of the Pilisaru Project became a big challenge. The Central Environmental Authority (CEA) was responsible for both the implementation and enforcement of the project. This, however, created a conflict of interest since it could not enforce its own activities. For example, there was no follow-up after funding was provided to the local authorities. This caused poor management of the facilities and some authorities went back to dumping organic waste in landfills. The dual role played by the CEA affected the efficiency of the project. The decision to have the CEA responsible for both implementation and enforcement might have been a political move. Otherwise, the CEA should have handed over the implementation of a project to the MoLGPC and remained responsible for its enforcement.

4.2.2.3.3 Institutional/organizational factors

There are several organizations or agencies that played important roles in the implementation of the Pilisaru Project. The Central Environmental Authority and the Ministry of Environment oversaw the project at a national level. The National Solid Waste Management Support Centre (NSWMSC) was also established the same year as the Pilisaru Project with the aim of providing technical support to the local authorities. These national institutions collaborated with the urban councils to provide technical solutions for the initiatives that got approved. This was especially crucial as most municipalities lacked the technical resources needed to manage composting facilities (IGES, 2020).

4.2.2.3.4 Social-cultural factors

At the beginning of the project, many composting facilities faced the challenge of receiving unsegregated waste which necessitated more workers to sort it at the facilities (IGES, 2020). To address this, a behaviour change at the household level was needed. As mentioned in the case

of Matale, conducting awareness campaigns showed the people the benefits of separating waste. Enforcement of regulations to collect only segregated waste also pushed the households to separate the waste to ensure it was collected (Storey et al., 2013). Another cultural factor that impacted the project outcomes was the public's perception of composting and lack of trust in the quality of the compost. Some of the local authorities overcame this by doing regular testing with accredited laboratories which created confidence in the buyers. Due to poor management in some municipalities, there was bad odour and the presence of wild animals making the people protest the establishment of composting plants in densely populated areas (IGES, 2020).

4.2.2.3.5 Technical factors

The provision of necessary equipment under the Pilisaru Project helped overcome the challenge authorities faced of inadequate resources. The National Solid Waste Management Support Centre also made it possible for the authorities to seek any technical support that they needed in their projects. Like Waste Concern, most local authorities also relied on low-cost and low-tech techniques through windrow composting. This minimized the need for specialized equipment and advanced technical skills making it possible for local people to get involved.

Despite the use of simple technology, some of the facilities lacked skilled workers to manage the activities at the facilities. One of the interviewees explained that this was because of two factors. The first was that jobs in waste management facilities are not prestigious so they experience high turnovers. Most of the staff that had been trained at the on-set of the projects would leave often reducing the technical capacity. Secondly, there was no continuous or regular training at the facilities so new workers were not equipped with the relevant skills needed to manage the operations.

4.2.2.4 Organic composting in Sr Lanka today

Composting in Sri Lanka continues to face many challenges including poor compost quality, lack of financing, and high operational costs (Roy et al., 2021). Only 10-25% of the collected MSW is composted (Davila et al., 2022). Of the composting facilities that were started during the Pilisaru project, only about half are still operational. More recent studies show that successful implementation of national-level composting projects will require better planning, greater public awareness, introduction of appropriate regulatory frameworks, markets, and availability of technology (Roy et al., 2021; Fernando, 2019). From interviews conducted however, it appears small-scale, or backyard composting is a common practice where people compost food waste and other items like cow dung and rice husks.

More recently, the government of Sri Lanka introduced a ban on chemical fertilizer imports in April of 2021 with the goal of promoting organic farming. The justification for the policy was based on concerns that non-communicable diseases like chronic kidney disease were increasing because of reliance on chemical fertilizer (Davila et al., 2022). This explanation has however been disputed as the evidence is still not available and the main reason for the ban was in a bid to help protect the country's foreign currency reserves as it undergoes a major economic crisis. Nevertheless, the ban was very abrupt, without a transitional period and led to food shortages since the organic fertilizer produced in the country was not able to meet the demand. To reduce the pressure, the government redirected fertilizer subsidy farms to help paddy farmers produce organic fertilizer (Davila et al., 2022). The government also provided loans to fertilizer makers who would purchase compost from the public to enrich it. Figure 4-5 shows images of enriched compost produced by a private company in Sri Lanka. The private companies sell a fixed quantity to the government and the rest is sold directly to buyers. After continued protests from farmers around the country, the ban was partially lifted in November 2021 (Perera, 2022).

Figure 4-5. Images of enriched compost packaged for sale

5 Kenyan Context Analysis

This chapter presents a brief overview of Kenya, discusses how the concept of circular economy can be applied or understood from the Kenyan perspective, and explains the status quo of solid waste management in the country. A few examples of circular economy models in organic waste management are presented.

The data presented here was obtained from literature review, conducting observations in three urban areas in Kenya, and interviewing different stakeholders involved in waste management, including private companies, CBOs, and residents.

5.1 An overview of Kenya

Kenya is a lower middle-income country located on the eastern part of the African continent with the neighbouring countries being Somali, Ethiopia, South Sudan, Uganda, and Tanzania, see Figure 5-1. As of 2021, the total population was about 50 million with 14 million (28%) of this population living in urban areas (Statista, 2022) The country is divided into 47 counties. Since 2013, Kenya operates under a two-tier government structure with a national government and 47 autonomous county governments. The county governments are responsible for most of the administrative duties as well as service delivery (Ministry of Environment and Natural Resources, 2016).

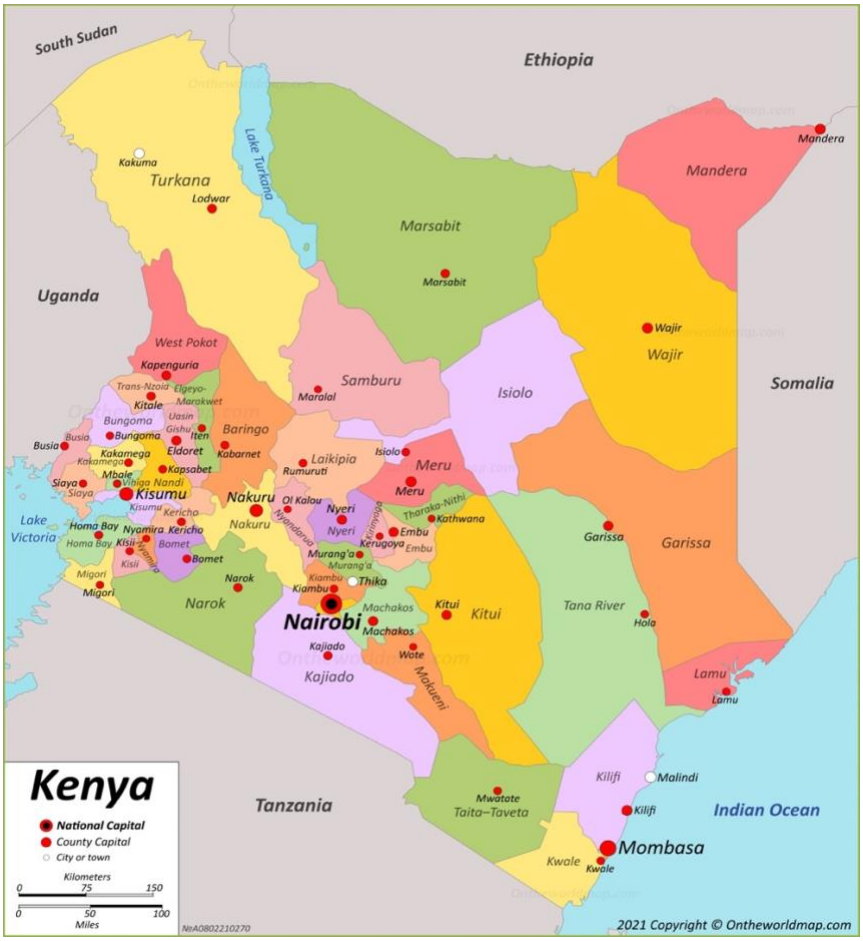

Figure 5-1. Map of Kenya showing the 47 counties (Source emergencymedicinekenya.org)

5.2 Contextualization of circular economy in Kenya

Like many developing countries, the concept of circular economy has not yet become mainstream in Kenya as is the case in most developed countries. However, the lack of academic publications does not imply the non-existence of circular practices as these can be identified through more popular environmental discourses such as sustainable development (Turing, 2021). As Turing discusses, most of the circular economy discourse focuses on a technocentric and European point of view which has meant that the less industrialized economies in the Global South have been left out of the discussion in CE. Turing (2021) suggests using a 'quiet sustainability' lens to determine cases of CE in Kenya.

Quiet sustainability was first discussed by environmental geographers Smith and Jehlička (2013, p.34). Quiet is the idea that 'large sections of humanity may already be on sustainable pathways without feeling the need to proclaim the fact loudly.' It conceptualizes the 'widespread practices that result in beneficial environmental or social outcomes and that do not relate directly or indirectly to market transactions but are not represented by their practitioners as relating directly to environmental or sustainability goals' (Smith and Jehlička, 2013, p.1). From this perspective, CE becomes something that has been in practice for a very long time. Practices such as using manure as fertilizer are widespread in the country and exemplify closed-cycle practices which are central to CE. CE is, therefore, not new, or foreign. It exists but under other pre-existing terminologies of sustainability. It is therefore important that when analysing CE in the Global South, or Kenya in this case, the concept is adapted to be more inclusive of alternative models (Turing, 2021).

But even going back to the technocentric approach to CE, there is a growing interest in the adoption of CE at a national level to address some of the challenges in the country, and for CE to become a pathway to achieving sustainable development goals. For example, Kenya's Vision 2030 Agenda advocates for the adoption of industrial ecology and cleaner production principles to achieve green growth while also reducing harmful environmental effects (Koech & Munene, 2020). As will be discussed in section 5.4, we will see some examples of CE in waste management in Kenya.

5.3 (Organic) Solid waste management in Kenya

Solid waste management in Kenya is in a dire state, especially in large urban areas like Nairobi, Mombasa, and Kisumu (Ministry of Environment and Natural Resources, 2016). This is aggravated by the increasing urban population and increased income levels that lead to higher consumption and waste generation (Ddiba et al., 2020; Guerrero et al., 2013). It is estimated that around 22, 000 tons of waste are generated per day with 40% of it coming from urban areas (Ministry of Environment and Forestry, 2019). The urban population in Kenya is expected to grow from 28 million today to 40 million by 2050 (blog.worldbank.org, 2016). This means that if no interventions are made, waste management will only get worse and will lead to more harmful effects for the people and the environment. The national government is making efforts to improve the situation as witnessed by some recent national policies and initiatives like the National Sustainable Waste Management Policy and the Nationally Appropriate Mitigation Action (NAMA): A circular economy solid waste management approach for urban areas in Kenya (Ministry of Environment and Natural Resources, 2016). The following sections look in more detail at each dimension of ISWM model as it applies to Kenya. Table 5-1 summarizes the challenges facing waste management in Kenya.

Table 5-1. A summary of challenges facing waste management in Kenyan urban areas

Stage in waste cycle	Challenges experienced
Generation	• Lack of waste separation • Public attitude towards waste
Collection/Transportation	• Inaccessibility due to poor roads • Limited capacity • Inadequate infrastructure for collection • High collection fees by private companies
Treatment	• Improper or underdeveloped technology • Lack of technical skills
Disposal	• Open dumping and un-engineered landfills

5.3.1 Waste elements

Waste in most urban areas is generated by households, commercial establishments like restaurants and hospitals, as well as industries (Sibanda et al., 2017). A unique feature of urban areas in Kenya is the open-air markets (Ferronato et al., 2019) where people sell fresh agricultural produce among other items. The frequency of waste collection varies from twice a day to once a week (Guerrero et al., 2013). However, the overall rate of collection is around 30-50% (Sibanda, 2013; Tan, 2012). This is a result of limited collection capacity by the local authorities (collection bins, waste trucks, and carts), inaccessibility to the densely populated areas, and poor roads especially during the rainy seasons (Sibanda, 2017; Storey, 2015; Ddiba, 2020). In places where private services have been contracted for waste collection, the ability to afford to pay, for such services impacts collection rates (Monyoncho, 2013), leaving the urban poor population without collection services. There is no waste segregation at the source due to missing infrastructural support during collection or transportation. The highest fraction by weight of the waste generated is organic which makes up about 65-70% (Sibanda, 2017).

Waste is mostly collected for disposal due to limited availability and accessibility of waste treatment options. The county governments lack enough capital to invest in infrastructure and build the capacity needed for better waste management (Ministry of Environment and Forestry, 2019). There is some recycling of plastic waste (Monyoncho, 2013) as well as composting for some of the organic waste at the household level and in rare cases, at the municipality level (Guerrero, 2013; Sibanda, 2017, Monyoncho, 2013). However, most of the waste collected ends up being dumped in unsanitary and open landfills (Guerrero, 2013; Ferronato et al., 2019), which are sometimes made from abandoned quarries, natural depressions, and old mining areas (Monyoncho, 2013). The uncollected waste is dumped in undesignated places including on the sides of the roads or in open public spaces (Monyoncho, 2013) where it is occasionally burned to reduce the volume (Ministry of Environment and Natural Resources, 2016).

The current state of waste management causes a lot of negative effects for the people and the environment. The Dandora dumpsite for example has had adverse effects on the children living around the dumpsite. Dandora is the only official dumpsite in Nairobi and covers a total area of 43 hectares. It is un-engineered, meaning that the leachate has been percolating into the soil and contaminating the groundwater for years. A study done by United Nation Environmental Program (UNEP) on 328 children living in the surrounding areas showed that half of them had

blood lead levels equal to or exceeding the poisonous threshold (Ministry of Environment and Natural Resources, 2016).

5.3.2 Stakeholders

There are multiple stakeholders involved in waste management in Kenya. This includes the national and local government, non-government organizations (NGOs), private contractors, various government ministries, community-based organizations (CBOs), and the informal sector (Ddiba, 2020; Monyoncho, 2013; Sibanda et al., 2017). Since the devolution of the government into two tiers in 2013, county governments became responsible for all activities related to waste management. In many cases, the authorities outsource the services to licensed private companies, especially in larger cities like Nairobi and Kisumu (Ministry of Environment and Natural Resources, 2016; Sibanda et al., 2017). However, due to the limited resources of the local government, their waste management services are very unreliable, especially in densely populated areas, poor neighbourhoods, and informal settlements. These places assume the responsibility of managing their waste through CBOs (Sibanda et al., 2017). CBOs are small to medium-sized groups of people that come together with a common objective of improving the livelihoods of the community. For example, the *Kwa Muhia Environmental Group* from Nakuru is made up of 60 members and they do various environmental-related activities including waste collection and recycling. For affluent neighbourhoods, it is common for them to contract private waste management companies since they can afford to pay the collection fees (Paes et al., 2019). The informal sector is also very central in waste management in many developing countries, including Kenya (Storey et al., 2015; Ferrenato et al., 2019). Waste pickers provide value at different stages, with some offering door-to-door collection services for a fee while others generate income from recovering some of the waste, mostly plastics and metal, and selling them to recycling facilities or the Jua-kali industries, which is the artisanal market in Kenya (Okungu et al., 2018).

There is also a growing number of public-private partnerships in a bid to improve waste management. These include local authorities partnering with local and international NGOs as well as community initiatives (Ferronato et al., 2019; Sibanda et al., 2017). Tukahirwa et al. (2013) describe the arrangements between government, private companies, and CBOs as institutional pluralism or fragmentation depending on how the responsibility is distributed among them. There is also the involvement of international institutions that mostly support waste management projects through development agencies and private investors. Lastly, the residents in these urban areas play a key role through their everyday practices and involvement in waste management activities as well as their attitudes towards waste.

The government also has national institutions that are responsible for different aspects of waste management. The National Environmental Management Authority (NEMA) is responsible for ensuring a clean environment for all citizens (Ministry of Environment and Natural Resources, 2016). It is responsible for the implementation of all policies and coordinating all matters related to the environment. NEMA is mandated to develop regulations, prescribe measures and standards, and issue guidelines for the management and conservation of natural resources and the environment (Koech & Munene, 2020; Ministry of Environment and Natural Resources, 2016). The Kenya Bureau of Standards (KEBS) is responsible to ensure all products meet the required standards. KEBS is therefore involved in quality assurance of items like compost or products resulting from other recycling activities (Ministry of Environment and Natural Resources, 2016).

5.3.3 Factors influencing organic waste management in Kenya

The factors are discussed in order of their significance.

5.3.3.1 Financial and economic factors

As is the case with many developing countries, limited financial capacity is one of the key factors affecting waste management in Kenya. The local authorities have a limited budget for waste management activities. (Paes et al., 2019; Sibanda et al., 2017). An effective waste management system requires funding to cover costs for land acquisition, construction of facilities, purchase of equipment, training of the staff, compensation for the workers, and other operational costs (Capuano Mascarenhas et al., 2021; Roy et al., 2021; Storey et al.,2015). Limited finances impact the collection rates as there are very few waste collection vehicles and an inadequate workforce. The people most affected by this in urban areas are the urban poor since they cannot afford the collection fees needed to pay for private waste collection services. Disposal in open dumpsites is also the most common approach as it is the cheapest alternative despite the negative impacts it has on the people and the environment.

Funding is also a challenge for private actors and CBOs that are involved in waste management. The two people interviewed who are part of CBOs explained how funding is inconsistent and short-term. Additionally, the lack of government support and backing of community-based initiatives affects donor and investor confidence in the programs. Access to external funding sources is also contingent on meeting several requirements, which further affects small CBOs and companies that have limited resources and capacity. It is therefore common for such initiatives to end their operations once the initial funding runs out.

The market for compost is also very underdeveloped in Kenya (Ministry of Environment and Natural Resources, 2016), which challenges the economic viability of any business venture trying to compost commercially. Additionally, since open dumping of waste is common, willingness to pay for the collection of (organic) waste is also low. Any commercial enterprise in waste management is therefore expected to generate most of its revenue from the sale of compost or other recovered resources (Ministry of Environment and Natural Resources, 2016).

5.3.3.2 Political and legal factors

There are several national policies and strategies aimed at improving the solid waste management system in Kenya starting with the Environmental Management and Coordination Act (EMCA) of 1999 which stipulates that every person in Kenya is entitled to a clean and healthy environment. The EMCA act led to the formation of the National Environmental Management Authority (NEMA) as well as County Environment Committees (Koech & Munene, 2020). In 2015, NEMA launched the National Solid Waste Management Strategy guided by the Zero Waste Principle. The goal was to have the country follow 7Rs: Reducing, Rethinking, Refusing, Recycling, Repairing, and Refilling. The strategy is designed to cover a period of 15 years within the Vision 2030 framework and to be reviewed every 5 years. The strategy sets out the minimum requirements that must be met by county governments in areas across the waste management cycle. While the strategy has set out actions that need to be implemented such as development policies required and the building of better waste management facilities, their actual implementation is yet to be done.

Kenya also experiences poor and weak enforcement of the policies, which is caused by a lack of political commitment from the government and limited financial and human capacity. As is the case in many developing countries, Kenya faces numerous development challenges such as

healthcare, education, and infrastructure development which are prioritized over waste management issues. This leads to poor funding of waste management initiatives and a lack of engagement at county levels. Kenya also has a long-standing history of corruption (Turing, 2020) which negatively affects policy implementation. This is either through mismanagement of resources meant to address waste management issues or the use of bribes to avoid fines or penalties for not adhering to the requirements.

5.3.3.3 Social-cultural factors

There is a lack of awareness and knowledge about the importance and benefits of better waste management. This leads to poor practices like open dumping and littering (NEMA, 2015). There is also a lack of awareness about waste segregation leading to the collection of mixed waste which impacts the potential of resource recovery. As suggested by one of the interviewees, awareness should be promoted through school programs since children are knowledge multiplicators. This also creates a society where such habits are ingrained from a young age.

The perception of products recycled or made from waste further discourages waste recovery. However, with increasing awareness being created by private companies and CBOs, people are becoming more aware of the benefits of resource recovery and there has been growing excitement about being able to get compost from organic waste.

5.3.3.4 Technical factors

Despite the presence of a large and inexpensive labour market, there is limited technical expertise when it comes to waste management techniques. This affects even low-tech methods like composting leading to the production of low-quality compost. Acquisition and retention of skilled labour require capital, which is another limited resource. As a result, the current waste management facilities and pieces of machinery operate at sub-optimal capacities (NEMA, 2015). In many cases, when there are technical issues with equipment, operations are halted as there are no experts on site to fix the problems. Repairs of machinery can take a long time leading to the piling of waste at the facilities. The lack of technical skills also leads to most of the waste being collected for disposal since this is the best available alternative.

5.3.3.5 Environmental factors

While the availability of land is a challenge in urban areas, there are large tracts of land in rural areas in Kenya. This makes it easy for the county government to opt for landfill waste since it is the cheapest and easiest alternative.

5.4 Current examples of circular approaches being used for organic waste management in Kenya

A few actors are adapting circular approaches to manage organic waste in Kenya with the majority being private companies. The three companies below show that CE in organic waste management is a growing area in Kenya.

5.4.1 TakaTaka Solutions

TakaTaka Solutions is a private waste management company in Nairobi. The company began operations in 2011 with a small composting plant in Kangemi, collecting about 500kgs of waste per day. Today, the company collects about 60 tons of waste daily and separates it into 40 fractions. They recycle 95% of the collected waste with the inorganic fractions being sold to

various recycling plants in Nairobi (Koech & Munene, 2020; TakaTaka Solutions, 2022). The company has created more than 350 full-time jobs. They currently run three sorting sites, one composting plant, two plastic recycling plants, one incinerator, and three buy-back centres. The composting plant uses the windrow composting technique and the high-quality compost produced is sold to farmers, gardeners, and landscapers (TakaTaka Solutions, 2022).

Waste segregation is at the core of their business model since, without separation, they cannot add value to the different waste fractions. A big part of their operations is therefore providing training modules on waste separation. They teach this to households and business owners and build capacity for youth to conduct training for others. The company creates value for the community not only by creating employment for youth, but their activities also ensure that the urban areas are cleaner, and value is created from waste. Their next steps are to have the compost they produce meet the European Union (EU) standards to ensure the product they create is of good quality and useful to the farmers. Overall, their model is financially sustainable and does not require subsidies or other support from the government.

5.4.2 Safi Organics

Safi Organics is a fertilizer producer based in Mwea in Kenya. The goal of the company is to decentralize fertilizer production while using rice husks, which are otherwise disposed of by burning (Koech & Munene, 2020). Safi Organics uses a three-step process to convert rice husks into fertilizer. Once the rice husks are collected, pyrolysis is done where the husks are heated in a low-oxygen environment and turned into biochar. Lastly, the biochar is boosted using the company's enhancement formula and is packaged for sale (Mitchell, 2021). The company also trains youth groups to produce their biochar and at the same time provides employment opportunities (Koech & Munene, 2020). A unique aspect of Safi Organics is the use of advanced technology, both hardware, and software, to manage and regulate the production process. They have partnerships with the Massachusetts Institute of Technology and other academic institutions. The fertilizer has had a great impact on the farmers as it is more affordable and can boost crop yields by an average of 30%. The company wants to scale its operations into all emerging markets to help farmers improve their soils (Safi Organics, 2022).

5.4.3 Sanergy

Sanergy was founded in 2010 to provide a solution to sanitation challenges experienced by the urban poor in slum areas in Nairobi. Most slum areas in Nairobi lack proper sanitation systems like toilets and sewer systems. Sanergy provides Fresh Life Toilets that can be emptied regularly. The collected waste is taken to special bio-digesters where it is broken down and used to produce biogas. The residue is stabilized and converted into fertilizer. One of the biogas plants has a capacity of 250kW of electricity that will be used to power the slums (Koech & Munene, 2020). Sanergy also collects other organic waste and uses Black Soldier Flies (BSF) to produce insect-based animal feed. The frass residue left from BSF production is mixed with organic waste and composted using windrow technique to produce high-quality compost (Sanergy, 2021).

6 Transferability of the circular approaches to Kenya

This chapter presents an analysis of how the circular approaches being used in Bangladesh and Sri Lanka can be transferred to Kenya. As discussed in section 3.4.2, to identify how policies in one place can be adapted to another location, it is crucial to not only evaluate the policies based on their outcomes but also to establish the concrete mechanisms through which the outcomes were achieved. This chapter begins by establishing the logic models of the two case studies. Based on these two models, a potential model will be suggested for the Kenyan context by integrating the key lessons learned and accounting for the country's contextual factors.

6.1 Waste Concern mechanism model

Waste Concern started by **conducting research** about waste management in Dhaka and surveying the residents about their satisfaction with the waste management services at the time. Additionally, they collected information about willingness to pay for waste collection services. This enabled the organization to **identify the gap** (Rose, 1991) that needed to be addressed and showed that there was a market for waste collection services and willingness from the people to participate in the project. After this, they established the first composting plant that was targeted for a small section of Dhaka City and whose capacity was only 3 tons. In the beginning, the plant was only receiving about half of its capacity then within 4 years started operating at capacity. This approach of **starting with a small plant that also served as a demonstration** was prudent as it allowed them to test their approach at a small scale before expanding their operations. There have been cases where big plants with heavy machinery have been established at the start of a project and then failed (Monyoncho, 2013).

Another aspect of the Waste Concern model was that they **started by collecting unsorted waste and sorting it at the composting plants.** One of the people interviewed stated that this is a quicker solution than waiting for households to learn how to segregate waste since **behaviour change can be difficult to enforce**. More so, being a private actor, the organization could not enforce waste separation. This model also worked because the **labour needed** for sorting at the plant was not only **readily available** but was also **affordable.** Furthermore, the use of **simple and low-cost technology** meant that labour was available locally. This model met the two requirements that Rose (1991) discusses. That solution needs to be both **practical and desirable.** The desirability was further enhanced by the fact that the benefits of the program were enjoyed by all the people involved. The **good partnerships** that Waste Concern also had with the fertilizer company made it possible to market the product and generate revenue from the compost sale. The presence of a market for compost is a common problem when it comes to composting projects, as was seen in the case of Sri Lanka. The **success of the initial plant at Mirpur prompted the government to support** the project and became a big contributor to the successful replication of the model in other locations in Sri Lanka and led to partnerships with other international institutions.

Figure 6-1 shows a simplified logic model of the Waste Concern project. It is important to note that it is difficult to show all the links between different interventions and outcomes. As Rose (1991) states, such a diagram should be a bit generic and not include details, especially those that are specific to time and place. The logic model, therefore, only shows some of the key factors, especially those that the author considers relevant for transfer. Additionally, given the difficulty of attributing an outcome to one or more interventions, it is important to know that there could be other logical explanations of the outcomes that are not tied to the interventions done by Waste Concern.

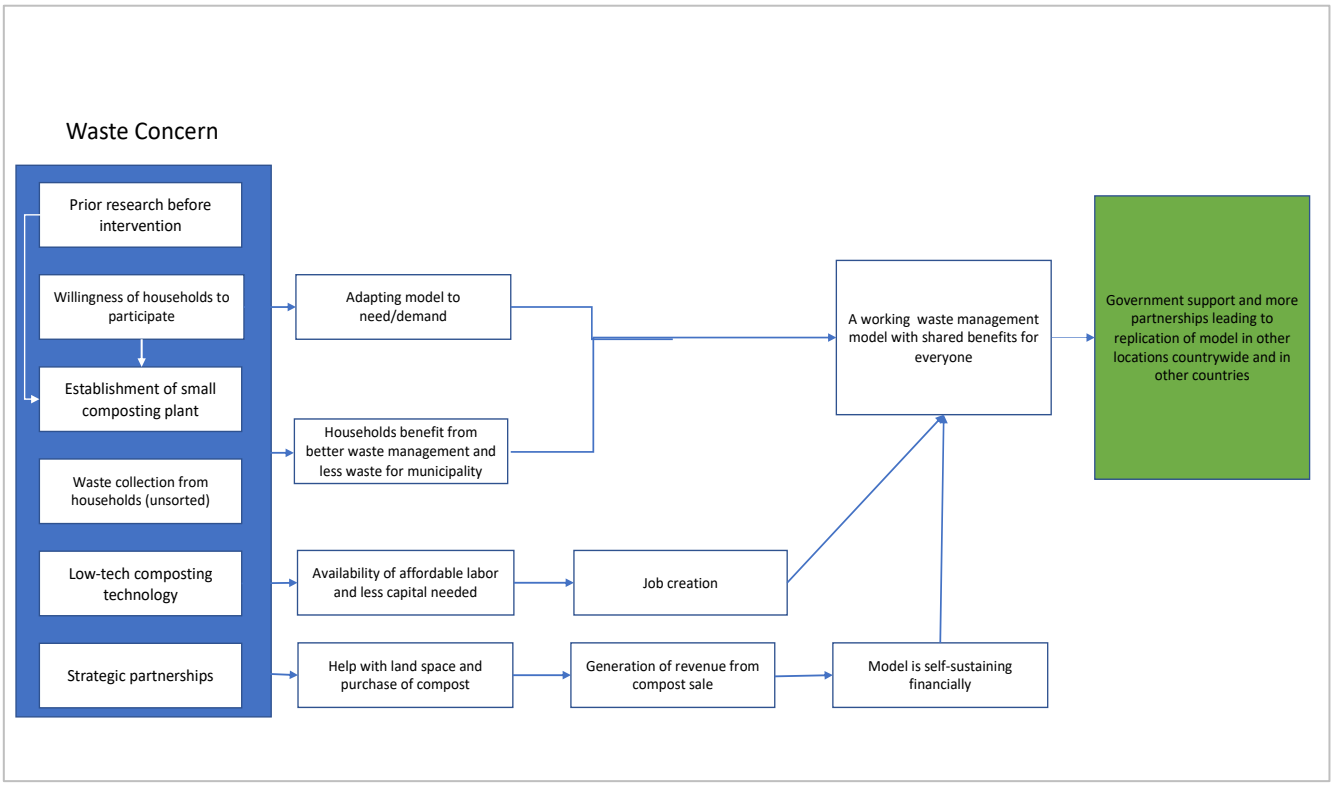

Figure 6-1. Logic model of Waste Concern waste management approach (Source: developed by the author based on literature review)

6.2 Pilisaru Project conceptual model

The Pilisaru Project was a **government initiative** to provide financial and technical support to local authorities who were undertaking waste management programs. The proposals for the projects had to be approved by the Central Environment Agency (CEA). Once the proposal for a local authority was approved, the government offered money in the **form of a grant** that was used to establish the waste management plant and purchase equipment. The program also involved **training of the staff** on aspects such as composting. Once the funding was released to the local authorities, they were responsible for implementing the programs in their jurisdictions.

As discussed in section 4.2, the approaches taken by the different local authorities varied, although there were many similarities. Most of them **collected unsorted waste which was then sorted at the composting facilities**. This ended up being a bottleneck to the system as waste ended up piling up at some of the facilities. The **composting technique used was the same one used by Waste Concern**, windrow composting. Secondly, many of the authorities **did not have a market for the compost**. The ability to sell the compost was also impacted by a lack of **assurance about its quality**. This demonstrated a lack of foresight from the program as it had not come up with a strategy of how the compost that was being produced would be sold or distributed (Roy et al., 2021).

Since the CEA oversaw the implementation of the project and was also responsible for its enforcement, it also created **a conflict of interest**. Based on the interviews, the CEA **did not strictly follow up on the local authorities' activities to monitor** the projects they were undertaking. Many of the authorities were not composting properly while others were still

collecting waste and dumping it in landfills. The local authorities lacked any incentive to ensure the success of their projects since there were **no fines or penalties** for poor waste management.

As introduced in section 3.4.2, there were some **implementation and theory failures** linked to the Pilisaru Project. The first theory failure was the assumption that the provision of capital would address all the challenges the local authorities had raised, and they would henceforth manage the waste better. However, it turned out that providing capital was not enough if the projects were not able to generate enough revenue to cover their **operational costs** when the funding stopped. This was aggravated by **implementation failure** from both the local authorities who did not compost the waste properly and the CEA who did not have any retributions for local authorities that were not adhering to the waste management practices. The second **theory failure** was the assumption that offering training to the staff at the onset of the projects would create enough technical capacity to maintain the operations. The reality however was that jobs in waste management, especially the manual jobs, were not prestigious and had a **high turnover**. Due to this, within a very short period, the technical capacity decreased significantly as people who had been previously trained left their jobs. Since the was no contiguous or regular training, there were not enough skilled people left to manage activities at the facilities. This ended up affecting the effectiveness of composting.

It was only in Western Province which has a provincial-level waste management authority (WMA) that there was **enforcement and intervention** to help address the challenges the local authorities faced with implementation. By ensuring only sorted waste was collected from households and enforcing tipping fees from local authorities, the composting plants in the province had better outcomes. The WMA also intervened to ensure the **quality of the compost** was maintained and got tested by accredited laboratories. This led to higher sales of the compost and generated more revenue for the composting plants. Despite the fact that the revenue generated by the plants was not profitable, they were able to cover the operational costs of the plants thus making them financially sustainable without needing to rely on external funding. On the other hand, for the local authorities in other provinces that were not able to generate any or enough revenue from compost sales, their operations were greatly affected especially after funding from the project ended. Figure 6-2 shows the causal links between all these factors.

6.3 Comparison of the two case studies

The two cases present two different approaches by two different actors. The Pilisaru Project can be seen as a **top-down approach** as it was an initiative started by the government and was implemented and enforced by the Central Environment Agency (CEA). On the other hand, Waste Concern was a **bottom-up approach**, an initiative that was started by a private actor and then got support from the government and became replicated in other locations across the country. As much as there are some huge differences between the two approaches, there are some **common features** among them. For instance, the reliance on **low-tech technology that was labour intensive** is present in both cases. For both cases, this was justified based on the economic context of the two countries. Both have **limited financial and technical capacity** (Ashikuzzaman & Howlader, 2020; Roy et al., 2021; Yedla, 2012) to invest in advanced technological methods of waste management and are also impacted by a **lack of skilled labour** to manage such equipment. In both countries, there was an **adequate supply of labour** to support simple but labour-intensive techniques. The other similarity was the **perception of compost by the public or customers**. For Waste Concern, they addressed this by having the **compost tested in laboratories and by partnering with the fertilizer-making company**

that not only enriched the compost but was also responsible for marketing and selling it. The WMA in Western Province in Sri Lanka also intervened and facilitated **testing of the compost** and marketed it to international buyers. However, the other local authorities in Sri Lanka did not have any institutions to help with the strategy to market the product, and this affected the potential of the plants to generate revenue.

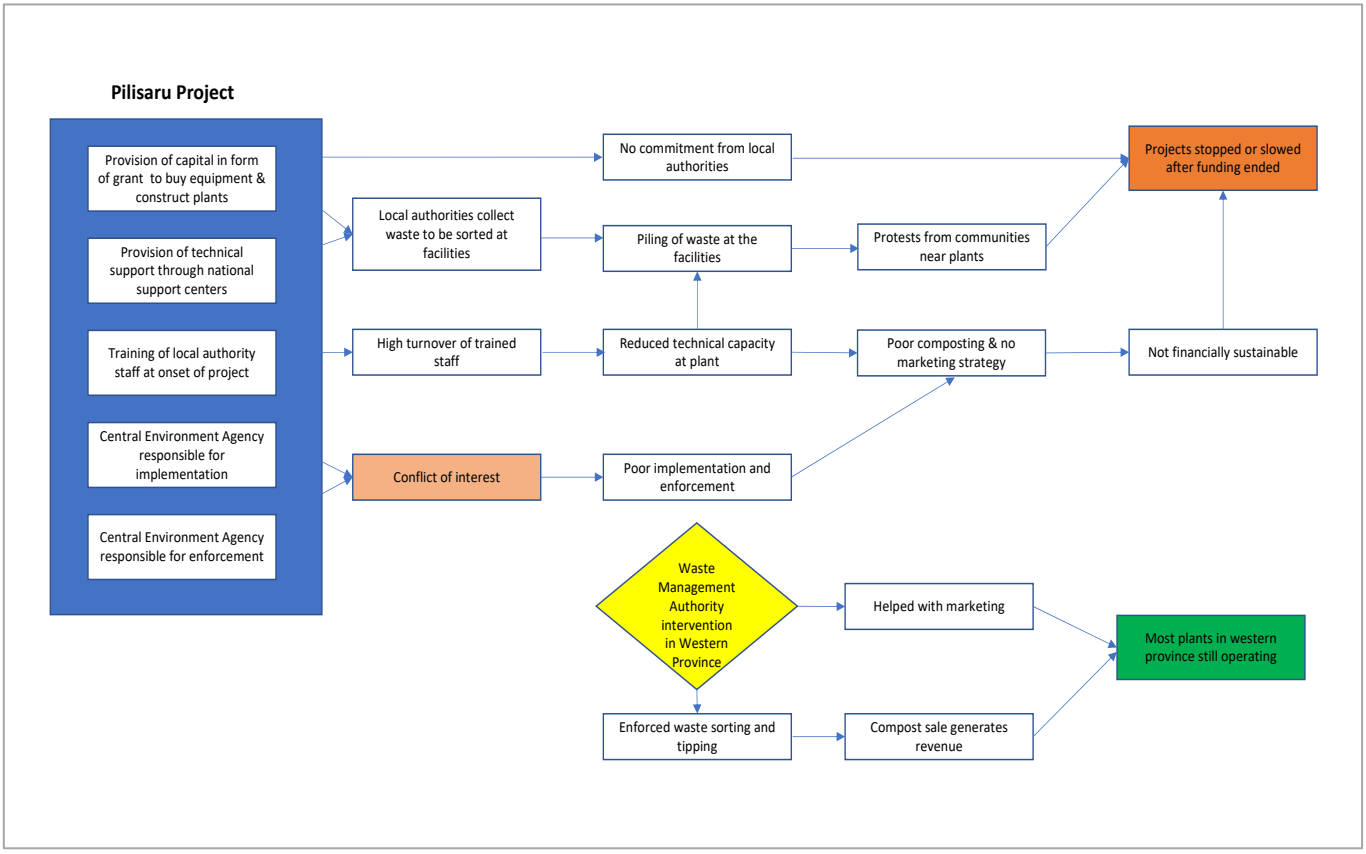

Figure 6-2. Logic model for Pilisaru Project (Source: Developed by the author based on interviews and literature review)

The **differences** between the two approaches stand out more than the similarities. Despite the goal of both cases being to improve the state of waste management, the **commitment and ownership of the initiatives** are quite dissimilar. In Bangladesh, there was initial research done by Waste Concern to scope the problem and to also engage the households who were the waste producers. The fact that the households were **willing to pay for waste collection**, there was buy-in to the initiative from them as they also benefitted from getting a cleaner environment. Waste Concern also managed the composting process to ensure that the **compost produced was of high quality** to ensure it was bought by Map and Alpha Agro Industries. On the other hand, in Sri Lanka, the project was designed by the national government and was implemented by the local authorities who **had not been engaged to share their viewpoints** about the specifics of the program. This was one of the reasons cited by one of the interviewees as the reason why its implementation was not very successful in some municipalities. A lack of engagement meant that the **buy-in** from the local authorities and their commitment to the projects was not strong to ensure they were sustainable long-term. Another explanation was that since the money provided was in form of a grant, there was also **no ownership** from the local authorities who had no financial incentive to ensure success of their programs.

Additionally, the Pilisaru Project being a national project needed **more coordination** in terms of its implementation and enforcement compared to Waste Concern. Unlike Waste Concern, the Pilisaru Project involved several government bodies at the national and local levels.

6.4 Lessons from the case studies and potential logic model for Kenya

This section borrows lessons from the two cases to design a possible logical model that might be applicable for resource recovery from organic waste in Kenya. Rose (1991) describes this process of combining elements from two different places as hybridization. To pinch the applicable lessons from the two locations, the two questions introduced in section 3.4.2 need to be revisited.

1. *"How much trouble did they have, given their level of these resources"?*
2. *Are we better or worse off than they were with respect to these resources?"*

The first question can be answered by looking at the common challenges that were faced in the two cases. These have been discussed in Chapter 4 and in sections 6.1 and 6.2. They can be summarized as 1) lack of waste separation leading to the need for more labour at the composting plants, 2) poor compost quality or lack of assurance about its quality, 3) lack of a marketing strategy for the compost, 4) lack of or poor enforcement and 5) lack of commitment from the local authorities. Given these challenges, how better or worse off is Kenya?

Waste separation is not practiced in most urban areas in Kenya. As discussed in section 5.3, this is because of the lack of infrastructure required for collecting separate streams of waste. It is also because most waste is collected primarily for disposal since there are limited opportunities for recovery of different waste streams. Since waste separation requires infrastructural investment and behaviour change from the waste generators to start separating their waste, this could be a challenge for Kenya. However, as was seen in both Waste Concern and the Pilisaru Project, they started by **collecting unsegregated waste** and sorting it at the facility. This was possible because there was an availability of affordable labour, which is also the case in Kenya. Nonetheless, this is not a sustainable solution as was observed in some local authorities in Sri Lanka where waste began piling at the composting facilities. It is necessary to plan accordingly, to ensure the waste being brought to the facilities does not exceed the capacity of the plant When dealing with unsorted waste, there must be **channels where the other non-organic waste streams can be disposed of**. In Kenya, there are many companies that are using recovered materials as their inputs, including the large Jua Kali industry, which presents an opportunity for partnerships. The collection of unsorted waste should also be **phased out** with time after **awareness campaigns** about waste separation and the **supporting infrastructure** has been developed. **Enforcement of policies** around waste separation can be done to ensure that only separated waste is collected.

In Sri Lanka, the issue of poor-quality compost was caused by a lack of proper technical skills for composting as well as the lack of waste segregation. If waste separation can be achieved at the source or if it can be done effectively at the composting facilities, the quality of compost could be improved. Additionally, the **workers doing the composting need to be trained**. This should also be done **regularly to account for high turnovers** which might be happening in waste management in Kenya as well. Apart from doing regular training, it might be more sustainable to **improve the working conditions of the people** working in the facilities as this

would reduce turnover and increase the technical capacity. For example, Kuliyapitiya Urban Council (KUC) in Sri Lanka did this by providing flexible working hours for the workers and doing health check-ups once a month (IGES, 2020). With regards to assurance of the quality of the compost, having accredited laboratories test the compost was seen to improve the credibility of the compost and increase trust from buyers. Local authorities would therefore need to work with such laboratories or other institutions that can help assure the public about the quality of the compost. While there are private laboratories such as the Crop Nutrition Laboratory Services Ltd (Cropnuts), the **government can provide testing services** through national institutions like the Kenya Agricultural Research Institute (KARI). This would enable **accessibility of compost testing services nationally and at affordable rates.**

Based on a study cited by the Ministry of Environment and Natural Resources (2016), there is a **ready market for compost** in Kenya. According to the study, the current demand is estimated to be in the excess of 100,000 tons/year while the current production is at around 10,000 tons/year. This shows a **huge demand gap** that can be filled by initiatives like those of the Pilisaru Project or Waste Concern. However, there are other aspects of **marketing** that need to be in place to streamline the whole value chain from compost production to access to the compost for purchase. Local governments or private actors that are undertaking compost production should **partner with fertilizer distributors** who can supply the compost to a larger radius through their networks. The government can also act as a **bulk buyer of compost** and resell it through its institutions. Through market-based instruments like **subsidies**, the government can also help reduce the cost of production of compost to make it accessible to farmers and other buyers. It is important, however, that the compost is **marketed correctly**, as a soil enricher and not fertilizer, unless it has been enriched to meet the nutrient content of fertilizers. Moreover, making people aware of the benefits of compost can help increase their willingness to buy.

Lack of, or weak policy regulation is a common problem in many developing countries including Kenya (Monyoncho, 2013; Storey et al., 2015). This is caused by a lack of financial capacity to facilitate effective enforcement and by issues like corruption. If the government was to launch an initiative like Pilisaru as is proposed in the Ministry of Environment and Natural Resources (2016) publication on CE for waste management, it would need to **strongly implement policies** like waste segregation and conduct **regular monitoring** of composting projects to ensure they were operating as expected. To avoid the issue of conflict of interest that was seen in Sri Lanka where CEA was both the implementing and enforcement body, it would be crucial to have two separate institutions for each role. The Ministry of Environment and Natural Resources could be responsible for implementation in collaboration with the county governments, while **NEMA could be responsible for enforcement** of any policies, as well as monitoring. The government should also have **strong regulations** regarding waste separation or proper composting, failure to which those responsible should be **warned or fined**. The Kenyan plastic ban that came into effect in 2017 was very effective in reducing the amount of plastic paper bags in the country due to the heavy fines that were set for violation of the regulation (Behuria, 2021). Given the success it had, it is possible that equally strict regulations on waste management could yield positive outcomes. This could be done by **banning the disposal of organic waste in landfills**. Other policies could be designed to help in the production and marketing of compost. For instance, the government could provide subsidies to compost producers to reduce the cost of production and make the compost affordable.

Long term sustainability of any project is dependent on **commitment** from the actors involved in the process. In Sri Lanka, most of the local authorities struggled to keep their projects running

after the government funding ended. According to one of the interviewees, only some of the municipalities that were proactive about seeking external funding were able to continue operating as usual. They also suggested that since all the funding for the projects was given as a grant it did not create a sense of ownership from the local authorities. One suggestion for Kenya would therefore be to have a **co-financing arrangement** with the national and county governments and private actors. In Kenya, one of the challenges facing waste management, in general, is the fact that it is not a prioritized issue (Ministry of Environment and Natural Resources, 2016) which leads to poor funding of waste management initiatives from the government. If Kenya is to address the issue of organic waste management, **political commitment at the national and county levels** will be needed. Furthermore, since priorities change with new political regimes, the commitments should be **long-term** to avoid reprioritization when new leaders come into power.

In addition to looking at the challenges that were experienced in the case studies, it is important to look at the factors that led to positive outcomes. Otherwise, if these features are not present in Kenya or cannot be replaced with functionally equivalent alternatives (Rose, 1991), addressing the resources that they struggled with would not be enough to predict transferability. The success factors, especially in the case of Waste Concern, can be summarized as 1) initial assessment of the problem and engagement with the households, 2) choice of simple, low-tech technology, 3) starting with a small demo project before scaling, 4) strategic partnerships and lastly, as was seen in Western Province in Sri Lanka, 5) intervention and enforcement of regulations by the government.

Based on multiple studies that have been conducted in different urban areas in Kenya (Ministry of Environment and Natural Resources, 2016; Monyoncho, 2013; NEMA, 2015), and the interviews conducted during this study, it is evident that many residents in urban areas are dissatisfied with the current state of waste management. Therefore, **engagement with people** in urban areas could also be used to create awareness about the benefits of improved waste management and to educate them about waste segregation. This could be done through **media (TV and radio)** campaigns and by **educating school children** on waste separation and its importance. Awareness campaigns, and surveys to gauge people's willingness to pay for improved waste management services, could also be conducted using **mobile phones** since more than 90% of Kenyans have a mobile subscription (Namunwa, 2019). Given the autonomy of county governments in Kenya, such campaigns could be carried out at the county level to collect information that is **relevant and specific** to each county.

The **choice of technology** to be used for resource recovery is a major factor to consider. Given the economic context of Kenya where financial capacity is limited, the use of simple **low-cost technology** would be more suitable for Kenya. This is not to say it is the optimal choice, but given the status quo, other methods would require a high capital investment that might not easily accessible. Like Bangladesh and Sri Lanka, the availability of affordable labour would not be a barrier. The use of simple technology would also prevent reliance on advanced technical skills that might not be available as well as avoid spending money on acquiring expensive equipment for more advanced resource recovery methods. However, it is important to note that simple technologies like composting are also dependent on the **availability of land** to set up the composting plants. This could be a challenge for the main urban areas like Nairobi where land is scarce. Additionally, the volumes of waste generated in the big urban areas might become a bottleneck when composting manually since it is a slow process. In such cases, the county government should consider investing in more advanced technology that can handle the huge

volumes of waste generated but one that can also be supported using locally available resources and skills.

When rolling out a national project, it can be wise to start with **pilot projects**. As was seen from Waste Concern, they started with a small composting plant and the model was replicated in other locations only after it was proved to be a **viable solution**. On the other hand, the Pilisaru Project was rolled out at the same time countrywide and there were many challenges that were common among the local authorities. Had they tested the model in a few municipalities before launching it nationally, they might have identified these challenges and addressed them beforehand. Kenya's National Solid Waste Management Strategy was created from an assessment of five urban areas: Kisumu, Eldoret, Mombasa, Thika, and Nakuru (NEMA, 2015). Since data on various waste management aspects from these towns is already available, they could serve as the **pilot locations**. The five urban areas are however bigger than most urban areas in Kenya, so a few other urban areas should be included to determine if the same approach would be applicable to all urban areas, or if some **adaptations** need to be made based on size.

Strategic partnerships were crucial for both Waste Concern and Pilisaru Project. Such partnerships would also be needed in Kenya. County governments can collaborate with academic institutions to help in improving the process of composting or in innovating better waste recovery methods. To improve the marketing of the compost, there should be partners with fertilizer makers and distributors such as Agro-Organics Ltd and MEA Fertilizers who have national distribution networks.

The presence of the companies like TakaTaka Solutions, Safi Organics and Sanergy, refer to section 5.4, presents a unique opportunity for the national and local governments. Given the experience of these companies, they could be **consulted** when designing circular models for management of organic waste. These companies could also help **lead the transition** to circular approaches for organic waste management. Moreover, they could contribute to the **policy making process** to ensure that the policies are pragmatic and relevant. Such partnerships with the government could increase investor confidence leading to involvement of international organizations. Lastly, they could be used as **exemplars** from whom other actors can learn.

Accounting for all these features, a suggested conceptual model is shown in Figure 6-3.

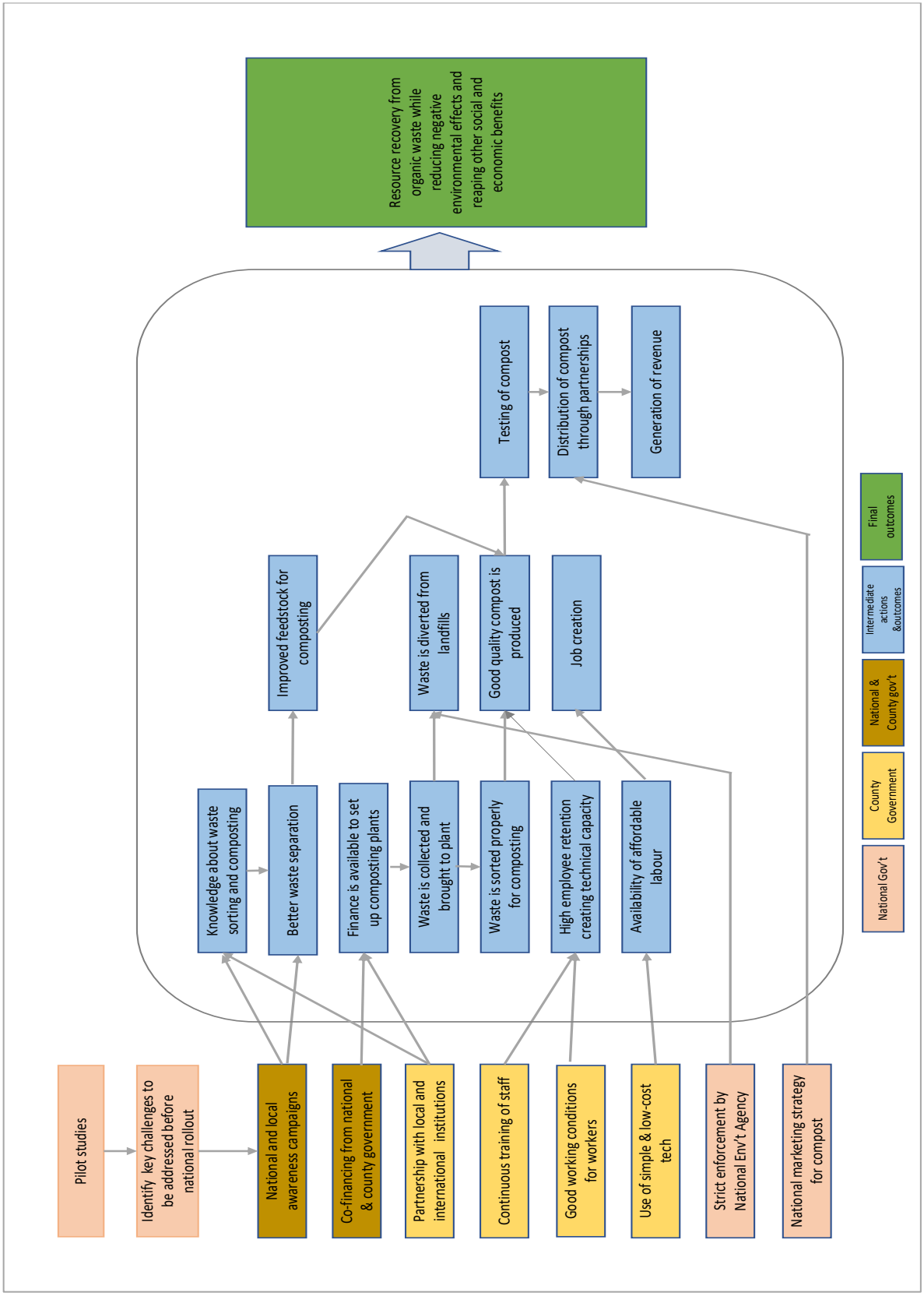

Figure 6-3. Potential conceptual model for organic waste management through composting (Source: Developed by the author)

7 Discussion

This chapter critically discusses the findings and analysis from Chapters 4, 5, and 6 and the implications of those findings. It also discusses the research methodology and the analytical framework and how they could have affected the results of this research.

7.1 Discussion on findings and analysis

The findings show that the concept of circular economy is not new to Kenya. Practices such as composting and reusing materials have been in practice for a very long time. These practices are however understood from more mainstream discourses such as sustainability. The view that CE is not widespread in Kenya and in many developing countries also arises from the technocentric view of the concept. Such a view however can be dangerous as it places many practitioners of CE outside its boundaries. Therefore, it is crucial to expand the understanding of CE to include these activities that might fall outside its current conceptualization. Discussion of CE in developing countries like Kenya should not present it as a western approach or a new solution to existing challenges but rather a different lens from which to view sustainability issues. By doing so, existing practices can easily be integrated into the concept. CE could also be presented as a way of streamlining already existing practices by making them more systematic through the involvement of different stakeholders to create wider value chains.

The case studies that were chosen for this research present two different approaches to adopting circular approaches in organic waste management, one started by a private actor and the other being a national-wide government initiative. Despite this huge difference, there are many similarities in terms of the stakeholders involved and the influencing factors. In both cases, there was the involvement of multiple actors such as local authorities, NGOs, different government institutions, waste generators, and private companies. Influential factors such as waste segregation, use of simple low-cost technology, presence of policies and their implementation, and availability of a market for compost affected both cases. Waste Concern and the Western province in Sri Lanka could be seen as successful cases when compared to the other municipalities involved in the Pilisaru Project. However, since the analysis of Waste Concern was limited to the initial years of the project, and focused mostly on the first composting plant, it is possible that this conclusion is deficient. For the Pilisaru Project, there were different outcomes based on the location of the local authority, with programs in the Western Province being more successful because of the intervention of the provincial waste management authority. The two cases offer very important lessons that can guide the implementation of such approaches in Kenya.

Based on the findings from the case studies and the analysis of the current state of organic waste management in Kenya, it can be deducted that a hybrid model could be designed for Kenya. The contextual similarities between the case study countries and Kenya reduce the need to find suitable alternatives to some of the key features of implementation. The level of economic development in Kenya supports the adoption of similar technologies that are simple and inexpensive. Such techniques would be labour-intensive which would not be a challenge as there is the availability of affordable labour in Kenya. However, some of the challenges that were experienced in the case studies would need to be addressed for these approaches to work in the country. The problem of lack of policies or their weak implementation could be a huge barrier to a successful transfer of such approaches.

Given the current initiatives in Kenya aimed at improving the state of waste management in the country, these findings could be used to inform the decision-making process. While the National

Solid Waste Management Policy and the related National Solid Waste Management Strategy highlight the need to improve the state of waste management in the country, they do not present a clear approach that will be used to improve the situation. The companies in Kenya already leading such initiatives could offer blueprints from which the national and local governments can learn. They could also be involved in shaping the policies related to CE and organic waste management.

7.1.1 Generalisability of findings

While the findings were based on case studies where composting was the method used for resource recovery, they can be extended to other methods of resource recovery from organic waste. Some aspects such as stakeholders involved would vary based on the resource being recovered. However, there are key features that would be needed to ensure the projects achieve their intended outcomes. These are summarized below.

- *Conducting prior research to identify gaps, market needs, and project requirements*

Implementation of any initiative requires prior research to establish the problem and determine the best solution. In resource recovery, research can be done to understand aspects such as waste composition, community perception of the problem, stakeholders involved, and the economic viability of a project. Research should also be done continuously to improve technological processes and innovate new products.

- *Creating awareness and educational campaigns on resource recovery and related benefits*

Campaigns can be used to inform people about the resource recovery initiative and educate them on any new requirements such as source separation. Informing them of the benefits of such initiatives might also make them more willing to participate especially if the benefits are shared equally. From the case studies, benefits such as a cleaner environment and job creation made the projects desirable for the local people.

- *Choosing a suitable technology based on available resources and project objectives*

The technical needs of a resource recovery initiative could be a driver or barrier. Adapting the technology to be used to fit with the social-economic context of a place is crucial. This can help prevent hurdles such as lack of capital to buy equipment and lack of relevant skills to operate machines or fix any failures. For many developing countries where financial and technical capacity is limited, opting for simple, low-cost but labour-intensive techniques might be more pragmatic considering the availability of inexpensive labour. Furthermore, continuous training of staff on the relevant skills is also necessary to build enough technical capacity to manage operations.

- *Availability of market for the recovered products and clear marketing strategies*

Availability of a market of the final output or resource recovered is a key component of any resource recovery initiative. As was seen in the case studies, the perception of such products might be affected by people's perception of products recovered from waste. Ways to assure the public of the quality of such products such as testing products in accredited labs is therefore necessary. Additionally, having standards that such products need to meet can increase their credibility. Having a clear marketing strategy is also crucial to ensure people are aware of the

products. Partnering with relevant stakeholders who might have larger distribution networks can also help avail the product to a larger population.

- *Clear and pragmatic policies and their enforcement*

Policies can be effective means of achieving desired outcomes. Most methods of resource recovery are dependent on waste separation. Policies can be used to promote waste segregation for example by ensuring only sorted waste is collected. Government policies such as subsidies can also be used to promote resource recovery methods. Closely linked to the presence of policies is their enforcement. With the efficiency of policies in many developing countries being impacted by weak enforcement, it is important to have policies that are easy to enforce.

- *Creating strategic partnerships*

Partnerships between different stakeholders can help with many aspects of resource recovery initiatives. Partnerships with private actors who are already undertaking similar projects can create learning opportunities. Partnerships with international development organizations or donors can also help overcome some of the challenges facing these initiatives such as ack of funding or inadequate technical capacity. Furthermore, government partnerships can boost investor confidence.

Additionally, some of these findings might be applicable to other countries that share some contextual similarities with Sri Lanka, Bangladesh, or Kenya. This would especially be the case if characteristics like waste composition, need for simple technology, and availability of labour are comparable. However, as noted in the case of Kenya, exact replication is not possible since there are other contingent factors that would be different.

7.2 Discussion on methodology

7.2.1 Data collection

Data collection for the Waste Concern case study was affected by the lack of relevant people to interview. The findings were based solely on scientific papers and publications by the organization. This could have affected the findings since there could be information that was not included in the literature. Additionally, the available literature did not represent all the stakeholders that were involved in the project. Moreover, this meant that the author could not get very detailed information about the current operations of the organization, apart from the information provided on their website. The use of two case studies however overcame the first limitation since interviews were conducted with other stakeholders from the Pilisaru Project and by consolidating data from both cases, it was possible to have a more holistic view.

7.2.2 ISWM and Extrapolation

The use of both the ISWM model and extrapolation-oriented case research provided a complementary approach to this study. The ISMW model broke down the case studies into three dimensions making it easier to identify the actors, their roles, and the processes that were taking place in the waste cycle. This was used in answering research questions 1 & 2. Once the experiences of the case studies and the state of organic waste management in Kenya had been established, extrapolation was used to answer research question 3. As explained in section 3.4.2, the first step of extrapolation is similar to theory-driven evaluation, and this was used to understand the mechanism by which the case studies achieved the observed outcomes. The

second step then used the lessons from the evaluation and designed a potential logic model for Kenya.

7.2.3 Case study design

Case studies are very useful when trying to determine if policies that have been implemented in other places would work in another context. In this research, the aim was to understand details such as interventions done in the waste cycle, stakeholders involved and their roles, and the influencing factors. The decision to choose two case studies instead of one was to reduce the limitations of generalizability and study biases from one case. Despite the fact that the two case studies were different in their designs, their objective matched, and therefore comparisons could be drawn between the two. While it was difficult to access in-depth information for the two cases, especially for Waste Concern, due to a lack of established contact or most-up-to date publications, both cases showed how circular approaches to organic waste have been implemented. They also provided insights for Kenya and other developing countries that could benefit from adopting such approaches. The use of a case study design was fitting for this research as it provided a way to study a practice in a real-world context.

8 Conclusion and further research

This chapter summarizes the findings and analysis and provides recommendations on areas for future research.

While most studies looking at waste management in Kenya look at MSW in general, this research focused on the organic waste stream, which forms the biggest share of MSW in Kenya. The aim of the research was to explore if, and how, the circular approaches that were used to manage organic waste in Bangladesh and Sri Lanka could be transferred to the Kenyan context. For this purpose, data was collected by conducting 13 interviews and doing an extensive literature review. The approaches used in the case studies were analysed by reconstructing their logic models. The key features of these models were then assessed in comparison to the status quo in Kenya. This provided key lessons that were used to design a potential organic waste management model for Kenya. A summary of the findings is provided below by answering the main research questions that were introduced in Section 1.3.

This thesis hoped to contribute to the existing research that has been done at the intersection of CE and organic waste management. Given the limited research that has been done in this area, especially for studies targeting developing countries, this thesis sets a foundation for other researchers. It also provides information that could be used by practitioners in developing circular models for the management of organic waste.

RQ1. What are the experiences of specific aspects of circular organic waste management in Bangladesh and Sri Lanka?

Both Bangladesh and Sri Lanka adopted circular approaches to improve the overall state of waste management. In Bangladesh, it was initiated by Waste Concern, a social business enterprise, through their decentralized composting project, while in Sri Lanka, it was a national government initiative through the National Pilisaru Project. Before the interventions, there was dissatisfaction with the existing systems, and waste was collected for disposal in landfills. With the introduction of resource recovery, they began collecting waste and taking it to the composting facilities. Waste Concern employed people to collect waste using rickshaws while in some municipalities in Sri Lanka the vehicles that were used in waste collection announced their presence using music. While both initiatives started by collecting unsorted waste, with time they started collecting only sorted waste since sorting at the facility required more labour and affected the quality of compost. To facilitate waste separation, there were awareness campaigns to educate the people about the benefits of separation and to show them how to properly sort waste. For example, in Matale, Sri Lanka, the public health department did door-to-door visits at least once a month to teach the people about waste separation. In Sri Lanka, some local authorities experienced challenges of waste piling at the facilities which led to protests from the residents. Additionally, due to the lack of strict enforcement in the Pilisaru Project, there were some local authorities who continued to dispose of the waste in landfills.

There were multiple stakeholders involved in each of the case studies. Waste Concern started the initiative as a sole actor but in partnership with Lions' Club which provided the land and Man and Agro Industries which enriched and distributed the compost they produced. However, after the initial success of their first plant, the government got involved and offered support by providing land and championing for replication of the model in other locations. At the same time, other international stakeholders and NGOs got involved by providing funding and being implementation partners. Waste Concern's composting project went ahead to become the first in the Clean Development Mechanism of the Kyoto Protocol. For the Pilisaru Project, the

stakeholders involved varied based on the municipality. The government was however a major actor through the provision of funding and technical support for the projects. The choice to have the Central Environment Agency (CEA) as the institution responsible for the implementation and enforcement was proved to be ineffective as there was no follow-up on the projects or retribution when local authorities failed to adhere to the requirements. In both cases, the waste generators were also important as they provided the feedstock for composting and also benefited from cleaner environments and job creation.

There were several influential factors in the two case studies. The key common factor between them was the use of a simple and low-cost technique for composting. This was appropriate for both countries given the availability of affordable workers to support labour-intensive processes. The use of simple technology also makes use of locally available resources and skills. Another common factor was the people's perception of the compost. In both locations, this was addressed by working with accredited laboratories to assure the public about the quality and credibility of the product. One key difference between the two cases was the approach to marketing the compost. Waste Concern partnered with Map and Agro Industries, a fertilizer-maker, and this enabled them to distribute their enriched compost more broadly. On the other hand, many local authorities in Sri Lanka had difficulties selling their compost. This showed a lack of foresight from the Pilisaru Program which had not come up with a strategy of how the compost produced would be marketed. Other influential factors included creating awareness and building strategic partnerships.

RQ2. What is the current state of organic waste management in Kenya?

Currently, most of the waste in Kenya is collected for disposal in landfills and open dumpsites. Waste segregation is not a common practice since there is neither the supporting infrastructure nor the availability of widespread resource recovery initiatives to make use of the different waste streams. There are several stakeholders involved in waste management in the country. County governments are responsible for all activities related to waste management. Some county governments, especially those with large urban populations, outsource waste management services to licensed private companies. This system is however not efficient as it leaves some urban poor neighbourhoods unserved since they cannot afford to pay for waste collection services. In these areas, community-based organizations (CBOs) and the informal sector self-organize to manage their waste. The National Environment Management Authority (NEMA) is responsible for the enforcement of any regulations related to the environment which includes waste management. While waste management is included in the Kenya Vision 2030 development programme, and NEMA published the National Solid Waste Management Strategy, there is still not much groundwork that has been done.

On the topic of circular economy (CE) in Kenya, this study showed that it is not a foreign concept since circular practices like composting and reuse of material have been in place for years. While these practices are common and more widespread throughout the country, CE, as seen from the technocentric lens, is not widespread. However, the presence of companies like TakaTaka Solutions, Safi Organics, and Sanergy show that this is a growing area of interest and there are several resource recovery opportunities from organic waste. Outside of the organic waste management spere, Kenya is also advocating for the adoption of principles such as cleaner production and industrial ecology which could lead to more widespread CE initiatives.

RQ3. How can the circular approaches in the two countries be transferred to the Kenyan context?

There are many shared social-economic factors between Kenya and the two case studies that make it possible for Kenya to adopt similar approaches to manage organic waste. To begin with, organic waste forms the highest share of MSW in Kenya thus the feedstock needed for composting would be readily available. Kenya is also faced with similar challenges of inadequate financial and technical capacity but also has a large inexpensive labour force. The use of simple and low-cost techniques would, therefore, be suitable for the country. Nevertheless, by establishing the mechanisms that led to the outcomes in the case studies, some key features need to be in place to implement similar approaches successfully. The creation of pragmatic policies related to organic waste management would be very crucial. Given the importance of waste separation, policies should promote behaviour change through campaigns and restrict the collection of unsorted waste. Strict enforcement of such policies should also be done to avoid similar outcomes as was seen with some local authorities in Sri Lanka. Another important aspect to be addressed is the market for compost. While there is a higher demand for compost than is currently produced in the country, see section 6.4, a clear marketing strategy would be needed to streamline the value chain from compost production to availability of compost for purchase.

In conclusion, the circular approaches that were implemented in Bangladesh and Sri Lanka can be transferred to Kenya. However, this would not be a case of replicating them due to the contextual differences but extrapolating them and seeking alternatives for the features that might be different or absent in the Kenyan context.

8.1 Recommendations for further research

During this study, there were some gaps identified that could benefit from further research. The following areas are recommended for future research:

- **A quantitative study using either cost-effective analysis (CEA) or cost-benefit analysis (CBA)** to determine if the implementation of suggested approaches would be cost-efficient.
- **Policy evaluation and design for circular approaches in organic waste management.** As was stated in section 1.5, this study did not focus on government policies. An evaluation of the existing policies in this area could highlight how policies could be used to promote CE in organic waste management. Such research could also be used in designing new policies for other countries or in improving any existing ones.
- **Financing mechanisms for CE models in waste management**. Availability of funding for various development projects is a common challenge for developing countries. A study into possible financing models could help establish other ways of raising capital for such initiatives.

Bibliography

6, P., & Bellamy, C. (2013). *Principles of methodology: Research design in social science*. SAGE Publications Ltd. https://rbdigital.rbdigital.com

Ahmed, S. A., & Ali, S. M. (2006). People as partners: Facilitating people's participation in public–private partnerships for solid waste management. *Habitat International*, *30*(4), 781–796. https://doi.org/10.1016/j.habitatint.2005.09.004

Alam, O., & Qiao, X. (2020). An in-depth review on municipal solid waste management, treatment and disposal in Bangladesh. *Sustainable Cities and Society*, *52*, 101775. https://doi.org/10.1016/j.scs.2019.101775

Anschütz, J, IJgosse, J, Scheinberg, A (2004) Putting Integrated Sustainable Waste Management into Practice: Using the ISWM Assessment Methodology ISWM Methodology as Applied in the UWEP Plus Programme (2001-2003)

Ashikuzzaman, Md., & Howlader, Md. H. (2020). Sustainable Solid Waste Management in Bangladesh: Issues and Challenges. In A. Pariatamby, F. Shahul Hamid, & M. S. Bhatti (Eds.), *Advances in Environmental Engineering and Green Technologies* (pp. 35–55). IGI Global. https://doi.org/10.4018/978-1-7998-0198-6.ch002

Bardach, E. (2004). The Extrapolation Problem: How Can We Learn from the Experience of Others? Journal of Policy Analysis and Management, 23(2), 205–220. http://www.jstor.org/stable/3326147

Barzelay, M. (2007). Learning from Second-Hand Experience: Methodology for Extrapolation-Oriented Case Research. *Governance*, *20*(3), 521–543. https://doi.org/10.1111/j.1468-0491.2007.00369.x

Batista, M., Goyannes Gusmão Caiado, R., Gonçalves Quelhas, O. L., Brito Alves Lima, G., Leal Filho, W., & Rocha Yparraguirre, I. T. (2021). A framework for sustainable and integrated municipal solid waste management: Barriers and critical factors to developing countries. *Journal of Cleaner Production*, *312*, 127516. https://doi.org/10.1016/j.jclepro.2021.127516

Behuria, P. (2021). Ban the (plastic) bag? Explaining variation in the implementation of plastic bag bans in Rwanda, Kenya and Uganda. *Environment and Planning C: Politics and Space*, *39*(8), 1791–1808. https://doi.org/10.1177/2399654421994836

Bekchanov, M., & Mirzabaev, A. (2018). Circular economy of composting in Sri Lanka: Opportunities and challenges for reducing waste related pollution and improving soil health. *Journal of Cleaner Production*, *202*, 1107–1119. https://doi.org/10.1016/j.jclepro.2018.08.186

Blogs.Worldbank.Org (2016) What will Kenya's urban future look like for newborns James and Maureen? Retrieved December 14, 2021, from https://blogs.worldbank.org/africacan/what-will-kenyas-urban-future-look-like-for-newborns-james-and-maureen

Boulding, K.E. (2003). The Economics of the Coming Spaceship Earth.

Capuano Mascarenhas, L., Ness, B., Oloko, M., & Awuor, F. O. (2021). Multi-criteria analysis of municipal solid waste treatment technologies to support decision-making in Kisumu, Kenya. *Environmental Challenges*, *4*, 100189. https://doi.org/10.1016/j.envc.2021.100189

CGIAR (2019) Outcome Evaluation of Research for Development Work Conducted in Ghana and Sri Lanka under the Resource, Recovery and Reuse (RRR) Subprogram of the CGIAR Research Program on Water, Land and Ecosystems (WLE)

Cofie, O. O., Drechsel, P., Agbottah, S., & Veenhuizen, R. van. (2009). Resource recovery from urban waste: Options and challenges for community-based composting in sub-Saharan Africa. *Desalination*, *248*(1–3), 256–261. https://doi.org/10.1016/j.desal.2008.05.063

Coryn, C. L. S., Noakes, L. A., Westine, C. D., & Schröter, D. C. (2011). A Systematic Review of Theory-Driven Evaluation Practice From 1990 to 2009. *American Journal of Evaluation*, *32*(2), 199–226. https://doi.org/10.1177/1098214010389321

Dandeniya, W. S., & Caucci, S. (2020). Composting in Sri Lanka: Policies, Practices, Challenges, and Emerging Concerns. In H. Hettiarachchi, S. Caucci, & K. Schwärzel (Eds.), *Organic Waste Composting through Nexus Thinking* (pp. 61–89). Springer International Publishing. https://doi.org/10.1007/978-3-030-36283-6_4

Das, S., Lee, S.-H., Kumar, P., Kim, K.-H., Lee, S. S., & Bhattacharya, S. S. (2019a). Solid waste management: Scope and the challenge of sustainability. *Journal of Cleaner Production*, *228*, 658–678. https://doi.org/10.1016/j.jclepro.2019.04.323

Das, S., Lee, S.-H., Kumar, P., Kim, K.-H., Lee, S. S., & Bhattacharya, S. S. (2019b). Solid waste management: Scope and the challenge of sustainability. *Journal of Cleaner Production*, *228*, 658–678. https://doi.org/10.1016/j.jclepro.2019.04.323

Davila, F., Esham, M., & Nilanthi Jayathilake. (2022). *Political Economy Analysis of Organic Waste Value Chains in Sri Lanka*. https://doi.org/10.13140/RG.2.2.10152.44801

Ddiba, D (2020) Exploring the circular economy of urban organic waste in sub-Saharan Africa: opportunities and challenges. Licentiate thesis in Planning and Decision Analysis, KTH Royal Institute of Technology

Ddiba, D., Andersson, K., Koop, S. H. A., Ekener, E., Finnveden, G., & Dickin, S. (2020). Governing the circular economy: Assessing the capacity to implement resource-oriented sanitation and waste management systems in low- and middle-income countries. *Earth System Governance*, *4*, 100063. https://doi.org/10.1016/j.esg.2020.100063

Ddiba, D., Andersson, K., Rosemarin, A., Schulte-Herbrüggen, H., & Dickin, S. (2022). The circular economy potential of urban organic waste streams in low- and middle-income countries. *Environment, Development and Sustainability*, *24*(1), 1116–1144. https://doi.org/10.1007/s10668-021-01487-w

Diener, S., Semiyaga, S., Niwagaba, C. B., Muspratt, A. M., Gning, J. B., Mbéguéré, M., Ennin, J. E., Zurbrugg, C., & Strande, L. (2014). A value proposition: Resource recovery from faecal sludge—Can it be the driver for improved sanitation? *Resources, Conservation and Recycling*, *88*, 32–38. https://doi.org/10.1016/j.resconrec.2014.04.005

Donner, M., Gohier, R., & de Vries, H. (2020a). A new circular business model typology for creating value from agro-waste. *Science of The Total Environment*, *716*, 137065. https://doi.org/10.1016/j.scitotenv.2020.137065

Donner, M., Gohier, R., & de Vries, H. (2020b). A new circular business model typology for creating value from agro-waste. *Science of The Total Environment*, *716*, 137065. https://doi.org/10.1016/j.scitotenv.2020.137065

EMF - Ellen MacArthur Foundation, 2013. Towards the circular economy. Economic and business rationale for an accelerated transition. https://www.

ellenmacarthurfoundation.org/assets/downloads/publications/EllenMacArthur-Foundation-Towards-the-Circular-Economy-vol.1.pdf (Last accessed on 29/04/2022).

EMF- Ellen MacArthur Foundation, 2015. Growth within a circular economy vision for a competitive Europe. https://www.ellenmacarthurfoundation.org/assets/downloads/publications/EllenMacArthurFoundation_Growth-Within_July15.pdf (Last accessed on 30/04/2022).

Enayetullah, I & Sinha, A.H.Md. M (n.d.) Community Based Decentralized Composting. Experience of Waste Concern in Dhaka https://wasteconcern.org/publications-2/

EPA (2020) Best Practices for Solid Waste Management: A Guide for Decision-Makers in Developing Countries (October 2020EPA 530-R-20-002)

Ezeah, C., & Roberts, C. L. (2012). Analysis of barriers and success factors affecting the adoption of sustainable management of municipal solid waste in Nigeria. *Journal of Environmental Management*, *103*, 9–14. https://doi.org/10.1016/j.jenvman.2012.02.027

Fernando, J (n.d.) National 'Pilisaru' Waste Management Programme

Fernando, N & Silva, M (2020) Municipal Solid Waste Governance in Sri Lanka: A literature review. R4D Project: Challenges of Municipal Waste Management: Learning from post-crisis initiatives in South Asia

Fernando, R. L. S. (2019). Solid waste management of local governments in the Western Province of Sri Lanka: An implementation analysis. *Waste Management*, *84*, 194–203. https://doi.org/10.1016/j.wasman.2018.11.030

Ferronato, N., Rada, E. C., Gorritty Portillo, M. A., Cioca, L. I., Ragazzi, M., & Torretta, V. (2019). Introduction of the circular economy within developing regions: A comparative analysis of advantages and opportunities for waste valorization. *Journal of Environmental Management*, *230*, 366–378. https://doi.org/10.1016/j.jenvman.2018.09.095

Ghisellini, P., Cialani, C., & Ulgiati, S. (2016). A review on circular economy: The expected transition to a balanced interplay of environmental and economic systems. *Journal of Cleaner Production*, *114*, 11–32. https://doi.org/10.1016/j.jclepro.2015.09.007

Guerrero, L. A., Maas, G., & Hogland, W. (2013). Solid waste management challenges for cities in developing countries. *Waste Management*, *33*(1), 220–232. https://doi.org/10.1016/j.wasman.2012.09.008

Gunaruwan, T.L & Gunasekara, W.N (2016) Management of Municipal Solid Waste in Sri Lanka: A Comparative Appraisal of the Economics of Composting

Hai, F. Ibney. & Ali, M. (2005). A Study on Solid Waste Management System of Dhaka City Corporation: Effect of Composting and Landfill Location. UAP Journal of Civil and Environmental Engineering, (1), 18-26

Halder, P.K.; Paul, N.; Hoque, M.E.; Hoque, A.S.M.; Parvez, M.S.; Rahman, M.H.; Ali, M. (2014) Municipal Solid Waste and its Management in Rajshahi City, Bangladesh: A Source of Energy. Int. J. Renew. Energy Res. 4, 1

Halimah Ismail. (2015). *Good Governance in Malaysia's Integrated Solid Waste Management- Challenges in Policy Implementation towards the Public*. https://doi.org/10.13140/RG.2.1.3015.8244

Halog, A., & Anieke, S. (2021). A Review of Circular Economy Studies in Developed Countries and Its Potential Adoption in Developing Countries. *Circular Economy and Sustainability*, *1*(1), 209–230. https://doi.org/10.1007/s43615-021-00017-0

Harir, A.I., Kasim, R. and Ishiyaku, B. (2015) Exploring the Resource Recovery Potentials of Municipal Solid Waste: A Review of Solid Wastes Composting in Developing Countries. International Journal of Scientific and Research Publications, 5, 8 p.

Henry, R. K., Yongsheng, Z., & Jun, D. (2006). Municipal solid waste management challenges in developing countries – Kenyan case study. *Waste Management*, *26*(1), 92–100. https://doi.org/10.1016/j.wasman.2005.03.007

Hettiarachchi, H., Caucci, S., & Schwärzel, K. (Eds.). (2020). *Organic Waste Composting through Nexus Thinking: Practices, Policies, and Trends*. Springer International Publishing. https://doi.org/10.1007/978-3-030-36283-6

Hettiarachchi, H., Meegoda, J., & Ryu, S. (2018). Organic Waste Buyback as a Viable Method to Enhance Sustainable Municipal Solid Waste Management in Developing Countries. *International Journal of Environmental Research and Public Health*, *15*(11), 2483. https://doi.org/10.3390/ijerph15112483

Hoornweg, D Bhada & Tata, Pe (2012) What a Waste: A Global Review of Solid Waste Management. Urban development series; knowledge papers no. 15. World Bank, Washington, DC. © World Bank. https://openknowledge.worldbank.org/handle/10986/17388 License: CC BY 3.0 IGO.

IGES (2020) Towards Sustainable Operation and Management of Centralized Composting in Sri Lanka

Islam, S (2021) Urban Waste Management in Bangladesh: An Overview with a Focus on Dhaka

JICA (2016) Data Collection Survey on Solid Waste Management in Democratic Socialist Republic of Sri Lanka. Japan International Cooperation Agency.

Joseph, K. (2006). Stakeholder participation for sustainable waste management. *Habitat International*, *30*(4), 863–871. https://doi.org/10.1016/j.habitatint.2005.09.009

Kaza, S., Yao, L. C., Bhada-Tata, P., & Van Woerden, F. (2018). *What a Waste 2.0: A Global Snapshot of Solid Waste Management to 2050*. Washington, DC: World Bank. https://doi.org/10.1596/978-1-4648-1329-0

Kirchherr, J., Reike, D., & Hekkert, M. (2017). Conceptualizing the circular economy: An analysis of 114 definitions. *Resources, Conservation and Recycling*, *127*, 221–232. https://doi.org/10.1016/j.resconrec.2017.09.005

Koech, M. K., & Munene, K. J. (2020). Circular Economy in Kenya. In S. K. Ghosh (Ed.), *Circular Economy: Global Perspective* (pp. 223–239). Springer Singapore. https://doi.org/10.1007/978-981-15-1052-6_12

Koop, S. H. A., Koetsier, L., Doornhof, A., Reinstra, O., Van Leeuwen, C. J., Brouwer, S., Dieperink, C., & Driessen, P. P. J. (2017). Assessing the Governance Capacity of Cities to Address Challenges of Water, Waste, and Climate Change. *Water Resources Management*, *31*(11), 3427–3443. https://doi.org/10.1007/s11269-017-1677-7

Korhonen, J., Honkasalo, A., & Seppälä, J. (2018). Circular Economy: The Concept and its Limitations. *Ecological Economics*, *143*, 37–46. https://doi.org/10.1016/j.ecolecon.2017.06.041

Leal Filho, W., Brandli, L., Moora, H., Kruopienė, J., & Stenmarck, Å. (2016). Benchmarking approaches and methods in the field of urban waste management. *Journal of Cleaner Production*, *112*, 4377–4386. https://doi.org/10.1016/j.jclepro.2015.09.065

Ma, J., & Hipel, K. W. (2016). Exploring social dimensions of municipal solid waste management around the globe – A systematic literature review. *Waste Management*, *56*, 3–12. https://doi.org/10.1016/j.wasman.2016.06.041

Mamun, S., & Mascie-Taylor, C. G. N. (2019). Double Burden of Malnutrition (DBM) and Anaemia under the Same Roof: A Bangladesh Perspective. *Medical Sciences*, *7*(2), 20. https://doi.org/10.3390/medsci7020020

Marmolejo, L. F. (2012a). *Perspectives For Sustainable Resource Recovery from Municipal Solid Waste in Developing Countries Applications and Alternatives*. https://openresearchlibrary.org/content/2f02d3ce-4e8d-47e0-b951-338c077fec80

Marmolejo, L. F. (2012b). *Perspectives For Sustainable Resource Recovery from Municipal Solid Waste in Developing Countries Applications and Alternatives*. https://openresearchlibrary.org/content/2f02d3ce-4e8d-47e0-b951-338c077fec80

McDonough, W., & Braungart, M. (2002a). *Cradle to cradle: Remaking the way we make things* (1st ed). North Point Press.

Meyer, C. B. (2001). A Case in Case Study Methodology. *Field Methods*, *13*(4), 329–352. https://doi.org/10.1177/1525822X0101300402

Ministry of Environment and Forestry (2019) National Sustainable Waste Management Policy

Ministry of Environment and Natural Resources (2016) Nationally Appropriate Mitigation Action on a Circular Economy Solid Waste Management Approach for Urban Areas in Kenya

Ministry of Environment & Renewable Energy (2012) Annual Performance and Accounts

Mitchell, F. (2021, May 10). Safi Organics - Local, sustainable fertiliser from Kenya. Atlas of the Future. https://atlasofthefuture.org/project/safi-organics/

Monyoncho, G. O (2013) Solid Waste Management in Urban Areas in Kenya: A case study of Lamu Town.

Mosler, H. J., Drescher, S., Zurbrügg, C., Rodríguez, T. C., & Miranda, O. G. (2006). Formulating waste management strategies based on waste management practices of households in Santiago de Cuba, Cuba. *Habitat International*, *30*(4), 849–862. https://doi.org/10.1016/j.habitatint.2005.09.008

Munthe-Kaas, H., Nøkleby, H., Lewin, S., & Glenton, C. (2020). The TRANSFER Approach for assessing the transferability of systematic review findings. *BMC Medical Research Methodology*, *20*(1), 11. https://doi.org/10.1186/s12874-019-0834-5

Murray, A., Skene, K., & Haynes, K. (2017). The Circular Economy: An Interdisciplinary Exploration of the Concept and Application in a Global Context. *Journal of Business Ethics*, *140*(3), 369–380. https://doi.org/10.1007/s10551-015-2693-2

Namunwa, K. (2019, March 11). Kenya leads Africa in Smartphone usage. BussinessToday. Retrieved May 17, 2022, from https://businesstoday.co.ke/kenya-leads-africa-smartphone-usage/

National Environment Management Authority (NEMA) (2015) The National Solid Waste Management Strategy

Okungu, V., Chuma, J., Mulupi, S., & McIntyre, D. (2018). Extending coverage to informal sector populations in Kenya: Design preferences and implications for financing policy. *BMC Health Services Research*, *18*(1), 13. https://doi.org/10.1186/s12913-017-2805-z

Otoo, M., & Drechsel, P. (Eds.). (2018). *Resource recovery from waste: Business models for energy, nutrient, and water reuse in low- and middle-income countries*. Routledge.

Paes, L. A. B., Bezerra, B. S., Deus, R. M., Jugend, D., & Battistelle, R. A. G. (2019a). Organic solid waste management in a circular economy perspective – A systematic review and SWOT analysis. *Journal of Cleaner Production*, *239*, 118086. https://doi.org/10.1016/j.jclepro.2019.118086

Paes, L. A. B., Bezerra, B. S., Deus, R. M., Jugend, D., & Battistelle, R. A. G. (2019b). Organic solid waste management in a circular economy perspective – A systematic review and SWOT analysis. *Journal of Cleaner Production*, *239*, 118086. https://doi.org/10.1016/j.jclepro.2019.118086

Parvin, M., & Begum, A. (2018). Organic Solid Waste Management and the Urban Poor in Dhaka City. *International Journal of Waste Resources*, *08*(01). https://doi.org/10.4172/2252-5211.1000320

Perera, B. A. (2022, May 10). Why are Sri Lankans protesting in the streets? BBC News. https://www.bbc.com/news/world-61028138

Rizos, V., Behrens, A., van der Gaast, W., Hofman, E., Ioannou, A., Kafyeke, T., Flamos, A., Rinaldi, R., Papadelis, S., Hirschnitz-Garbers, M., & Topi, C. (2016a). Implementation of Circular Economy Business Models by Small and Medium-Sized Enterprises (SMEs): Barriers and Enablers. *Sustainability*, *8*(11), 1212. https://doi.org/10.3390/su8111212

Rizos, V., Behrens, A., van der Gaast, W., Hofman, E., Ioannou, A., Kafyeke, T., Flamos, A., Rinaldi, R., Papadelis, S., Hirschnitz-Garbers, M., & Topi, C. (2016b). Implementation of Circular Economy Business Models by Small and Medium-Sized Enterprises (SMEs): Barriers and Enablers. *Sustainability*, *8*(11), 1212. https://doi.org/10.3390/su8111212

Rose, R (1991) What is Lesson-Drawing? Journal of Public Policy, 11(01) http://www.jstor.org/stable/4007336

Sabki Mirza Hussein, Lee Chew Tin, Bong Cassendra P. C., & Klemes Jiri J. (2018). A review on the economic feasibility of composting for organic waste management in asian countries. *Chemical Engineering Transactions*, *70*, 49–54. https://doi.org/10.3303/CET1870009

SafiOrganics. (2022). Safi Sarvi Organic Fertilizer. Retrieved May 17, 2022, from https://safiorganics.co.ke/about/

Sanergy. (2021). Sanergy. Retrieved May 17, 2022, from https://www.sanergy.com/

Schröder, P., Anantharaman, M., & Anggraeni, K. (Eds.). (2019). *The circular economy and the global south: Sustainable lifestyles and green industrial development*. Routledge, Taylor & Francis Group.

Sibanda, L. K., Obange, N., & Awuor, F. O. (2017). Challenges of Solid Waste Management in Kisumu, Kenya. *Urban Forum*, *28*(4), 387–402. https://doi.org/10.1007/s12132-017-9316-1

Sinnathamby et al. (2016) Factors Affecting Sustainability of Municipal Solid Waste Composting Projects in Sri Lanka. International Research Conference iNCOTeM,

Smith, J., & Jehlička, P. (2013). Quiet sustainability: Fertile lessons from Europe's productive gardeners. *Journal of Rural Studies*, *32*, 148–157. https://doi.org/10.1016/j.jrurstud.2013.05.002

Statista (2022, April 25 29). Urban population in Kenya 2015–2020. https://www.statista.com/statistics/1225064/urban-population-in-kenya/

Storey, D, Santucci, L, Aleluia, J Varghese, T (2013) Decentralized and Integrated Resource Recovery Centers in Developing Countries: Lessons Learnt from Asia-Pacific

Storey, D., Santucci, L., Fraser, R., Aleluia, J., & Chomchuen, L. (2015). Designing effective partnerships for waste-to-resource initiatives: Lessons learned from developing countries. *Waste Management & Research: The Journal for a Sustainable Circular Economy*, *33*(12), 1066–1075. https://doi.org/10.1177/0734242X15602964

TakaTaka Solutions. (2022). TakaTaka Solutions. Retrieved May 17, 2022, from https://takatakasolutions.com/

Tukahirwa, J. T. (2011). *Civil society in urban sanitation and solid waste management: The role of NGOs and CBOs in metropolises of East Africa*. [publisher not identified].

Tukahirwa, J. T., Mol, A. P. J., & Oosterveer, P. (2013). Comparing urban sanitation and solid waste management in East African metropolises: The role of civil society organizations. *Cities*, *30*, 204–211. https://doi.org/10.1016/j.cities.2012.03.007

Turing, J (2021) Understanding the Circular Economy in Kenya: Critiquing the Dominant Discourse. The University of Edinburgh 2021

Wainaina, S., Awasthi, M. K., Sarsaiya, S., Chen, H., Singh, E., Kumar, A., Ravindran, B., Awasthi, S. K., Liu, T., Duan, Y., Kumar, S., Zhang, Z., & Taherzadeh, M. J. (2020). Resource recovery and circular economy from organic solid waste using aerobic and anaerobic digestion technologies. *Bioresource Technology*, *301*, 122778. https://doi.org/10.1016/j.biortech.2020.122778

Wang, S., Moss, J. R., & Hiller, J. E. (2006). Applicability and transferability of interventions in evidence-based public health. *Health Promotion International*, *21*(1), 76–83. https://doi.org/10.1093/heapro/dai025

Waste Concern (2004) SAARC Workshop on Solid Waste Management https://wasteconcern.org/publications-2/

Waste Concern. (2022). Waste Concern. Retrieved May 16, 2022, from https://wasteconcern.org/

Welivita, I., Wattage, P., & Gunawardena, P. (2015). Review of household solid waste charges for developing countries – A focus on quantity-based charge methods. *Waste Management*, *46*, 637–645. https://doi.org/10.1016/j.wasman.2015.08.018

Wiesmann, U., Hurni, H., NCCR North-South (Program), & Universität Bern (Eds.). (2011). *Research for sustainable development: Foundations, experiences, and perspectives*. NCCR North-South, Centre for Development and Environment (CDE) and Institute of Geography, University of Bern.

Wilson, D. C., Velis, C., & Cheeseman, C. (2006). Role of informal sector recycling in waste management in developing countries. *Habitat International*, *30*(4), 797–808. https://doi.org/10.1016/j.habitatint.2005.09.005

Blogs.Worldbank.Org (2016) What will Kenya's urban future look like for newborns James and Maureen? Retrieved December 14, 2021, from https://blogs.worldbank.org/africacan/what-will-kenyas-urban-future-look-like-for-newborns-james-and-maureen

Xing, W., Lu, W., Zhao, Y., Zhang, X., Deng, W., & Christensen, T. H. (2013). Environmental impact assessment of leachate recirculation in landfill of municipal solid waste by comparing with evaporation and discharge (EASEWASTE). *Waste Management*, *33*(2), 382–389. https://doi.org/10.1016/j.wasman.2012.10.017

Yedla, S. (2012). Replication of urban innovations – prioritization of strategies for the replication of Dhaka's community-based decentralized composting model. *Waste Management & Research: The Journal for a Sustainable Circular Economy*, *30*(1), 20–31. https://doi.org/10.1177/0734242X10380116

Yin, R. K. (2003). *Case study research: Design and methods* (3rd ed). Sage Publications.

Zurbrügg, C., Drescher, S., Rytz, I., Sinha, A. H. Md. M., & Enayetullah, I. (2005). Decentralised composting in Bangladesh, is a win-win situation for all stakeholders. *Resources, Conservation and Recycling*, *43*(3), 281–292. https://doi.org/10.1016/j.resconrec.2004.06.005

Appendix 1 Interview Guide

Interview guide developed by the author

Case Studies

1. Could you briefly introduce yourself and tell me more about your research work?
2. What are some resource recovery approaches being used to manage organic waste in Sri Lanka?
3. Are you familiar with the Pilisaru Project
4. If so, who were the main stakeholders involved in the project and their roles?
5. What kind of partnerships were there in different local authorities?
6. What have been the outcomes, both expected and unexpected, of the Pilisaru Project?
7. What were the main factors contributing to the success or failure of the project?
8. Are there any policy interventions that were undertaken by the government to promote these projects ?
9. If these approaches were to be replicated in other countries, what are the main factors that should be considered?
10. How would you describe the current state of organic waste in Sri Lanka?

Kenya Context

1. Could you briefly introduce yourself and tell me more about your work and the work of your company/organization?
2. How would you describe the current state of organic waste in Kenya?
3. Who are the main stakeholders involved in waste management in Kenya and what role does each of them play?
4. Are you familiar with the concept of circular economy, and if so how would you describe it in terms of (organic) waste management?
5. What are your thoughts on adopting circular approaches to help deal with organic waste in Kenya?
6. What kind of partnerships need to be developed in order to promote such approaches?
7. What would be the main factors that would drive the adoption of these approaches
8. What would be the main barriers in adopting these approaches
9. In what ways can the government help in adoption of circular approaches to organic waste?
10. What would be the benefits of transitioning from the current ways of managing organic waste to circular models?

For the private companies/organizations (CBOs) implementing circular models

11. What has been the experience of implementing this model? What have been the big drivers and the main challenges?
12. What would you say are the main barriers that prevent the scaling of such models to a national level?
13. What kind of partnerships are there between your organization and other stakeholders?

Appendix 2 Pictures taken at Kibuye Market composting site