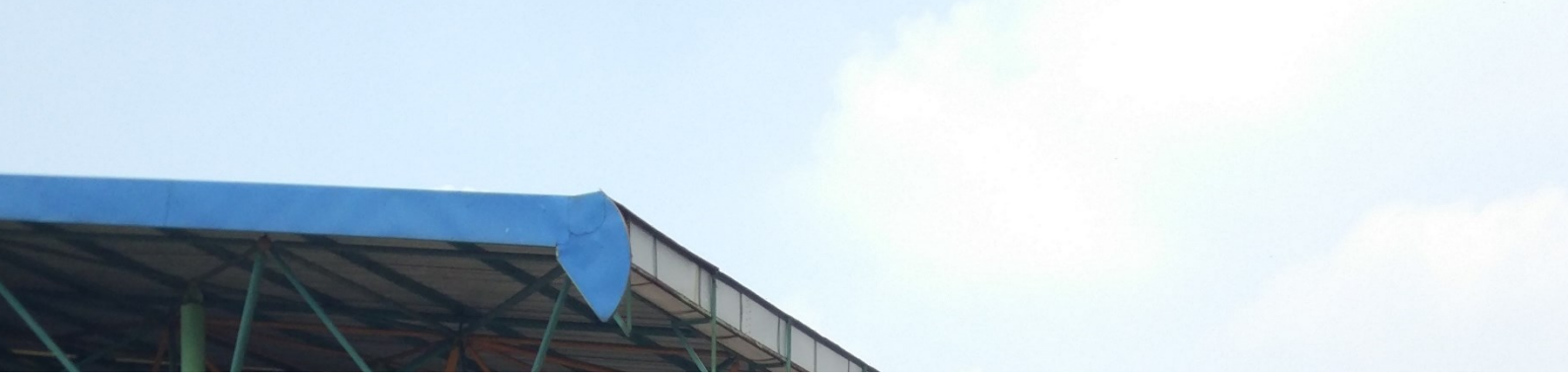

Transitioning towards Circular Economy on Municipal Solid Waste Management in Bali, Indonesia

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Transitioning towards Circular Economy on Municipal Solid Waste Management in Bali, Indonesia

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Preface

Environmental issue, especially waste management, is a prominent issue in my country, Indonesia. Through my personal experience working on waste management in Indonesia, I know it is not a simple task to solve the issue. Therefore, this thesis was created out of my concern towards waste and circular economy in Indonesia, in the hope that I can contribute to providing a multi-dimensional insight into the transition towards circular economy in waste management value chain. On an additional note, we all need to remember that change can only happen when we all collaborate and work together towards solving the issue.

This thesis will not be possible without all the support that I have received.

First and foremost, I would like to thank my graduation committee, Dr. ir. Jaco Quist and De. Hanieh Khodaei. Thank you for all your support during the course of my thesis research process despite all the shortcomings that I have been showing the past few months. All of the critical feedback that you have been giving me during our meetings helped me tremendously to giving my best for my thesis. And I will never forget how the two of you have always been very kind and caring towards me and keep reminding me not to forget to take care of myself all these times. I appreciate that greatly, and that has been helping me to keep pulling through.

I would also like to thank all of my interviewees and colleagues who have been helping me by giving me their insights on municipal solid waste management in bali and circular economy. I can see the passion that beamed through during our conversations! Waste management is a complex issue, but I believe that a change can really be made if you all are the ones behind it.

To all my friends, thank you for becoming my second family in these foreign countries far from home. To all of my friends whom I met during my Master's, living 11,329 km away from home during this pandemic is hard. However, you guys gave me the best years of my life, and suddenly, it is not hard anymore. All the meals we had together, all the travels, and all of our conversations will forever stay within my heart. Wherever part of the earth we will end up in the future, I hope we stay as close as how we are now. To all of my friends back in Indonesia, you guys have always been my best support system since 0. I finally did it, and this would not happen without all of our talks and chats and your confidence in me. Thank you.

Lastly, I will not be in this position without the emotional support that my family have been giving me throughout my Master's years. All the video calls and messages that you have been giving me have kept me afloat during the years. Despite the distance between Indonesia and Sweden, and then the Netherlands, I can feel all your unconditional love, support, and prayers towards me. I love you, and I will always do.

Leiden, 24 August 2022

Sandy Indriana

Executive Summary

Research Background

Municipal Solid Waste has been an issue that is affecting people globally. The rapid urbanization and population growth created an immense waste generation in the process, making it more difficult to completely manage the waste due to the amount and complexity of the waste composition. Indonesia is not excluded from the issue, where there is an absence of an effective waste management system in the country. Bali Province is a region where the primary economic source is tourism, and the development of tourism in the region is reflected in the increase in waste generation in the Province. The current waste management system in Bali could not follow the rate at which the waste is generated, therefore causing the waste to be mismanaged and losing its potential to be recovered.

Bali still implements the conventional paradigm of the linear economy using take-make-dispose, where the materials are simply collected, transformed into products that are used, and discarded as waste. This system relies mainly on the usage of landfills. However, Bali is currently facing the issue of waste overflowing in landfills, and the landfills are on the verge of closing. As a solution to the old paradigm, Circular Economy (CE) is introduced where it can minimize resource input and waste, emission, and energy leakage by slowing, closing, and narrowing the material and energy loops. To create a transition from linear to circular economy in Bali's MSWM context, a systemic analysis based on a multi-dimensional approach is needed. Value Chain Analysis (VCA) is one way to explore strategic and misalignment within the chain to increase value and economic sustainability, and by integrating social and environmental aspects, a more sustainable competitive advantage can be reached.

However, gaps are found in the existing literature, where most of the study on waste management in Bali focuses on the system's technical part. Another gap is within the VCA frameworks, where most of the VCA in waste management are used in a narrow scope, whether it is a specific agent, activity, or product. And last, the current discussions related to CE revolved around the importance of CE rather than the enabling environment to create a change for CE. Therefore, this thesis tries to answer the following research question:

How can value chain analysis be used for the transition towards circular economy for the current municipal solid waste management in Bali?

Research Approach

The research approach is made in three parts. The first part will cover a brief overview of the current MSWM system in Bali to understand its local context. The second part will identify the value chain of the system, which will be described based on the System Analysis, Stakeholder Analysis, and simplified Material Flow Analysis (MFA). The last part will analyze the challenges and opportunities for transitioning to CE and define the range of measures needed for the transition to happen based on the challenges and opportunities. The data collection method is done through three different methods, which are desk-based research based on peer-reviewed scientific journals and grey literature, interviews, and data obtained from third-party.

Results and Analysis

From the analysis of the value chain, it is found that although the financial issue is a prominent issue for a circular MSWM system in Bali, the issue is intertwined with other dimensions, such as the political, technological, environmental, and social dimensions. Therefore, through systems thinking, it is found that to create a circular MSWM system in Bali, three ranges of measures are needed to be taken, which are: (1) holistic system; (2) equal knowledge; (3) fair financial scheme.

First, a holistic and robust waste management system is needed to create a solid foundation for the transition to happen. With the presence of holistic and robust waste management, waste management from upstream to downstream can be developed equally in all regions in Bali, in accordance with the local context of each city and region. Second, equal understanding and knowledge of the core concept of a circular waste management system are needed. When there is a gap in knowledge between stakeholders, it will be hard for the operators of the system to implement the concept that is being made by the leaders. Therefore, community development and capacity building are needed to create equal knowledge. Third, an evaluation of the waste financial scheme in Bali is needed, as currently, there are many opportunities to gain more budget for waste management. These opportunities are waste retribution fees and external funding from grants, CSRs, or EPRs. After the three ranges of measures are steadily applied in creating a circular municipal waste management system in Bali, the future step that can be taken is taking CE into more than just waste management.

Discussion

Based on the results, transitioning to CE needs a systemic change. This systemic change can be created based on the rethinking of the system to extend the lifespan of a product, and waste avoidance can be considered the future of CE in Bali. By using the 9R framework, redesigning the whole system into one that extends the lifetime of a product and avoids the creation of waste at all costs can be developed. It is also important that to make resource efficiency in CE happen, cooperation from all stakeholders and a solid foundation of waste management in the system are needed.

The result of this study enhances the knowledge of applying VCA as a method to analyze the transition of a MSWM system to CE in a developing country. This study can also be used as additional knowledge that identifies MSWM system in Bali from the political, social, economic, and environmental aspects and not only focuses on the technical aspect of it. A recommendation is also provided for policymakers on the measures needed to transition towards CE in the context of MSWM in Bali.

This study comes with a limitation where there is an issue of generalization due to the broad geographical and system scope of the study. Besides, there is a time limit where the study is conducted to fits within the timeframe for 30 ECTS. The geographical limitation is also present as the study is done in the context of Indonesia, while the researchers reside in the Netherlands. All data collection methods are made in an online setting, and therefore some nuances might not be picked up during the data collection. Online settings also make it harder to conduct an interview with the informal sector, and therefore the data collected for informal sectors are taken from third

parties. Lastly, only limited information on the quantitative economic value of the system is found, making it harder to focus the result on the financial design of the system.

Conclusion and Recommendation

Answering the main research question, transitioning to CE is not a simple task where it can be solved with one solid solution. There is interconnectedness between all the activities and the stakeholders, and therefore in order to transition towards CE, the holistic system from the upstream to the downstream need to be brought into the light. First, there needs to be a robust circular waste management system created in order for the system to work sustainably. A robust system will make sure that when the stakeholders are ready, the environment supporting the readiness will not change and, therefore, a real transition will occur. Second, the agents in the system need to have an understanding and knowledge of the core concept of a circular waste management system. Once there are common conceptions and understanding, it will create a smoother transition to CE. Last, the funding for waste management in Bali needs to be evaluated to be more in accordance with the reality of the waste management situation in Bali. The possibilities of external funding, such as from investors or private companies, can also be explored to create additional income or the development of the system.

This study fills the gap in analyzing the value chain in the context of the whole waste management system. In addition, this study also fills the gap of identifying the enabling conditions for the transition towards CE rather than just acknowledging the importance of CE in the system. Further research can be conducted in a smaller system boundary to seek the system in a more context-specific result, as the condition between one area to another might differ. Future research focusing on each challenge, opportunity, or range of measures for transitioning to CE is also recommended to create a concrete action plan for the measures to happen.

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Abbreviations

APBD	Anggaran Pendapatan dan Belanja Daerah
APBN	Anggaran Pendapatan dan Belanja Nasional
BUMDes	Badan Usaha Milik Desa
BAPPENAS	Badan Perencanaan Pembangunan Nasional
CE	Circular Economy
CSR	Corporate Social Responsibility
DKLH	Dinas Kehutanan dan Lingkungan Hidup
DPRD	Dewan Perwakilan Rakyat Daerah
EPR	Extended Producer Responsibility
JAKSTRADA	Kebijakan Strategis Daerah
JAKSTRANAS	Kebijakan Strategis Nasional
Kemendagri	Kementerian Dalam Negeri
KLHK	Kementerian Lingkungan Hidup dan Kehutanan
KSM	Kelompok Swadaya Masyarakat
MSW	Municipal Solid Waste
MSWM	Municipal Solid Waste Management
PUPR	Kementerian Pekerjaan Umum dan Perumahan Rakyat
TPS3R	Tempat Pengelolaan Sampah berbasis Reduce, Reuse, Recycle
UPTD	Unit Pelaksana Teknis Daerah

1. INTRODUCTION

1.1. Municipal Solid Waste Management Problem

Municipal solid waste has been an issue that is globally affecting people in the world. It is a specific category of waste stemming from households and can include commercial and industrial wastes, depending on the reporting standard (Wilson & Velis, 2015). Along with rapid urbanization and population growth, waste generation per capita increases. This causes waste management to be more difficult and expensive due to the increasing amount of waste and the complexity of the waste generated where one material is fused with another, making it more difficult to be processed (Kaza et al., 2018). Globally, an average of 2.7 billion tonnes of waste were generated in 2019 and is expected to grow to 2.89-4.54 billion tonnes by 2050 (Sarc et al., 2019).

Unless any active sustainability measures are enforced, the increment of the generated waste will still escalate to its global peak as far as the year 2100 (Hoornweg et al., 2015). The measures differ in different parts of the world. While high-income countries often have well-established complex waste management systems that have been developing for a long time, low- and middle-income countries usually depend heavily on landfills (Cano et al., 2022).

Indonesia is not excluded from the issue. Being identified as one of the two largest polluters of marine plastic pollution in the world (Jambeck et al., 2015), Indonesia is facing Municipal Solid Waste Management (MSWM) problems as well due to the absence of an effective waste management system (Hidayat et al., 2019). In particular, Bali Province in Indonesia is a region where the primary economic source is tourism. The increase of development in tourism is also reflected to the increment in waste generation in the Province (Widyarsana et al., 2021). However, the established waste management system usually could not follow the rate at which the waste is generated (Jambeck et al., 2015). The difficulty stems from the fragility of the waste management system, lack of financial resources, and limited participation of residents (Makarichi et al., 2018). Furthermore, a more sustainable and circular waste management system is needed.

Indonesia, in general, is currently in the process of shifting into a more sustainable waste management system. Government and organizations have started to publish reports on the current situation and how to transition to a more sustainable system. One of the ministries in Indonesia that did research on CE in Indonesia is the Ministry of National Development Planning (BAPPENAS), which they are working on publishing reports and projects such as "Social and Environmental Benefit of Circular Economy" report (BAPPENAS et al., 2021), or Food Loss and Food Waste report (BAPPENAS, 2021). The Municipality in Bali also attempted to manage waste generated by the community, as reported in the Regional Research and Development Planning Agency of Bali Province (Bali Province, 2010).

Bali still implements the old paradigm of take-make-dispose, where the materials are simply collected, transformed into products that are used, and discarded as waste (Widyarsana et al., 2021). Landfilling is the primary waste management system in Bali, where there are ten landfills that serve its nine cities/regencies. Widyarsana et al. (2021) reported that 822,555 tons of waste are generated annually in Bali, with 34.45% mismanaged and 54.06% being sent to the landfill, and only the rest goes to the waste processors. Landfilling in Bali is seen as a method to responsibly manage waste since landfilling prevents the leakage of waste into nature. However, it is to be noted that some landfills in Bali are on the verge of overfilling and are planned to be closed soon (Praptono, 2021).

If this issue persists, Bali will lose its main waste management facility, which is landfills, and further leakage of waste into nature will be hard to be tackled.

As a solution to the old take-make-dispose paradigm, Circular Economy (CE) is often introduced on the premise that it can minimize resource input and waste, emission, and energy leakage through slowing, closing, and narrowing the material and energy loops (Fatimah et al., 2020; Calderón Márquez and Rutkowski, 2020; Romero-Hernández & Romero, 2018; Geissdoerfer et al., 2017). However, a transition to CE in the system is not an instant process where it needs to be built with respect to not only the economy but also social and environmental aspects with collaboration from various involved stakeholders. Efficiency in the system is gravely needed for it to have systemic competitiveness (Kaplinsky and Morris, 2000). Value Chain Analysis (VCA) is one way to explore strategic and misalignment within the chain to increase value and economic sustainability, and by integrating social and environmental aspects, a more sustainable competitive advantage can be reached (Fearne et al., 2012)

1.2. Knowledge Gap and Problem Statement

Currently, Indonesia still generally apply the conventional take-make-dispose concept of linear economy in managing the MSW (Widyarsana et al., 2020). While several means to implement CE on MSWM in Indonesia are done, the actual enforcement of CE in MSWM is still lacking due to the absence of rules and regulations combined with lack of enforcement, insufficient funds, and the dearth of educational programmes at all levels in regards to waste management (Diaz, 2017).

Understanding MSWM in a CE at a regional level is important to foster environmental outcomes and the total resource management chain (Tsai et al., 2020). However, most of Bali's study focuses on the system's technical part. One study was done on the recycling characteristic of municipal solid waste in Bali (Widyarsana et al., 2021), with another one regarding the viability of the Integrated Sustainable Waste Management approach (Koski-Karell, 2019). A previous study reviewing the current state of solid waste management was also done, however, it focuses mainly on looking into the key features of several cases done in Bali (Macrae, 2012). Thus, a more holistic view through social, technical, economic, and environmental aspects with a pinpoint on the crucial and lucrative activity is still needed in order to be able to create feasible future steps in changing Bali's MSWM system.

Within various available theories related to CE, Value Chain Analysis (VCA) provides a systematic study between agents and activities of a firm governing the transactions between different stages of the process (FAO, 2013). Therefore, VCA will help identify the cross-linkages between the system's quantitative and qualitative analytical approaches (FAO, 2013). However, the current VCA study in waste management still focuses on the value chain of a specific agent, activity, or product rather than the whole system. Some examples are the typology of MSW recycling value chain (Cano et al., 2022), VCA of waste cooking oil for biodiesel production (Guabiroba et al., 2017), VCA of UK iron and steel flows (Dahlström & Ekins, 2006), and VCA of informal sector recycling in Cairo, Egypt (Jaligot et al., 2016). Therefore, this study is provided to fill in the gap for using VCA to analyze the whole system, specifically MSWM system in Bali.

Additionally, the current discussions related to CE revolves mostly on the importance of CE rather than the challenges to make CE flourish in the system (Iacovidou et al., 2021). Therefore, in addition to VCA, a system thinking approach is vital to complement the analysis on the dynamics between processes, values, and actors in the value chain. This approach will align the priorities and transform the current practices, speeding up the process of closing the loops (Iacovidou et al., 2021). By taking VCA and systems thinking perspective into this study, an improvement to the current system's chain can be explored to create a competitive advantage and ease the transition into CE. While the previous researches are important as a building block, this study will explore it through a holistic perspective, specifically in Bali, Indonesia, a province in a developing country where the concept of CE is not widely applied yet.

1.3. Research Objective

This study will focus on the topic of the municipal solid waste management system in Bali, specifically on its opportunity to transition from linear to CE. It aims to look into the system's value chain and investigate the room for improvements that will lead to the transition and further lessen the municipal solid waste problem.

1.4. Research Question

In order to meet the research objective, the main research question can be formulated as follows:

How can value chain analysis be used for the transition towards circular economy for the current municipal solid waste management in Bali?

The following set of sub-questions will then be explored to answer the main research question:

a) What is the current waste management situation in Bali?
b) What is the current municipal solid waste value chain in Bali?
c) What are the challenges and opportunities, and how do we transition towards a more circular municipal solid waste management in Bali?

And to answer the sub-research questions, the list of data collection methods and the outputs of the sub-questions are listed in **Table 1.1**.

Table 1.1 Data Collection Methods

Sub-Questions	Data Collection Methods	Output
SQ1. What is the current waste management situation in Bali?	1. Literature review of peer-reviewed journals and reports 2. Third-party data collection 3. Interview	Overview of the waste generation, the composition of waste, and current MSWM practice in Bali
SQ2. What is the current municipal solid waste value chain in Bali?	1. Literature review of peer-reviewed journals and reports 2. Third-party data collection	Value chain diagram of municipal solid waste

Sub-Questions	Data Collection Methods	Output
	3. Interview	management and its value in Bali
SQ3. What are the challenges and opportunities in transitioning to a more circular municipal solid waste management in Bali?	1. Literature review of peer-reviewed journals and reports 2. Third-party data collection 3. Interview	Lists of challenges and opportunities in transitioning to CE through systems thinking approach along with the range of measures for transitioning to CE

1.5. Research Structure

Chapter 1 explains the introduction of the research, where the main problem, knowledge gap and problem statement, research objective, and research questions are described. Chapter 2 clarifies the research background, where the current global situation of MSWM, CE concept, VCA, and systems thinking approach are demonstrated. Chapter 3 explain the methodology where the research design and framework, analytical methods and theoretical framework used, data collection method, the scope of the study, and the limitations are mentioned. In chapter 4, the results and analysis section will disclose the result of the research on the current MSWM system in Bali, the value chain of MSWM in Bali, and the challenges and opportunities to transition to CE in Bali. Chapter 5 explains the discussion of the study, and chapter 6 concludes the study by answering the research questions.

2. BACKGROUND

This chapter focuses on describing the literature review on the background and concept of MSWM system in Bali, Circular Economy (CE), and Value Chain Analysis. Firstly, the narration of MSWM condition in a global context will be explained and further specified in the local context of MSWM condition in Bali, Indonesia. To be able to provide an overview of MSWM system in Bali, an approach will be explained as a basis for the analysis of the system's overview. Secondly, the concept of CE will be elaborated, starting from the old paradigm of an economy to the concept of CE in relation to MSWM. At the end of the CE section, an approach to analyzing the transition to CE is explained. Lastly, Value Chain Analysis (VCA) as the main method of the research is explained to understand its background and specific context to the waste sector.

2.1. Municipal Solid Waste Management Situation in Bali

2.1.1. MSWM Globally

Globally, under a business-as-usual scenario, generated waste is expected to grow to 46 billion tonnes, with MSW being accounted for 2.89-4.54 billion tonnes of the generation by 2050 from an average of 2.7 billion tonnes in 2019 (Maalouf & Mavropoulos, 2022). Rapid urbanization and population growth are linked to the increase in waste generation per capita. As it continues to grow, the significant imbalance between the MSW generation and the actual management of MSW persists in escalating to uncontrolled waste disposal (Kaza et al., 2018; Maalouf & Mavropoulos, 2022).

Approximately only 19% of waste is being recycled or composted, and another 11% goes through incineration, while the rest of the waste is either being sent to the landfill (37%) or openly dumped (33%) (Kaza et al., 2018). Another research found that almost 42% of MSW goes to uncontrolled dumpsites, is openly burned, or leaks into the natural environment (Maalouf & Mavropoulos, 2022). Inadequately treated MSW production could cause multiple environmental impacts such as greenhouse gas emissions, ocean plastic accumulation, and nitrogen pollution (Chen et al., 2020). Solid waste disposal, specifically in landfills, contributed to the production of 3-4% of global anthropogenic greenhouse gas emissions in CH_4 (Monni et al., 2006). As plastic has become a dominant material in daily life, around 4.8 to 12.7 million tonnes of plastic waste is entering the ocean (Jambeck et al., 2015). Moreover, long-term health impacts might arise due to MSW landfill leachate to the groundwater and surface water, which causes nutrient imbalances as well as heavy metals contamination (Kjeldsen et al., 2002).

While the issue of improper waste management is happening globally, there are still differences in the situation between high- and low-income countries. The issue is growing at different regional levels, not only in quantity but also in how they manage their waste. A study by World Bank Group (Kaza et al., 2018) shows that low- and middle-income countries are predicted to increase their waste by approximately 40% or more, while it is only 19% in high-income countries by 2050. In addition, only about 48% of waste is collected in the cities of low-income countries. That number decreases even more outside of urban areas to 26%, with only 16% of the waste stream being materials that are possible to be recycled (Kaza et al., 2018). On the contrary, high- and middle-income countries have a universal waste management system. In general, high- and middle-income countries have better waste management systems, such as controlled landfills, recycling facilities, composting facilities, or incinerators, but low-income countries rely primarily on open dumping (Kaza et al., 2018).

With these differences in the situation, a low- and middle-income countries have more difficulty as the lack of a structured and functioning MSW management system is prominent, along with the disinterest of its citizen and the absence of international influence (Marshall & Farahbakhsh, 2013). Therefore, global trends of waste generation and its treatment is currently insufficient to reduce the environmental impact. A broader international action to develop a more practical approach to solid waste management is being demanded (Chen et al., 2020; Wilson & Velis, 2015).

2.1.2. MSWM in Bali

Indonesia, with a total population of more than 261 million in 2016, is considered a lower-middle-income country and is not excluded from the growing problem of its municipal solid waste (Kaza et al., 2018). Around 26 million tonnes of waste was generated in 2021, with only 63.95% of waste being treated and the rest going untreated in Indonesia (Kementerian Lingkungan Hidup dan Kehutanan, 2021). MSW, being the largest generated waste, contributed to 40.9% of the total waste in Indonesia (Kementerian Lingkungan Hidup dan Kehutanan, 2021). In Indonesia, MSW is defined by the Solid Waste Management Act 18/2008 as the residues of daily human activities or residues of natural processes in solid forms. The conventional collect-transport-dispose is the general method of MSWM being used all over Indonesia, where the municipality transports the MSW from a designated collection point to the final dumping point, usually an open dumping landfill (Damanhuri et al., 2014). The dire condition of bad MSWM being a national issue, a Presidential Decree was released in 2017 regarding the National Strategy and Policy of Municipal Solid Waste (JAKSTRANAS) which stated the target of 30% waste reduction and 70% waste handling by 2025.

Bali province is a region in Indonesia consisting of nine cities/regencies. It is one of the most famous tourist destinations in Indonesia where the number of tourists coming to visit the area, around 4.9 million people, exceeds its total population, 4.2 million people, in 2018 (Widyarsana et al., 2020). Yearly, they generated up to 822,555 tonnes of waste, mainly comprised of organic waste for approximately 65% of the total, 15.67% of plastic waste, and others. Nearly 283,369 tonnes/year of waste goes unmanaged in Bali, with the rest being processed in the landfill or sold outside of Bali (Widyarsana et al., 2020). Similar to the general system that applies in Indonesia, Bali itself still relies on the conventional collect-transport-disposal methods. With the rapidly increasing rate of waste generation, the generated waste quickly exceeds the capacity of available landfills, shortening their useful lifespan (Made et al., 2021). In 2021, it was announced that the biggest landfill in Bali, Suwung Landfill, would be closed soon as it reached its maximum capacity and is on the verge of overflowing (Praptono, 2021).

Not only with the problem of its landfill, Bali, as an area that is surrounded by the sea, also poses a significant impact on its aquatic environment. Famous for its recreational and tourism activities, the waste generated in Bali profoundly influences the abundance of stranded marine debris (Suteja et al., 2021). Efforts were made to reduce marine debris, including the establishment of the National Action Plan on Marine Plastic Debris, with the target to reduce 70% of marine plastic debris by 2025. However, as it is a transboundary issue, marine debris has become a complex matter that requires an integrated approach between various stakeholders at the national, provincial, and municipal levels (Purba et al., 2019).

2.1.3. Five Aspects of Waste Management

The success of waste management does not depend solely on the technical aspects but also on other non-technical aspects such as how to create order in the system, how an institution should manage the system, how to finance the system, and how to involve the community in waste management activity. The Ministry of Public Works and Public Housing (PUPR) of Indonesia developed an approach to creating a waste management development in Indonesia called 'Five Aspects of Waste Management'. This approach is developed as a standard planning pattern for waste management, where five important aspects affect waste management in Indonesia which are: (1) Policy/Regulation; (2) Institutions; (3) Operational Technique (Technical and Operational); (4) Finance; and (5) Stakeholder Participation (Damanhuri & Padmi, 2010). The five aspects work as a gear, where one aspect has to work together with the other, as shown in **Figure 2.1**.

Figure 2.1 Five aspects of waste management act as a gear that moves the whole system together (Waste4Change, 2021)

The regulatory aspects are based on the fact that Indonesia is a state law, which depends on the currently applied regulations. Waste management in Indonesia needs the power and fundamental law, some of them being the forming of an organization, retribution collection, or public order. Institutions aspect is based on the legal bodies that manage the economic, social, cultural, and community of the serviced area. Technical and Operational aspect consists of the basic planning of waste management activities such as waste containers, waste collection, waste transportation, waste disposal, and waste processing. Finance aspect is a financial component that is calculated based on investment cost, operational and maintenance cost, management cost, development cost, and community development cost. Lastly, Stakeholder Participation aspect is an aspect where the awareness, knowledge, and willingness of the community are being considered. It is an essential aspect since no matter how good a program is, if there is no community to run the program, then it will come to a halt.

2.2. Circular Economy

2.2.1. Linear Economy Concept

Bali still relies on the conventional collect-transport-dispose method, where the waste is disposed of in landfill (Widyarsana et al., 2020). The disposal of waste at the landfill without attention to the whole life cycle of the products is considered a linear model of the economy (Kolesnik & Merkulina, 2021). Linear economy happens when excessive exploitation of natural resources is being done and returned to the environment in the form of harmful waste (Sørensen, 2018). It can also be generally summarized as take-make-dispose, where you take the needed resources, make the goods to be sold and make profits, and dispose of everything that is not needed, including products that are at the end of their lifecycle (Sariatli, 2017).

With the growing global population, an increase in the consumption of resources is inevitable. Along with the lack of holistic urban management, economic losses as a result of structure waste and negative environmental impacts are bound to happen (Ellen Macarthur Foundation, 2017). While the linear model proved to be sufficient in the past, with the business-as-usual scheme, there is a chance for the economy to be supply-constrained in the future due to the practice (Ellen MacArthur Foundation, 2013). The conventional 'take-make-dispose' paradigm is causing the loss of material value since they are prone to end up in landfills (Purwanto & Prasetio, 2021). In addition, anthropogenic factors based on the linear model can lead to irreparable damage to the environment, such as climate change, including global warming (Lobova & Tyryshkin, 2021). When MSW is not treated at all, they release toxic substances, such as heavy metals directly into the soil and also affect vegetation diversity (Ali et al., 2014). However, if it is treated by only disposing of them in the landfill, it can also produce a considerable amount of greenhouse gases which are responsible for global warming (Bogner et al., 2008). Therefore, the current 'take-make-dispose' paradigm of the linear economy needs to be changed in order to create a more holistic solution to MSW issue.

2.2.2. Circular Economy Concept

The main alternative concept is Circular Economy (CE), where the idea of materials from waste is recreated, recovered, and maintained in the system (Cano et al., 2022). Promoted by Ellen Macarthur Foundation, CE explores how it replaces the end-of-life concept by designing materials, products, systems, and business models (Ellen MacArthur Foundation, 2013). Several literature reviews on CE have been published, where various sets of definitions were found (Kirchherr et al., 2017). Quoted from Kircherr et al. (2017), "CE is an economic system that replaces the 'end-of-life' concept with reducing, alternatively reusing, recycling and recovering materials in production/distribution and consumption processes. It operates at the micro level (products, companies, consumers), meso level (eco-industrial parks) and macro level (city, region, nation and beyond), with the aim to accomplish sustainable development, thus simultaneously creating environmental quality, economic prosperity and social equity, to the benefit of current and future generations. It is enabled by novel business models and responsible consumers.". Another definition of CE is a system where the minimization of resource input and waste, emission, and energy leakage are achieved through slowing, closing, and narrowing material and energy loops (Geissdoerfer et al., 2018). These are done in order to keep products, components, and materials at their highest utility and value at all times (Bocken et al., 2017).

Ellen MacArthur Foundation (2022) further explained that CE is based on three principles that are driven by design which are (1) eliminate waste and pollution; (2) circulate products and materials at their highest value; and (3) regenerate nature. It ultimately seeks to decouple economic growth and development by distinguishing two types of the cycle: the technical and biological cycles shown in **Figure 2.2**. The technical cycle seeks to keep products in the loop through reuse, repair, and remanufacture, while the biological cycle seeks to return the nutrients from biodegradable materials to return to earth. These are done to keep materials at their highest value without letting them become waste, as well as to allow nature to regenerate and further progress within the cycle.

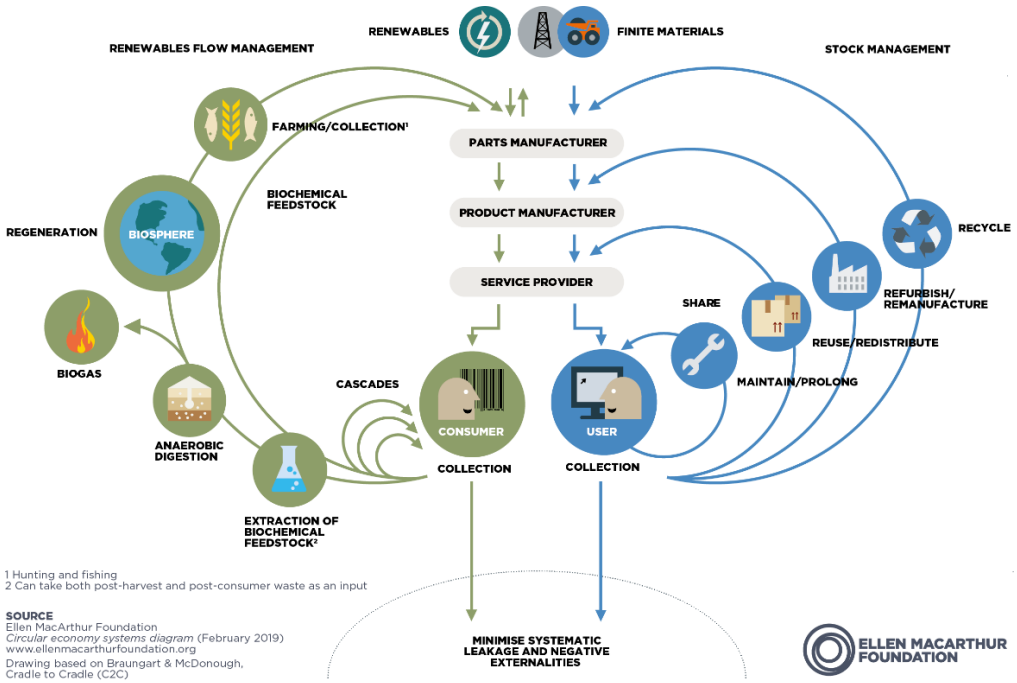

Figure 2.2 Circular economy systems diagram

2.2.3. CE in relation to MSWM

The concept of CE has been used for the improvement of MSWM. It serves as the basic model for better resources and minimization of waste by slowing, closing, or extending the loop that accounts for waste input-output to create inventories of economic flows (Tsai et al., 2020; Velvizhi et al., 2020). A well-designed MSWM plays an important role in reducing environmental footprint and resource preservation, in line with CE. Therefore, policy implementation to endorse CE in waste legislation are currently being pushed in various regions. The European Union released a Circular Economy Action Plan where waste and recycling are being highlighted as one of the policy areas (European Commission, 2020). By implementing CE in their vision for 2045, Indonesia is also trying to adopt CE into their strategies, where an analysis study can be seen in a report released by Kementerian PPN/Bappenas, namely The Economic, Social, and Environmental Benefits of a Circular Economy in Indonesia (Kementerian PPN et al., 2021).

The advantages of applying CE approach in MSWM are currently being studied in order to persuade most important stakeholders to consider CE approach as the future approach. An integrated design of MSWM system that is based on a circular perspective by P-graph (a bipartite graphical optimisation tool) was analyzed and able to avoid 411 kg CO_{2eq}/t of processed MSW and achieves a potential profit of 42 EUR/t of processed MSW (Fan et al., 2020). While not focusing on MSW, a study in Indonesia showed the potential of applying a circular approach in various waste sectors for economic, environmental, and social benefits. It has the potential to generate an additional 593 trillion IDR (42.2 billion USD) to 638 trillion IDR to the country's gross domestic product (GDP), reduce 18-52% of waste generation in each sector and avoid 126 million tonnes of CO_{2e} emissions, as well as creating 4.4 million net cumulative jobs by 2030 (Kementerian PPN et al., 2021).

2.3.1. Systems Thinking Approach

CE is a concept that is being realized at multiple levels, from the individuals to the landscape surrounding it. This nature of the concept shows that the diversity of resources, needs, and power structures across cities need to be accounted to adopt a more effective and inclusive CE (Nogueira et al., 2020). While the study on the importance of achieving CE and its benefits have been discussed extensively, its multi-faceted challenges surrounding the implementation are less debated within past studies (Iacovidou et al., 2021). The study of the barriers is needed to create the enabling conditions for transitioning to CE in the system. In this situation, systems thinking approach is necessary to recognize the interconnectivity of economic, political, social, and ecological issues across temporal and spatial dimensions (Williams et al., 2017).

Various theories, frameworks, and strategies related to system thinking approach as an attempt to promote CE have been developed in the past. However, these theories primarily focus on reducing material and energy usage in the economy without considering the social, political, economic, and ecological background (Iacovidou et al., 2021). Some examples of these theories are the performance economy (Stahel, 2010), cradle-to-cradle (McDonough & Braungart, 2002), and industrial symbiosis (Chertow, 2000).

Therefore, Iacovidou et al. (2021) tried to address this system thinking approach gap by looking into the system's multi-dimensional perspective. In understanding the challenges surrounding the system and supporting the transition to CE, Iacovidou et al. use the 'five levels of information' as a framework, where five interconnected sub-systems are being considered. This framework will facilitate the analysis of socio-technical and techno-economic changes for realizing the transition (Iacovidou et al., 2020). These five sub-systems are: (1) resource flows and provisioning service; (2) governance, regulatory framework and political landscape; (3) business activities and the marker; (4) infrastructure and innovation; and (5) user practices; as shown in **Figure 2.3**.

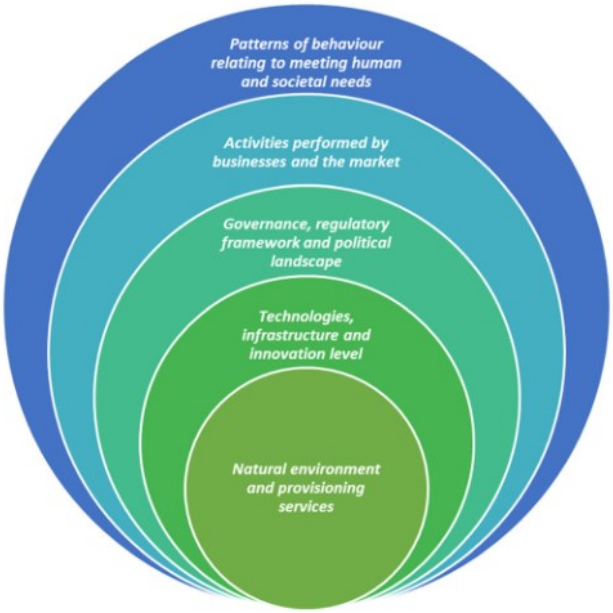

Figure 2.3 The 'five levels of information'; a conceptual approach to understanding the dynamics, drivers and barriers of systems (Iacovidou et al., 2021)

The transformative view of CE principle in waste management is closely related to waste prevention and zero waste, especially through the R-hierarchies (Reike et al., 2018). The concept of R-hierarchies is based on how we are doing 're-' or 'again', which expresses the essence of CE (Sihvonen & Ritola, 2015). 3Rs is the most popular concept in waste management with the meaning of 'Reduce, Reuse, Recycle'. It is also the basis of waste management in Indonesia based on Law No. 18 of 2008. 'Reduce' means the prevention of activities where waste might generate through it. 'Reuse' is the checking, cleaning, or repairing operations in which products can be reused. Lastly, 'Recycle' is the recovery operation where waste materials are processed into products, materials, or substances (Sihvonen & Ritola, 2015). In the past, an end-of-pipe solution is a preferable option where it focuses on the waste management system that processes the waste before its discharge into the environment, such as recycling (Dutt & King, 2014). However, in CE, the hierarchies are reversed as end-of-pipe solutions are thought of as not preventing waste but only limiting pollution (Idowu et al., 2022). Therefore in the recent hierarchy, Reduce is the preferable option to be sought first before the other two concepts, as shown in **Figure 2.4**.

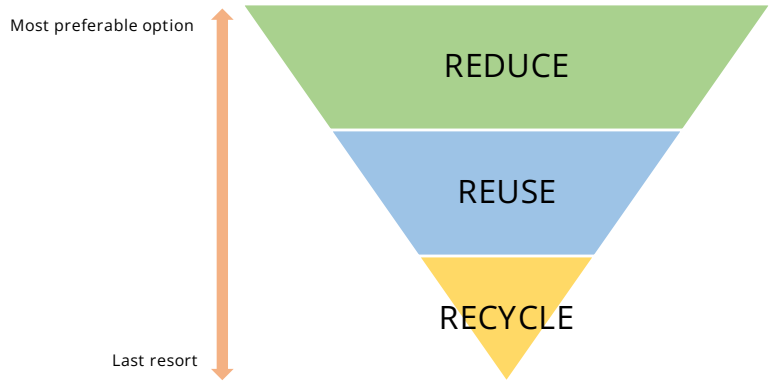

Figure 2.4 3R Hierarchies

Bali could also gains from implementing CE in the Province's current practice. Their current take-make-dispose paradigm is starting to show its negative impact through the gradually failing of the current MSWM system and marine debris generation. Despite the promising benefits of implementing circular approaches in waste, developing countries such as Indonesia still have a hard time actually enforcing the concept due to the absence of rules and regulations combined with lack of enforcement, insufficient funds, and the dearth of educational programmes at all levels in regards to waste management (Diaz, 2017). MSWM itself is a complex issue that entangles various sets of stakeholders and processes that are interconnected in the system. Additionally, the best approach to applying CE differs depending on the country's current condition and therefore, simply copying another country's success story will not be guaranteed immediate success.

The stakeholders in Indonesia still need to analyze further the feasibility of the approach in their own context by taking into account the current waste amount and composition and practices (Fan et al., 2020), and only after then proceed with it. In that regard, the potential for applying CE specifically to waste management in Bali is still unknown. Utilizing VCA is one way to identify the different activities and actors and evaluate their performances in the chain (Jaligot et al., 2016). By identifying these actors, the most important activities and interactions within the chain can be modified (Humphrey & Navas-Alemán, 2010) and therefore easing the transition to CE.

2.3. Value Chain Analysis

2.3.1. VCA in general

VCA is defined as the full range of activities which are required to bring a product or service from conception, through the different phases of production (involving a combination of physical transformation and the input of various producer services), delivery to final consumers, and final disposal after use (Kaplinsky et al., 2000). First introduced by Michael E. Porter (Porter, 1985), VCA will identify the sequence of productive activities that create value, in which the product or service is worth more for each activity in the chain, using the model shown in **Figure 2.5**. It is also mentioned that VCA can expose strategic and operational misalignments within chains, consequential misallocation of resources, as well as opportunities for improvements that will create value and economic sustainability (Fearne et al., 2012).

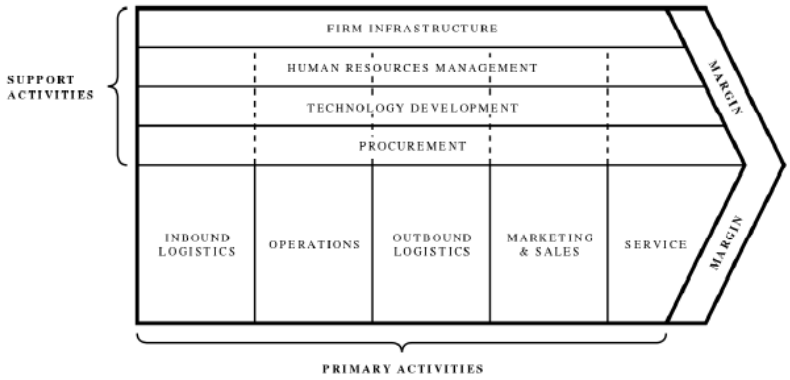

Figure 2.5 Value Chain Model by Porter (1985)

However, the current global applications of VCA are mostly made by emphasizing the roles of businesses and firms in improving the economic performances of the existing value chain (Herman & Thai, 2020). While it is the core of global VCA, a strategy with consideration to not only economic but also social and environmental drivers that is sustainable and inclusive is needed to be established (Ricketts et al., 2014). Incorporating social and environmental costs and benefits are currently being brought to attention for VCA in order to create a more sustainable competitive advantage, and the broader perspective will establish compatibility between internal economic sustainability and external socio-environmental consequence (Fearne et al., 2012; Porter, 1985). Therefore, it is important to seek further than just the chain's internal stakeholders, where the new perspective can lead to sustainable competitive advantage.

2.3.2. VCA in the waste sector

VCA is an interdisciplinary approach since the analysis is gathered from various disciplines, starting from industrial economics to the agent's strategic behaviour (FAO, 2013). It is suitable for analyzing MSWM due to the nature of MSWM, where it is a multi-dimensional system that needs to be approached from various aspects such as the social, technological, political, economic, and environment. The material and economic value chain also serve as one of the basic elements in CE, where the transformation toward a closed-loop system requires different measurements of value-adding processes (Chizaryfard et al., 2021). Several frameworks have been developed in order to apply VCA to the waste sector, such as the framework for informal sector recycling, the framework for recycling, and the framework for integrating the informal recycling sector and resource management system (Jaligot et al., 2016; Scheinberg & Simpson, 2015; Velis et al., 2012).

Scheinberg and Simpson (2015) developed a Recycling Framework Analysis, including the Recycling Framework Diagram, which entails a new form of institutional analysis and visualization of inclusive recycling performance in low- and mid-income countries. The recycling framework diagram is a schematic representation of the specific, local realities of relationships between the service chain and the value chain, as shown in **Figure 2.6**. Both diagrams were then modified to fit a case in Botswana, where the informal recyclers become the sole point of connection between the two chains. These diagrams can be used to analyze institutional relationships, understand the position of the informal sector, and predict in some way the performance of recycling.

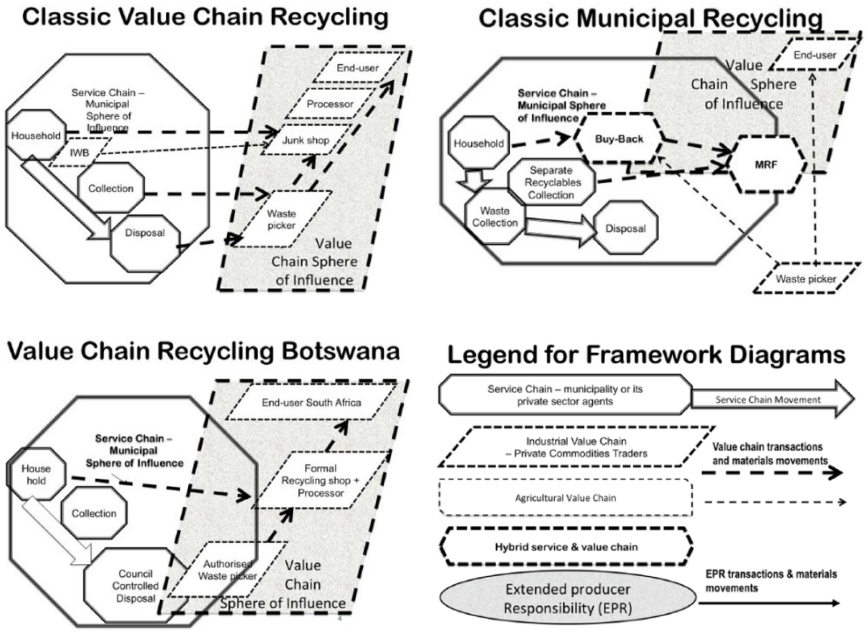

Figure 2.6 Classic value chain recycling and municipal recycling (top) and a modified diagram for the case in Botswana (bottom) *(Scheinberg & Simpson, 2015)*

Velis (2012) developed an analytical framework and tool 'InteRa' for the informal recycling sector in waste and resource management systems in developing countries. **Figure 2.7** illustrates the identified four primary interfaces of the framework, which are (1) between the informal recycling sector and solid waste management; (2) the materials and value chain; (3) society; and (4) organization and empowerment. This framework can be used to design a possible intervention of SWM that consider the interdependencies between the four interfaces.

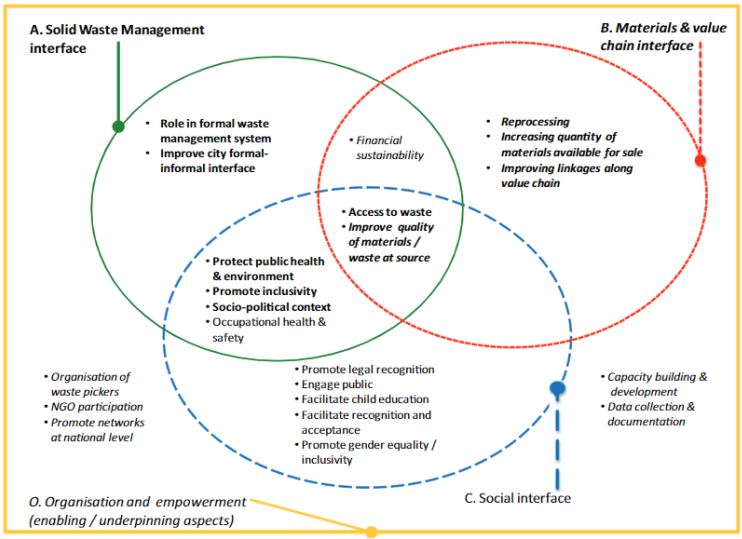

Figure 2.7 InterRa analytical framework and typology of interventions, showing the interdependencies (Velis et al., 2012)

Jaligot et al. (2016) developed a methodology to apply VCA to the informal recycling sector, using a toolkit that comprises of four stages, which are (1) mapping of the value chain; (2) tabulating the value added at each step in the value chain; (3) identifying and applying a set of indicators for the development of the value chain; and (4) developing a system dynamic map, as shown in **Figure 2.8**. In order to identify the value chain of MSWM system in Bali, the first and second steps of the framework will be used. These two steps will result in the value chain map, along with the quantitative value of each step in the chain.

Stage	Name	Purpose
1	Map of value chain	Map the *steps* in the value chain for a particular recycled material
2	Value added at each step in the chain	Document distribution of income and benefits along the value chain
3	Indicator set for value chain development	Identify the barriers and constraints to informal sector recycling, and analyse potential changes to address those
4	System Dynamic Map, showing connections between indicators	Map the connections, in order to identify the critical indicators – i.e. those with the greatest impact on the system. These critical indicators represent the key points of intervention to develop the value chain.

Figure 2.8 Four-stage VCA toolkit (Jaligot et al., 2016)

By using the first two steps of the toolkit, a value chain mapping can be generated, where the examples can be seen in **Figure 2.9** and **Figure 2.10**.

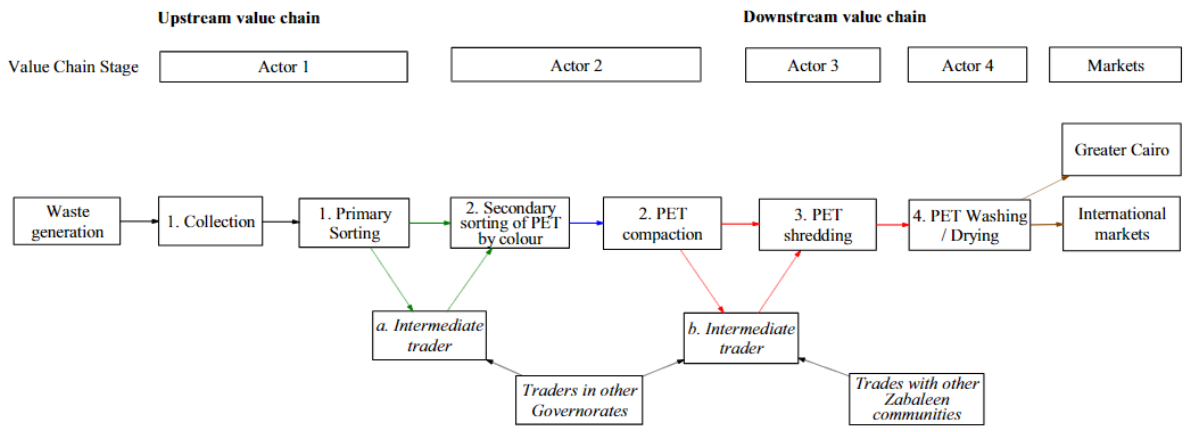

Figure 2.9 Example of the PET value chain (Jaligot et al., 2016)

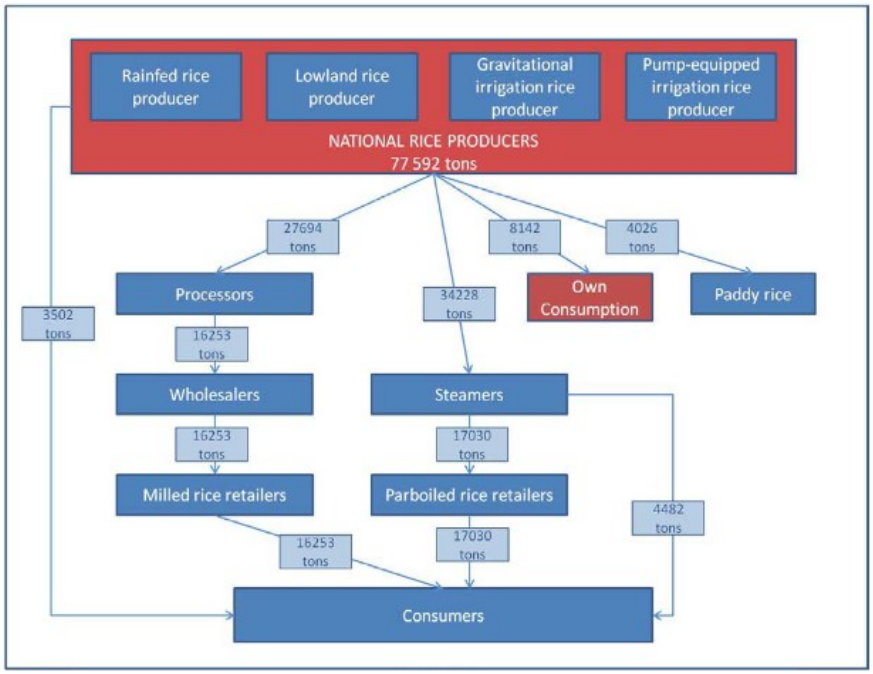

Figure 2.10 Example of the rice value chain (FAO, 2013)

2.4. Conclusion

This section focuses on the conclusion of the literature found on the topic of MSWM in Bali, VCA, and CE. MSWM issue is a complex issue requiring cooperation between stakeholders in the private and public sectors, organizational capacity, and adequate technologies, infrastructures, and facilities holistically from upstream to downstream. Therefore, to be able to understand how to transition to CE, a holistic point-of-view is needed based on a multi-dimensional approach. Before starting the analysis on transitioning to CE for MSWM in Bali, an understanding of the current MSWM in Bali, Indonesia, is needed. Therefore, an analysis through 'Five Aspects of Waste Management' that is developed by PUPR is used. This approach seeks the analysis of waste management based on its technical and non-technical aspects (Damanhuri & Padmi, 2010), thus providing a basic overview of the current MSWM system in Bali, Indonesia.

After understanding the overview of the current MSWM system in Bali, a deeper analysis of the issue in the system along with its agents and activities is made. One of the available methods relevant to CE theories is VCA, which can be used to analyze different measurements of value-adding processes in the transformation toward CE (Chizaryfard et al., 2021). It is an interdisciplinary approach, as it gathers information from sets of interrelated elements, whether it is from markets to the environment and natural resources (FAO, 2013). VCA has to look at value chains from different but correlated perspectives, therefore allowing the identification of issues in Bali's MSWM system.

While VCA will analyze the agents and activities in the value chain and its added value, a complementary study of the enabling environment to implement a transition to CE is necessary.

The Systems Thinking approach tries to understand the way recovery systems operate in a multi-dimensional perspective of value in social, economic, and political contexts and understand the context in which circularity can flourish (Iacovidou et al., 2021). Accordingly, the Systems Thinking approach will be able to recognize the interconnectivity across different dimensions and provide the context of how CE can be implemented in Bali's MSWM system.

One of the approaches available to identify VCA in the waste sector is the VCA toolkit by Jaligot et al. (2016). This framework is chosen in the study as it considers not only the standard practice in VCA, which mainly focuses on the economic part of the chain, but also the technical and social part of it. The VCA toolkit by Jaligot et al. (2016) applied VCA to the informal recycling sector comprising four stages. However, only the first two stages, i.e., the map of the value chain and value added at each step in the chain, will be used since the VCA purpose in this study is to identify the value chain of the MSWM system in Bali, rather than the actual final output of the toolkit to identify interventions and the activity with the most significant impact in the system. This VCA toolkit is also chosen since it creates a complementary of previously existing approaches, e.g., InterRa by Velis (2012) and Recycling Framework Diagram by Scheinberg and Simpson (2015), where it provides sequential methodology in analyzing the complex informal recycling sector. The output of the VCA toolkit will be the Bali MSWM system's value chain mapping, where the activities' added value can be seen through the analysis.

Since this study focuses on the whole system rather than just the recycling part of it, a Systems Thinking approach is then adapted into this study's methodology to cover the analysis of the enabling environment for CE transition. The Systems Thinking approach by Iacovidou et al. (2021) is chosen because it considers the CE's challenges through the system's social, political, economic, and ecological aspects, while other Systems Thinking approaches still lack the cohesiveness in addressing the CE challenges. The 'five levels of information' developed by Iacovidou et al. (2021) will produce an output that is the interpretation of the challenges and opportunities of the Bali MSWM system and serve as the basis for analyzing the needed enabling environment for transitioning to CE.

3. METHODOLOGY

3.1. Research Flow

This research explores the possibility of transitioning to CE for MSWM in Bali, Indonesia. A study focusing on understanding the nature of the phenomena in its real-life case is preferred to gain insight into the current value chain of the MSWM system in Bali. Bali consists of nine cities/regencies, and therefore the research will see a general overview of the cities/regencies. The qualitative method will be done as it is widely used for evaluation and organizational learning tools, as well as to gain a holistic view of the research problem in its nature (Baškarada, 2014).

The methodology of the study will be done following the research flow diagram, as shown in **Figure 3.1**. First of all, a background literature review will be done in order to understand the knowledge gap as well as the urgency of the research that is being planned. The literature review will also enrich the core concepts of the theoretical frameworks that are being used in the research. In this part, data regarding current literature on waste issues in Bali and VCA are being explored.

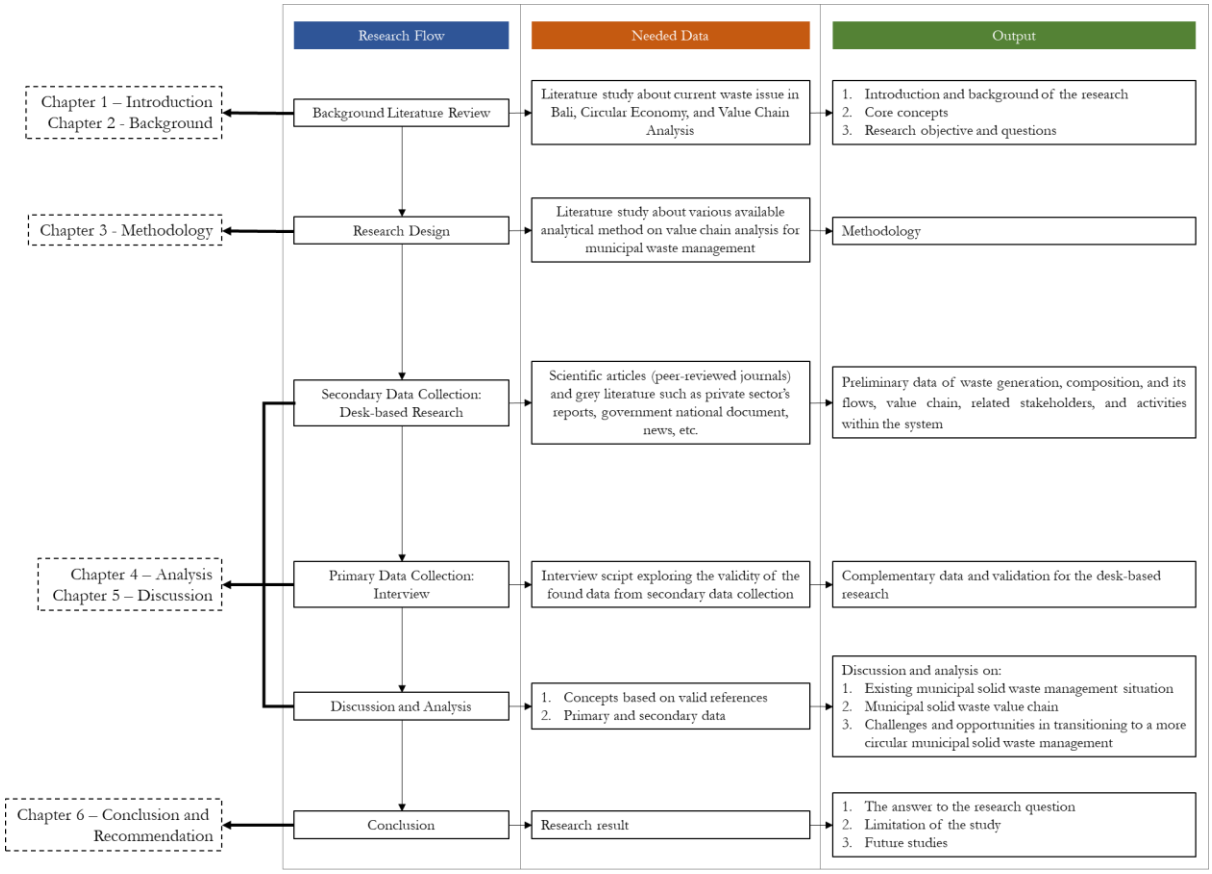

Figure 3.1 Research Flow Diagram

Second, the research design is made through the thesis proposal, which includes the introduction and background of the issues, the core concepts used, research questions, and methods on how to answer the research questions by analyzing the result of the background literature review.

Third, secondary data collection through desk-based research will be conducted for preliminary data collection. It will be conducted through peer-reviewed journals, as well as grey literature such

as reports from governmental or private sectors. The grey literature will be included to broaden the information window and see from different perspectives. The keywords that will first be used are "circular economy", "value chain analysis", "Bali", or "municipal solid waste management", with future changes that might be done along with the research. It will also include quantitative data collected from third-party who are the stakeholders involved in the system. Those stakeholders are Waste4Change, Merah Putih Hijau Bali, Bali Partnership, and Waste Bank 1. The secondary data collection will gain insights into the answers to all the sub-questions, which are: (1) the current waste management situation in Bali; (2) the current municipal solid waste value chain in Bali; and (3) the challenges and opportunities in transitioning to a more circular municipal solid waste management in Bali.

Fourth, interviews are used as the primary data collection where it aims on achieving views from various sectors of stakeholders. The procedure and script of the interview will be based on the three sub-research questions, which are to look into the current MSWM situation, understand the MSWM system's value chain, and transition to CE.

Fifth, discussion and analysis will be done in order to answer the research questions.

Lastly, conclusions will be made to show the summary of the answers, limitations of the study, and future studies based on the overall research result. The research flow processes are iterative, where adjustments can be made based on the research findings.

3.2. Research Design

To understand the context of MSWM system in Bali, an approach called 'Five Aspects of Waste Management' (Damanhuri & Padmi, 2010) is used. This approach will provide a brief overview of the MSWM system to understand the background and as a basis to further seek improvement in the system. After understanding the basic overview of the system, the analysis of the value chain of the system is made based on the toolkit provided by Jaligot et al. (2016). This toolkit was chosen as it seeks into the value chain of informal sector recycling, where it is an integral part of a waste management system. In addition, the toolkit already complements previously existing approaches in waste management scape, therefore making it more relevant. As the toolkit covers only one part of the system, which is the recycling sector, an analysis of the system through Systems Thinking is used. The methodology used in Systems Thinking is 'Five Levels of Information' provided by Iacovidou et al. (2021), where it will seek the enabling condition for the current MSWM system to transition towards CE. The research design is visualized in **Figure 3.2**.

Figure 3.2 Research Design

3.3. Analytical Methods and Theoretical Framework

The study will use the combination of the VCA toolkit as developed by Jaligot et al. (2016) and the systems thinking approach as developed by Iacovidou et al. (2021) as the primary analytical method and framework. The first two stages of the VCA toolkit will be used to identify the quantitative flows in the Bali MSWM system's value chain. It will be achieved by adapting the toolkit to various available analytical methods, which are Systems Analysis and Stakeholder Analysis. For the next step, five levels of information from the systems thinking approach will be used to recognize the challenges and opportunities surrounding the system.

3.2.1. Five Aspects of Waste Management

The identification of five aspects of waste management will give a brief overview of the current MSWM in Bali. This will illustrate the whole system and provide a background on how the basic system works. This first step will be done by explaining the system through five different aspects,

which are: (1) regulations; (2) institutions; (3) technical and operational; (4) finance; and (5) public participation. Regulations aspect will seek into the current applied regulations in Bali, and Institution aspect will look into the formal legal bodies that manage the system. Technical and Operational aspect will look into the basic technologies, facilities, or infrastructure for the operation of waste management activities. Finance aspect will identify the financial component of the system, and Public Participation aspect will look into the societal aspect of the system, where awareness, knowledge, and willingness are discussed.

3.2.2. Value Chain Mapping and Value Addition

Value chain mapping will visualize the different steps/actors and show the links and interactions between all the actors. In this stage, the actors involved in Bali's MSWM will be identified, as well as the key activities with values in the chain. It will explore the question of what are the main activities in the value chain, who are the actors involved in the activities, and how are the interactions within the value chain.

In the next step, values are added for each activity in the value chain to understand the roles and benefits of each activity. This will be done by exploring the stocks and flow variables within the value chain, such as the number of stocks in each activity. This stage will also provide the initial overview of which activities have the most or least value for further analysis of whether they can be improved or not. Stage one and stage two of the framework are done by analyzing the system (Systems Analysis) and the stakeholders/actors (Stakeholder Analysis).

a. Systems Analysis

Significant developments are needed for the management of waste. Furthermore, with its material complexity, taking system perspectives is crucial to improving waste management (Andersson et al., 2019). Systems analysis itself is the examination of the elements and linkages in a system, where it can be applied to the linkage between various elements of human development and environmental change for policy formulation towards more environmentally sustainable development pathways compared to the past (Shaw & Öberg, 1994).

When assessing waste management systems, it is recommended to have a mass-balanced approach based on the input-output of the entire system so that the complexity of the system is apparent, and the cross-checking plausibility of available information will be allowed (Allesch & Brunner, 2014). One of the system analysis methods is Material Flow Analysis (MFA), which quantifies mass and substance flows among processes (Zurbrügg et al., 2014). It is done by analyzing the activities such as transportation, transformation, or storage of materials in a defined system using its main principle of mass balance (Allesch & Brunner, 2015).

MFA can be applied to analyze flows of resources in a city or region and changes in consumption patterns, solid waste or wastewater treatment infrastructure, waste and wastewater reuse practices, and environmental pollution (Zurbrügg et al., 2014). It also has its advantages where it can be used to determine the potential to reduce, reuse, and recycle waste, as well as prevent threats that might happen to the system (Widyarsana et al., 2020). The system analysis method that will be used in this study is MFA, however it will be conducted in a simplified way through referencing based on desk-based research

b. Stakeholder Analysis

Due to its heterogeneous nature, MSWM is a complex process where it involves and affects various types of stakeholders (dos Muchangos et al., 2017). It is fundamental to identify what types of agents perform the activities in order to understand the structure of the value chain (FAO, 2013). In this case, the system which was previously analyzed through MFA. This step brings about the aggregation of agents into homogenous and relevant categories, based on their similar characteristics, where the categories are manageable and clear with a balance of accuracy and simplicity (FAO, 2013). The result of the systems analysis and stakeholder analysis will then be integrated and visualized into a value chain map to gain insight into the first and second stages.

c. Five Levels of Information Approach

CE is a complex concept where there is interconnectedness between systems that needs a holistic assessment. A system thinking approach using five levels of information describes the key information on the dynamics and drivers of current practices towards CE (Iacovidou et al., 2021). These five levels of information are ecosystem/provisioning services, technologies/infrastructure, institutions, business practices/market, and user practices, as shown in **Figure 2.3**.

Iacovidou et al. (20210) explained these five levels of information, where ecosystem/provisioning services will identify the natural ecosystem impacted by resources consumption, production and management, and the role of provisioning services in supporting circularity. Technologies/infrastructure concerns the technological and infrastructure element in the resource recovery system. Institutions analyze the political aspect underlying the socio- and techno-economic aspects of the system. Business practices/markets concern the organizational relations on resource flow through the system, where economic incentives, market stability, and information flow drive the activities of the businesses and impact the wider system. Lastly, user practices refer to the behavioural pattern in meeting human needs and values. These five levels of information will result in an identification of the challenges and opportunities of transitioning to CE.

3.4. Data Collection Method

Several data collection methods are used to answer the research question of the study, which are literature reviews, third-party data collection, and interviews. The collected data from each sub-research question will create and output that was previously mentioned in **Table 1.1**. The outputs will then contribute to answering the main research question, which is "How can value chain analysis be used for the transition towards circular economy for the current municipal solid waste management in Bali?".

Literature Reviews

In doing a study, it is important to build the research and relate it to the existing knowledge through literature reviews. A literature review will create a foundation for advancing knowledge and provide an overview of areas where research is disparate and interdisciplinary (Snyder, 2019). This study will analyze into MSWM system in Bali and CE, which is an interdisciplinary topic. Therefore, the

literature review will be approached through semi-systemic reviews, as it will provide an overview of a broad topic (Snyder, 2019). Through semi-systemic reviews, a general overview will be outlined rather than listing all relevant articles on the topic, and it can be helpful to provide a historical overview of a topic and the state of knowledge (Snyder, 2019).

Literature reviews in this study are conducted to bring together the information on the current MSWM condition in Bali, including its material flows, value chain, stakeholders, and activities within the system. It is also done to gather knowledge on CE and its context in the waste sector, and Value Chain Analysis as a method to analyze the value chain in MSWM system. The study is done on peer-reviewed journals and grey literature such as national governmental documents, private sector reports, and other publicly available information such as online databases or news. Web of Science, Scopus, and Google Scholar are used to find peer-reviewed journals on the relevant topics. The search words used are "Municipal Solid Waste Management", "Circular Economy", and "Value Chain Analysis" with the specific region of Indonesia and Bali. Only peer-reviewed journals in English are analyzed. The abstract of the journals is first reviewed to see the relevancy of the found journal with the topic. When a relevant journal is found, the references of the found journal will also be examined to dig further on the topic regarding MSWM system and CE in Bali in specific or Indonesia in general. Grey literature is also consulted as there is limited research found in the local context of Bali.

Third-party data collection

Third-party data collection is done to complement the result of the literature reviews and interviews, especially on the detailed data concerning numbers or figures, or a summary of research that is previously made by the experts. It is done through the extraction of data from documents or reports that are personally retrieved from various waste management stakeholders in Bali, Indonesia. The data collection was done in accordance with the ethics assessment in TU Delft, to make sure that the data are stored securely to prevent the risks happening to participants of the research. The detail of the ethics assessment on third-party data collection is explained in **Appendix A**.

Interviews

A study on literature might not capture the most recent situation on the MSWM system in Bali, and therefore interviews with several stakeholders were conducted. The interview will be done in a semi-structured interview, used most often for qualitative research purposes in the social sciences for its versatility and flexibility. A semi-structured interview, while generally following a guide that is priorly devised for the interview, still allows for discovery as it enables the interviewer to improvise follow-up questions based on the participant's responses (Kallio et al., 2016; Magaldi & Berler, 2018). The main topic of the semi-structured interview will include quantitative data on waste flow and its value, the position of the stakeholders in the chain, the barriers and constraints in applying CE to MSWM, and the key points of intervention to develop the value chain.

All interviews were held in an online setting due to geographical constraints between the researcher and the interviewees. Twelve semi-structured interviews and one message exchange were held with various stakeholders involved with MSWM system in Bali. The interviewees are chosen based on the researcher's initial analysis based on the literature review of the stakeholders involved with the MSWM system in Bali. These stakeholder groups can be seen as stakeholders that are influencing the system, stakeholders that are in the system, and stakeholders that are overseeing the system. They are the Government (stakeholders influencing the system), Waste Bank, TPS3R, Private Waste Management Company, and Informal Sector (stakeholders in the system), and Researchers/Experts (stakeholders overseeing the system). The detailed interview protocols and guide can be found in **Appendix B**.

3.5. Scope of Study

The geographical scope of the study will be limited to Bali Province in Indonesia. The Province consists of nine regencies/cities, namely Badung Regency, Bangli Regency, Buleleng Regency, Gianyar Regency, Jembrana Regency, Karangasem Regency, Klungkung Regency, Tabanan Regency, and Denpasar City as shown in **Figure 3.3**.

Figure 3.3 Bali Province Map (wikipedia.com)

The subject of the study will be municipal solid waste, which are the residues of daily human activities or residues of natural processes in solid forms, including organic and inorganic waste.

3.6. Limitation

Limitations of the study happen in data collection due to the geographical scope of the study. Most of the data collection is done virtually, rather than doing on-field data collection. Therefore, it is harder to capture on-field situations, especially regarding informal sectors, as there is very little information regarding informal sectors online or organizations that focus on studying informal sectors in waste management. Another limitation is the generalization of the result due to the scope of the study, where the whole system of MSWM is analyzed, and the whole Bali Province is set as the location.

4. RESULTS AND ANALYSIS

In this part, the results are taken based on primary and secondary data sources. The primary data sources are taken from interviews from six different sectors of stakeholders on MSWM in Bali, which are the government, private waste collector, Waste Bank, TPS3R, researcher/education, and informal waste sector. The secondary data sources are based on desk-based research on publicly available scientific journals, news articles, websites, and reports, as well as data collected from a private report of a third party.

4.1. The current MSWM system in Bali, Indonesia

This section will analyze into the current situation of MSWM system in Bali, Indonesia. First, the waste composition is identified to understand what are the majority of MSW that is generated in Bali. Second, the brief overview of the current MSWM system in Bali will be described based on the Five Waste Management Aspect provided by Damanhuri & Padmi (2010).

4.1.1. Municipal Solid Waste Composition in Bali

In Indonesia, the definition of Municipal Solid Waste (MSW) is explicitly written in Article 1 of Law No. 18 of 2018 on Waste Management, where it is a solid residual of daily human activities or natural processes. Article 2 paragraph (2) further explained that MSW includes household waste that is not including faeces and specific waste. It also includes waste that is similar to household waste, such as waste from the commercial area, special areas, social facilities, public facilities, or other facilities. Specific waste, as mentioned in the article, is hazardous waste, waste that comes from a disaster, construction waste, waste with no sufficient technology to manage, and waste that is not periodically being generated, which this waste is not considered MSW. To simplify it, MSW in Indonesia is usually divided into three types of waste which are organic waste, inorganic waste, and residual waste. Organic waste is the waste that can be decomposed naturally. Inorganic waste is waste that cannot be decomposed naturally and has to be processed to create value. Residual waste is waste that cannot be processed at all, usually due to the lack of technology to process the waste.

In the year 2020, around 4.2 million residents and 4.9 million tourists will generate up to 822.555 tonnes of waste or equivalent to 0.54 kg/person/day (Widyarsana et al., 2020). The biggest waste generator is Denpasar City, the capital of the Province and the centre of government activities in Bali. It is also the city with the highest population, and to accommodate that, they provide the most settlements and companies, as well as tourism activities (Widyarsana et al., 2020). The details of waste generation in each cities/regencies can be seen in **Figure 4.1**. The majority of MSW in Bali Province is household waste, being accounted for as much as 61,72% of the total waste (Widyarsana et al., 2020). In detail, the waste is composed of food waste, wood and leaves, paper, plastic, metal, cloth and textile, rubber, glass, hazardous waste, and others, as shown in **Figure 4.2**.

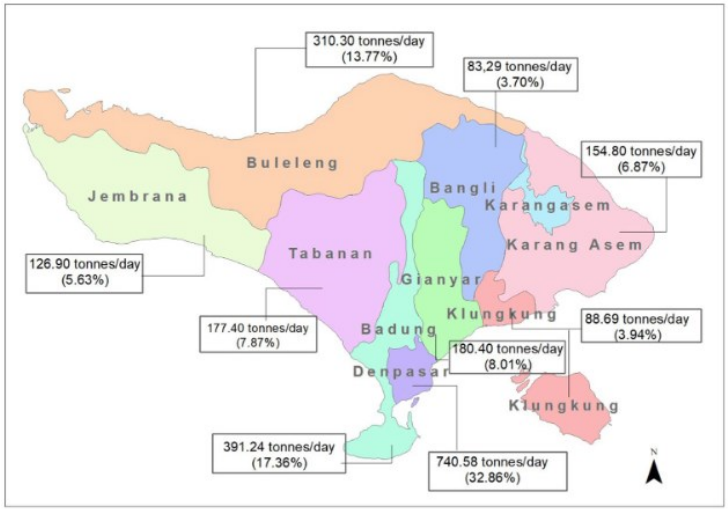

Figure 4.1 Waste generation per cities/regencies in Bali Province (Widyarsana et al., 2020)

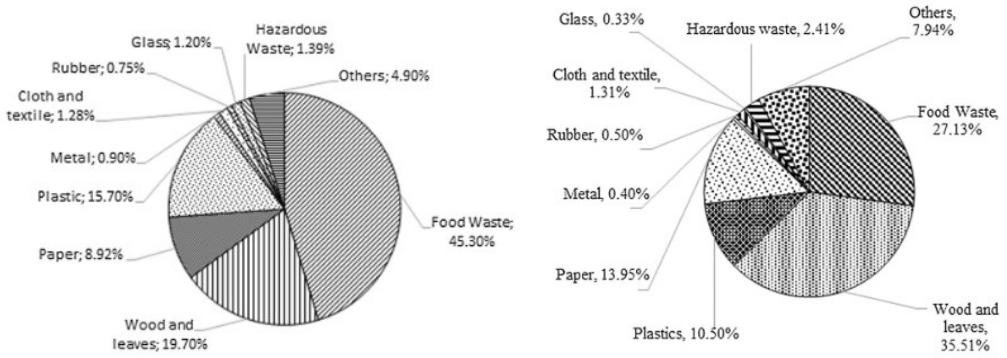

Figure 4.2 Waste composition at source (left) and at landfills (right) (Widyarsana et al., 2020)

4.1.2. How MSW are managed in Bali

Out of the total generated waste, only 48% of waste in Bali is considered "properly managed", while the other 52% is still mismanaged (Bali Partnership, 2019). Nevertheless, in that 48% of properly managed waste only 4% are being recycled, and the other 44% are disposed of in the landfill. While a landfill is supposed to be the final waste processing site, in reality, open dumping practices are still widely used and therefore, "managing" waste to a landfill would only mean moving the waste from one place to another. Within mismanaged waste, there are three main ways of disposal that are done by the society which are burnt (19%), disposed to the environment (22%), and disposed to the water bodies (11%), as shown in **Figure 4.3**.

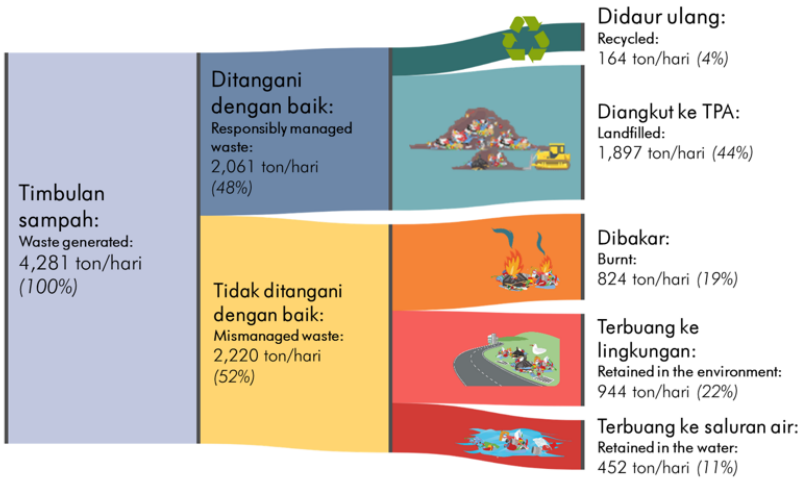

Figure 4.3 Waste management in Bali Province (Bali Partnership, 2019)

MSWM is a complex process where it involves many aspects, whether it is technology, social, financial, or regulations. In Indonesia, MSWM can be analyzed through five aspects which are policy/regulation, operational technique, institutions, finance, and stakeholder participation (Damanhuri & Padmi, 2010). This section will analyze the current MSWM practice in Bali through the five different aspects.

a. Policy/regulations

Regulations aspect will seek into the current applied regulations in Bali. In Indonesia, several laws focusing on waste and waste management have been developed in order to solve the increasing waste issue in the country. It first started with Law 18 of 2008 on Waste Management, which now serves as the basis for national waste management policies and practices, including MSWM in Indonesia. In this policy, the government started to recognize that landfill is not the solution to Indonesia's waste problem, and therefore relying too much on them will enhance the waste pollution issue in the future. Following the law, further policies to encourage proper waste management started to develop and emerge, with the summary as seen in **Figure 4.4**.

In an effort to support the law, Kementerian PUPR released Regulation of Ministry of Public Works No. 3 of 2013 on Implementation of Solid Waste Infrastructure and Facilities. This regulation mandated that the manager of an area must provide temporary waste storage (TPS), a waste processing area with the 3R principle (TPS3R), and an integrated waste management site (TPST). In addition, cities/regencies' governmental bodies also must provide TPS or TPS3R in the residential area.

Another important regulation is Presidential Decree No.97 of 2017 on National Policy & Strategy on Management of Household Waste and Household-like Waste (JAKSTRANAS). JAKSTRANAS is a road map toward the National waste management targets, which are 30% waste reduction and 70% waste handling by 2025 for 2025 Clean-from-Waste Indonesia. The waste reduction here is defined as the reduction of waste at source, reduction of waste generation per capita, as well as reduction of waste leakage to the environment. Waste handling, on the other

hand, is defined as the reduction of waste that is transported to the landfill and the increment of the amount of waste that is treated through means of waste processing, e.g., composting, recycling, and thermal recovery. Through Jakstranas, regional and local governments are mandated to create regional policies that aim to fulfil the target, called JAKSTRADA.

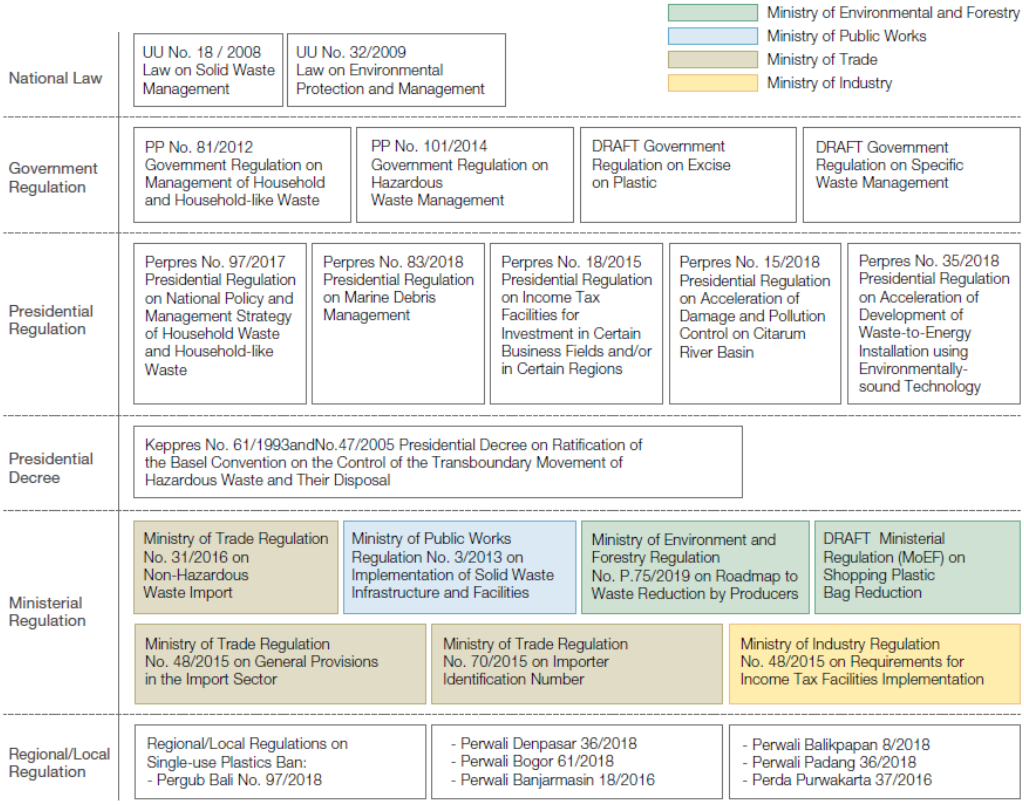

Figure 4.4 Summary of national waste management regulations in Indonesia as of August 2019 (MoEF, 2020)

Through the National laws and regulations, the regional and local governmental bodies are forced to act upon it, including Bali Province. In Bali, the administrative divisions are divided into one city and eight regencies, which are Denpasar City, Badung Regency, Bangli Regency, Buleleng Regency, Gianyar Regency, Jembrana Regency, Karangasem Regency, Klungkung Regency, and Tabanan Regency. Under the city/regency, there is also the Desa (Administrative Village), which is a smaller administrative area in the sub-system of the cities/regencies government with authority to regulate governmental affairs in the area.

However, there is also the presence of a Desa Adat/Desa Pakraman (Cultural village) in Bali, which is an autonomous region for Hindus residence of Bali that regulates its residents based on the tradition of customs and manners (Widyarsana & Salmaa, 2019). It is also a unity of the area where the population, together on joint responsibility (village manners), performs worship, with a view to maintaining the sanctity of the village land, as well as maintaining the temple in a village (Atmaja, 2020). In Pakraman Village, there is a different governance system as well as a special instrument of customary laws that function to regulate the rights and obligations of the community and the norms of the traditional law institution, called Awig-awig. It is based on the religious, cultural views of life, and local customs of the community (Karangasem Regency, 2016). Awig-awig is created by the society through democratic values with appreciation towards the society and people's opinion and thus more respected and holds higher value in the local community's perspective (Arjawa &

Jayantiari, 2017). Therefore, it is important in Bali to also try to approach waste management issues through the cultural village, as they are more respected by the local community

Two of the main regulations regarding waste management in Bali are Regulation of Governor of Bali No. 47 of 2019 on Source-based Waste Management, and Regulation of Governor of Bali No. 381 of 2021 on Source-based Waste Management in Administrative Village and Cultural village. Before these regulations were finalized, some regulations that are derivative of the national laws were also made in each of the cities/regencies, such as Regulation of Denpasar City No. 50 of 2018 on JAKSTRADA in Household Waste and Waste Similar to Household Waste Management, Regulation of Badung Regency No. 21 of 2011 on Waste Service Fee. While the law and regulations efforts are being made, there are still problems with public engagement and law enforcement of the regulations in Bali.

Regulation of Governor of Bali No. 47 of 2019 on Source-based Waste Management is the most current regulation that is trying to be enforced to create a more sustainable MSWM system. It is derived from the Regional Regulation of Bali Province no. 5 of 2011 on Waste Management, which stated that source-based waste management is needed in order to improve public health and environmental quality. It is explicitly stated that the objective of the regulation is to ensure a clean culture, improve environmental quality, improve public health, create economic value for waste, and increase the participation of producers, Desa Adat, and Administrative Villages/Wards in waste management. It also covers the definition of waste type and waste source, the requirement and explanation of household waste management, specific waste management, waste management by the producers, residual waste management, the obligations, prohibitions, public participation, guidance and supervision, and financing.

On the other hand, the Governor of Bali's Decree No. 381 of 2021 on Source-based Waste Management in Administrative Village and Cultural village is a more specific regulation to realize Regulation of Governor of Bali No. 47 of 2019 on Source-based Waste Management. It is a guideline for source-based waste management in Administrative Village and Cultural village, where it covers the background, strategies, governance, and organic farming program development.

b. Technical and Operational

Technical and Operational aspect will look into the basic technologies, facilities, or infrastructure for the operation of waste management activities. The current MSWM system in Bali in majority still implements the conventional linear economy concept or collect-transport-dispose system where it makes very minimal attempt to process the generated waste and confides on the landfill as the final dumping site (Widyarsana et al., 2022). In this system, the waste is just being collected and transported from the source to the Transfer Depo (TPS) and then only transported again without any additional processing to be disposed of in the landfills, shown in **Figure 4.5**. This system is also limited to the urban areas, whereas in some rural areas, open burning and dumping to dispose of their waste are still being used (Widyarsana et al., 2021). However, in some Administrative Village or Cultural Village, there is the presence of Waste Bank and TPS3R. These infrastructures serve as the processing site for the waste in order to reduce the waste that is being disposed of directly to the landfill.

Figure 4.5 Conventional MSWM system

Waste at source

At the source, the MSW in Bali is commonly mixed, without any segregation of different kinds of waste. However, in some cases, in the villages where the TPS3R or Waste Bank are present, waste sorting into three types is enforced. These three types of waste are organic, inorganic, and residual waste. The detailed list of what can be defined as organic, inorganic, and residual waste differs from place to place depending on the available technology to process the waste or the available market in the area. However, generally organic waste is biodegradable waste which can be processed through biological means such as composting, whereas inorganic waste is non-biodegradable waste such as paper, plastic, metal, glass, and residual waste is the rest of the waste that can not be processed at all (Damanhuri & Padmi, 2010). This waste is collected door-to-door for each resident by the formal waste collector from the local Environmental and Sanitary Agency in each cities/regencies and then transported to the TPS. This collection system also poses a problem where the government does not provide a segregated transportation mode or scheduled collection, and therefore all the waste from sources that were previously segregated individually will end up mixed again in the process.

TPS

TPS in Bali is dominated by 6 m^3 containers that are spread all over the villages (Widyarsana et al., 2020). It is a temporary communal shelter for waste located in the residential area, where the waste that is collected from the source is contained before being taken to the landfill. While this facility is supposed to be temporary, Bali is currently having a waste management issue where the landfill is overfilled, and therefore the formal waste collectors are not able to dispose of them at the landfill. This resulted in the waste being stuck in the TPS, overflowing, and even damaging the surrounding environment due to the pollution (balipost, 2022; Supartika, 2022). Therefore, in an attempt to reduce the amount of waste that goes to the landfill, the development of TPS3R, Waste Bank, and TPST are enforced by the local government. This also aligns with the effort to fulfil the target stated in Jakstranas, where the amount of waste is expected to be reduced and more to be managed by 2025.

TPS3R

TPS3R is a waste reduction facility where the pre-processing of collected MSW happens (Widyarsana et al., 2020). The technical requirements of the TPS3R are stated in Regulation of Ministry of Public Works No. 3 of 2013. It is a semi-formal facility which is provided by the local government. In the long-term, the management of the facility is given to the Community Voluntary Contribution Group (KSM), where the local residents are the ones who are responsible for the operation of the facility in the hope of being self-sufficient. In this facility, there is a process of segregation of waste, from mixed waste into recyclables, organics, and residuals. Afterwards, the recyclables are collected to be sold, the organics are composted, and the residual waste is collected to be disposed of at the landfill.

In total, there are 115 TPS3R in Bali as of 2021 (MoEF, 2021). However, there is a problem with the sustainability of the facility. The facility is expected to be a self-sufficient facility, where it can seek monetary gains to provide the operation through waste reselling and the collection of waste fees from the residents. Therefore, once the facility is built by the local government and provided with the proper equipment, they will not have any involvement with the facility other than advisory roles for several months. In reality, while this works for some of the TPS3R, many become inactive due to the lack of means to make the facility sustain.

For example, there are 33 TPS3R provided by the local government in the Badung regency. However, five of them have become inactive, and another five are being converted into another facility in 2022 (Waste4Change, 2022). This happened due to several reasons, such as (1) no proper equipment provided yet to the facility or the equipment is not suitable for the facility; (2) the money earned is not sufficient to cover the operational costs of the facility; (3) no segregation from source resulted in the increased difficulty on extracting valuable waste to be sold, and thus most of them are categorized as residual waste instead; (4) the difficulty of looking for the customer of the end-product of the organic waste which is compost; (5) the current waste fee from each household are not enough to cover the cost of managing waste from each of it. Nevertheless, if the fee is increased, there will be resistance from the residents to pay for the appropriate amount; and (6) land availability issues where the waste facility is seen as something dirty and not appealing, therefore, it is hard to gain approval from the residents to operate the facility.

Waste Bank

Based on the Regulation of Minister of Environment No. 13 of 2020 on Guidelines for Implementing Reduce, Reuse, Recycle through Waste Bank, a Waste Bank is defined as a facility that sorts and collects waste that has economic value and can be recycled or reused. It is a community-based facility that can be integrated with the TPS3R. Additionally, it is developed and managed by the local community to collect recyclable waste that is valuable to be sold to the recyclers.

There are 14 Central Waste Bank and 299 Unit Waste Bank facilities recorded in Bali Province (MoEF, 2021). The service of a Waste Bank in Bali can be arranged in two ways, where (1) the customer can visit the Waste Bank that they are registered to and deposit their waste, or (2) the bank officer can visit each house to collect the waste (Widyarsana et al., 2020). The collected waste will then be weighed and valued for a sum of money for the customer, which will be saved in their personal account. After the collection, the officer will sell the waste to other stakeholders, whether they are aggregators of waste called pengepul (Intermediate Informal Collector) or recyclers.

While the facility could gain revenue in the process, the waste that is being sold is still in its original state with no further processing, and therefore the monetary value of the waste is at its lowest point. However, sometimes, the waste can also be repurposed into a product with a function, such as a bag, wallet, or other usable products, and hold larger value to be sold. It is then a matter of looking for the right market to sell the product that becomes an issue. There is also a problem with the waste quality as the waste has to be clean and separated to be able to create monetary value. This often creates a shortcoming in public engagement, where the society thinks it is more convenient to just throw their waste into the garbage bin rather than cleaning and separating the waste to gain a little bit of money.

Landfill

In the nine cities/regencies, ten landfills are being used in Bali Province, which are:

1. Temesi landfill in Gianyar regency;
2. Bangli regional landfill in Bangli regency;
3. Linggasana landfill in Karangasem regency;
4. Suwung regional landfill in Denpasar city;
5. Bengkala landfill in Buleleng regency;
6. Mandung landfill in Tabanan regency;
7. Peh landfill in Jembrana regency;
8. Sente landfill in mainland Klungkung regency;
9. Jungut Batu landfill in Nusa Lembongan Island of Klungkung regency; and
10. Biaung landfill in Nusa Penida Island of Klungkung regency

In Indonesia, Law No. 18 of 2008 stated that the end-of-pipe solution should be changed into a new paradigm where the waste is valuable materials with economic value. Therefore, open dumping landfill is not suggested to be relied upon, and it is supposed to be closed after one year of operation. However, in reality, the landfills in Bali are still operating with open dumping practice, where the waste is just being stacked on top of each other without pre-processing. This poses an environmental problem, where the leak of leachate might happen to the surrounding area, as well as the abundance amount of greenhouse gases that are being emitted from the landfill (Bogner et al., 2008).

On three out of the ten landfills in Bali, a waste composting facility is being provided in order to reduce the amount of waste being dumped. These three landfills are Temesi landfill, Mandung landfill, and Sente landfill (Widyarsana et al., 2020). At Temesi landfill, the organic waste is manually separated from the mixed MSW. Then, the organic waste is composted using forced aeration composting by blowers. The compost would then be sieved and cured, and the matured compost will be sold (Pandyaswargo & Premakumara, 2014). The challenge is then to appropriately market the product to potential buyers in order to attain cost recovery.

Many of these landfills are on the verge of being closed due to the issue of overcapacity. The progress of urban development and tourism without adequate waste management resulted in the increasing waste generation with no means to properly process it into something valuable. Five out of the ten landfills are almost full, and two are considered to be in a state of overcapacity (Widyarsana et al., 2022), where Suwung regional landfill is already planned to be closed in 2022 (radarbali.id, 2022). Due to the limited capacity of the land, lack of the proper processing infrastructure, transportation mode, and equipment in the landfill, the temporary solution that is being done is illegal waste disposal on vacant land (Irianto & Arygunartha, 2020). This illegal waste disposal happened not only on the land but also on water bodies such as a river. In some cases, the waste is disposed to a cliff in which, after a while, the waste will be pushed down into the river and ends up in the sea.

Other than the issue of overcapacity, landfills in Bali often encounter social issues where there is resistance from the local residents due to the disturbance that it causes, such as in Sente landfill and Peh landfill (Bali Berkarya, 2018; Fajar Bali, 2018). These disturbances are caused by the mismanagement of the landfill's operation. Without the proper management of the landfills, the

distinct waste smells tend to spread across the area and pollution to the groundwater sources might happen. In addition, Suwung landfill often got caught on fire, especially in 2019 when it happened two times (Dinata, 2019). Based on the interview, these fires are not a natural occurrence but often due to the attempt to reduce the amount of waste in the landfill. While these fires are supposed to be minor, they could accidentally spread across the surface and result in a big-scale fire. These incidents are deemed hazardous to the local resident's health and safety, and a protest where the society demands the local government to close the landfill is done as a resistance. However, closing the landfill will not be possible due to the demand for a site to dispose the generated waste.

c. Institutions

Institution aspect analyze into the formal legal bodies that manage the system. In Bali, two central institutions are responsible for MSWM: the Environment and Forestry Agency (DKLH) and the Village (Desa). DKLH is responsible for the rules and regulations of each city/regency's MSWM. They have the role as the lawmakers of waste management and waste facility permits, carrying out the education and coordination related to waste, provision of facilities and infrastructures, and the supervision of the operation of landfills and other waste management stakeholders. In some TPS3R in Denpasar city, the Waste Management Technical Implementation Unit (UPTD Pengelolaan Sampah) under the Agency is also responsible for taking the role of operating the facilities and infrastructures.

Desa is a smaller administrative area, where there could be different institutions such as Village-owned Enterprise (BUMDes) or Community Voluntary Contribution Group (KSM). While KSM is an institution owned by the residents, BUMDes is owned by the authority of the village. These institutions mainly have the role of human resources in operating the facilities and infrastructures. They are responsible for operating the facilities and infrastructure as the management bodies, waste collectors, machine operators, waste segregator, and composter.

d. Finance

Finance aspect will identify the financial component of the system. In general, there are two main sources of funding for MSWM in each cities/regencies of Bali: Local Government Budget (APBD) and waste retribution. APBD is an annual governmental budget that the local governments draft through agreements within the Regional House of Representatives (DPRD). The allocated budget for APBD differs from one cities/regencies to another.

Waste retribution is a fee for providing services related to waste management that is paid by the residents or commercial area to the local government. The amount of waste retribution also differs, usually depending on the type of house or area. It is regulated in the Regulation of City/Regency, as shown in **Table 4.1**. While the amount of it is regulated in the regulation, it is not the most updated regulation yet in terms of time. In reality, the retribution cannot cover the expenses of the operation of MSWM in Bali.

For example, the amount of waste retribution in Badung Regency, as stated in the regulation, is between IDR 4.000 to 12.000 per household per month (EUR 0,26 to 0,77 per household per month). As for the commercial area, it only amounted from IDR 50.000 to IDR 600.000 per month

(EUR 3,19 to 38,28 per month). The actual amount of waste retribution in Badung Regency is decided through an on-field survey to estimate the volume of the generated waste and how often the collection frequencies are needed. For some Cultural village, the amount of waste retribution is written on their Awig-awig and decided based on the consensus of the local residents. As of 2021, the amount of waste retribution in Badung Regency for the residential area is IDR 10.000,- to 60.000,- (EUR 0,64 to 3,83) per household per month, and IDR 20.000,- to 10.000.000,- (EUR 1,28 to 637,89) per month for commercial area.

In its implementation, this increased amount is only enough to barely cover the operational fees within the minimum wage for the operator, and the amount can be more optimized by enforcing a fair waste retribution billing. In some cases, some households are not being charged with waste retribution, although they are in the scope of MSWM services.

Table 4.1 Waste Retribution Regulation on each Cities/regencies

City/Regency	Regulation
Badung Regency	Regional Regulation of Badung Regency No. 21 of 2011
Bangli Regency	Regional Regulation of Bangli Regency No. 10 of 2011
Buleleng Regency	Regional Regulation of Buleleng Regency No. 17 of 2011
Gianyar Regency	Regional Regulation of Gianyar Regency No. 7 of 2011
Jembrana Regency	Regional Regulation of Jembrana Regency No. 13 of 2011
Karangasem Regency	Regional Regulation of Karangasem Regency No. 11 of 2011
Klungkung Regency	Regional Regulation of Klungkung Regency No. 15 of 2012
Tabanan Regency	Regional Regulation of Gianyar Regency No. 20 of 2011
Denpasar City	Regional Regulation of Denpasar City No. 24 of 2011

Besides the two main sources of funding, with the presence of TPS3R and Waste Bank, some additional funding can be gained through the reselling of waste. Not only that, but the potential collaboration with private sectors can also add additional funding, although it might not be in terms of monetary. One example is Indonesia Power's Corporate Social Responsibility (CSR) effort, where they are giving a waste chopper and plastic pellet machine to TPS3R 1, Denpasar City. While this is not a direct monetary gain, this will help the TPS3R process their recyclable waste into a form that will hold more value in money compared to its original state and therefore be sold at a much higher price.

e. Public participation

Public Participation aspect will look into the societal aspect of the system, where awareness, knowledge, and willingness are discussed. The regional cultural philosophy of Bali is the Three Causes of Prosperity (Tri Hita Karana) which are harmony among people, nature or environment, and god/gods. This philosophy supports the conservation of natural resources and incorporates it into resource management. Traditionally, the Balinese will only dispose of waste after reclaiming the usable resources and making sure that no adverse effects will happen to the environment (Koski-Karell, 2019). For example, they are managing their organic waste to be used as compost

or animal feed, and therefore not wasted completely. However, with the development of technology and with how more non-biodegradable waste is created, the more we see that MSW in Bali is not being treated properly (Koski-Karell, 2019).

While society is highly involved in Bali's MSWM system through their participation within the KSM, the awareness is not well spread between all the households. In Badung Regency, only 33% of the TPS3R's customers did segregation at source due to their perception of how they are already paying waste retribution (Waste4Change, 2022). This is affected by the people's mindset, where they think if they pay for a service, then they do not have to do anything in order to get the most out of the service. Furthermore, only 37% of TPS3R in Badung regency ever get socialization on waste segregation, and it is reckoned as one of the reasons why waste segregation is not working (Waste4Change, 2022). In spite of that, there is a willingness to learn from the public, where 87% of the Bali community feels ready to segregate their waste and make an effort on reduce, reuse, and recycle (Bali Partnership, 2019). This shows that this happens mostly not because people do not want to take care of their waste but more to the lack of education and awareness on the importance of managing their waste properly. One of the education measures that can be done is by creating guides for the community to be used, as shown in **Figure 4.6**.

Figure 4.6 Example of how Waste4Change try to educate on how to sort our waste at source through the guide (Waste4Change, 2018)

4.2. Value Chain of MSW in Bali

Value Chain Analysis can help to answer the question of whether a value chain creates value-added and who are the one creating the values. It will then aid in providing the existing circularity potential for each stage of the value chain. This section aims to analyze the value chain of the MSWM system in Bali. First, Systems Analysis will be done on the current MSWM system in Bali, where a systems mapping will be generated. Second, Stakeholder Analysis is done by looking into the stakeholders involved and their influence on the system and illustrated through the stakeholder mapping. Third, value chain mapping and the summary of the monetary flows in the value chain, along with its improvement potential, are explained.

4.2.1. Systems Analysis

This section will explain the current MSWM system in Bali along with its challenges. Based on the literature review, MFA of the system can be found, and therefore the quantification MFA is analyzed. Afterwards, the system of the MFA is adapted based on the result of the interviews, where it is found that there are two types of MSWM systems currently occurring in Bali. They are the conventional collect-transport-dispose system and source-based waste management system.

a. Quantification of Material Flow Analysis

MFA quantifies mass and substance flows among processes and analyzes flows of resources in a system (Zurbrügg et al., 2014). A study was done by Widyarsana et al. (2020) on MSW material flow in Bali Province, Indonesia, as shown in **Figure 4.*7***. It was conducted through interviews with Regional Government, Environmental Services, informal and formal sectors, 400 residents, and direct measurement with 200 households.

The research shows that the initial stock of the waste can be calculated by multiplying the total waste generation (0.54 kg/cap/day) by the total population (4,183,072 people). The accounted initial stock is 822,555 tonnes per year. Of the 100% stock, only 5.72% and 4.81% are being recovered to the Waste Bank and TPS3R, respectively. The rest of the waste is either processed directly to the landfill (24.4%), collected at TPS (37.06%), or mismanaged (34.45%).

The low waste recovery rate from the source (10.53%) happened due to the low awareness of the sources on the environmental issues surrounding MSW (Waste Bank 1, personal communication, 19 June 2022). However, the public cannot be blamed solely for this issue. From the start, community development is not well given by the Government, whether it regards the new regulations, operating the facilities, or what the public actually needs to participate on in the system (Private Waste Management Company 1, personal communication, 15 July 2022; Widi, personal communication, 25 July 2022). Frequently, the new regulations are promoted through digital means, and therefore only a limited number of people can receive the new pieces of information. Therefore the importance of inclusive community development and information sharing is once again highlighted in order to be able to prevent the leakage of materials in the system.

In TPS, a considerable amount of waste (304,856 tonnes/year) is collected in the form of mixed waste. Here, the role of the informal sector, especially waste scavengers, is prominent since they are trying to recover valuable materials from mixed waste. First-level informal sectors are able to recover 8.18% (52,069 tonnes) of waste per year as they are treating waste as an income resource.

These recovered waste further diverts the materials from the flow, preventing more waste from being disposed of at the landfill. While waste scavengers do the majority of the material recovery from TPS, waste crews who collect MSW from the source to the TPS also conduct material recovery, albeit in a smaller amount (2,126 tonnes/year).

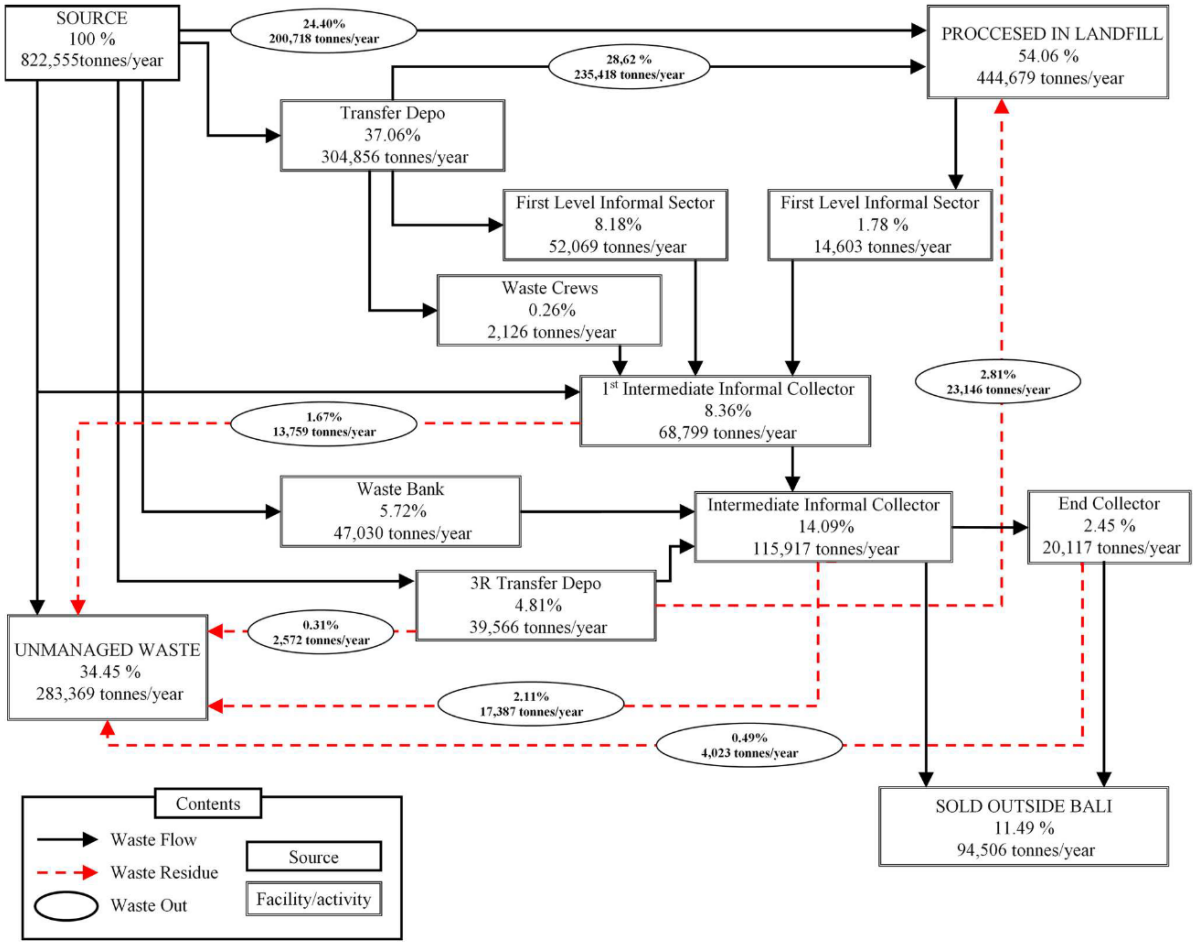

Figure 4.7 MFA of MSWM in Bali (Widyarsana et al., 2020)

More than half of the generated MSW are processed in Landfill (54.06%). This shows that Bali Province still relies heavily on the landfill for their waste processing; therefore, the issue of overcapacity and landfill closing causes a big commotion within the system. Landfill as the method of disposal is preferable due to its low cost compared to other disposal methods (TPS3R 2, personal communication, 17 June 2022). Thus, solutions or technologies that could enhance waste processing in the landfill are crucially needed (Expert 1, personal communication, 21 June 2022). At the landfill, material recovery is also done by the informal sector (1.78%), where they are able to sell the collected materials to Intermediate Informal Collectors.

Mismanaged waste here can either be waste illegally dumped on open land, waste disposed to the water bodies, or waste burning. In addition, the residual waste from informal sectors' waste recovery process also adds to the amount of mismanaged waste. Per year, 34.45% (283,369 tonnes)

of waste is being mismanaged in Bali Province, which could happen due to several reasons. One of them is the enforcement of source-based waste management regulations where people are forced to self-manage their waste without adequate infrastructure or facilities (Expert 1, personal communication, 21 June 2022). While law enforcement is good, Bali still relies heavily on landfill. Since the landfill is planned to be closed, the stakeholders involved are looking for an alternative to dispose of the waste without bringing it to the landfill: illegal dumping. Another reason is the low service rate and inadequate service facility, where many people are not yet being serviced by formal waste management services (Expert 1, personal communication, 21 June 2022). Therefore, the solution must be thought of holistically from upstream to downstream, and not force just one side to do everything. The scale of readiness, whether from the source to self-manage their waste or from the MSWM infrastructures and facilities available, needs to be ensured before the enforcement is done (Expert 1, personal communication, 21 June 2022).

Within the system, transactional activities are done through waste selling and buying. The recovered materials are often sold to informal sectors such as Intermediate Informal Sector, ranging from small, medium, or large scale. Intermediate Informal Sector recovered 13.09% (115,917 tonnes/year), which part of it is sold to End Collector in Bali (2.45%), and outside of Bali (11.49%). The details of transactional activities will be explained further in Value Chain Analysis section.

b. Conventional collect-transport-dispose system

The conventional collect-transport-dispose system is the most common type of system that is applied in Bali. In this system, the waste is just generated at the source, collected at the TPS, and then transported from the TPS to be disposed of at the landfill, as shown in **Figure 4.8**.

Figure 4.8 Conventional collect-transport-dispose system MSWM flow

In this system, the waste generated from the source are not sorted by the generators, whether it is from residential areas or commercial areas. Several reasons are causing the absence of waste separation to happen, such as lack of awareness from the source, no adequate infrastructure for the waste to be separated at home (Government 1, personal communication, 4 July 2022), or heterogeneity of the population and the nature of commuting society, especially in bigger cities (Waste Bank 1, personal communication, 19 June 2022). Usually, the waste is collected by the source using a container for mixed waste outside of the house for residential areas, or in their designated area for the commercial areas.

For the source themselves, there are two different types depending on whether they are in a service area for waste management or not (Expert 2, personal communication, 16 July 2022). For the group included in the waste management service area, their waste is collected door-to-door by the responsible parties and transported to the TPS. The responsible parties, in this case, can either be community-based organizations such as Swakelola and KSM, or an governmental-based

organizations such as UPTD and DKLH, depending on the decision of each village. The waste is collected using a three-wheeled motorcycle or a small truck. On the other hand, the group not included in the waste management service area usually brings their waste to the closest available TPS by themselves.

Transfer depo, usually in the form of a container, is a stationary area designated for temporary waste storage. After the container is full or depending on the schedule, the waste will be transported and disposed of at the landfill by the local DLH. Transfer depo on itself possess several problems whether it is on their condition or the situation regarding the depo. One problem is the emergence of illegal TPS, which is empty land that is being misused as a waste dumping spot or an empty land next to a cliff, where the waste is pushed down to the river bodies when accumulating (Expert 1, personal communication, 21 June 2022). These illegal TPS pose not only health hazards to the surrounding neighbourhood but could also contaminate the surrounding groundwater, water bodies, and soil. Another issue is when the waste is not transported from the TPS but instead accumulates in the area. Several reasons causing this issue are the lack of waste management service in the area, the inadequate existing services, and the overload of the landfill (Expert 1, personal communication, 21 June 2022). These issues are also causing a societal problem, where the society often acts upon protesting the existence of the area. In these TPS, the existence of waste scavengers is also a prominent condition, where they usually pick up the valuable materials from the mixed waste.

A landfill is an area that is supposed to be an end processing site for all collected waste. However, in reality, most landfills only apply an open dumping system with no other waste processing; therefore, there is no waste reduction; instead, it just grows in the area. In both the TPS and the landfill, there are the presence of waste scavengers who are trying to collect valuable waste, such as PET bottles, from the pile (Expert 2, personal communication, 16 July 2022). While this is a form of waste separation that can reduce the amount of waste being disposed to the landfill, it is a dangerous practice where the waste scavengers work in high-risk conditions (Sembiring & Nitivattananon, 2010). Usually, they wear limited to no safety and protection gear, which are only pieces of clothes to cover the nose and worn-out boots, thus increasing their risks of being exposed to viruses and pathogens (Nuripuoh et al., 2022).

While the conventional system is the typical system used in Bali, the Government starts being aware of the rising issues and plans to change them. In 2019, Bali's Governor released Regulation of Governor of Bali No. 47 of 2019 on Source-based Waste Management, and followed after with Regulation of Governor of Bali No. 381 of 2021 on Source-based Waste Management in Administrative Village and Cultural village. The regulations are meant to increase society's awareness, as the source of waste, on the importance of managing their own waste through waste separation. Via the regulations, public participation is expected to increase as there is legal force behind the action and the public will understand the importance of waste management and how to do it. Along with the increment of public participation, the rate of waste separation is expected to increase, therefore, only the residual waste is supposed to be disposed to the landfill. The other waste, i.e., organic and inorganic waste, are envisioned to be processed in their intended facilities, such as TPS3R and Waste Bank.

c. Source-based waste management system

After the release of Regulation of Governor of Bali No. 47 of 2019 and Regulation of Governor of Bali No. 381 of 2021, the system applied to the MSWM in Bali started to change. The system that was once implemented the collect-transport-dispose method is now trying to be shifted into a more circular system where it focuses on the source as the main waste management agent. This source-based waste management system enforces the sources to manage their waste through 3R efforts.

While this regulation is still not enforced equally, some areas, especially the more significant and busier ones, such as but not limited to Denpasar City, have already tried to implement this regulation in their Villages. This unequal enforcement of the regulation between areas is also one of the problems in Bali's MSWM, where law enforcement is not yet proportionate in all Cities/regencies. The law enforcement still depends on the political will of the people in charge to divide between different interests and how to make waste management a priority (Government 1, personal communication, 7 July 2022).

However, a source-based waste management system is still the current system that is being developed for the whole Bali Province, and therefore looking more into details of the system is preferable as it is more susceptible to the current environment of MSWM in Bali. In the future, a source-based waste management system is planned to be implemented in all villages as Bali is in a waste crisis state (Dhae, 2021). Based on the identified system, the activities being involved can be divided into five groups, which are:

a. Waste Disposal at Source
b. Waste Collection
c. Waste Processing
d. Waste Selling and Buying
e. End Waste Disposal

This section will analyze the source-based waste management system within these five groups, visualized in **Figure 4.9**.

Waste Disposal At Source

The Regulation of Governor of Bali No. 47 of 2019 stated that the source has the responsibility to manage their waste, whether it is through material reuse, plastic reduction, waste sorting, or waste processing. Therefore, the acceleration to implement the regulation was done through the collaboration of various Ministries with the local government. One example is the Ministry of Public Works and Public Housing (PUPR), which gave three villages in Bali IDR 1,1 trillion for acceleration funding. It is used to build TPS3R infrastructure and the facilities needed to run the system, such as waste collecting vehicles, chopping machines for organic waste, or sieving machines. While the funding help in kicking off the source-based waste management system, it is still not optimum due to the lack of community development. This lack of community development, monitoring, and law enforcement is causing gaps in knowledge within the community and instead creating another problem (Merah Putih Hijau Bali, personal communication, 15 July 2022).

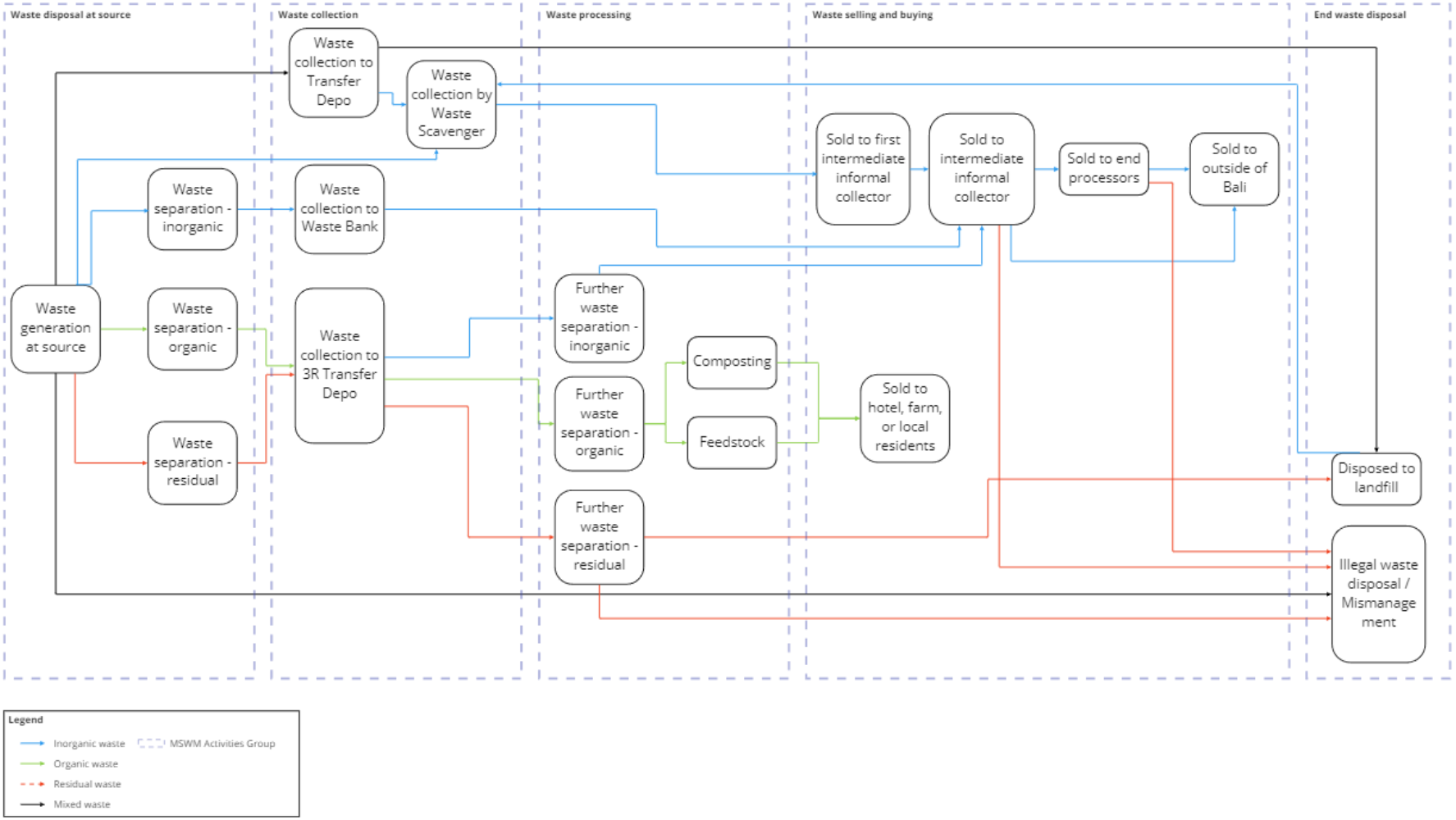

Figure 4.9 MSWM System flow of source-based waste management system

At the source, the waste is supposed to be sorted into five different types: compostable waste, reusable waste, recyclable waste, hazardous waste, and residual waste. However, in the implementation, most waste sorting is done into three types: organic waste, inorganic waste, and residual waste, which aligns with the Governor of Bali's Decree No. 381 of 2021 on Source-based Waste Management in Administrative Village and Cultural village. Waste sorting into five types is currently seen as something complex, as the public awareness on waste separation is still low. The implemented waste sorting into those three types is also not yet perfect, and many are still mixed, resulting in more residual waste than valuable waste to be processed (TPS3R 1, 14 June 2022).

Some villages also struggled to start the waste sorting system, for example in Tanjung Benoa village. However, through community development and constant education, 80% out of its 1000 residents of Tanjung Benoa Village are now sorting their waste into those three types (TPS3R 2, personal communication, 17 June 2022). It is also a common view of the various stakeholders being interviewed, where a community development is an essential first step to promote a more sustainable MSWM system. Without community development, programs that are implemented in a Village tend to come to a halt after a while due to the lack of enthusiasm and knowledge to make the program sustainable.

Waste Collection

After the waste is sorted by the source, they are obliged to put their waste in the designated location, whether it is outside of their house or a communal area depending on the rules in the Village, based on the set schedule by the responsible administrator of the waste management in the Village. For example, when it is decided that Monday is the scheduled day for organic waste collection, then the community are obliged to only put organic waste outside for collection. If the waste is not sorted and not in accordance with the collection schedule, then the waste collector will not collect the waste. On the scheduled day, the waste collectors that come from the responsible administrator of waste management in the Village will collect the waste and bring them to TPS3R.

While this works in one of the interviewed areas, Lebih Village in Gianyar Regency, it is not the case in many other areas in Bali Province. First, many of the waste is not sorted and just thrown out when the source's waste bin is full. Second, these waste collectors perceive that since the residents have already paid for their service, they must collect the waste no matter the condition (Waste Bank 1, personal communication, 19 June 2022). Therefore, many of the waste that goes to the TPS3R are still mixed waste that needs further waste separation in order to gain more economic value.

Waste Bank comes as an option, where the local residents can choose whether to throw their inorganic waste to be collected by TPS3R or bring them to the Waste Bank. These Waste Banks only accept valuable materials, depending on their waste buyer's market. Since there are incentives when people deposit their waste to the Waste Bank, oftentimes, it is the preferable option for the society (Waste Bank 2, personal communication, 20 July 2022). This shows that an incentive is still needed to kickstart public participation and awareness in waste sorting.

Besides TPS3R and Waste Bank, the conventional TPS is still being used in the areas where these facilities are not yet established. In TPS, all waste is transported and collected to the facility despite the conditions. After the collection at TPS, all waste is disposed of in the landfill. Besides the waste disposal at the landfill, there is the presence of waste scavengers at the facility. Waste scavengers usually recover the waste that is already mixed, whether it is from the TPS, from the landfill, or directly from the source. However, the informal sector's contribution to resource recovery is usually not recognized (Government 1, personal communication, 7 July 2022). People usually do not see this sector's benefits and contributions to environmental health and sustainability (Sembiring & Nitivattananon, 2010).

Waste Processing

TPS3R, in its fundamental purpose stated in the regulation, is intended to be used as the processing facility for organic and hazardous waste only. The inorganic waste is directed to be sent to Waste Bank or FPS, and residual waste is placed in a designated waste bin and transported to the landfill. Both Waste Bank and TPS3R usually exist together in one village. The facilities can be managed by the same organization or different ones, but they will always empower the local residents as the administrator of the organizations.

In the implementation, there is a misperception that TPS3R is the same as TPS, and therefore all three types of waste are usually collected to TPS3R (Waste Bank 1, personal communication, 19 June 2022). Since the waste sorting quality from the source is still low, after the collection, these waste is then sorted again to separate the organic, inorganic, and residual waste. After sorting into those three waste types, further separation is also done within the types to boost the economic value of the waste depending on the available technology, the capacity of the facility, and the available market. Based on an interview with Merah Putih Hijau Bali (Private Waste Management Company 1, personal communication, 15 July 2022), an example is that the inorganic waste is further separated into a more specific types of valuable materials, e.g., plastics to PET bottles, HDPE, or LDPE, and the organic waste can be separated into waste for Black Soldier Fly (BSF) feedstock and waste for composting. The residual waste that emerge from the sorting is collected in a container provided by DLH and disposed to the landfill, depending on the schedule or when the container is full. This waste sorting is done manually by the waste sorting workers in the organization.

Waste Selling and Buying

After being collected at TPS3R, Waste Bank, or TPS, the valuable materials and the waste products are sold. While the actual flows differ in each area, the valuable materials are generally sold to Central Waste Bank before being sold to Intermediate Informal Collector and End Collector. Central Waste Bank acts as the aggregator for Unit Waste Bank since the Intermediate Informal Collectors do not accept waste when they are in a small amount. As the Central Waste Bank acts depending on the available waste market, the prices at which they buy the waste from Unit Waste Bank also depend on the current market price.

Central Waste Bank will then sell their waste to Intermediate Informal Collector, and the Intermediate Informal Collector will sell them to End Collector, whether they are Recyclers or other bigger aggregators that are formally registered as a business. Not all recyclable materials can be processed in Bali. Factories to recycle rigid valuable plastics, e.g., PET and PP are already present in Bali; however, no facilities or technologies are present yet for low-value materials such as Multi Layered Plastic (MLP) or plastic bags. Therefore, these materials are sold outside Bali, especially to Banyuwangi or Pasuruan in East Java (Expert 2, personal communication, 16 July 2022). This act can be seen as a leak of profits, and if it could be prevented, it would create additional economic value in the materials that revolve in Bali Province.

Besides the sales of materials from the waste, some products can also be created from the waste, specifically organic waste. Most of the organic waste collected in TPS3R are made into compost, and besides compost, it can also be made into feedstock for pork, or BSF. These products are then sold to hotels, farms, or local residents. However, currently there is a problem in selling all the produced compost. Many produced compost are still piling up at TPS3R, and therefore they need to be connected to potential buyers (Private Waste Management Company 1, personal connection, 15 July 2022).

End Waste Disposal

The last activity in the system is the end disposal of the waste. The residual waste that emerge from all the process in the system are disposed to the landfill by DLH. It can be collected in the form of mixed waste directly from TPS or after waste sorting in TPS3R. Disposal to the landfill currently faces many issues, which were mentioned in all of the interviews as the main issues surrounding MSWM in Bali right now. Specifically, the issue of the closing of the regional landfill, Suwung Landfill, which receives all the waste from Denpasar City, Badung, Gianyar, and Tabanan Regencies.

4.2.2. Stakeholder Analysis

In understanding a system's value chain, it is vital to grasp the types of stakeholders who perform the activities (FAO, 2013). In this section, the stakeholders that revolve around the MSWM system's activities will be defined and aggregated into several different types: the Policymakers, Educators/Donors, Source of Waste, Waste Collectors, Waste Market, and End Processors, as visualized in **Figure 4.10**. Their roles, activities, and obstacles surrounding their roles in the system will be analyzed in this section.

Policymakers and Educators/Donors are the stakeholders who are not directly involved in the waste management process. However, their decisions affect the system considerably, such as through the creation of regulations by the Government or CSR from private companies, which will give resources to the system for managing the waste. The rest of the groups are stakeholders whose activities are directly in the waste management process.

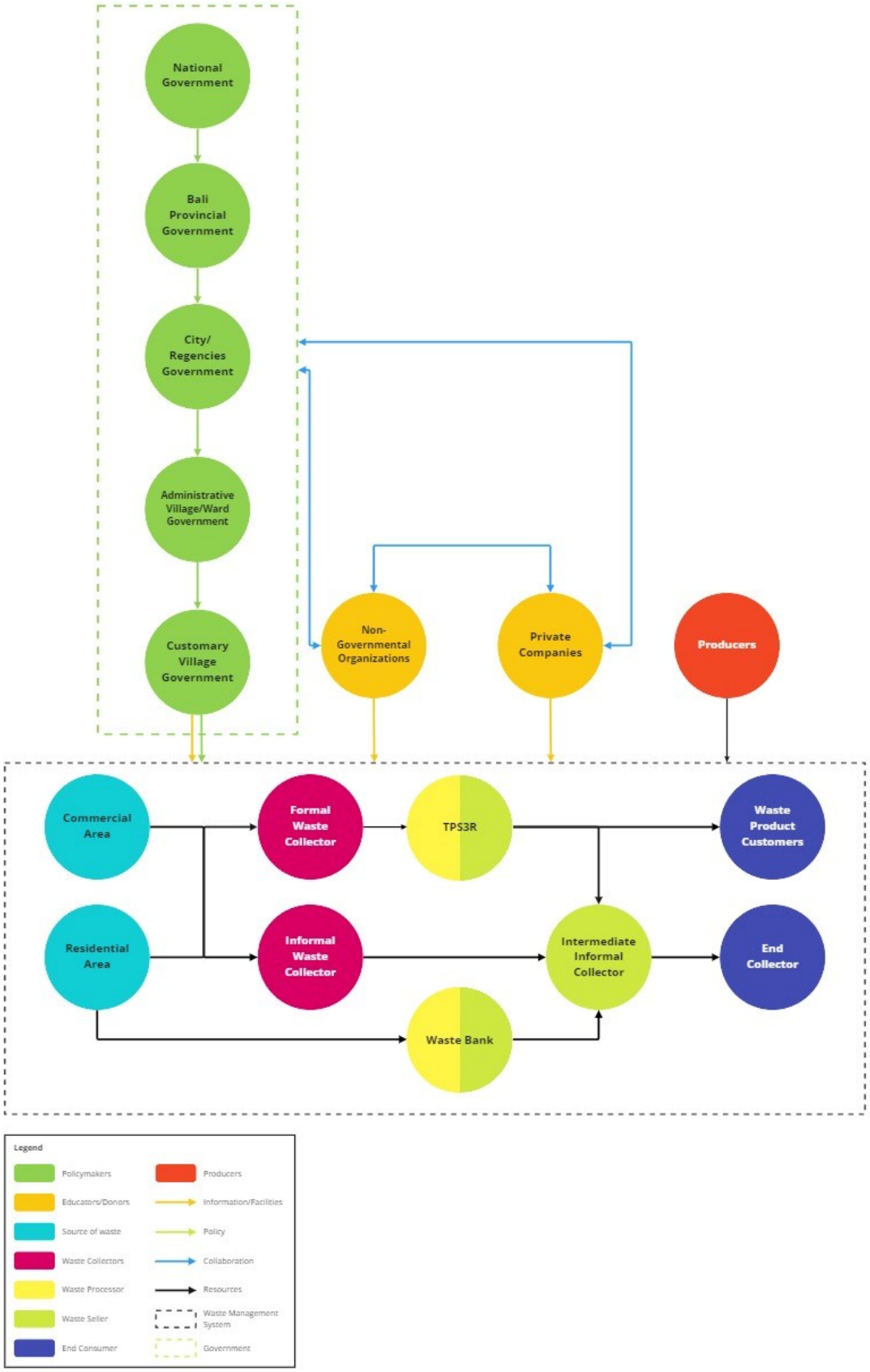

Figure 4.10 Stakeholder mapping

a. Policymakers

In Bali MSWM system, the policymakers are one of the main stakeholders mentioned by most of the interviewees. It includes all levels of policymakers, starting from the National Government, Regional Government, and Village Government. One unique trait of Bali Province is the existence of the Cultural village, which is an autonomous region for Hindus residents of Bali that regulates its residents based on the tradition of customs and manners (Widyarsana & Salmaa, 2019).

The main activity of the policymakers is as the responsible body that oversees the whole system through the regulations they create. These regulations will also affect the decisions taken in the system, as rewards and punishment exist for those who do not comply with the laws. The higher the policymakers' level is, the less they are involved in the on-field daily operation and focus only on helping, except when cooperation between different levels or areas is needed. For example, BAPPENAS as a ministry has the primary task of planning and budgeting, as well as a think tank and enabler (BAPPENAS, 7 July 2022). The decisions and regulations of the National Government will then be derivated to the Regional, Administrative Village, and down to the Cultural village Government.

The Administrative Village Government has the task of arranging the operation of the provided waste management infrastructures and facilities based on the recommendation or decree of the Regent/Mayor. MPH Bali visualized the ideal governmental network and roles in Bali's MSWM System, specifically in Gianyar Regency, for the material and waste management program, as shown in **Figure 4.11**. In the diagram, it is shown that collaboration between the Governmental Agencies is highly needed in order for the waste management flow to be more holistic. With the Village Government as the centre of the activities, the Regional Government are the creator of the enabling environment for the transition to CE to be realized.

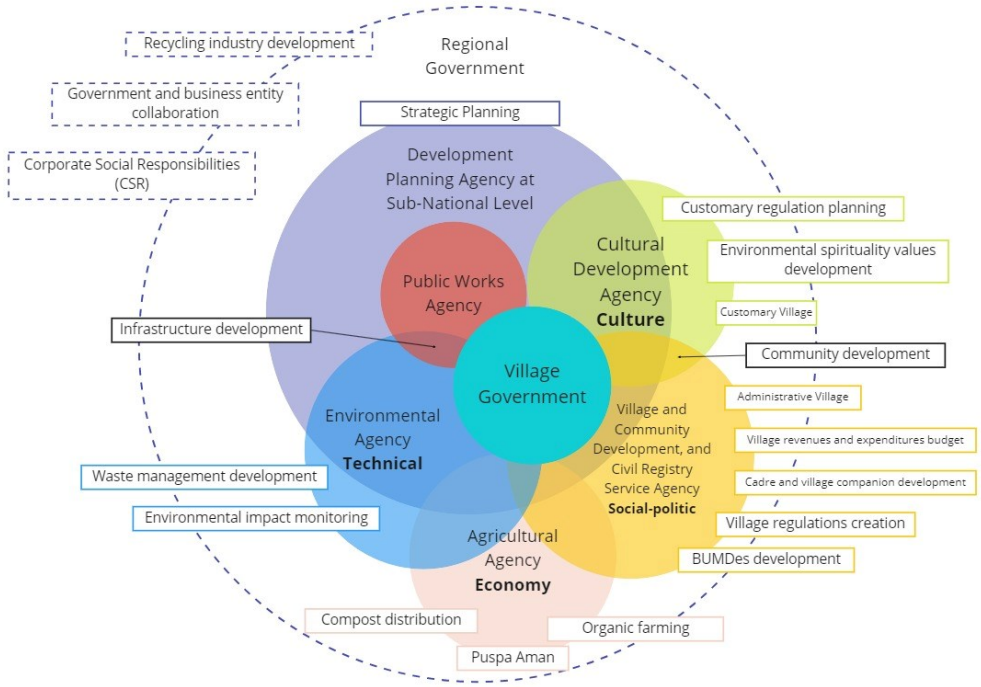

Figure 4.11 Governmental Network and Roles in Bali's Municipal Solid Waste Management System (Translated from Private Waste Management Company 1, personal communication, 15 July 2022)

Besides the mentioned roles and activities in the diagram, several vital roles that need coordination between levels are mentioned in the interviews, which are: (1) Monitoring the enforced law; (2) Coordinating national and regional revenues and expenditure budget according to the needs of Villages; (3) Building a system that can create an enabling environment for the community that are willing to change; (4) Enforcing the regulations that are created; (5) Finding the middle-ground between the government and the grassroots. One important activity that has to be highlighted is providing community development for behaviour change in society. In order for this to happen, the program needs to be long-term and not just a temporary program at the start of new regulation.

Problems exist among policymakers in implementing a sustainable waste management system in Bali. Some of them are:

1. There are different levels of understanding between the governmental levels, some policymakers lack the core concept of good waste management, and therefore they are easily swayed by external interventions (Expert 2, personal communication, 16 July 2022). This is more exaggerated when economic benefits are promoted in the process by the external parties, as the financial issue is the most crucial one in the system. A holistic waste management system needs to be understood by all levels of policymakers
2. There are conflicts of interest between the politicians, and regulations are not free from it. In addition, the government is constantly changing; therefore, it is hard to implement long-term concepts and ethics that will be brought through different management (Expert 2, personal communication, 16 July 2022).
3. The needed participation of the society based on the government in waste sorting or responsibilities of the waste is still unsure due to political matters. Politicians tend to create something that is preferred by society so that they will get chosen for the next term (Widiasari, 25 July 2022).
4. Source-based waste management is currently hard to implement due to the impact of the pandemic. Not only is it harder to enforce the regulations in society, but it also lessens the regional budget. Thus, waste management budget relies heavily on the national budget, not the regional ones. The regional budget for waste management can be gained from the waste retribution fee of the waste sources. However, many areas still fail to collect these fees from them or put too low prices on the fee (Expert 1, personal communication, 21 June 2022).
5. As finances are one of the central issues revolving MSWM system, policymakers are targeting private sectors on helping to build the facilities that they are planning to make, e.g., through grants or investation (Expert 3, personal communication, 24 June 2022).
6. It is hard for the regional government to oversee the whole cities/regencies in detail. Therefore the cities/regencies government and village government need to be able to self-manage their own area's waste management system (Expert 1, personal communication, 21 June 2022).

b. Education/Donors

Education/Donors group as identified are the Non-governmental organizations (NGOs) and Private Companies whose activities are in giving resources to the system, whether through money, knowledge or other means of resources. NGOs are mostly relied on based on their knowledge and

expertise in waste management and local understanding, where they can help educate the other stakeholders. Private companies can give resources to the system through their CSR efforts or as external consultants who are doing information sharing, giving insights to the other stakeholders on the situation in the system and what is needed by the system. They also often do collaborations between each other and with the policymakers, where they will gain mutual benefits from the collaboration. The problem that exists in this group are:

1. When bureaucracy is involved, they sometimes back off and are unwilling to be involved with the policymakers since it is usually complicated (Expert 2, personal communication, 16 July 2022).
2. The solutions that this group gives are sometimes based on their own profits, however, an actual integrated solution is needed for the urgent landfill issue (Expert 3, personal communication, 24 June 2022).

c. Producers

Producers can be considered both directly and indirectly involved in the waste management operation. Producers, as the name implies, are the producer of the products that are being used by the sources. Most producers in Indonesia currently apply a business-as-usual business model where the circularity of their materials are not being considered in the model design. Therefore, most of the waste generated from their products are being disposed of in the landfill rather than being retrieved back and recovered. This shows that producers are indirectly involved in the system, as they are only creating products and leave it as it is in the system. However, as the issue of packaging waste keeps arising, the government started to implement a policy limiting single-use plastic in Bali. The Regulation of the Governor of Bali no. 97 of 2018 on limiting single-used waste generation took place, thus forcing the producers to change their single-use plastic to one that is reusable.

Law no. 18 of 2008 on Solid Waste Management describes the strategy of mandating the producers to manage their non-recyclable waste through Extended Producers Responsibility (EPR). EPR schemes extend a producer's responsibility for a product to the post-consumer stage of a product's life cycle (Ellen Macarthur Foundation, 2021). As a response to the regulation, the producers are forced to create a scheme for managing the waste generated from their products. To further promote the EPR scheme, the Ministry of Environment and Forestry (KLHK) Regulation no. 75 of 2019 on Waste Reduction Roadmap by Producers further provides guidelines on how the producers can develop their EPR scheme based on 3R (Reduce, Reuse, Recycle) concepts in CE. As these regulations are a national framework that must be adopted by each regional government, including Bali, the EPR scheme is expected to be adopted by all producers in the system. Once the EPR scheme is implemented, the producers will be directly involved in the operational system, as they will be responsible for the recovery of their own products. This direct involvement is often made through a collaboration between stakeholders, e.g., the collaboration between Tetra Pak, The Body Shop, and AQUA with EcoBali Recycling to retrieve their packaging.

d. Source of Waste

Source of Waste in this group can be described as Residential and Commercial Areas. The residential area covers the people who reside within the autonomous area, whether they are locals or settlers. Commercial areas mean the commercial sectors that are in the autonomous area, e.g., hotels, cafés, restaurants, villas, offices, or other commercial sectors. As the source-based waste management regulations are currently being pushed in Bali, the source of waste is deemed the most important stakeholder in the system. They have the responsibility to manage the waste that they are generating through 3R means in order to make sure that the burden of waste that is being disposed of in the landfills is lessened. These waste management by the source as defined by Regulation of Governor of Bali No. 47 of 2019 on Source-based Waste Management are (1) reusing products or packaging that can be recycled and decomposed naturally; (2) reducing waste generation through not using single-used plastic; (3) using a product that produced the least waste; (4) sorting the waste; (5) sending not naturally decomposable waste to Waste Bank; (6) processing naturally decomposable waste; and (6) preparing waste bin to contain residual waste. While this source-based waste management system is starting to be implemented, it is not equally applied in all villages in Bali. Most of the development happens in the city, with the regencies being less developed, and therefore the result of the enforcement of the regulations cannot be seen prevalently.

Not only through managing their own waste, but the source of waste also have the responsibility to pay for waste retribution fee in order for them to be serviced with waste management. However, in reality, not 100% of the population in Bali pays for their waste services, and most of them pay less than what is deemed sufficient to even provide them with waste services (Sihotang, personal communication, 11 June 2022). However, the sources cannot be blamed alone for this. There are various reasons causing this issue to happen, such as the lack of a solid waste management system from the government that can be provided to the sources or the lack of knowledge of the sources to understand the importance of sustainable waste management services. There are also various degrees of understanding of the MSWM system between the sources. Thus, long-term community development is crucial to create behaviour change and realize the source-based waste management system envisioned by the policymakers.

e. Waste Collectors

Waste collectors can be divided into formal waste collectors and informal waste collectors. Formal waste collectors are the entities recognized formally by the government, whether through the ownership of business permits or if they are directly under a governmental agency. In Bali, examples of formal waste collectors are private waste collectors such as EcoBali Recycling and Mulung Parahita, waste crews under DKLH, or TPS3R crews under the Village. Stakeholders that are part of informal waste collectors are waste scavengers and junkmen. These waste collectors have the role of collecting waste from the source and bringing them to the next step in the system, whether it is waste processing or waste selling.

In formal waste collectors, the problems often mentioned are related to the inadequacy of their vehicles and facilities for collecting waste, whether it is regarding the capacity, quantity, or the feature of the vehicle where it cannot be used to collect previously sorted waste at the same time (TPS3R 2, personal communication, 17 June 2022). Even though formal waste collectors are

officially recognized by law, there is an issue where these workers are often not paid justly and only below the minimum wage of fulfilling their sufficient well-being (TPS3R 2, personal communication, 17 June 2022). These two problems are closely related to financial issues, since the waste retribution collected from the source or the government's budget cannot cover the waste collectors' needs.

While formal waste collectors collect waste regardless of the type to the processing site, informal waste collectors only collect waste with high value, where they can sell the materials and gain profits from it. Informal waste collectors act as the middleman between the source and material buyers to yield more profits, such as Waste Banks, intermediate informal collectors, or end collectors (Expert 2, personal communication, 16 July 2022). Waste scavengers collect the waste from the TPS, individual waste containers, or landfills. Usually, the type of waste that is collected depends on the needs of the material buyers. Some waste scavengers work directly under an intermediate informal collector, where they are given a place to live, food, and wage in return for fulfilling the quota of needed materials to be collected (Expert 6, personal communication, 1 August 2022). There are also waste scavengers who work independently, without ties to other bigger stakeholders. Another type of informal waste collector is the junkmen, who collect valuable materials door-to-door from the source in return for money or utensils.

Informal waste collectors contribute a lot to material recovery efforts in MSWM system, as they can reach areas that are not yet serviced by the formal waste collector (Expert 6, personal communication, 1 August 2022). However, their works are not recognized by the other stakeholders. They face much backlash as they are often discriminated against and are associated with risk, unhygienic environments, criminal activities, homelessness, unemployment, poverty, and backwardness (Sembiring & Nitivattananon, 2010). They also work in an unsafe conditions, with no safety equipment when collecting the waste.

Most of the time, informal waste collectors are not the local residents of the area where they collect the waste from (Waste Bank 1, personal communication, 19 June 2022). Therefore, the presence of informal waste collectors are deemed as an interference and competition to the formal waste management system, as villages are trying to empower their own community and facility to manage the waste (Expert 2, personal communication, 16 July 2022).

Research about the role of informal sectors and inclusivity has been done (Jaligot et al., 2016; Sembiring & Nitivattananon, 2010; Wilson et al., 2006), and integrating informal sector into the formal MSWM sector is being thought of as one of the solutions. However, there are complexities in formalizing informal sectors, as this requires not only financial capital but also human, social, and physical and public infrastructure capital (Sembiring & Nitivattananon, 2010). The limitation of resources also makes it difficult for the policymakers to adopt any policy that requires additional cost to the budget, and formalizing informal sector in MSWM is thought as making waste collection more inefficient and ineffective (Wilson et al., 2006). Therefore, further detailed research on the consequences of integrating informal waste sector into the formal waste sector in MSWM is needed.

f. Waste Processors

Waste processors here are defined as the group of stakeholders who aggregate the collected waste in order to process it into marketable products, whether it is in its raw form or processed into a new item. TPS3R and Waste Bank are the ones identified in the group. TPS3R and Waste Bank are usually self-managed by the local residents of the village. An organization recognized by the Village is created to manage the facilities after being discussed by the Village Government and the residents. The organizations in charge of the facilities can be different depending on the village, which some of them are Community Voluntary Contribution Group (Kelompok Swadaya Masyarakat/KSM), self-management (Swakelola), Utilization and Maintenance Group (Kelompok Pemanfaatan Pemeliharaan/KPP), and program at village level to educate women on various aspects of family welfare (Pendidikan Kesejahteraan Keluarga/PKK).

Waste Bank processes collected waste into sorted clean materials that are ready to be sold to the intermediate informal waste collector or end collector. Similar to waste scavengers, the waste that they collect and process depends highly on the needs of the buyer. For example, Waste Bank Desa Lebih Banjar Beten Kelod sell their waste to Waste Bank 1, where Waste Bank 1 is able to buy 52 types of materials, and thus Waste Bank Desa Lebih Banjar Beten Kelod can collect more types of waste compared to other waste processors (Waste Bank 2, personal communication, 20 July 2022). Some examples of the waste accepted by Waste Bank 1 are shown in **Figure 4.12**.

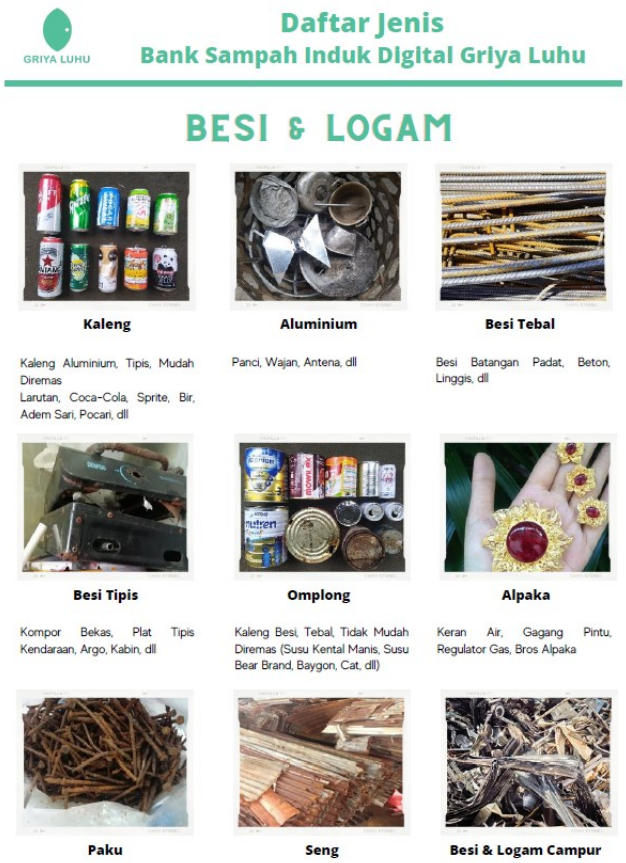

Figure 4.12 Examples of metals that are accepted by Waste Bank 1 (Waste Bank 1, personal communication, 19 June 2022)

Waste Bank also face a problem within itself where it is hard to look for people who are willing to commit to managing the facility, as a job involving working with waste is seen as dirty and not desirable (Waste Bank 2, personal communication, 20 July 2022). A more intense collaboration between Waste Bank and the government as the policymakers is realized as an important move, especially on community development and raising awareness of MSWM. In addition, not all areas in Bali have implemented Waste Bank in their MSWM system, although this can raise awareness of source-based waste management system due to the incentive that it entails (Waste Bank 1, personal communication, 19 June 2022). More end processors of the waste who are able to recycle types of materials that are not yet processable are also needed in order to be able to reduce waste disposal to the landfill. Especially since new regulations such as the use of electric vehicles are planned to be set, processors of e-waste are needed to exist in the system (Waste Bank 1, personal communication, 19 June 2022).

TPS3R collect all types of waste, whether they are organic, inorganic, or residual. The inorganic waste that they collected are sold to the intermediate waste collector or end collector, the organic waste is processed into compost, wet compost, or feedstock, and the residual waste is disposed to the landfill. There is a demand from TPS3R for new in-house technology to process the incoming waste to the facility as currently, the rate of generated waste has started to catch up with the capacity of the facility (TPS3R 1, personal communication, 14 June 2022). This applies to all type of waste, as inorganic waste takes a long time to be processed, residual waste is sent to the landfill without any processing, and inorganic waste lose its actual monetary value when it is only sorted and cleaned rather than processed into shredded materials or pellet. In this case, a connection with education/donors will be able to help in developing technologies or information sharing to the facility.

g. Waste Market

Waste seller here is defined as the group of stakeholders whose main role is in the transaction of waste, materials, or products derived from waste. While TPS3R and Waste Bank are defined as waste processors, they also do transactions with their waste by selling it to the customers, intermediate informal collectors, or end collectors. In addition to those two stakeholders, intermediate informal collectors are added to this group where junkshop ranging from small, medium, and large junkshop are parts of it. Waste product customers are included as well, where they are the one who buys the derivative products of the processed waste.

Usually, the selling flow of materials goes from the smaller scale seller to bigger scale ones due to the materials coming from waste being bought by the end processors only when they are in an ample amount of quantities. Thus, aggregators are needed as the middleman between the smaller scale seller that are directly involved with the source and the end collectors. However, in Bali, not all the flows go step-by-step, as many small junkshops sell it to the end processor directly (Expert 3, personal communication, 24 June 2022).

Based on the interview with Waste4Change, small and medium junkshops usually get their waste from waste scavengers, individuals, TPS3R, or Waste Bank. They then sell the waste to bigger junkshop, some of which are recognized as formal businesses with sole proprietorship (Usaha Dagang/UD). Besides accepting materials from small and medium junkshops, these bigger

junkshops also directly accept waste from the commercial sector, such as malls or bus stations. Bigger junkshops are commonly partnered with end processors already to sell their waste since they have big capacity that can meet the requirements of the end processors (Expert 2, personal communication, 16 July 2022). However, some stakeholders are hesitant to actually collaborate with junkshop as sometimes it is hard to verify the sustainability factor of the business, such as where the materials end up or what they are doing with the materials (Private Waste Management Company 1, personal communication, 15 July 2022).

Interview with Expert 2 uncovers that in the waste market there are entities who control the market unfairly, especially between the smaller junkshop with the end processors. As the smaller and medium junkshop only cares about getting money no matter how small it is, the bigger junkshop and end processors often buy their materials at a very low price. Sometimes the bigger junkshops also lose profits from the end processors due to an unjust business practice they are applying. The end processors often pay substantial lump sums of money in advance to the junkshop when the current waste price is low, so that they can get more materials with the same amount of money. This payment applies for future shipments until the junkshop fulfilled the quota of the bought materials. In reality, if the junkshop sells the materials according to the current waste price, they can get more profits.

As the government formally recognizes TPS3R and Waste Bank, they can sell their waste at a fairer price to a reliable buyer such as Waste Bank 1, as they are recognized as one of the central Waste Banks in Bali. The price of waste is highly fluctuating, depending on the market price. Therefore Waste Bank 1 tries to control the price and lessen the burden of the waste seller by determining their waste price every six months (Waste Bank 1, personal communication, 3 August 2022), while informal aggregators are changing their prices every week or month. This practice will then give the smaller aggregators a fair price when selling their waste.

Waste product consumers are stakeholders who are the target market of MSW derivative products. Some of the products that can be found from processed MSW are compost, wet compost, feedstock, and BSF. These products are usually made by TPS3R, and sold to the waste product consumers who are local farmers, commercial sectors such as hotels, or individuals. In Bali, there is a problem in TPS3R where they have an abundance of waste products from organic waste, but lack of buyers to empty out their stock. Therefore, networking with policymakers is needed, especially to connect them with these waste product consumers to ease the product distributing process (TPS3R 2, personal communication, 17 June 2022).

h. End Processor

End processors are defined as the group of stakeholders that process the recyclable materials from the waste into new products. The stakeholders in this group are factories and recyclers. In Bali, there are not that many factories and recyclers exist, and most are only processing rigid plastics such as PET and PP, and a factory that processes cardboard and paper for packaging paper. In addition, the extent to which they process the recyclable materials in Bali are just compression. Only a small amount of processors chop the materials into shredded plastics, and even smaller amounts process the material into plastic pellets (Expert 1, personal communication, 21 June 2022). Consequently, most of the recyclable materials recovered in the system are sent or sold to

East Java, such as Banyuwangi or Pasuruan city (Expert 2, personal communication, 16 July 2022). A loss of profit is happening here since the price of the plastic pellet can be higher by ten to twentyfold compared to just cleaned materials. Thus, locally processed waste is needed to give more economic profits in Bali and to realize that a policy change by the policymakers is needed to allow more factories to be built in Bali (Expert 1, personal communication, 21 June 2022). Moreover, since there are still a lot of recyclable materials that cannot be processed locally, more variety of end processors are also needed in Bali to prevent more waste from going to the landfill (Waste Bank 1, personal communication, 19 June 2022).

4.2.3. Value Chain Mapping

This section will focus on characterizing the value chain of the MSWM system in Bali. A visualization of the value chain will be created by integrating the systems analysis and stakeholder analysis, and the added value along the value chain will be embedded. Based on interviews and literature study, the main activities in Bali's MSWM system can be divided into five activities, which are: (1) Waste disposal at source; (2) Waste collection; (3) Waste processing; (4) Waste market; and (5) End waste disposal. Besides those five activities in the value chain, there is also monetary flow that is outside of the activities but directly impacts the activities, such as the monetary flow coming from the policymakers and the educators/donors. The research also shows that financial issue is a prominent issue within all levels of stakeholders and activities in the system. Therefore, the potential for improvement of the monetary flow will be described in the analysis.

In VCA, the value added to each step in the value chain is analyzed in order to document the distribution of income and benefits along the value chain (Jaligot et al., 2016). However, due to the broad scope of the study, this study will only describe the monetary flows surrounding the activities without the actual monetary value. The related monetary flows and their potential will be explained in this section, with **Figure 4.13** depicting the value chain of the MSWM system in Bali and the summary seen in **Table 4.2**.

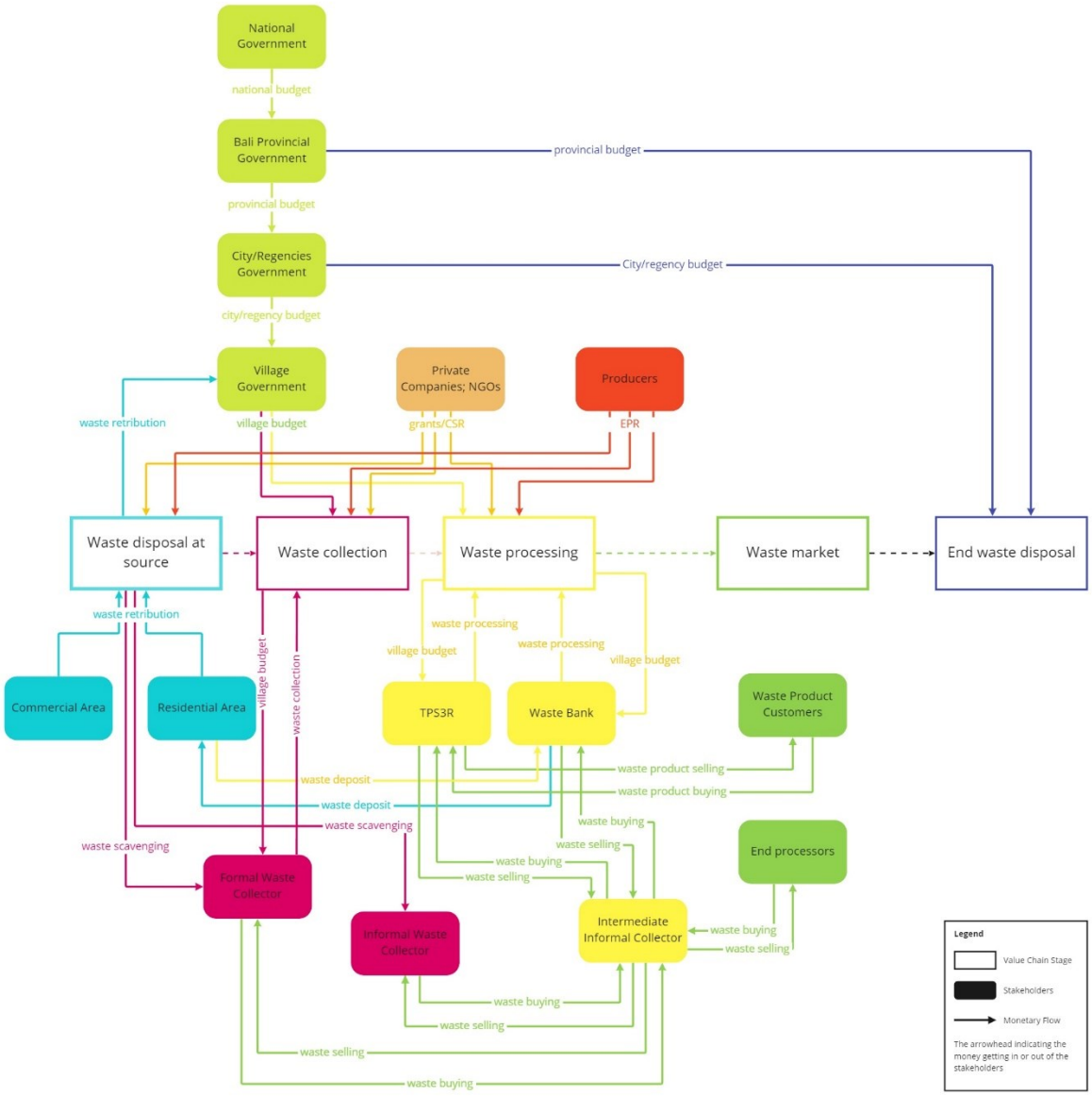

Figure 4.13 Value Chain of Bali MSWM System

a. Waste disposal at the source

In waste disposal at the source, the monetary flows are the waste retribution in which the source needs to pay in order to be serviced. This waste retribution fee is paid by the source, whether they are the commercial sector or residential sector, to the village government that is responsible for managing MSW in their area, depending on the regulations that are applied. The residents of the village are also able to get profits by depositing their waste to the Waste Bank by becoming a member of the Waste Bank in their area.

The waste retribution fee is one of the main monetary support in the MSWM system, and they are supposed to be used for waste management operations, starting from the upstream to the downstream. However, in the realization, the waste retribution fee that is being billed is not enough to cover the whole waste management process and is only able to or even not enough to cover the fee from waste collection to waste processing in TPS, TPS3R, or Waste Bank (Government 1,

personal communication, 7 July 2022). The fee is currently too small and needs to be raised based on the need of the village. An analysis of how much the proper waste retribution fee to be billed is needed and be delivered to the upper governmental level for them to revise the regulations applied in the area. Once this fee is raised, the citizen can demand the local government to be more involved and pay more attention to local MSWM improvement. However, things to be noted is that if the fee is suddenly raised, resistance will appear from the sources. Due to this reason, educations and counselling are essential to be given from the source's perspective to lessen the resistance (Expert 1, personal communication, 21 June 2022).

There are also cases where some areas are not being serviced with a formal MSWM system or when someone is being serviced, but they are not being charged for the waste retribution fee (Expert 1, personal communication, 21 June 2022). For that reason, further inspection of the service area of the MSWM system in Bali and the recipient of the services need to be done in order to maximize the amount of waste retribution fee that can be collected.

When a Waste Bank exists in a village, the residents of the said village can join their program to get incentives when they are sorting and depositing their waste. While regulations are already made in order for Waste Bank to be implemented, e.g., Regulation of Mayor of Denpasar no. 45 of 2020 on 3R activities through Waste Bank, the enforcement of the system is still low. Not only that, the awareness of the public is not equal, and therefore a lot of the residents are still hesitant to join the program. In order to solve the issue, it can start with long-term community development. This sharing of information and knowledge can lead to behaviour change, which will increase the source's awareness and interest in joining Waste Bank's program.

b. Waste collection

In waste collection activity, the monetary flows come from the village budget, waste collecting, and material recovery. Formal waste collectors get their income from the budget of the village government. This budget comes from the paid waste retribution fee of the sources and the annual budget decided by the cities/regencies. In doing a waste collection, operational costs need to be paid every month, whether it is for the wage of the workers, maintenance of the facility, maintenance of the vehicles, or the procurement of new vehicles or technologies.

As previously mentioned in the Stakeholder Analysis section, formal waste collection workers are often not paid justly and only below the minimum wage of fulfilling their sufficient well-being (TPS3R 2, personal communication, 17 June 2022). This shows that currently, the budget is not enough to cover the expenses for a holistic MSWM system, and therefore further inspection of how much the actual budget is needed by the village. This analysis should consider the realization of the budget from upstream to downstream and the capacity and willingness to pay from the sources. When the actual budget is analyzed, approved, and given, adequate wages and facilities can be provided to the waste collectors.

Increasing effectiveness and efficiency in the waste collecting process is also important to optimize the owned budget. One thing that can be done is to create more collaboration with policymakers and educators/donors, where they can provide the analysis of the required facilities, technologies, vehicles, or skillsets to increase productivity. After the analysis is done, community development,

whether it is towards the sources or the waste collectors, according to the vital knowledge and skillsets to be learned, can be given to boost the effectiveness and efficiency of the process.

Material recovery is also one of the monetary flows happening in waste collecting activity. This can be done by both the formal waste collector and informal waste collector, as explained in the Stakeholder Analysis section. While it is one of the monetary flows in the system, the material recovery is made through scavenging waste informally from TPS or from the sources. Therefore, rather than promoting material recovery informally, incorporating the existing informal system into the operations of the formal MSWM system is preferable to protect their livelihood and improve their working conditions (Wilson et al., 2006). However, establishing the formalization of the informal sector is shown to be expensive (Sembiring & Nitivattananon, 2010; Wilson et al., 2006), and therefore, its importance needs to be researched first before being taken place. It is also aligned with what is being done by BAPPENAS, where they are planning to create the roadmap to integrate informal sectors into the formal MSWM system in the future (Government 1, personal communication, 7 July 2022). Through this method, these informal sectors will then be acknowledged by other stakeholders.

c. Waste processing

Waste processing activity possesses the waste processing and village budget as the monetary flows. Similar to waste collection, there are operational costs that entail the waste processing activity at TPS3R and Waste Bank. These can be for the wage of the workers, the maintenance of the facility, the maintenance of the used technology, and the procurement of new technology in the facility. The money to pay for the operational costs comes from the village budget, which consists of the budget given by the village government and the waste retribution fee.

Currently, the waste processing that happens in TPS3R and Waste Bank is still the most basic waste processing, such as waste sorting, cleaning, and compression for inorganic waste, composting or turning into feedstock for inorganic waste, and simply disposed of for the residual waste. However, to improve the process, they are hit with financial issues as the current budget is only able to run the business as usual (TPS3R 2, personal communication, 17 June 2022) and is not sufficient to improve the process.

Similarly to the waste collecting process, there are potentials to increase effectiveness and efficiency in the process and lessen the costs, which are: (1) creating more collaboration with external stakeholders for knowledge, information sharing, and research regarding the situation of the village and what are suitable to improve the situation; (2) community development based on the research on what is essential to the village to improve the effectiveness and efficiency of the process, thus lessen the cost of waste processing. The village government also have to be proactive, where they can discuss the actual village budget of the waste processing with TPS3R and Waste Bank and bring the discussion to the upper governmental level.

A limitation might arise when TPS3R and Waste Bank are managed by different organizations. In this case, they will end up reducing the profits of each other, as the people have to choose between bringing their waste to the TPS3R or to the Waste Bank (Expert 1, personal communication, 21 June 2022). For example, when TPS3R is managing all three types of waste, they are gaining profits

from three different sources of income: village budget, waste retribution fee, and waste sales. Waste sales are mostly gained from selling inorganic waste such as plastic and paper. Moreover, when society chooses to bring their waste to Waste Bank, the TPS3R will gain significantly less money from the sales. If the facilities are managed by two different entities, the profit from waste sales in Waste Bank will then not be shared at all with TPS3R. In some cases, TPS3R sell their waste to the Waste Bank (TPS3R 2, personal communication, 17 June 2022), where they will gain profit but in a less amount than it is supposed to be. In an ideal situation, TPS3R and Waste Bank should be managed together by using the division of the processed waste types in each facility, i.e., TPS3R for organic waste and Waste Bank for inorganic waste, not two different entities that extend the waste flow.

d. Waste market

In the waste market, the monetary flows come from the transaction of waste and its products. Waste selling is done by both formal and informal waste collectors, TPS3R, Waste Bank, and intermediate informal collectors. The problem in the waste market, especially for the seller, is the fluctuating price of the waste, which changes depending on the global price of the market. As explained previously in the Stakeholder Analysis section, there are individuals who control the market unfairly, and therefore the smaller seller is only able to sell their waste at a very low price while the bigger one gains most profits from it. For that reason, a fair market environment needs to be created, where the help of various stakeholders will contribute to the realization of the environment. Policymakers are the ones who are supposed to know most of the stakeholders and conditions in their jurisdiction area. Knowledge and information sharing of the fair market from the government is crucial to be informed to the smaller waste seller (Expert 2, personal communication, 16 July 2022). Information, especially on networking, is vital to the small seller so that they can collaborate with a reliable and fair waste buyer to get the most profit out of the materials.

Besides having a fair market environment, the waste seller can gain more profits if they create more valuable materials out of the waste that they have. The price of a plastic pellet is much higher than the price of a cleaned PET bottle (Expert 1, personal communication, 21 June 2022). Thus, having an improvement in waste processing technology will also increase the profits out of the materials that they sell. Collaborations with more types of end processors are also essential in order to be able to process and sell more types of materials. When the variety increases, they can create more profits out of it.

As for the waste buying flow, intermediate informal collectors especially big junkshop, and end processors, are the main buyers of the collected materials in the chain. They are the ones who control the prices in the market as they are the end buyers of the materials. Therefore their role is vital in creating a fair market environment and establishing fair principles in determining the waste price. However, this might be found difficult as these entities are for-profits organization. Community-based waste processors are needed in Bali to tackle this issue, e.g., village-scaled end processors that are managed by the BUMDes so that the cycle of production and consumption can be kept within the village (Private Waste Management Company 1, personal communication, 15 July 2022).

Waste product selling and buying happen between TPS3R and the waste product consumers. This flow is still not optimum since in most TPS3R the stocks of the products, especially compost, are abundant in the facility. In addition, farmers are still hesitant to switch to organic farming since compost is more expensive than chemical fertilizers, and the chemical fertilizers can yield harvests more quickly than compost (Private Waste Management Company 1, personal communication, 15 July 2022). Therefore, the role of policymakers once again is crucial here where they can create a vessel to connect the seller and buyer of the waste products. While the system for organic farming is already stated in Regulation of Governor of Bali no. 15 of 2021 on the implementation of regional regulation no 8 of 2019 on the organic farming system, an incentive that can promote the usage of compost to the farmers are also necessary for the farmers to change their method to organic farming, e.g., subsidy on compost (Private Waste Management Company 1, personal communication, 15 July 2022).

e. End waste disposal

In the value chain, end waste disposal's monetary flow entails the regional budget for waste management. It is decided by the policymakers where they are responsible for the maintenance of the landfill and cleaning up of the waste that is mismanaged in the region. However, there is still financial restriction to the end waste disposal, especially the landfill, which resulted in the bad operation of the landfill. It is a loss of profit since the landfill's lifetime might reduce when a landfill is made with a good design but operated inappropriately (Government 1, personal communication, 7 July 2022). The reduction of landfill lifetime will result in the halt of the waste management system, as Bali still relies mainly on landfill. When the system is halted, waste will overflow in each step of the system and increase the overall cost of management due to the need for an alternative option for cleaning up the generated waste. Mismanaged waste can also cause the loss of profits for waste management. This is due to the need for cleanup of mismanaged waste, e.g., waste that ends up in the water body or waste that is disposed of illegally in an empty land.

Therefore, it is crucial for the policymakers in Bali, whether they are at the provincial or cities/regencies level, to analyze the needed budget for the whole waste management process from the upstream to the downstream. Especially with the issue of the closing of the Suwung landfill, waste management can be pushed as a critical issue to be prioritized in the regional budget and therefore improve the whole condition of the system.

f. Monetary flow from outside of the activity

From outside of the activity, there are two monetary flows that come into the chain, which are governmental budgets from the government and grants from private companies or NGOs.

Governmental budget

The governmental budget, starting from the national budget down to the village budget, is a complex item since the allocation highly depends on the priority issues within the region. Currently, waste management is not the priority issue being pushed. Nationally, waste management budget allocation is only 0,51% or IDR 5,3 trillion out of the total national budget (Putra, 2022). It is proven to be not enough, as some areas still struggle with the inappropriate condition of the facilities or vehicles that are used for waste management (Kumparan, 2022; wartabalionline, 2022). Therefore, waste management needs to be pushed as one of the priority issues in budget discussion in order for the budget to be increased.

To realize the increase in waste management budget, the regional government starting from the village, cities/regencies, and province, needs to calculate their actual spending on waste management to cover the waste management from the upstream to the downstream. To help with the process, the Ministry of Home Affairs of Republic Indonesia (Kemendagri) already created Ministry of Home Affairs of Republic Indonesia Regulation no. 7 of 2021 on the procedure of waste retribution fee calculation for waste management execution. The regulation explains in detail what the calculator is used for, what is needed to fill in the calculator, and what is the output of the calculation. Presently, the regulation is not being enforced equally in all regions. Therefore the national government need to be stricter in enforcing the calculator to be used by the regional government so that they can propose the needed budget and push waste management to be a priority issue.

Grants/Corporate Social Responsibility

Grants or CSRs to the system can be given by private companies, investors, or NGOs who are collaborating with other stakeholders. While this is valuable since the budget within the system is not enough to provide for themselves, some of the grants that are given are not a good fit for what is actually needed by the recipient, e.g., grants for a program which allows people to trade 1 kg of plastic with 1 kg of rice. It is not a sustainable practice since it could plant a mindset that the waste is actually valued the same as the rice, while the actual price of 1 kg of plastic is IDR 300 and 1 kg of rice is IDR 11.000. Once the grants are stopped being given, the program will automatically stop. However, the mindset of the people is already impacted by the program since they are used to having their waste valued more than its actual price. This creates an additional hurdle for a sustainable practice to be applied. These kinds of a program where a mindset is planted in a society can hinder a sustainable waste management practice from being applied (Waste Bank 1, personal communication, 19 June 2022). Thus, it is important for the recipient of the grants to have basic knowledge of waste management to know what they actually need and not blindly accept any grants that are given to them. It is also crucial for the granters to implement a program with a long-term impact rather than something with a short-term impact.

Extended Producer Responsibility

As previously explained in section 4.2.2. on Stakeholder Analysis for Producers, EPRs programs contribute to economic income to the system. It is done by the Producers, who have to be responsible for the recovery of their products. In most EPR schemes in Bali, the Producers collaborate with waste collectors or waste processors to recover their product's packaging. The monetary value can be given to the system through business contracts, where they pay specific amounts to the collectors and processors in return for receiving their product's packaging back.

While the current EPR focuses on collection and processing of product's packaging, EPR scheme can be done more holistically. An initiative called Indonesia Packaging Recovery Organizations (IPRO) was made in Indonesia, with operations in East Java and Bali. IPRO is trying to promote systemic change on EPR, and other means of monetary income to the system by the producers can be seen there. There are three programs of IPRO, which are (1) collection and recycling, (2) co-investment, and (3) communication and engagement (IPRO, 2022). In collection and recycling

program, IPRO pays aggregators and recyclers for proof of recycling and collection through incentives. In co-investment program, IPRO provides co-funding for the set-up of the new collection, sortation system, and development of existing infrastructure. And last, in communication and engagement programs IPRO finances enabling activities to support the expansion of the other two programs. Therefore, it can be seen that there are possibilities for income to the system through the EPRs scheme that is not only in collection and processing of waste but also in creating the supporting environment for the recovery of their product's packaging.

Table 4.2 Summary of Bali MSWM Value Chain Analysis

Value Chain Stage	Monetary Flow		Related Stakeholders	Improvement Potential
	In	Out		
Waste disposal at the source	Waste retribution		Village Government	- Further inspection of people who are in the service area but are not charged with the waste retribution - Analyzing the proper waste retribution based on the capability to pay, willingness to pay, and need of the village
		Waste retribution	Commercial Area Residential Area	Increasing waste retribution based on the capability to pay, willingness to pay, and the need of the village
	Waste deposit		Residential Area	Community development to increase source's awareness and interest in joining Waste Bank's program
Waste collection	Village budget		Formal waste collector	Analyzing the needed budget of the village and its willingness to pay to increase the wage of the collector and provide adequate waste collection facilities
		Waste collecting		- More collaboration with the policymakers and educators/donors to analyze what collection facilities are needed to increase productivity - Community development to increase the quality of waste sorting by the source and lessen the cost of waste collection

Value Chain Stage	Monetary Flow		Related Stakeholders	Improvement Potential
	In	Out		
	Material recovery		Formal waste collector Informal waste collector	Future research on the importance of waste scavengers to analyze their contribution and what can be improved for their well-being
Waste processing		Waste processing	TPS3R Waste Bank	- Opening more collaboration with external stakeholders to receive knowledge and technology on waste processing - Community development to increase the quality of waste sorting by the source and lessen the cost of waste processing
	Village budget		TPS3R Waste Bank	Analyzing the needed budget of the village and its willingness to pay to provide adequate waste processing technology
Waste market	Waste selling		Formal waste collector Informal waste collector TPS3R Waste Bank Intermediate Informal Collector	- Knowledge and information sharing from the government for a fair waste market - Collaborating with reliable waste buyers to get the most profit out of the materials - Improvement in processing technology to process materials into higher-priced materials - Collaborating with more end processors for more types of materials to be accepted and sold
		Waste buying	Intermediate Informal Collector End processors	Applying the fair trade principle when establishing a waste price

Value Chain Stage	Monetary Flow		Related Stakeholders	Improvement Potential
	In	Out		
	Waste product selling		TPS3R	- Collaboration with the policymakers to connect sellers and buyers of waste product - Creation of regulations that can promote the use of compost
		Waste product buying	Waste product customers	- Collaboration with the policymakers to connect sellers and buyers of waste product
End waste disposal	Regional budget		Bali Provincial Government City/Regency Government	- Analyzing the needed budget of the region to cover the MSWM cost from upstream to downstream
Other activities*	National budget		National Government Bali Provincial Government City/Regency Government Village Government	- Utilizing a calculator from Kemendagri to calculate the needed village budget, which will be elevated to the regional and national budget - Pushing waste management as one of the priority issues when deciding the regional budget
		Grants CSRs	Private Companies Investors NGOs	- Providing grants or knowledge sharing depends on the needs of the recipient, not the wish of the donor - Focusing on a program with long-term impact rather than short-term impact
		EPRs	Producers	- Creating a supporting environment for recovery, e.g., IPRO program of co-funding and financing enabling activities

4.3. Challenges and Opportunities for Transitioning to CE

Five levels of information is a system thinking approach that will describe the key information on the dynamics and drivers of current practices towards CE and result in an identification of the challenges and opportunities of transitioning to CE (Iacovidou et al., 2021). At the end of this section, the ranges of measures for transitioning to CE based on the challenges and opportunities is defined. **Table 4.3** summarizes all the challenges and opportunities identified in this section.

4.3.1. Challenges and opportunities

This section will discuss the challenges and opportunities of Bali's MSWM based on the five levels of information, which are : (1) resource flows and provisioning service; (2) governance, regulatory framework and political landscape; (3) business activities and the market; (4) infrastructure and innovation; and (5) user practices based on the previous analysis on VCA.

Resource flows and provisioning service

Resource flows and provisioning services will identify the natural ecosystem impacted by resource consumption, production and management and the role of provisioning services in supporting circularity. The challenges and opportunities are as follows:

Challenges

While a source-based waste management system is currently trying to be implemented in Bali, not everyone immediately implements the regulations in their daily lives. There are still people who do not sort their waste before disposing of it (Waste Bank 2, personal communication, 20 July 2022). Consequently, the impurities in the disposed waste will reduce recovered material quality and make it unsuitable for recycling (Eriksen et al., 2019). Since they are hard to process, this low-quality waste is often ignored and disposed of directly at the landfill, thus creating the risk of waste leakage to the environment.

Another challenge is the mismanagement of waste, where illegal waste disposal occurs. When mismanagement happens, most materials are lost in the process, and material recovery is practically impossible to do. In Bali, 283,368 (34.45%) out of 822,555 tonnes/year of waste is mismanaged (Widyarsana et al., 2020). This mismanaged waste is mishandling in waste management, whether they are burnt, disposed of at the water bodies, or dumped on open land. In households, the mismanaged waste handling percentage is 26% of waste burning, 7.8% of waste dumping on open land, and 4.9% of waste disposal to water bodies (Widyarsana et al., 2020). In addition to the difficulty of waste recovery, mismanagement is detrimental in both environmental and social aspects. Soil and water contamination, air pollution, marine littering, and public health issues are some of the recurring impacts of mismanagement. In order to be able to receive the materials back in the flow, additional costs will be needed, e.g., clean-up costs, and thus creates more challenges for a circular process.

Opportunities

As a response to the challenges, source-based waste management is promoted by the local government in Bali to mitigate mismanaged waste. However, law enforcement still needs to be

tightened up for the regulations to happen. More possibilities for material recovery will arise when the regulations start to be practised. There is still much potential for material recovery in Bali, as currently, many materials are being disposed of directly instead of processed. With the proper waste system governance, a more circular waste management system with long-term sustainability is expected to appear.

Governance, regulatory framework and political landscape

Governance, regulatory framework and political landscape analyze the political aspect underlying the socio- and techno-economic aspects of the system. The challenges and opportunities are as follows:

Challenges

CE is a relatively new concept in Indonesia, and its definition is not yet concrete as there is a disparity of knowledge between different levels of policymakers. Especially at the governmental level, CE is not yet a widely used term. Especially at the regional level, the current system in Bali still focuses on increasing the recyclability of waste rather than resource efficiency, e.g., through the development of Waste Bank, TPS3R, and TPST. While recycling might reduce the problem of overflowing waste in Indonesia right now, it only eliminates waste at its end but does not prevent waste from being generated. Soon, recycling will not be enough to overcome the amount of waste produced; therefore, a CE that focuses on preventing waste from being created at all needs to be the solution.

In politics, conflicts of interests always happen, especially on which services are considered essential or not. Indonesian Law 23/2014 on Local Government stated that in Indonesia, waste management falls under Mandatory Non-Basic Services, therefore, less priority is given compared to those of Mandatory Basic Services. In addition, as the member of the governmental seat changes periodically, it also rapidly changes the interests and issues being prioritized, depending on who is currently leading the government. Less priority means less budget is allocated to waste management issues, thus causing insufficient services, which also applies in Bali. Furthermore, the amount of waste retribution fee that the citizens of Bali pay is not yet enough to cover the whole waste management process from the upstream to the downstream. Providing basic waste management services to every citizen of Bali is not yet achievable, and transitioning to CE still has a long way to go if the financial issue is not solved.

There is also a lack of human resources at the governmental level who understand the core concept of good waste management (Expert 2, personal communication, 16 July 2022). When the core concept is not grasped clearly, it might affect the decision-making process. An external intervention, such as incoming investors or new best available technology, will highly affect the decision rather than the best-suited decision for the region. It is not the best move to be taken, as before jumping into a new solution, it is best to create a solid foundation of a sustainable holistic system.

Regulations are often made without considering the grassroots but more based on the government's knowledge and vision. These regulations are usually hard to be implemented in the field due to the gap between the knowledge of the government and the operators (TPS3R 2,

personal communication, 17 June 2022). Moreover, there is a lack of incentives or supporting regulations on innovations for transitioning to CE, thus hindering niche innovations for CE from emerging. As for the available regulations, oftentimes, the enforcement is not yet present. Therefore, although the regulations that promote a step to CE such as source-based waste management system regulation are already there, the implementation is still lacking.

Opportunities

While it is previously mentioned that the common conception of CE in Indonesia still revolves around waste recycling, BAPPENAS has started to realize that CE is beyond waste management. They perceive CE to focus on how the flow from the upstream to the downstream need to be more efficient (Government 1, personal communication, 7 July 2022). In response, they have been doing studies on CE in Indonesia, e.g., "The Economic Social and Environmental Benefits of a Circular Economy in Indonesia". Besides the report, they are also trying to develop an indicator for CE to be used by other ministries to reduce misinterpretation and mislabelling in implementing CE. This move will create an opportunity to lessen the knowledge gap between different governmental levels.

While creating an official common conception of CE will close the gap between different governmental levels, another knowledge gap between the government and other stakeholders also needs to be closed. A hub that focuses on CE can be one of the solutions to this knowledge gap. Through a hub, the information from both sides of the stakeholders can be shared openly; therefore, the newest update on the CE issue can be discussed. Currently in Bali, an aspiration forum exists for the Government to receive aspirations from various stakeholders, depending on the forum's theme. Forum Komunikasi Penggiat Lingkungan (Environmental Activists Communication Forum) is one of the forums available for environmental issues, which discusses waste issues in Bali, mainly plastic waste (Pemerintah Provinsi Bali, 2019). While this forum creates a space for various environmental stakeholders to connect with the Government, this is only a one-time event. Thus, the obtained information in the forum might be obsolete in the nearest future.

A hub specializing in CE topics in Bali will create a space where various stakeholders can communicate and share their most updated information related to CE periodically. The presence of a hub will also help in the study conduction on CE in Bali. As the hub will gather all the stakeholders related to CE, the issue can easily be discussed in the channel to gain a win-win solution. The hub can also be used to increase law enforcement, where the government can monitor and evaluate whether the related stakeholders are implementing the regulations they publish.

When the knowledge gap is lessened, creating more political interest in CE also needs to be done. Creating more political interest in CE could possibly happen in the future since BAPPENAS stated that the next JAKSTRANAS target for 2025-2029 will try to include CE explicitly in the goal (Government 1, personal communication, 7 July 2022). This new national goal will force the regional government to update their regional target into one that fits the goal of meeting CE nationally, including Bali. In addition to the possibility of a new regional target, Bali's current

regulations also promote circularity in waste management, although not explicitly. This promotion is shown through Regulation of Governor of Bali No. 47 of 2019 on Source-based Waste Management and Governor of Bali's Decree No. 381 of 2021 on Source-based Waste Management in Administrative Village and Cultural Village. These regulations will promote circularity based on the upstream, where the sources are required to self-manage their waste through R-hierarchies methods. Additionally, to create more impact, these regulations need to be implemented on the Cultural Village scale as its regulations, i.e., Awig-awig, as Awig-awig are more respected and followed by the local residents than just regional regulations (Expert 1, personal communication, 21 June 2022.

One of the solutions for financial issues at the governmental level is by re-evaluating the current waste retribution fee in each city/regency. Kemendagri already provides a tool through the Ministry of Home Affairs of Republic Indonesia Regulation no. 7 of 2021 on the waste retribution fee calculation procedure for waste management execution. The current waste retribution fee is too low and insufficient to cover the whole MSWM system's operation. This tool will help the local government calculate how much each household should pay to create a circular MSWM system. After the analysis is done, it is also crucial for Bali's cities/regencies government to update their waste retribution fee regulations, as the latest regulations were only updated in 2011.

Business activities and the market

Business activities and the market concern the organizational relations on resource flow through the system, where economic incentives, market stability, and information flow drive the activities of the businesses and impact the wider system. The challenges and opportunities are as follows:

Challenges

The main circularity challenge at this level is that the producers are still defensive of their business practice, where business as usual is still preferable compared to implementing CE in their business model (Expert 2, personal communication, 16 July 2022). Implementing CE on an already established business is a high-risk move where the producers can lose profits. However, the participation of producers in CE is vital because they need to be responsible for the products they create. When the producers are willing to change, and the government responds to it by creating relevant regulations for CE initiatives, a transition to a more circular model in MSWM system is possible to be achieved (Expert 4, personal communication, 26 July 2022).

The landfill is on the verge of closing, and the proposed alternative by the local government in Bali is TPST, e.g., TPST Samtaku. However, TPST is still an expensive method for the end disposal of waste since it is privately owned by a for-profit entity. It has become a challenge to the waste collectors and processors to create circularity with the waste they collect as they have limited funding to manage it. Due to the limited funding, they have no choice but to dispose of their waste at the cheapest option available, the landfill. If no other solutions are proposed, and the landfills are closed, the waste mismanagement rate might increase as there is no other option for the end disposal. Therefore, a community-oriented waste processing business practice as the end disposal is needed in Bali, especially ones that can be done locally (Private Waste Management Company 1, personal communication, 15 July 2022).

Currently, there is a disproportionate demand and supply of materials from waste and waste products. The amount of recyclable materials for the industry in Indonesia is still limited, and therefore, waste import is being relied on by the industries (Iswara, 2021). The problem is not on the low amount of available materials but on the lack of the proper waste processing method to recover the materials. Thus, many materials are disposed of in landfill rather than being recovered. On the other hand, waste products such as compost are piling up in TPS3R due to the lack of buyers (TPS3R 2, personal communication, 17 June 2022). Although the quality of the produced compost is already proven in the laboratory to be competitive in the market, the buyers still prefer to buy chemical fertilizers due to their lower price. Connecting the demand and supply in Bali is still a problem, and regulations to support the market are needed.

Opportunities

The initiatives of producers on the Extended Producer Responsibility (EPR) scheme is one of the opportunities to create circularity on one point of the MSWM system. EPR schemes extend a producer's responsibility for a product to the post-consumer stage of a product's life cycle (Ellen Macarthur Foundation, 2021). Indonesia already created a regulation to support EPR scheme, which is the Ministry of Environment and Forestry (KLHK) Regulation no. 75 of 2019 on Waste Reduction Roadmap by Producers. In response to the regulation, several producers in Indonesia created Indonesia Packaging Recovery Organizations (IPRO), a voluntary, non-profit, independent, and professionally managed organization focused on increasing the collection and recycling of used packaging. IPRO currently operates in East Java and Bali, where they focus on the systemic approach of EPR. Their activity consists of collecting their packaging waste, providing co-funding for the development of waste management methods, and financing enabling activities for their programs (IPRO, 2022). While the government acknowledged EPR and explained it in the regulation, it is still a voluntary act and not mandatory to be implemented by all the producers. However, with the creation of producer's cooperatives such as IPRO, the implementation of EPR can be more attractive and organized for the producers.

Similar to the opportunities in governance, regulatory framework, and political landscape level, the presence of a hub could help the market strengthen the connection between one stakeholder to another. When one stakeholder needs problem-solving, it can be done more effortlessly since all parties can share their capability and needs in one channel, thus making it easier to connect the supply and demand

Infrastructure and innovation

Infrastructure and innovation concern the technological and infrastructure element in the resource recovery system. The challenges and opportunities are as follows:

Challenges

Technological and infrastructure elements for waste management in Bali still rely on landfill. However, this method does not promote circularity since the waste is disposed of without further processing. In addition, the issue of landfill closing is affecting the whole system, where the waste collectors and processors will not be able to dispose of their residual waste once the landfill is closed. The solution to reducing the amount of waste being disposed of in the landfill is waste

recovery, but the existing waste processing facility is inadequate. Whether it is the smaller waste processors such as TPS3R and Waste Bank or the end processors such as recycling facilities or factories, both are facing the same problem.

In smaller waste processors, the waste processing that they are doing is just sorting and cleaning the materials they receive. Further waste processing is not possible to be done since they lack the funding to have even a simple in-house waste processing technology such as a plastic shredder. On the other hand, the problem with the end processing is the limited available end processors to be chosen for a specific type of material. Currently, materials which are able to be processed locally are only rigid plastics such as PET and PP, while other materials are either sold outside of Bali or disposed of in the landfill.

Developing infrastructure and innovation to promote CE is a cost-extensive process, and it is currently not possible in Bali due to the insufficient available MSWM budget. Limited space, technology, and vehicles with inappropriate conditions to be used in smaller waste processors hinder the MSWM system on a village scale. Due to this, illegal waste dumping is often seen as the solution to disposing of the generated waste, although it only moves the problem from one area to another.

Opportunities

Innovation in technology that can process inorganic, organic, and residual waste in a circular waste system is crucially needed to recover more resources in the future. However, these innovations will not be enough if they are not accompanied by the technical knowledge and capacity of the human resources who implement the technology. If the technology exists but still lacks the capable resources to manage the technology, it will shorten its lifetime and defeat the purpose of innovation. A more stable and robust holistic system is then needed so that the innovation will thrive, and one of the potentials can be seen from a cities/regencies-scale waste processing system. Examples of these waste processing systems are TOSS in Klungkung Regency and Temesi Recycling in Gianyar Regency, where they promote a holistic waste management system that starts from upstream to downstream and is managed by the regencies.

Another innovation promoting circularity in Bali is the implementation of organic farming, where the farmers use compost that is produced locally from organic waste in the village (Private Waste Management Company 1, personal communication, 15 July 2022). Network building on compost production from household scale, village scale (TPS3R), and cities/regencies scale (landfill) is needed to create circularity. The circularity starts when households produce organic waste, which will then be processed into compost in the village or cities/regencies. Compost produced from the village and cities/regencies is then distributed to the farmers, where they will produce organic harvests that are sold to the households again, as shown in **Figure 4.14**.

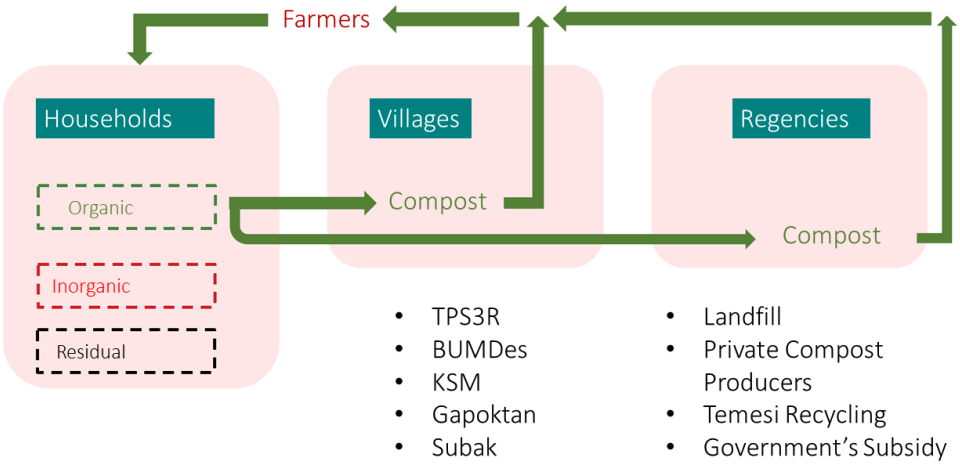

Figure 4.14 Organic material circular economy
Translated from: MPH Bali, 2022

User practices

User practices refer to the behavioural pattern in meeting human needs and values. The challenges and opportunities are as follows:

Challenges

Consumers' choices have the power to change the current regime, which can drive innovation in new business models' development and technologies (Iacovidou et al., 2021). Therefore in Bali, it is important to target the community to create a foundation for establishing a circular MSWM system. Currently, there is a knowledge gap between the policymakers and the ones who are targeted to implement CE, i.e., society. It is also hard to look for the people who are willing to commit to the change long-term, as there are no clear incentives behind the change. This gap in knowledge also causes resistance to change, especially when a physical facility is needed to support the change. People tend to reject the idea of a waste management facility existing in their area since it is perceived as something hazardous, unsightly, and dirty.

In user practice, one of the big challenges in transitioning to CE is the issue of inclusivity of the smaller informal sector in the system. These informal sectors, especially waste scavengers, junkmen, and junkshop, depends on material recovery from waste for their livelihoods. Implementation of CE without concerning the informal sector will diminish their livelihoods. Therefore, it is vital that the measures taken still protect the livelihoods of the informal sector and work on improving their living and working conditions and efficiency (Wilson et al., 2006).

Opportunities

Stakeholders are already aware that public participation is important in realizing CE, and various initiatives for community development and capacity building to implement a circular MSWM system are already taking place. Some of the examples are MPH Bali's program in holistic behaviour change, Bye Bye Plastic Bag community who promotes the reduction of single-use

plastic bag usage, and Malu Dong community which educate people to dispose of their waste in the right place. The goal of these initiatives is to create behaviour change in the people so that they are aware of what is good waste management, what their roles are in it, and what they can do to support the change. The community in Bali are willing to change, given that proper capacity building and facility are provided to them (Expert 3, personal communication, 24 June 2022).

Table 4.3 Summary of circularity challenges and opportunities

Levels of Information	Circularity Challenges	Circularity Opportunities
Resource flows and provisioning service	• Low quality of materials • Mismanagement of waste	• Many materials are still potential to be recycled
Governance, regulatory framework and political landscape	• CE is still around waste recycling issue, not yet into resource recovery • Waste management is not a political priority, and therefore the budget allocation is small • The changing of management • Financial problem: lack of budget for MSWM and injustice waste retribution fee • Lack of human resource who understands CE at a core level • The creation of regulations are not considering the grassroots situation • No incentives on innovations for transitioning to CE • Lack of law enforcement	• BAPPENAS is already aware of the future of CE, and currently creating indicators for CE that can be implemented by other ministries • JAKSTRANAS target on waste management and future JAKSTRANAS target that will explicitly include CE on its goal • Regulation of Governor of Bali No. 47 of 2019 on Source-based Waste Management • Governor of Bali's Decree No. 381 of 2021 on Source-based Waste Management in Administrative Village and Cultural village; there is the possibility to be more acknowledged if done within cultural village scale • Financial solution and enforcement implementation using the calculator provided by Peraturan Kemendagri No. 7 of 2021 • Possibility of update for waste retribution fee • A holistic system that is previously studied and agreed upon which can give a win-win solution to all stakeholders • A hub that can connect the government and all other stakeholders to communicate with each other
Business activities and the market	• The producers are still defensive of their business practice and prefer doing business as usual rather than concerning more CE	• The existence of EPR initiatives from the producers to take back their waste e.g., EcoBali Recycling partnering with the producers, Danone-AQUA initiatives.

Levels of Information	Circularity Challenges	Circularity Opportunities
	• Lack of waste processing business practice that are community-oriented	• A hub to connect the demand and supply of materials from waste and waste product
Infrastructure and innovation	• Primarily relies on landfills, which are currently overloaded • Need more type of waste processing facility to process more types of waste • Limited space, technology, and vehicles for the existing waste processing facility such as TPS3R • Waste illegal dumping often happens	• The addition of technology that can process recyclables to be more valuable in smaller scale facility • The addition of technology that can make the organic waste processing more efficient in smaller scale facility • The addition of technology that can process the residual waste instead of just being dumped to the landfill • The existence of regency-scale waste processing facility such as TPST in Denpasar, TOSS in Klungkung, Temesi Recycling in Gianyar • Organic farming program by MPH Bali
User practices	• Different understanding and knowledge on CE • Finding community that will commit to the change • Resistance on change • Not inclusive towards smaller informal sector	• Stakeholders are already aware that public participation is important in realizing CE • The community are willing to change, if given proper education and facilities

4.3.2. Transitioning toward Circular Economy

Identifying challenges and opportunities is the first step in understanding what the issues are and how we can work around the issues in Bali's MSWM system. To actually be able to transition towards CE, concrete action is needed holistically throughout the system and done in cooperation with all stakeholders. This section will identify the range of measures on how Bali's MSWM system can be brought towards circularity based on the results. The three identified ranges of measures that are needed to create a circular MSWM system in Bali are (1) a holistic system, (2) equal knowledge, and (3) a fair financial scheme, visualized in **Figure 4.15**. All measures have to work together, and when one measure is neglected, it might hinder the other measure from taking place.

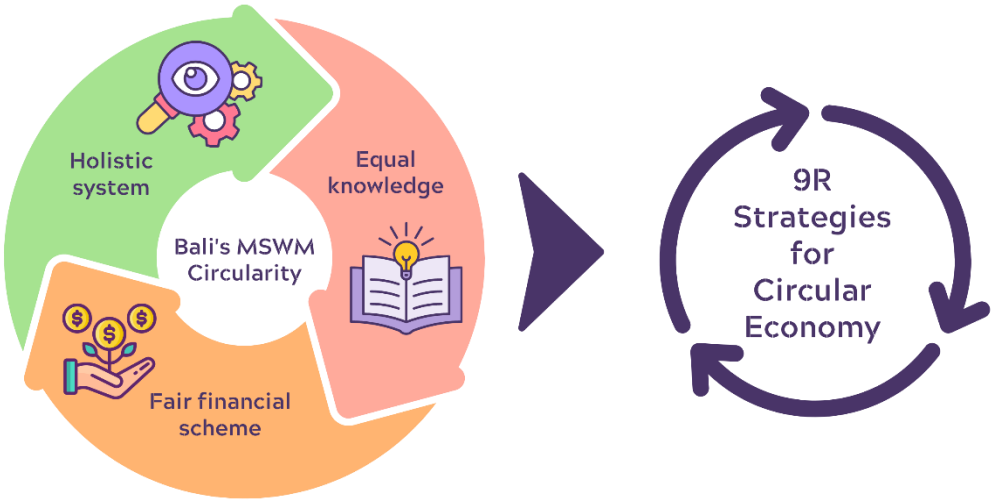

Figure 4.15 Measures for MSWM system transition to CE in Bali

Holistic and robust waste management system as a foundation

The main problem in Bali's MSWM system currently is the lack of a holistic and robust waste management system that can be relied on as a foundation. The current system is also not sufficient to cover all areas and households in Bali, where there are still households that are not being serviced with a formal waste management system. In addition, the development of waste management systems and initiatives focus the most on the busiest region of Bali, Denpasar City, while the other regencies are less attended. **Figure 4.16** visualizes the mapping of the existing recycling efforts and waste management organizations in Bali, where it can be seen that most of them are situated in Denpasar City.

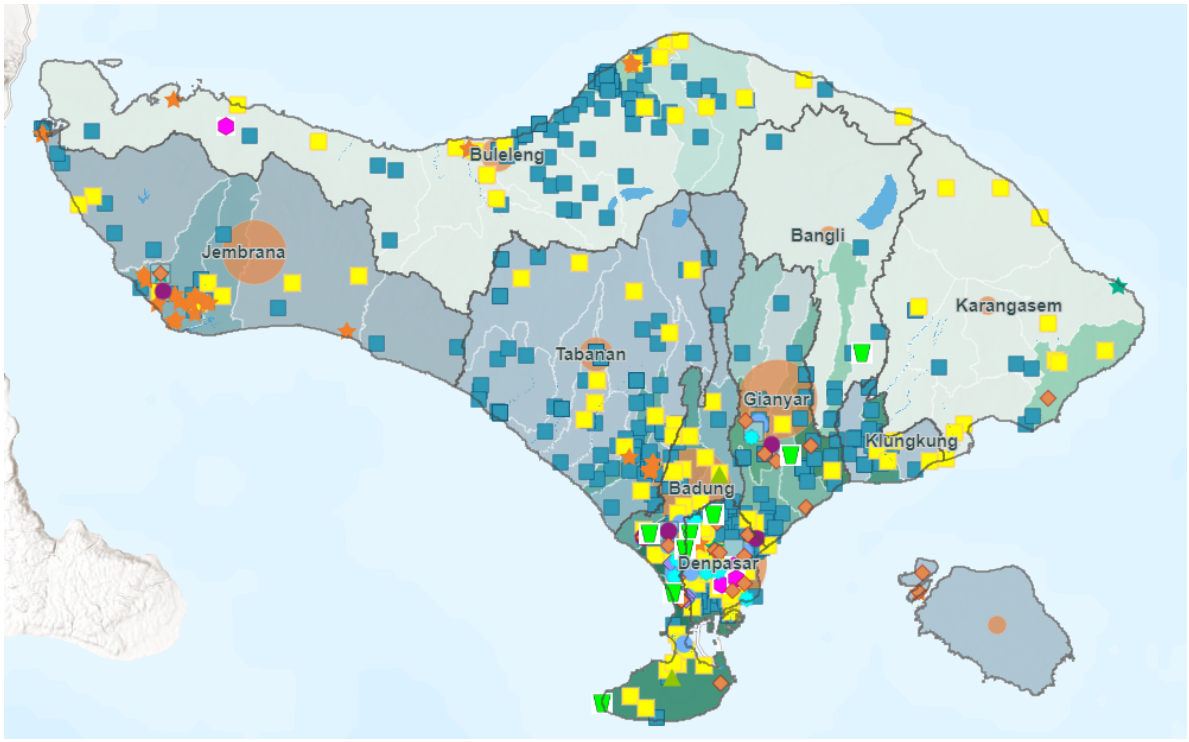

Figure 4.16 Recycling efforts and organization on waste management in Bali; the icons show the identified recycling efforts and existing waste management organizations in Bali, which is mainly located in Denpasar City (Bali Partnership, 2019)

A holistic and robust waste management system can be seen as a system that can support waste management from upstream to downstream and is developed equally in all regions of Bali. This system also needs to be stable, where it does not change and needs not to be too dependent on who the current leaders are. Currently, waste management is not at the top of political interests in Indonesia, and it reflects on how it is in Bali as well. Waste management is a part of environmental services that fall under Non-Basic Services in the mandatory national affairs (SYSTEMIQ, 2021). Therefore, the agendas are created with less priority, giving poor budget allocation and attention to the development of the system.

To be able to create a holistic waste management system in Bali, the first step needed is the evaluation of the current MSWM situation and feasibility study, which is done specifically in the context of each city and region in Bali. This evaluation needs to take into account the regional waste target, JAKSTRADA, and existing regulations for waste management, such as Regulation of Governor of Bali No. 47 of 2019 on Source-based Waste Management, and Regulation of Governor of Bali No. 381 of 2021 on Source-based Waste Management in Administrative Village and Cultural Village. The study also needs to cover the issue of the requirements for economic, social, and technology in each city and regency, as only covering one issue will not serve as a solid foundation for creating a system.

When a firm knowledge of what is needed in the system is identified, the knowledge must be made into action and, most importantly, enforced by the regional government to be implemented in their cities/regencies. All stakeholders involved from the upstream to the downstream in Bali MSWM system need to be involved in the holistic system. The R-hierarchies have to be implemented upstream by the sources as the foundation of a source-based waste management

system. The waste collectors and processors need to operate the MSWM system accordingly to accommodate the waste that is being managed by the sources based on the R-hierarchies. Moreover, to be able to do that, the government must also provide them with adequate waste management facilities and infrastructures for their operation. Downstream end disposal facilities beside landfills also need to be planned, which is expected to accommodate the type of waste that is currently not feasible to be processed technologically, e.g., further development of regional TPST and TOSS. Besides end disposal facilities, an additional variety of material processors/technologies also needs to be supported locally in Bali to reduce the leakage of profits out of the Province. It is to be noted that these new facilities need to be more inclusive towards smaller waste processors, as they are working in a community-based system. If the inclusivity is neglected, the waste could end up being mismanaged as they have no capability or capacity to manage the waste properly. With the planning of a holistic system that is supported by law enforcement and is made in the context of each city and region, an effective MSWM system that could maximize waste recovery is expected to take place.

Equal understanding and knowledge of the core concept of a circular waste management system

Planning and implementing a holistic system is vital in building a foundation for CE. However, the implementation will not take place when there is a gap in knowledge between all the stakeholders. While several initiatives to discuss CE context in Indonesia are already made, e.g., Indonesia Circular Economy Forum, and the analysis of the National Circular Economy Strategy by BAPPENAS, the information sharing on the discussed concept is still lacking. All these discussions mostly approach the issue using a top-down approach, where the implementation at the grassroots is hard to achieve. In addition, even within the governmental levels, the interests, knowledge, and priorities of the leaders differ in each city and regencies, thus making it harder to create an equal system in the whole region of Bali.

First of all, a shared conception of the core concept of a circular waste management system needs to be defined. There is an opportunity where the national government is already aware of the importance of CE and planning to include CE as one of JAKSTRANAS goals in the future. They are also in the process of developing indicators for CE, from the definition to what can contribute to CE, to reduce misinterpretations and mislabelling in the system. The update of JAKSTRANAS to include CE in one of the goals explicitly means that the transition to CE will be formally applied nationally with a target, and all ministries and institutions in Indonesia must follow suit in a similar manners to create a program related to the transition to CE. Furthermore, with the publication of the indicators, these governmental bodies will be able to have a guide on what contributes to CE and what do they have to do to reach the goals that are being targeted. From the national government, the programs and regulations must then be applied by the regional government in the context of their own region, i.e., cities and regencies in Bali Province.

After the programs and regulations are implemented in the local context of each city and regency in Bali, another task of the government is to create community development and capacity building for the operators of the system. These operators can either be the sources, the waste collectors, the waste processors, or other stakeholders related to MSWM system in Bali. Community development is essential to raise awareness among the stakeholders and to give a basic

understanding of why they have to do waste management by themselves. When there is a lack of awareness and understanding, people will tend to choose whatever options benefit them the best, albeit creating an adverse impact on the environment, such as illegal waste dumping or waste burning. The rise of awareness is also needed for the people to be interested in being involved with the waste management systems in their area. Bali focuses on the development of community-based waste management systems, e.g., TPS3R and Waste Banks. However, public participation is a voluntary act where there are no real incentives or punishment when participation is not present. Without the interest of people in managing the facilities, this system will not work and come to a halt when the initial support from the government is stopped, thus making it not sustainable.

When the awareness is raised, capacity building is the next step to increase the effectiveness of the holistic waste management system. Capacity building is important to seek the active participation of the public in waste management, where they will be asked to self-manage their waste. It can start from the sources, where they are educated on how to properly sort their waste and the importance of TPS3R and Waste Bank in processing their materials. Next, the operators of TPS3R and Waste Bank can be educated on how to enforce the circular waste management system in accordance with the infrastructure and technologies that they have. Without an adequate capacity to operate the facilities and infrastructure, no matter how good the design is, the provided facilities will tend to have a shorter lifetime than how they should be. They can also be educated on where the materials should go after the process in their facility to ensure that all the materials are managed responsibly and in a transparent channel. With the combination of community development and capacity building, the enforcement of source-based waste management in Bali is expected to happen more sustainably.

Evaluation of the waste financial scheme in Bali

The financial issue is one of the central issues in implementing a holistic waste management system in Bali. Without sufficient financial support, adequate facilities and infrastructure to provide a circular waste management system will not be possible to happen. However, through the value chain analysis, it can be seen that there are many points of improvement that can be made to increase the budget of the waste management system in Bali.

First of all, there is still a gap in waste retribution fees. This gap happened due to the lack of services in some areas in Bali and the lack of analysis of how much is needed for holistic waste management from upstream to downstream to take place in Bali. Based on a study by SYSTEMIQ, there is still more than a 50% gap between annual CAPEX and OPEX costs to operate a circular system per capita in Indonesia, shown in **Figure 4.17 and Figure 4.18**. The low rate of waste retribution fees also contributes to this gap, where the current waste retribution fees in Bali do not even cover the operational process in one point of the system, such as TPS3R (TPS3R 2, personal communication, 17 June 2022). An evaluation of the current waste retribution fee is needed, where the government can use the tools provided by Kemendagri in Ministry of Home Affairs of Republic Indonesia Regulation no. 7 of 2021 on the procedure of waste retribution fee calculation for waste management execution. After the evaluation and calculation are done, resistance will tend to happen in the public since waste management is currently seen as something that should not have a high price. Another community development to raise awareness on the fee increment is then needed to enforce the new waste retribution fee properly.

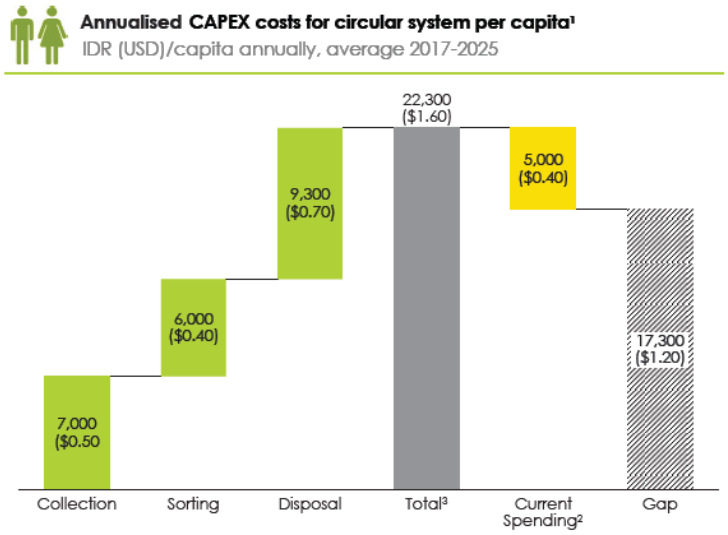

Figure 4.17 Annualised CAPEX costs for circular system per capita (SYSTEMIQ, 2021)

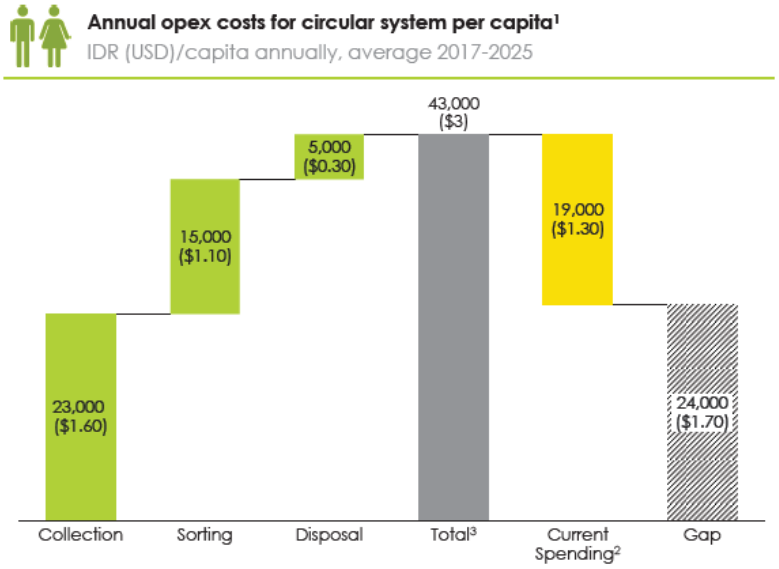

Figure 4.18 Annualised OPEX costs for circular system per capita (SYSTEMIQ, 2021)

Besides the evaluation and calculation of the waste retribution fee, the system can also have financial gain from private stakeholders such as corporates, NGOs, or investors. Corporates, especially producers, need to be responsible for the waste generated from their products. Therefore, the enforcement of EPR scheme based on the KLHK Regulation no. 75 of 2019 needs to be stricter for the waste management system in Bali. CSRs could also provide additional funding to the system, and therefore a regulation on CSR for a waste management system and socialization will benefit the system by contributing to the financial scheme. With the combination of waste retribution fees and external funding, a proper financial scheme needs to be evaluated to cover the whole process of the waste management system from upstream to downstream. Furthermore, after

the evaluation is done, the implementation and education on the realization of the study are expected.

Next step: more than just waste management

Circular Economy in Bali in recent times still focuses on waste management, where the importance of recycling is being highlighted. However, the essence of CE is more than recycling, as it should focus on resource management as a whole (Iacovidou et al., 2021). Once a holistic and robust MSWM system in Bali is steadily implemented, the next step toward circularity as more than waste management can be applied. The R-hierarchies can be adapted from 3Rs to 5Rs, or even 9Rs, where smarter product use and manufacture is the goal of the hierarchies. The 9R framework is visualized in **Figure 4.19**. To be able to achieve Circular Economy, **systemic change** is needed where rethinking products are the first step to redesigning the whole system into one that generates no waste to the landfill. Whether it is by lengthening a product's lifetime through the Reuse, Repair, Refurbish, Remanufacture, and Repurpose strategies or by extending its life through Recycle and Recover, Circular Economy will only happen when there is cooperation from all stakeholders and a solid foundation of waste management in the system.

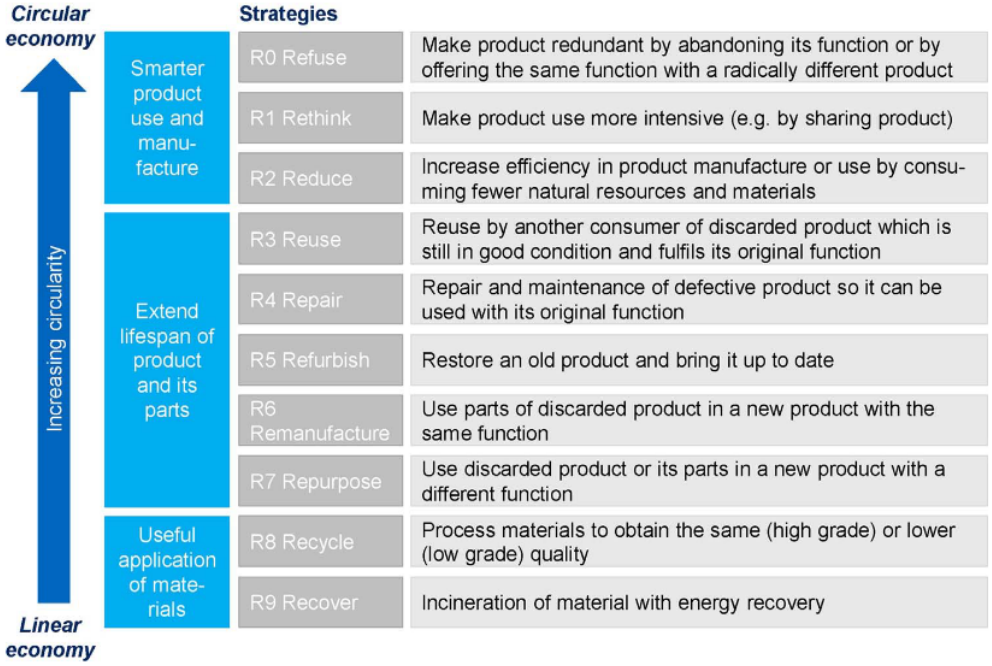

Figure 4.19 The 9R Framework (Kirchherr et al., 2017)

5. Discussion

This chapter will delve into the results in more detail. First, the discussion will focus on the implications of using VCA for the improvement of a MSWM system through CE context in Bali. Second, the results will be explained through the main challenges and opportunities of transitioning towards CE in Bali for their MSWM system.

5.1. Main challenges and opportunities for transitioning to CE

This section will present the main challenges and opportunities for transitioning to CE based on the findings found in Chapter 4.

Main Challenges

The main challenges of the transition are the lack of funding to promote circularity, the lack of a robust waste management system, and the lack of knowledge and capacity of the stakeholders. The lack of funding in the system happens to all levels of stakeholders, whether they are the policymakers, the sources, waste collectors, or waste processors. In governmental scape, waste management is not being pushed as one of the important issues, and therefore the budget is not enough to cover the costs of a basic waste management system, moreover to create a change in transitioning to CE. This issue is brought down to the lower levels, where it affects the operation of waste management on the village scale. These stakeholders who are managing waste on a village scale receive little to no money for waste management and therefore depend on the sources to provide income for them to operate the system. However, the income from the sources is not at its 100% potential yet. There are still many people who do not pay for the waste management services or pay for it but in a much lower amount than what is needed to cover the waste management operation.

The lack of a robust waste management system happened as there are political interests in implementing a waste management system. For example, the governmental management is changed periodically, and every time the management change, the pushed programs or the main issue of importance keep changing, and therefore there is a lack of inconsistency in the system. The lack of law enforcement also enhances this challenge, where the system ends up really depending on the leader whether to apply a sustainable MSWM system or not and not depends on the implemented regulations. The lack of knowledge and capacity to create a circular MSWM system also happened to various levels of stakeholders. The stakeholders lack a core understanding of CE, and therefore it is hard to implement a circular waste management system in Bali.

Main Opportunities

In order to change the current MSWM system to CE, the main challenges that are found can be reversed for the analysis of the main opportunities. The main opportunity is the possibility of creating a robust circular waste management system through the plan of implementing CE as the future national goal. This opportunity will change the landscape where the waste management system is implemented, as there will be a force of regulations for the national, regional, and local government to change their system into one that fits CE. This will help in developing an enabling

environment, and this change in the landscape will affect the whole system, starting from the upstream to the downstream. For example, the regional government will create regional goals based on the national goals that implement CE in the system. Next, local and village targets will be derivated from the regional targets and create an enabling environment for CE transition to happen. Source-based waste management systems in Bali will be more enforced to spread evenly in all villages of Bali, and the means to increase public awareness will be promoted through community development and capacity building in order for the system to operate. The waste collectors and operators will also be affected by this goal, as there will be an increase of importance for waste management issues, and the infrastructure and facilities of the operation will be developed to help the waste collecting and waste processing process. This change in the landscape will also promote niche innovations to emerge in the system, such as future research in the recyclability of materials in Bali to increase the resource efficiency of the system or new processing technology to be applied in the system.

However, of course, these opportunities will not happen without law enforcement from the government. As what happens currently, there is already a national target on waste management in JAKSTRANAS, but the enforcement of the target itself is still low. Therefore, first, enforcement is needed, and next, the cooperation of all levels of all stakeholders is important for the transition to CE to take place.

Transitioning to CE

Transitioning to CE needs a systemic change where the whole agents in the system must cooperate to be involved in the transition. Not only the agents but the enabling environment also has to be set for a niche transition to emerge and create a change in the current waste management landscape in Bali. By using the 9R framework, redesigning the whole system into one that extends the lifetime of a product and avoids the creation of waste at all costs is needed in the future. However, it is to be taken into the importance that this systemic change can only be done once a robust waste management system is made in Bali and all stakeholders involved are willing to cooperate in the change.

5.2. VCA for the improvement of MSWM system in CE context

MSWM issue is a complex problem where there is interdependence between various stakeholders and their activities. An interdisciplinary approach such as VCA is needed to analyze the system more comprehensively since VCA is argued starting from industrial economics to an agent's strategic behaviour. In addition, value chain is closely related to CE, as CE itself introduces a closed-loop value chain through the exchange of products, and the transformation towards closed-loop value chains should always be considered in CE transformation studies. In this study, an overview of the whole MSWM system in Bali is first analyzed to understand the underlying background of the MSWM system and how it operates in recent times based on five different aspects of waste management. These five different aspects are regulations, institutions, technical and operational, finance, and public participation, which shows the pattern of standards in Bali's

MSWM system. By initially recognizing how the general system operates, it will then be easier to notice the obstacles and points of improvement when notions from various sectors are gathered.

Next, the main analysis is done through VCA, where systems analysis and stakeholder analysis are integrated to create a comprehensive VCA of the MSWM system in Bali. Systems analysis examines the elements and linkages in a system. By looking into these elements and linkages, the shortcomings between one element to another are displayed and imply the challenges that arise for these elements to be connected sustainably. There are two systems in Bali's MSWM system that are currently being applied. One is the conventional collect-transport-dispose system, and the other is the source-based waste management system. The source-based waste management system is the current system that is being developed for the whole Bali Province, and therefore looking more into details of the system is done as it is more responsive to the current environment in Bali. The MFA of the system is also analyzed to understand the quantification of the flow and look into the leakage that is happening in the system. When leakage is happening, it shows that there are challenges for the agents to create a sustainable MSWM system, and it can be seen as a hotspot for improvement.

Stakeholder analysis unveils the aggregation of the agents into stakeholder groups who perform the activities in the system. Through this stakeholder analysis, the connection between one group to another is visualized. The pattern of connection between one group to another can be seen in the mapping, and it helps to understand their role and their underlying motivation for doing the role. It also uncovers what is needed by each of the stakeholder groups and how their connection to another group affects their activities. The stakeholders can be aggregated into seven different groups, which are policymakers, educators/donors, the source of waste, waste collectors, waste processors, waste sellers, and end processors. Not all groups are the ones who are doing the operation of the system. Policymakers and educators/donors are not involved directly in operation, but they are influencing the landscape of the system and therefore have equal importance to the system.

The value chain of the system is then produced by integrating systems analysis and stakeholder analysis into one value chain mapping. Both analyses complemented each other as the activities are done by the groups of stakeholders, and there is added value from the activities that are done. The added value is the documentation of the distribution of income and benefits. Furthermore, as a result, it is found that financial issue is one of the prominent issues, especially in creating a sustainable MSWM system in Bali. The monetary flow helps to look into the improvement potential of each point to generate more benefits for the system and promote a more sustainable system in the future. Although the findings of VCA focus on an economic perspective, various perspectives entailed the result of the findings, such as political, technological, social, and environmental perspectives. This shows that MSWM is a complex process where VCA, as an interdisciplinary analysis, can see into these various perspectives.

The VCA provide insights on the challenges and opportunities to transition into CE. When it is integrated with the five levels of information in the systems thinking approach, the key information of the drivers of the current practices towards CE can be looked into, and the challenges and opportunities are provided in five different holistic aspects. From the findings, it can be seen that although finance is one of the most prominent issues, there are other issues interconnected to the financial issues themselves. They are the lack of a robust system and the need for knowledge and

capacity building. Furthermore, it can also be seen that the government are involved in all of the five levels of information. The government has the capacity to create a landscape that will force the other stakeholders to follow into the transition towards CE. For example, the plan of putting CE as one of the goals in JAKSTRANAS will force the regional government of Bali to further put waste management and CE as their issue of importance. When the enforcement is applied, the other stakeholders will have no choice but to change their own mindset and system to one that follows the transition to CE.

The results and analysis see the value chain from multiple perspectives, which refine the observation of the challenges and opportunities for the transition. However, there is also an issue of generalization when this is applied to the whole MSWM system in Bali. Bali Province is a big province consisting of one city and eight regencies, and therefore there is a lack of depth in the analysis. Each area also has different characteristics, where the development, detailed system, and groups of stakeholders might differ from one to another. Nonetheless, VCA proved to be an interdisciplinary approach that gives an overview of the value chain of the MSWM system in Bali and its challenges and opportunities to transition to CE. This can be served as a building block for future studies, where a more detailed analysis of the system, such as pointing at one of the important activities or focusing on one cities/regencies in Bali, can be done.

5.3. Scientific contribution of the study

This section will discuss the scientific contribution of the study, where it contributes to the methodological scope and recommendation for the circularity.

Contribution to the methodology of VCA analysis

Current literature on VCA for MSWM and CE is still limited to the application of VCA for a specific agent, activity, or product (Cano et al., 2022; Guabiroba et al., 2017; Dahlström & Ekins, 2006; Jaligot et al., 2016). However, as the research approach of this thesis is the usage of Value Chain Analysis for analyzing transition of Bali's MSWM system to Circular Economy, the scope needs to be broaden into an analysis for the whole system. The basis of methodology used is the VCA toolkit from Jaligot et al. (2016) where VCA is used to analyze the value chain of the informal recycling sector in Cairo, Egypt. To broaden the scope, the methodology is then adapted to cover the analysis of the whole system. The Systems Thinking approach of 'Five Levels of Information' by Iacovidou et al. (2021) is then implemented into the methodology of the study to complement the analysis by looking into the enabling conditions for the transition towards CE. Therefore, the methodology of this study can contribute in filling the gap where a discussion of a holistic view on MSWM, and looking into the value chain of the system is created.

Contribution to the circularity of waste management system in Bali

The result of the study provides a recommendation for the measures needed by the stakeholders in Bali to transition towards Circular Economy. Besides the measures as the end output, this study also provides the analysis of MSWM system in Bali, who are the stakeholders involved, and what activities of in the value chain could contribute to the improvement of a more circular MSWM system. From the analysis, it can be seen that although VCA seeks the monetary flow in the value chain, the actual improvement of the system can only be made when a multi-dimensional aspect

is being considered. All economic, social, technological, political, and environmental aspects are of equal standings that need to be considered, which when one aspect is missing the system might not work as effectively as it should be.

5.4. Limitation of the study

Circular Economy is a relatively new concept in Indonesia, especially Bali. This research tried to delve into the concept and seek the possibility of the system's transition from a linear economy to a circular economy. With differences in interpretation and implementation for CE in MSWM context, this thesis holds its limitations and this sub-section will discuss further on the limitations it entails.

Issue of generalization

The geographical scope and system boundary of the research is relatively broad. All nine cities/regencies of Bali are taken into account in the research, and the whole MSWM system in Bali is made as its system boundary. This creates a generalization issue in the analysis, assuming the same situation happens in all regions of Bali. However, this assumption might inaccurately portray the MSWM system when it is taken to the context of one specific village in Bali, as the initial condition of one village to another differs.

Time and geographical limitation

This research is conducted in a limited timeframe where the scope of the thesis is made to fit within 30 ECTS. No comprehensive explanation of each city/regency in Bali has been done as the analysis assumes the same conditions apply to all cities/regencies in Bali. There is also a geographical limitation where the researcher is located in the Netherlands, while the research takes place in Bali, Indonesia. No field research was done, and all the data collection processes are done either through literature review or in online settings. The data collection method created biases as it is harder to capture the actual behaviour of the stakeholders in an online setting. In addition, online interviews with informal sectors were not possible to be done, and therefore there were no interviews done with the informal sectors. To cover for the lack of data in the informal sector, an additional interview with an expert who focuses on the informal waste sector in Bali was conducted. Nonetheless, this acquired data might not be accurate since it is collected from the point of view of third parties where their interpretations are present and not the actual stakeholders involved.

Limited information acquired on the quantitative economic value for value chain

In value chain analysis, adding the value of each activity is a standard practice to document the distribution of income and benefits along the value chain. Due to the combination in the limitation of generalization and limited information acquired during the data collection in this research, the quantitative economic value could not be documented. Even though the general economic activity that happens in the chain is described, this limitation makes it harder to focus the results on the financial design of the system.

6. Conclusion and Recommendation

This study explores the challenges and opportunities for the transition toward Circular Economy on Municipal Solid Waste Management in Bali, Indonesia. By employing an interdisciplinary approach, while the issue focuses on the economic perspective, all other perspectives entailing the issues, such as environment, social, political, and technological perspectives, are also being discussed. This chapter answers the formulated sub-questions that will lead to the answer to the main research question. Lastly, the recommendation for future research will be presented.

6.1. Conclusion

This section will answer the research questions formulated for the study. First, the sub-questions will be answered in order, and lastly, the answer to the main research questions will be explained through the findings of the sub-research questions.

Sub-research question 1

"What is the current waste management situation in Bali?"

Waste management in Bali is in a dire situation, where the system still mostly uses the conventional collect-transport-dispose system. It also relies a lot on the landfill as the main end processing site. However, there is an issue where the biggest and one of the regional landfill of Bali, Suwung Landfill, will be closed due to overflowing. To tackle the problem of waste management, the government released Regulation of Governor of Bali No. 47 of 2019 on Source-based Waste Management and Governor of Bali's Decree No. 381 of 2021 on Source-based Waste Management in Administrative Village and Cultural village. These regulations are created in order to promote sustainable waste management where the sources are the most responsible stakeholders for the waste, and therefore hoping to reduce the amount of waste disposed of in the landfill. While these regulations are already applied in many villages, most of the development still focuses on the city, and the rural areas still lack development. There is also much mismanagement of waste happening in Bali, where 34.45% of waste is still mismanaged. This leakage of waste is affecting health and the environment, where most of the waste is just disposed of freely on empty land and creates pollution. While 54.06% are processed in the landfill, there is still much potential for material recovery as most of the waste that is processed in the landfill is mixed waste instead of just residual waste.

Sub-research question 2

"What is the current municipal solid waste value chain in Bali?"

The current MSW value chain in Bali can be seen through the five groups of activities in the system, which are waste disposal at source, waste collection, waste processing, waste market, and end waste disposal. First, the waste disposal at the source is affected by the sources, which are the commercial and residential areas where they pay waste retribution for the operation of the system. This waste retribution fee is not yet optimum. In the future, the optimization of the fee is preferable. Second, waste collection is done by formal waste collectors and informal waste collectors, where formal waste collectors receive money from the village budget and use it for the

costs of waste collection operation. When a source-based waste management system is not implemented, most of the waste is still mixed and disposed of in the TPS, and therefore both formal and informal waste collectors often scavenge the valuable materials from the depo. This will create an additional income for them, as well as reduce the burden on the landfill. Third, waste processing is exhibited by TPS3R, Waste Bank, and intermediate informal collectors, where they process the collected waste into materials or products with more value. This basic processing for inorganic waste is sorting and cleaning of the materials. However, further processing can still be implemented to gain the optimum value, such as shredding, baling, or even processing into a plastic pellet. As for organic waste, the most common processing is the composting method and the creation of feedstock from waste. Networking between the producer and consumer of waste products is needed in this case as there is more supply than demand in the current market.

Fourth, the waste market entails the waste product consumer and end processors, who are the consumers of the materials and products that are created in the system. In the market, a fair trade concept still needs to be enforced as currently, the market is controlled by individuals who only want to gain the greatest benefits without considering the well-being of the other stakeholders. Last, end waste disposal is the disposal to the landfill and mismanagement of waste, which still faces a financial problem as the current budget is not enough to cover the whole waste management process. The mismanagement also shows leakage where an additional cleanup is needed and therefore creates additional costs to the system. It is important for the policymakers to analyze the actual budget for the whole waste management in order for the issue to be pushed forward. Outside of the main activity, there are also monetary flows affecting the system, which are the governmental budget and grants. The current government budget allocated to waste management in Bali is still far from enough. Therefore, the proposal of the actual budget is needed to be able to make waste management a priority issue. Grants can also help in the funding of waste management systems as the current funding is not sufficient. However, it is important for the granters to develop more on a program with long-term effects compared to ones with short-term effects to create a more sustainable impact on the recipient of the grants.

Sub-research question 3

"What are the challenges and opportunities, and how do we transition towards a more circular municipal solid waste management in Bali?"

The challenges and opportunities in transitioning to a more circular MSWM system in Bali can be seen through the five levels of information, which are resource flows and provisioning service, governance, regulatory framework and political landscape, business activities and the market, infrastructure and innovation, and user practices based on the previous analysis on VCA. First, in resource flows and provisioning services, the circularity challenges happened due to the low quality of materials in the system as it is currently mixed and mismanagement of waste. However, this also shows that there are still many potentials for the materials to be recovered, which needs the right waste system to happen. Second, governance, regulatory framework, and political landscape show that the current political landscape in Bali is not yet the optimum enabling environment for the transition to CE. While some regulations are already made, the monitoring and enforcement of the regulations are still low and thus need to be evaluated. However, the regulations in Bali itself

already show support for creating a circular waste management system, and CE is also being considered to be one of the national goals. This will stir a change in the landscape and push other stakeholders to align with the transition to CE. Third, business activities and the market shows that there are already innovation and business practices that promote circularity, such as EPR or organic farming program. Nevertheless, these are not enough, and many of the producers are still defensive about their business practices as a change to circularity will reduce the profits that they are expecting to gain and the consumer's interest in their products if the price increases. Fourth, infrastructure and innovation displayed that there is inadequacy in the existing waste management infrastructure and facility. Innovation in a suitable technology to process all the unmanaged waste is needed in order to reduce the amount of waste disposed of in the landfill and to promote the circularity of the materials. Lastly, user practice is one of the important aspects, however, there is still a lack of public awareness and knowledge of what is a good waste management system and CE. The lack of understanding further escalated to another problem, such as the resistance to change or finding people who are willing to commit to the change. At the same time, the stakeholders realize the importance of public participation in the system. Therefore, proper knowledge sharing, community development, and capacity building are needed to increase user practices in the system.

Main research question

"How can value chain analysis be used for the transition towards circular economy for the current municipal solid waste management in Bali?"

Transitioning to CE is not a simple task where it can be solved with one solid solution. There is interconnectedness between all the activities and the stakeholders, and therefore in order to transition towards CE, the holistic system from the upstream to the downstream need to be brought into the light. The value chain analysis shows that although financial is the most mentioned problem among all the stakeholders, the actual improvement to transition towards CE cannot be made solely by giving more money to the system. First, there needs to be a robust circular waste management system created in order for the system to work sustainably. This can be done by the policymakers by creating a regulation that promotes circularity in the system. However, the creation itself is not enough to stir a change in the current system and push innovations to appear. Monitoring and enforcement are needed for the waste management landscape to change. Once the law enforcement works, the stakeholders involved in the system will have no choice but to follow the rules and therefore create a change in the transition. A robust system will make sure that when the stakeholders are ready, the environment supporting the readiness will not change and, therefore, a real transition will occur.

Second, the agents in the system need to have an understanding and knowledge of the core concept of a circular waste management system. This is important so that the new system will be implemented in its optimum state and maximise the value that can be gained out of the circular system. When there is a knowledge gap between the stakeholders, a system that is being promoted might not be sustainable and ends up being stopped before it reaches its goal. Community

development and capacity building at all levels of stakeholders are important, but they also have to be in context with the knowledge that they actually need. The stakeholders are willing to do the change, however, there is still a lack of understanding in applying the change. Once there are common conceptions and understanding, it will create a smoother transition to CE.

Last, the funding for waste management in Bali needs to be evaluated to be more in accordance with the reality of the waste management situation in Bali. As there is not enough funding even to provide a 100% waste management system to the whole area of Bali, a transition to CE will be hard to be done. Therefore, the current waste retribution fee needs to be analyzed according to the calculator provided by Kemendagri, to know how much is the actual costs of a waste management system in the whole Bali Province. Once the costs are known, the sources need to be educated on their responsibilities for the waste retribution fee in order to maximize the budget that can be gained. The possibilities of external funding, such as from investors or private companies, can also be explored to create additional income or the development of the system.

Once a robust system is created and funded accordingly, then the transition to CE can be promoted in the system through the implementation of rethinking and redesign of the system.

6.2. Recommendation

6.2.1. Recommendation for CE transition on MSWM system in Bali

From the analysis and discussion, several recommendations can be made in order for the MSWM system in Bali to transition to CE.

Creating a holistic and robust MSWM system

In transitioning to CE, it is important first to create a solid foundation for the transition to happen. Currently, the MSWM system in Bali is still unequal and not well translated in all villages of Bali. It is also not categorized as one of the important issues in the political landscape, and thus there is little political interest in further developing sustainable waste management in Bali. Although a source-based waste management system is being enforced, the rate of enforcement is still low where it focuses mostly on the city, while the rural areas are still less developed. Therefore, it will be hard for a transition to happen as the current condition of all areas still differs a lot. By creating a solid and robust waste management system and enforcing the system equally, a plan for the change to CE can then be implemented.

Equal knowledge for all stakeholders through community development and capacity building

Community development and capacity building of the stakeholders are important as they are the ones who will implement the system that is being applied. Currently, there is still a lack of public awareness on what constitutes sustainable waste management. This lack of public awareness resulted in misconceptions in the waste management system, whether it regards the roles of each stakeholder, how to operationalize the provided technology or even the implication of waste in the environment. Each stakeholder has different interests and needs, and the knowledge gap will only create a bigger issue in the difference of interests, where one stakeholder might not want to

cooperate to create a circular waste management system. However, with the proper community development and capacity building of the stakeholders, a common ground of CE in the MSWM system can be created, and therefore a win-win solution for all the stakeholders can be reached.

Developing a fair financial scheme in waste management

The financial issue is one of the most prominent issues being mentioned by all of the stakeholders in Bali's MSWM system. The lack of budget to fund the whole MSWM system created a problem where not all areas of Bali have the privilege of being serviced with a waste management system. This further leads to the mismanagement of waste, where instead of processing the waste in a waste management facility, disposing of it on empty land, water bodies, or burning are preferable. A fair financial scheme is then important to be applied. The fairness is not only fair as in to be implemented in all areas of Bali Province but also fair as it considers the people's capability to pay and the actual costs of providing a waste management system. When the fair financial scheme is developed, it will create an opportunity for a solid foundation of a waste management system to be implemented equally and for future plans of CE transition to happen

Next step: towards circular economy

After the whole circularity strategy in Bali's MSWM, starting from the holistic system, equal knowledge, and a fair financial scheme is implemented steadily, the next step is moving towards CE, where the systematic change in the system is needed. This systematic change can be done through the rethinking of the system, with the goal of extending the life cycle of a resource and avoiding waste from being generated at all. It can be done step-by-step by first implementing 5Rs and following the 9Rs as the future goal. In order for the systematic change to happen, all stakeholders in the system need to be in cooperation with each other to make sure that the system is inclusive and benefits everyone.

6.2.2. Recommendations for future studies

In this study, there is still a limitation of the generalization of the analysis, where it might inaccurately portray the MSWM system when it is taken to the context of one specific village in Bali. Further research can be conducted to dive deeper into a smaller system boundary, whether it is from the geographical boundaries or the choice of activities that are taken as the boundaries. For example, research focusing on the recycling sector in Jembrana regency will provide essential insights to the stakeholders in Jembrana to create a circular waste management system that is in accordance with the local context. Furthermore, the challenges, opportunities, and recommendations that are found in this study can also be explored further. For example, future research can focus on the infrastructure and innovation that are needed in order to transition to CE based on the local context and what efforts are needed from all levels of stakeholders to tackle the challenges explained.

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Appendix A – Third Party Data Collection

As the research involves datasets collected from human participants, the data collection is in accordance with the ethics assessment required by TU Delft. The assessment involved Humen Research Ethics Checklist (HREC) and Data Management Plan (DMP) based on the template provided by TU Delft. HREC was completed to make sure that there are no risks for the participants in participating in the research, and if there are few risks, mitigation measures are already planned beforehand. DMP will make sure that the processed data will be stored securely, with a clear list of who can access the data to prevent data leakage. The assessments are then reviewed by the Faculty Data Steward. Once reviewed and revised, the documents are then submitted to the Ethics Committee for approval. After approval is given, the data collection from datasets collected from human participants can be conducted.

The third-party data collection is done through the extraction of data from documents or reports that are personally retrieved from various waste management stakeholders in Bali, Indonesia. This third-party data collection was done with the purpose of complementing the results of the literature review and interviews, especially for detailed data concerning numbers or figures, or a summary of previously done research by the experts.

Appendix B – Interview Protocols

All interviews were held in an online setting due to geographical constraints between the researcher and the interviewees. All interviews were held in Indonesian and later translated for transcription to English by the researcher. All participants were asked for consent to record the online interviews and data usage in the report. The recordings will only be accessible by the researcher and destroyed after the thesis project is complete. The transcription will be made anonymously, where only the numbered sector is written in the thesis report when referring to the interviewees. The transcription will provide the summary of each interview based on the questions made in the interview guide. The result will be analyzed manually, by comparing answers of the same questions from various perspective of the stakeholders.

B1 – Interview Request

To be able to conduct the interview, formal interview requests were made by the researchers to the interviewees through various means. Since the researcher is from Indonesia and has a working background in the waste management sector in Indonesia, the most efficient means of communication is through a messaging client, WhatsApp, as it is the most popular means of communication in Indonesia currently. The personal contacts were retrieved through the researcher's links of networks, and the initial introduction was mainly made through the messaging client. After the introduction, some communications were continued through formal exchanges of emails, while the others continued through the messaging client. For some interviewees, formal interview request letters were needed to conduct an interview.

B2 – Informed Consent Form

An informed consent form was sent after both sides agreed on the interview dates. The informed consent form provides the overview of the interview, along with the data management during and after the interview. The form was made based on the templates provided by TU Delft that conform to GDPR rules. The Informed Consent Form is shown in **Figure B.1** and **Figure B.2**. However, some interviewees consider filling out the consent forms a hassle. To tackle the issue, verbal consent was asked for and recorded before the start of the interview for all of the interviewees.

Informed consent form
for research with human participants

Authors : Sandy Indriana, based on templates provided by TU Delft
Last edited : 04 July 2022

You are being invited to participate in a research study titled "Transitioning towards Circular Economy on Municipal Solid Waste Management in Bali, Indonesia". This study is being done by Sandy Indriana from the TU Delft.

The purpose of this research study is to understand the current municipal solid waste management system and value chain in Bali, Indonesia, as well as the challenges and opportunities that for transitioning to circular economy, and will take you approximately 45 – 60 minutes to complete. The data will be used for master thesis research project. We will be asking you to answer questions related to the current municipal solid waste management situation, your job description in the system, as well as the pain points that you could think of in the system. The information discussed will not be commercially sensitive as the questions will highlight about your views of the current municipal solid waste management system and what is needed to change it rather than specifically targeting your programs/products.

The interview will be conducted online, through Zoom/Teams. As with any online activity the risk of a breach is always possible. To the best of our ability your answers in this study will remain confidential. The interview will be video-recorded, and to minimize any risks it will be stored in researcher's personal cloud drive, and deleted once the research is completed. The interview data (video-recording) will not be stored anonymously, however only your name and/or job description will be shown in the report if consent are given. If you are not consenting to your name and job description being written, you can choose to anonymised your name and job description, however which sector you originated from will be shown.

Your participation in this study is entirely voluntary and you can withdraw at any time. You are free to omit any questions.

For more information and questions, you can contact the Responsible Researcher during the project:
Name : Sandy Indriana
Phone number : +46739725992
e-mail : S.Indriana@student.tudelft.nl

And after the end of the project, you can contact the Research Supervisor:
Name : Dr. ir. Jaco Quist
e-mail : J.N.Quist@tudelft.nl

Figure B.1 Informed Consent Form Page 1

	PLEASE TICK THE APPROPRIATE BOXES	Yes	No
GENERAL AGREEMENT – RESEARCH GOALS, PARTICPANT TASKS AND VOLUNTARY PARTICIPATION			
1	I have read and understood the study information above, or it has been read to me. I have been able to ask questions about the study and my questions have been answered to my satisfaction.	☐	☐
2	I consent voluntarily to be a participant in this study and understand that I can refuse to answer questions and I can withdraw from the study at any time, without having to give a reason.	☐	☐
3	I understand that taking part in the study involves: • A video-recorded interview • A transcription of the video recording • An anonymised summary of the interview • Deletion of interview recording once the research is completed • Storage of pseudo-anonymised transcript for max 1 year in a secure storage at TU Delft	☐	☐
POTENTIAL RISKS OF PARTICIPATING (INCLUDING DATA PROTECTION)			
4	I understand that taking part in the study also involves collecting specific personally identifiable information (PII) which are name, email, and phone number, and associated personally identifiable research data (PIRD) which are my general job description and the sector I am associated with the potential risk of my identity being revealed.	☐	☐
5	I understand that personal information collected about me that can identify me, such as email and phone number will not be shared beyond the study team.	☐	☐
6	I understand that my associated PIRD such as my general job description and the sector I am associated with can be quoted in research outputs.	☐	☐
7	I agree that my exact statement from the interview can be quoted anonymously in research outputs.	☐	☐
(LONGTERM) DATA STORAGE, ACCESS AND REUSE			
8	I understand that after the research study the anonymous summary I provide will be used for Sandy Indriana's master thesis report that will be published in TU Delft open repository, and journal publications.	☐	☐
9	I give permission for the pseudo-anonymous data regarding municipal solid waste management in Bali that I provide to be archived for a maximum of one year in a protected OneDrive so it can be used for future research and learning.	☐	☐

SIGNATURES

_____	_____	_____
Name of Participant	Signature	Date

I have accurately read out the information sheet to the potential participant and, to the best of my ability, ensured that the participant understands to what they are freely consenting.

_____	_____	_____
Name of Researcher	Signature	Date

Figure B.2 Informed Consent Form Page 2

B3 – Interview Guides

The interviewees are gathered from various perspectives of MSWM in Bali, which are the Government (stakeholders influencing the system), Waste Bank, TPS3R, Private Waste Management Company, and Informal Sector (stakeholders in the system), and Researchers/Experts (stakeholders overseeing the system). An interview with national or regional governmental bodies is arranged in order to cover the understanding of the environment of the system encapsulating and influencing the MSW value chain. An interview with Waste Banks will examine the view of the community-based waste processors, while an interview with TPS3R will seek into the view of the waste collectors and waste processors that is community-based but developed by the government. Private Waste Management Companies will provide insight on the operational side of waste management, starting from the collection up to the end-of-life of the waste. The informal sector will supply the information on the informal sector side of the system, as informal sectors are always present in the system but often neglected. Lastly, the Researchers/Experts will provide a view of the whole system in general. The interviewee list can be seen in **Table B.1**.

Table B.1 Interviewee List

No	Sector	No	Interviewee	Role
1	Government	1	Government 1	Governmental body for Indonesia, with one of the agencies focusing on the environment and currently doing research on Bali
2	Private Waste Management Company	2	Private Waste Management Company 1	A company that focuses on behaviour change in MSWM
		3	Private Waste Management Company 2	Private waste collection company in Bali
3	Waste Bank	4	Waste Bank 1	Central Waste Bank in Bali
		5	Waste Bank 2	Unit Waste Bank in Bali
4	TPS3R	6	TPS3R 1	Active TPS3R in Denpasar City
		7	TPS3R 2	Active TPS3R in Badung Regency
5	Research/Experts	8	Expert 1	Lecturer in Indonesia's university who is actively doing research on municipal waste management system in Bali
		9	Expert 2	A representative from a collaboration effort between several universities, government, and private companies on the municipal solid waste management system in Bali

		10	Expert 3	A representative from a company that did research on municipal solid waste management system in Bali together with the Government
		11	Expert 4	A representative from a waste management initiative in Bali
		12	Expert 5	Waste management expert who is involved in Bali's governor waste working group
		13	Expert 6	PhD Candidate who is doing research on the informal waste sector in Bali

The interview guides were made to create the structure of the interviews and to provide the basis of the analysis by comparing answers to similar questions. The interview guides were made for each of the stakeholder groups, as each group have different goals of information that are being explored. The interview guides are as follows

Government

To understand:

1. MSWM condition as a whole
2. The formal flow of MSW
3. Rules & regulations that goes around MSWM system
4. Future plan of MSWM (whether it align with CE or not)
5. The barriers and enablers on the change

Questions:

Sub Research Question	Topic	No	Question (English)	Question (Indonesian)
0	General Question	1	Please introduce yourself, your name and role in XXX (insert the organization's name) and how is your work related to MSWM in Bali	Silahkan perkenalkan diri anda, nama dan peran anda dalam XXX (masukkan nama organisasi terkait) dan bagaimana peran dari pekerjaan anda dalam pengelolaan sampah di Bali
1	Insight on current MSWM	2	What are the main developments and issues related to MSWM in Bali?	Apa yang menjadi isu dan perkembangan utama yang terjadi pada pengelolaan sampah di Bali saat ini?
		3	Why does MSW become a problem in Bali? What are most important problems and issues?	Menurut anda, mengapa sampah rumah tangga menjadi masalah di Bali? Apa yang menjadi masalah utama?
		4	Are there any rules and regulations related to MSWM in Bali? a. For whom are those regulations applied?	Apakah ada peraturan terkait sampah rumah tangga yang berlaku di Bali? a. Untuk siapa saja peraturan tersebut berlaku?

Sub Research Question	Topic	No	Question (English)	Question (Indonesian)
			a. How are the regulations enforced?	b. Bagaimana peraturan tersebut ditegakkan?
2	Systems Analysis	5	How does the current MSWM system works in Bali and how do you position your organization in the system?	Bagaimana alur dari sistem pengelolaan sampah di Bali dan bagaimana anda memosisikan organisasi anda dalam sistem tersebut?
		6	What kind of waste are being categorized as municipal solid waste?	Apa saja sampah yang termasuk dalam sampah rumah tangga?
		7	How much MSW are being generated in Bali per day/month/year in total?	Berapa banyak jumlah sampah yang dihasilkan Bali setiap hari/bulan/tahunnya yang termasuk dalam sampah rumah tangga?
		8	How much MSW are being managed by Bali per day/month/year in total?	Berapa banyak jumlah sampah rumah tangga yang dikelola Provinsi Bali setiap hari/tahun
		9	How much MSW are being managed in each point of the flow in the system per day/month/year?	Berapa banyak jumlah sampah yang dikelola dalam masing-masing alur pengelolaan sampah di Bali?
3	Stakeholder Analysis	10	Who are the main stakeholders in Bali's municipal solid waste flow from disposal/collection till final processing or landfilling? a. What is their role/objective? b. What is their interest/objective? c. And how much influence do they have in the system?	Siapa saja pemangku kepentingan utama dalam alur pengelolaan sampah di Bali dari pembuangan/ pengangkutan hingga pemrosesan akhir/TPA? a. Apa saja peran mereka? b. Apa yang menjadi tujuan mereka dalam alur ini? c. Seberapa besar pengaruh mereka dalam sistem pengelolaan yang ada?
		11	Are there any informal sector that are involved in the waste flow?	Apakah ada sektor informal yang berperan penting dalam alur pengelolaan sampah ini?

Sub Research Question	Topic	No	Question (English)	Question (Indonesian)
			If yes, what are their roles and what is the government perception about the informal sector?	Jika ya, apa peran mereka dan apa pendapat pemerintah terkait sektor informal ini?
		12	Are there any stakeholders that are or can becomes a barrier in the current system?	Apakah ada pemangku kepentingan yang menjadi penghambat atau mungkin menjadi penghambat dalam sistem yang ada sekarang?
		13	Are there any past/ongoing collaboration between the government with other stakeholders related to municipal solid waste management? a. If yes, what collaboration is that? b. If no, why? Are there any plan to do collaboration in the future? (ask more details if there are any plans of collaboration)	Apakah ada kolaborasi yang sedang dilakukan oleh pemerintah terkait sampah rumah tangga dengan pemangku kepentingan lainnya? a. Jika ya, kolaborasi yang sedang dilakukan? b. Jika tidak, mengapa? Apakah ada rencana untuk melaksanakan kolaborasi? (tanyakan lebih lanjut jika memang ada rencana kolaborasi)
		14	Are there any missing link in the current system? Who are the missing links and why?	Apakah ada pemangku kepentingan yang tidak ada namun dibutuhkan dalam sistem pengelolaan sampah yang ada saat ini? Siapa pemangku kepentingan tersebut dan mengapa?
4	Transitioning to circular economy / Challenges & Opportunities	15	Are you aware with the concept of circular economy? a. If yes, what is the definition of circular economy that are being perceived by the government? a. If no, explain briefly what is circular economy.	Apakah anda mengetahui tentang circular economy/ekonomi sirkular? a. Jika ya, apa definisi pemerintah terkait ekonomi sirkular? b. Jika tidak, jelaskan apa itu ekonomi sirkular secara singkat

Sub Research Question	Topic	No	Question (English)	Question (Indonesian)
		16	Are there any plans or initatives on changing the current municipal solid waste management system to transition into circular economy? a. If yes, what are the plans? b. If not, are there any other plan of changes on the current waste management system or is it deemed to be sufficient enough?	Apakah saat ini sudah ada rencana atau inisiatif dalam perubahan sistem pengelolaan sampah rumah tangga menuju ekonomi sirkular? a. Jika ya, seperti apa rencananya? b. Jika tidak, usaha perubahan apa yang sedang dilakukan pemerintah untuk memperbaiki sistem pengelolaan sampah rumah tangga atau apakah sistem yang sudah ada sekarang sudah mencukupi?
		17	Are there any regulations that support transition process if there are other stakeholders that want to apply circular economy concept in their system? (e.g., grants, funding, etc.)	Apakah ada peraturan pemerintah yang dapat mendukung proses peralihan apabila ada pihak lain yang ingin menerapkan konsep ekonomi sirkular dalam sistem mereka? (contoh: pendanaan, hibah, dll.)
		18	Are there any obstacle that might happen in the process of changing the current municipal solid waste management system to circular economy?	Apa saja hambatan yang mungkin terjadi dalam proses perubahan sistem pengelolaan sampah rumah tangga menuju ekonomi sirkular?
		19	What are currently needed by the government to ease the process of changing the current municipal solid waste management system towards circular economy whether it is in social, economy, or technology aspect?	Apa saja yang dibutuhkan oleh pemerintah untuk memperbaiki sistem pengelolaan sampah rumah tangga menuju ekonomi sirkular baik secara sosial, ekonomi, maupun teknologi?
		20	Who are the stakeholders that should be involved in the changing process and what are their roles in it?	Siapa saja pemangku kepentingan yang seharusnya turun tangan dalam perubahan

Sub Research Question	Topic	No	Question (English)	Question (Indonesian)
				sistem dan apa saja peran mereka dalam perubahan tersebut?
		21	Are there any important issues that hasn't been addressed yet regarding MSWM and circular economy in Bali? Who do you think are relevant to be consulted regarding this matter?	Apakah menurut anda ada hal penting lainnya terkait pengelolaan sampah di Bali dan circular economy yang belum disampaikan? Dan siapa pemangku kepentingan yang dapat dihubungi berkaitan dengan hal tersebut?

Private Waste Management Companies

To understand:

1. The role of private waste management companies in the system
2. Learning about the waste that are going through the flow
3. Looking into the connection between private waste management companies and other stakeholders
4. Understanding the barriers and opportunities for private waste management companies to shift into circular economy

Questions:

Sub Research Question	Topic	No	Questions (English)	Questions (Bahasa Indonesia)
0	General Q	1	Please introduce yourself, your name and role in XXX (insert the organization's name) and how is your work related to MSWM in Bali	Silahkan perkenalkan diri anda, nama dan peran anda dalam XXX (masukkan nama organisasi terkait) dan bagaimana peran dari pekerjaan anda dalam pengelolaan sampah di Bali
1	Insight on current MSWM	2	What are the main developments and issues related to MSWM in Bali?	Apa yang menjadi isu dan perkembangan utama yang terjadi pada pengelolaan sampah di Bali saat ini?
		3	Why does MSW become a problem in Bali? What are most important problems and issues?	Menurut anda, mengapa sampah rumah tangga menjadi masalah di Bali? Apa yang menjadi masalah utama?
2	Systems Analysis	4	How does the current MSWM system works in Bali and how do you position your organization in the system?	Bagaimana alur dari sistem pengelolaan sampah di Bali dan bagaimana anda memosisikan organisasi anda dalam sistem tersebut?

Sub Research Question	Topic	No	Questions (English)	Questions (Bahasa Indonesia)
		5	Where is the waste collection coverage area and what are the source of the collected waste?	Di mana cakupan area pengumpulan sampah yang saat ini dilakukan dan dari mana saja sumber sampah yang diangkut berasal?
		6	What kind of waste are being collected and how much per day/month (kg)?	Jenis sampah apa saja yang dikumpulkan dan berapa banyak setiap hari/bulannya (kg)?
		7	How are the waste collected? How does the system work and what transporation mode are being used?	Bagaimana metode pengumpulan sampah yang digunakan? Moda transportasi apa yang digunakan dan bagaimana sistem operasional dari metode tersebut?
		8	What are being done to the waste (sold/recycled/thrown/others)?	Apa yang dilakukan dengan sampah yang sudah dikumpulkan? (dijual/dibuang/lainnya)
		8a	If being sold: a. What kind of waste are being sold? b. How much waste are being sold per day/month (kg)? c. To whom are the waste being sold? d. How much is the selling price of the waste?	*Jika dijual:* a. Jenis sampah apa saja yang dijual? b. Berapa banyak sampah yang dijual setiap hari atau bulannya? c. Ke mana sampah tersebut dijual? *d.* Berapa harga penjualan dari sampah tersebut?
		8b	If being recycled: a. What kind of waste are being recycled? b. How much waste are being recycled per day/month (kg)? c. Who recycled the waste? d. What recycling process are being done to the waste?	*Jika didaur ulang:* a. Jenis sampah apa saja yang didaur ulang? b. Berapa banyak sampah yang didaur ulang per hari/bulan (kg)? c. Siapa saja yang mendaur ulang sampah tersebut? d. Apa proses daur ulang yang dilakukan?

Sub Research Question	Topic	No	Questions (English)	Questions (Bahasa Indonesia)
			e. What are being done to the product of the recycled waste afterwards?	*e.* Apa yang dilakukan dengan produk dari sampah yang didaur ulang?
		8c	If thrown away: a. What kind of waste are being thrown away? b. Why do you throw away the waste? c. To where are the waste being thrown? d. Who are responsible for throwing out the waste? Does another stakeholder throw the waste out from the company?	*Jika dibuang:* a. Jenis sampah apa saja yang dibuang? b. Mengapa sampah tersebut dibuang? c. Ke mana sampah tersebut dibuang? d. Siapa yang bertanggung jawab untuk membuang sampah tersebut? Apakah ada pemangku kepentingan lainnya yang bekerja sama untuk pembuangan sampah?
		8d	If others: a. What are being done to the waste?	*Jika lainnya:* a. Apa yang dilakukan terhadap sampah tersebut?
		9	How much is your income per month? What is the source of income (client/waste selling/others)?	Berapa jumlah pendapatan yang diperoleh setiap bulannya? Dari mana sumber pendapatan tersebut (klien/penjualan sampah/lainnya)?
		10	How much is your operational cost per month? What is the most cost-consuming aspect?	Berapa pengeluaran yang dkeluarkan setiap bulannya? Aspek apa yang paling banyak menghabiskan biaya?
3	Stakeholder Analysis	11	Are there any other stakeholders that is directly interacting with you in the waste collection process? Who are the stakeholders and what are their roles and influence on you?	Apakah ada pemangku kepentingan lainnya yang berhubungan langsung dengan anda dalam proses pengumpulan sampah? Siapa saja pemangku kepentingan tersebut, apa peran mereka, dan bagaimana mereka mempengaruhi proses pengelolaan sampah yang anda lakukan?

Sub Research Question	Topic	No	Questions (English)	Questions (Bahasa Indonesia)
		12	Are you cooperating with informal sector in your waste collection process? a. If yes, what are their roles and what is your perception about them?	Apakah anda bekerja sama dengan sektor informal dalam proses pengumpulan? a. Jika ya, apa peran sektor informal dalam proses ini dan apa pendapat anda terkait sektor informal?
		13	Are there any stakeholders that you hope to collaborate or connect with your company to ease the waste collecting process? If yes, who are they?	Apakah ada pihak yang anda harapkan bisa bekerja sama dengan perusahaan anda untuk mempermudah proses pengangkutan sampah? Jika ya, siapa pihak tersebut?
		14	Are there any important stakeholders that are missing in the current MSWM system? Who are they and what will be their roles in the system?	Apakah ada pemangku kepentingan penting yang menurut anda kurang dalam keseluruhan sistem pengelolaan sampah yang ada saat ini? Siapa saja pemangku kepentingan tersebut dan peran apa yang dapat mereka ambil dalam sistem ini?
4	Transitioning to circular economy / Challenges & Opportunities	15	Are you aware of circular economy? Does your company apply the concept in the current system?	Apakah anda mengetahui tentang ekonomi sirkular? Apakah perusahaan anda menerapkan konsep tersebut dalam sistem yang sudah ada?
		15a	If yes: a. What is circular economy as being perceived by your company? b. How does your company apply the concept in your system?	Jika ya: a. Bagaimana definisi dari konsep ekonomi sirkular dalam perusahaan anda? b. Bagaimana perusahaan anda menerapkan konsep tersebut?
		15b	If no: a. Are there any future plans of applying the concept?	Jika tidak: a. Apakah ada rencana dalam perusahaan anda untuk menerapkan konsep tersebut?

Sub Research Question	Topic	No	Questions (English)	Questions (Bahasa Indonesia)
			b. If there are any future plans to apply the concept, why did you decicde to do that?	b. Jika ada rencana untuk menerapkan konsep tersebut ke depannya, mengapa anda memutuskan untuk melakukan hal tersebut?
		16	What is the main obstacles to apply circular economy in your MSWM system? And what are needed to overcome the obstacles?	Apa kendala utama untuk menerapkan ekonomi sirkular dalam sistem pengelolaan sampah anda? Dan apa yang dibutuhkan untuk dapat melalui kendala tersebut?
		17	Are there any important stakeholders that could help you to realize circular economy concept? Who are they and what are their roles specifically?	Apakah ada pemangku kepentingan penting yang dapat membantu anda untuk merealisasikan konsep ekonomi sirkular? Siapa saja dan apa peran mereka secara spesifik?
		18	Are there any regulations that support transition process if you want to apply circular economy concept in your system? (e.g., grants, tax exemption, etc.) a. If yes, what are they and did you take the opportunity to use the support? b. If no, do you think they are needed and what kind of regulations would you want to be exist?	Apakah ada peraturan pemerintah yang dapat mendukung proses peralihan apabila anda ingin menerapkan konsep ekonomi sirkular dalam sistem anda? (contoh: hibah, pemotongan pajak, dll.) a. Jika ya, apa peraturan tersebut dan apakah anda menggunakan kesempatan yang disediakan oleh peraturan tersebut? b. Jika tidak, apakah menurut anda hal tersebut dibutuhkan dan peraturan apa yang anda inginkan untuk ada?
		19	What are your hope for this company to improve your waste collection and able to transition towards circular economy in the future?	Apa harapan anda untuk perusahaan ini ke depannya agar lebih banyak sampah yang terkelola dan bisa melakukan perubahan menuju ekonomi sirkular?

Sub Research Question	Topic	No	Questions (English)	Questions (Bahasa Indonesia)
		20	Are there any important issues that hasn't been addressed yet regarding MSWM and circular economy in Bali? Who do you think are relevant to be consulted regarding this matter?	Apakah menurut anda ada hal penting lainnya terkait pengelolaan sampah di Bali dan ekonomi sirkular yang belum disampaikan? Dan siapa pemangku kepentingan yang dapat dihubungi berkaitan dengan hal tersebut?

Waste Bank

To understand:

1. One of the option for waste processing in Bali that is community-based
2. How their operate and their interaction with other stakeholders
3. How much influence they have in the system

Questions:

Sub Research Question	Topic	No	Questions (English)	Questions (Bahasa Indonesia)
0	General Q	1	Please introduce yourself, your name and role in XXX (insert the organization's name) and how is your work related to MSWM in Bali	Silahkan perkenalkan diri anda, nama dan peran anda dalam XXX (masukkan nama organisasi terkait) dan bagaimana peran dari pekerjaan anda dalam pengelolaan sampah di Bali
1	Insight on current MSWM	2	Why does MSW become a problem in Bali? What are most important problems and issues?	Menurut anda, mengapa sampah rumah tangga menjadi masalah di Bali? Apa yang menjadi masalah utama?
2	Systems Analysis	3	Since when did this waste bank formed? How did it start and who funded it?	Sejak kapan bank sampah ini dimulai? Bagaimana asal mulanya dan didanai oleh siapa?
		4	How does this waste bank operate?	Bagaimana bank sampah ini beroperasi?
		5	How many members and workers are in this waste bank?	Berapa banyak anggota di bank sampah ini?
		6	Where is the coverage area of the waste collection in this waste bank?	Di mana saja area cakupan pengumpulan sampah?

Sub Research Question	Topic	No	Questions (English)	Questions (Bahasa Indonesia)
		7	What kind of waste are being collected?	Jenis sampah apa saja yang dikumpulkan?
		8	How much waste are being collected per day/month (kg)?	Berapa jumlah sampah yang dikumpulkan setiap hari/bulan (kg)?
		9	What are the waste bank doing with the collected waste? (sold/repurposed/thrown away/others)	Apa yang dilakukan dengan sampah yang sudah dikumpulkan? (dijual/dikaryakan/dibuang/lainnya)
		9a	If being sold: a. What kind of waste are being sold? b. How much waste are being sold per day/month/year (kg)? c. To whom are the waste being sold? d. How much is the selling price of the waste?	*Jika dijual:* a. Jenis sampah apa saja yang dijual? b. Berapa banyak sampah yang dijual setiap hari atau bulannya? c. Ke mana sampah tersebut dijual? d. Berapa harga penjualand dari sampah tersebut?
		9b	If being recycled/repurposed: a. What kind of waste are being recycled/repurposed? b. What are being made out of the recycled/ repurposed waste? c. How much waste are being recycled/ repurposed per day/month/year (kg)? d. Who recycled/repurposed the waste? e. What are being done to the product of the recycled/repurposed waste afterwards?	*Jika dikaryakan:* a. Jenis sampah apa saja yang dikaryakan? b. Apa karya yang dibuat dari sampah tersebut? c. Berapa banyak sampah yang dikaryakan (kg)? d. Siapa saja yang mengkaryakan sampah tersebut? e. Apa yang dilakukan dengan sampah yang dikaryakan?
		9c	If thrown away: a. What kind of waste are being thrown away? b. Why do you throw away the waste?	*Jika dibuang:* a. Jenis sampah apa saja yang dibuang? b. Mengapa sampah tersebut dibuang?

Sub Research Question	Topic	No	Questions (English)	Questions (Bahasa Indonesia)
			c. To where are the waste being thrown? d. Who are responsible for throwing out the waste? Does another stakeholder collect it from here?	c. Ke mana sampah tersebut dibuang? d. Siapa yang bertanggung jawab untuk membuang sampah tersebut? Apakah ada pemangku kepentingan lainnya yang bekerja sama untuk mengumpulkan sampah dari bank sampah ini?
		9d	If others: a. What are being done to the waste?	*Jika lainnya:* a. Apa yang dilakukan terhadap sampah tersebut?
		10	What is your source of income and how much do you get per day/month?	Dari mana sumber pendapatan bank sampah ini dan berapa yang anda dapatkan setiap hari/bulan?
		11	How much is the operational cost each month?	Berapa biaya operasional yang dikeluarkan setiap bulannya?
3	Stakeholder Analysis	12	What are the main stakeholders that are interacting with this waste bank? What are their roles and how do they influence this waste bank?	Siapa stakeholder utama yang berhubungan dengan bank sampah ini? Apa saja peran mereka dan bagaimana pengaruh mereka kepada bank sampah ini?
		13	Are there any stakeholders that becomes or might become the barrier in your process?	Apakah ada pemangku kepentingan yang menjadi atau mungkin menjadi penghambat dalam proses pengelolaan sampah yang dilakukan oleh bank sampah?
		14	Are there any important stakeholders that are not yet collaborating with waste bank to ease the waste management process?	Apakah ada pihak yang menurut anda saat ini belum bekerja sama namun penting untuk bekerja sama ke depannya dengan bank sampah agar proses pengelolaan menjadi lebih mudah?
4	Transitioning to circular economy /	15	Are there any obstacles in your waste management process?	Apa kendala yang dihadapi dalam proses pengelolaan sampah yang anda lakukan?

Sub Research Question	Topic	No	Questions (English)	Questions (Bahasa Indonesia)
	Challenges & Opportunities	16	What do you think is needed to overcome the obstacles and process more waste in this waste bank?	Menurut anda, apa yang dibutuhkan oleh bank sampah ini untuk melalui kendala tersebut agar bisa mengelola sampah lebih banyak?
		17	What is your hope for the future of the waste bank so that there are more waste being treated in this waste bank?	Apa harapan anda untuk bank sampah ini ke depannya agar lebih banyak sampah yang terkelola?
		18	Are there any important issues that hasn't been addressed yet regarding MSWM and circular economy in Bali? Who do you think are relevant to be consulted regarding this matter?	Apakah menurut anda ada hal penting lainnya terkait pengelolaan sampah di Bali dan circular economy yang belum disampaikan? Dan siapa pemangku kepentingan yang dapat dihubungi berkaitan dengan hal tersebut?

TPS3R

To understand:

1. One of the option for waste treatment in Bali that is semi-formal (founded by the government and continued by the community)
2. How their operate and their interaction with other stakeholders
3. How much influence they have in the system

Questions:

Sub Research Question	Topic	No	Questions (English)	Questions (Bahasa Indonesia)
0	General Q	1	Please introduce yourself, your name and role in XXX (insert the organization's name) and how is your work related to MSWM in Bali	Silahkan perkenalkan diri anda, nama dan peran anda dalam XXX (masukkan nama organisasi terkait) dan bagaimana peran dari pekerjaan anda dalam pengelolaan sampah di Bali
1	Insight on current MSWM	2	Why does MSW become a problem in Bali? What are most important problems and issues?	Menurut anda, mengapa sampah rumah tangga menjadi masalah di Bali? Apa yang menjadi masalah utama?
2	Systems Analysis	3	Since when did this TPS3R was formed? How did it start and who funded it?	Sejak kapan TPS3R ini dimulai? Bagaimana asal mulanya dan siapa yang mendirikan?
		4	How does this TPS3R operate?	Bagaimana TPS3R ini beroperasi?
		5	How many workers are in this TPS3R? What are their roles?	Berapa banyak karyawan di TPS3R ini? Apa saja peran mereka?
		6	Where is the coverage area of the waste collection in this TPS3R?	Di mana saja area cakupan pengumpulan sampah?

Sub Research Question	Topic	No	Questions (English)	Questions (Bahasa Indonesia)
		7	What kind of waste are being collected?	Jenis sampah apa saja yang dikumpulkan?
		8	How much waste are being collected per day/month (kg)?	Berapa jumlah sampah yang dikumpulkan per hari/bulan (kg)?
		9	What are the TPS3R doing with the collected waste? (sold/recycled/thrown away/others)	Apa yang dilakukan dengan sampah yang sudah dikumpulkan? (dijual/didaur ulang/dibuang/lainnya)
		9a	If being sold: a. What kind of waste are being sold? b. How much waste are being sold per day/month/year (kg)? c. To whom are the waste being sold? d. How much is the selling price of the waste?	*Jika dijual:* a. Jenis sampah apa saja yang dijual? b. Berapa banyak sampah yang dijual setiap hari atau bulannya? c. Ke mana sampah tersebut dijual? d. Berapa harga penjualand dari sampah tersebut?
		9b	If being recycled: a. What kind of waste are being recycled? b. What products are made out of the recycled waste? c. How much waste are being recycled per day/month/year (kg)? d. Who recycled the waste? e. What are being done to the product of the recycled waste afterwards?	*Jika didaur ulang:* a. Jenis sampah apa saja yang didaur ulang? b. Apa produk dari daur ulang dari sampah tersebut? c. Berapa banyak sampah yang didaur ulang setiap hari/bulan/tahun (kg)? d. Siapa yang mendaur ulang sampah tersebut? e. Apa yang produk daur ulang sampah tersebut?
		9c	If thrown away: a. What kind of waste are being thrown away? b. Why do you throw away the waste?	*Jika dibuang:* a. Jenis sampah apa saja yang dibuang? b. Mengapa sampah tersebut dibuang?

Sub Research Question	Topic	No	Questions (English)	Questions (Bahasa Indonesia)
			c. To where are the waste being thrown? d. Who are responsible for throwing out the waste? Does another stakeholder collect it from here?	c. Ke mana sampah tersebut dibuang? d. Siapa yang bertanggung jawab untuk membuang sampah tersebut? Apakah ada pemangku kepentingan lainnya yang bekerja sama untuk mengumpulkan sampah dari TPS3R ini?
		9d	If others: What are being done to the waste?	*Jika lainnya:* Apa yang dilakukan terhadap sampah tersebut?
		10	What is your source of income and how much do you get per day/month?	Dari mana sumber pendapatan TPS3R ini dan berapa yang anda dapatkan setiap hari/bulan?
		11	How much is the operational cost each month?	Berapa biaya operasional yang dikeluarkan setiap bulannya?
3	Stakeholder Analysis	12	What are the main stakeholders that are interacting with this TPS3R? What are their roles and how do they influence this TPS3R?	Siapa stakeholder utama yang berhubungan dengan TPS3R ini? Apa saja peran mereka dan bagaimana pengaruh mereka kepada TPS3R ini?
		13	Are there any stakeholders that becomes or might become the barrier in your process?	Apakah ada pemangku kepentingan yang menjadi atau mungkin menjadi penghambat dalam proses pengelolaan sampah yang dilakukan oleh TPS3R?
		14	Are there any important stakeholders that are not yet collaborating with TPS3R to ease the waste management process?	Apakah ada pihak yang menurut anda saat ini belum bekerja sama namun penting untuk bekerja sama ke depannya dengan TPS3R agar proses pengelolaan menjadi lebih mudah?

Sub Research Question	Topic	No	Questions (English)	Questions (Bahasa Indonesia)
4	Transitioning to circular economy / Challenges & Opportunities	15	Are there any obstacles in your waste management process?	Apa kendala yang dihadapi dalam proses pengelolaan sampah yang anda lakukan?
		16	What do you think is needed to overcome the obstacles and process more waste in this TPS3R?	Menurut anda, apa yang dibutuhkan oleh TPS3R ini untuk melalui kendala tersebut agar bisa mengelola sampah lebih banyak?
		17	What is your hope for the future of the TPS3R so that there are more waste being treated in this TPS3R?	Apa harapan anda untuk TPS3R ini ke depannya agar lebih banyak sampah yang terkelola?
		18	Are there any important issues that hasn't been addressed yet regarding MSWM and circular economy in Bali? Who do you think are relevant to be consulted regarding this matter?	Apakah menurut anda ada hal penting lainnya terkait pengelolaan sampah di Bali dan circular economy yang belum disampaikan? Dan siapa pemangku kepentingan yang dapat dihubungi berkaitan dengan hal tersebut?

Research/Experts

To understand:

1. MSWM condition as a whole
2. The flow of MSW
3. Rules & regulations that goes around MSWM system
4. Future plan of MSWM (whether it align with CE or not)
5. The barriers and enablers on the change

Questions:

Sub Research Question	Topic	No	Questions (English)	Questions (Bahasa Indonesia)
0	General Q	1	Please introduce yourself, your name and role in XXX (insert the organization's name) and how is your work related to MSWM in Bali	Silahkan perkenalkan diri anda, nama dan peran anda dalam XXX (masukkan nama organisasi terkait) dan bagaimana peran dari pekerjaan anda dalam pengelolaan sampah di Bali
1	Insight on current MSWM	2	What are the main developments and issues related to MSWM in Bali?	Apa yang menjadi isu dan perkembangan utama yang terjadi pada pengelolaan sampah di Bali saat ini?
		3	Why does MSW become a problem in Bali? What are most important problems and issues?	Menurut anda, mengapa sampah rumah tangga menjadi masalah di Bali? Apa yang menjadi masalah utama?
		4	Are there any rules and regulations related to MSWM in Bali? a. For whom are those regulations applied? b. How are the regulations enforced?	Apakah ada peraturan terkait sampah rumah tangga yang berlaku di Bali? a. Untuk siapa saja peraturan tersebut berlaku? b. Bagaimana peraturan tersebut ditegakkan?

Sub Research Question	Topic	No	Questions (English)	Questions (Bahasa Indonesia)
		5	How does the current MSWM system works in Bali and how do you position your organization in the system?	Bagaimana alur dari sistem pengelolaan sampah di Bali dan bagaimana anda memosisikan organisasi anda dalam sistem tersebut?
2	Systems Analysis	6	What kind of waste are being categorized as municipal solid waste?	Apa saja sampah yang termasuk dalam sampah rumah tangga?
		7	How much municipal solid waste are being generated in Bali each day/month/year?	Berapa banyak jumlah sampah yang dihasilkan Bali setiap hari/bulan/tahunnya yang termasuk dalam sampah rumah tangga?
		8	How much municipal solid waste are being managed by Bali each day/month/year	Berapa banyak jumlah sampah rumah tangga yang dikelola Provinsi Bali setiap hari/tahun
		9	How much MSW are being managed in each point of the flow in the system per day/month/year?	Berapa banyak jumlah sampah yang dikelola dalam masing-masing alur pengelolaan sampah di Bali?
3	Stakeholder Analysis	10	Who are the main stakeholders in Bali's municipal solid waste flow from disposal/collection till final processing or landfilling? a. What are their roles/objectives? b. What are their interests/objectives? c. How much influence do they have in the system?	Siapa saja pemangku kepentingan utama dalam alur pengelolaan sampah di Bali dari pembuangan/ pengangkutan hingga pemrosesan akhir/TPA? a. Apa saja peran mereka? b. Apa yang menjadi tujuan mereka dalam alur ini? c. Seberapa besar pengaruh mereka dalam sistem pengelolaan yang ada?
		11	Are there any informal sector that are involved in the waste flow? a. If yes, what are their roles and what is your perception about the informal sector?	Apakah ada sektor informal yang berperan penting dalam alur pengelolaan sampah ini? a. Jika ya, apa peran mereka dan apa pendapat anda terkait sektor informal ini?
		12	Are there any stakeholders that are or can becomes a barrier in the current system?	Apakah ada pemangku kepentingan yang menjadi penghambat atau mungkin menjadi penghambat dalam sistem yang ada sekarang?

Sub Research Question	Topic	No	Questions (English)	Questions (Bahasa Indonesia)
		13	Are there any past/ongoing collaboration between the government with other stakeholders related to municipal solid waste management? a. If yes, what collaboration is that? b. If no, why? Are there any plan to do collaboration in the future? (ask more details if there are any plans of collaboration)	Apakah ada kolaborasi yang sedang dilakukan oleh pemerintah terkait sampah rumah tangga dengan pemangku kepentingan lainnya? a. Jika ya, kolaborasi yang sedang dilakukan? b. Jika tidak, mengapa? Apakah ada rencana untuk melaksanakan kolaborasi? (tanyakan lebih lanjut jika memang ada rencana kolaborasi)
		14	Are there any missing link in the current system? Who are the missing links and why?	Apakah ada pemangku kepentingan yang tidak ada namun dibutuhkan dalam sistem pengelolaan sampah yang ada saat ini? Siapa pemangku kepentingan tersebut dan mengapa?
4	Transitioning to circular economy / Challenges & Opportunities	15	Are you aware with the concept of circular economy? a. If yes, what is the definition of circular economy that are being perceived by you? b. If no, explain briefly what is circular economy.	Apakah anda mengetahui tentang circular economy/ekonomi sirkular? a. Jika ya, tanyakan apa definisi ekonomi sirkular menurut narasumber b. Jika tidak, jelaskan apa itu ekonomi sirkular secara singkat
		16	Are there any plans or initatives on changing the current municipal solid waste management system to transition into circular economy? a. If yes, what are the plans? b. If not, are there any other plan of changes on the current waste management system or is it deemed to be sufficient enough?	Apakah saat ini sudah ada rencana atau inisiatif dalam perubahan sistem pengelolaan sampah rumah tangga menuju ekonomi sirkular? a. Jika ya, seperti apa rencananya? b. Jika tidak, usaha perubahan apa yang sedang dilakukan pemerintah untuk memperbaiki sistem pengelolaan sampah rumah tangga atau apakah sistem yang sudah ada sekarang sudah mencukupi?

Sub Research Question	Topic	No	Questions (English)	Questions (Bahasa Indonesia)
		18	Are there any regulations that support transition process if there are other stakeholders that want to apply circular economy concept in their system? (e.g., grants, funding, etc.)	Apakah ada peraturan pemerintah yang dapat mendukung proses peralihan apabila ada pihak lain yang ingin menerapkan konsep ekonomi sirkular dalam sistem mereka? (contoh: pendanaan, hibah, dll.)
		19	Are there any obstacle that might happen in the process of changing the current municipal solid waste management system to circular economy?	Apa saja hambatan yang mungkin terjadi dalam proses perubahan sistem pengelolaan sampah rumah tangga menuju ekonomi sirkular?
		20	What are currently needed to ease the process of changing the current municipal solid waste management system towards circular economy whether it is in social, economy, or technology aspect?	Apa saja yang dibutuhkan oleh pemerintah untuk memperbaiki sistem pengelolaan sampah rumah tangga menuju ekonomi sirkular baik secara sosial, ekonomi, maupun teknologi?
		21	Who are the stakeholders that should be involved in the changing process and what are their roles in it?	Siapa saja pemangku kepentingan yang seharusnya turun tangan dalam perubahan sistem dan apa saja peran mereka dalam perubahan tersebut?
		21	Are there any important issues that hasn't been addressed yet regarding MSWM and circular economy in Bali? Who do you think are relevant to be consulted regarding this matter?	Apakah menurut anda ada hal penting lainnya terkait pengelolaan sampah di Bali dan circular economy yang belum disampaikan? Dan siapa pemangku kepentingan yang dapat dihubungi berkaitan dengan hal tersebut?

Informal Sector

To understand:

1. How the informal sector operate
2. The waste that goes through the informal sector
3. What their barriers are and how to overcome it

Questions:

Sub Research Question	Topic	No	Questions (English)	Questions (Bahasa Indonesia)
0	General Q	1	Please introduce yourself	Silahkan perkenalkan diri anda
1	Insight on current MSWM	2	Where is the waste collection coverage area?	Di mana cakupan area pengumpulan sampah yang saat ini dilakukan?
		3	How are the waste collected? How does the system work and what transporation mode are being used?	Bagaimana metode pengumpulan sampah yang digunakan? Moda transportasi apa yang digunakan dan bagaimana sistem operasional dari metode tersebut?
2	Systems Analysis & Stakeholder Analysis	4	What is the source of the collected waste?	Dari mana sampah yang dikumpulkan berasal?
		5	What kind of waste are being collected?	Jenis sampah apa saja yang dikumpulkan?
		6	How much waste is being collected per day/month (kg)?	Berapa banyak jumlah sampah yang dikumpulkan setiap hari/bulannya (kg)?
		7	Are all of the collected waste being sold? *If yes* a. How much are being sold each day/month (kg)?	Apakah seluruh sampah yang dikumpulkan kemudian dijual? *Jika ya*

Sub Research Question	Topic	No	Questions (English)	Questions (Bahasa Indonesia)
			b. How much is the selling price? c. Where do you sell your waste to *If no* a. What are you doing to the waste that are not being sold?	a. Berapa banyak sampah yang dijual setiap hari/bulannya (kg) b. Berapa harga jual dari sampah tersebut? c. Ke mana anda menjual sampah yang sudah dikumpulkan? *Jika tidak* a. Apa yang dilakukan dengan sampah yang tidak dijual?
		8	Do you know what the intermediate waste collector do to the waste that you sold?	Apakah anda mengetahui apa yang dilakukan pengepul terhadap sampah yang anda jual?
3	Challenges & Opportunities	9	Are there any obstacles in your operation?	Apakah ada kendala yang anda hadapi saat proses operasi yang anda lakukan?
		10	What are needed to overcome the obstacles?	Apa yang dibutuhkan untuk melalui kendala tersebut?
		11	What can be done by other people so that you can operate more easily?	Apa yang bisa dilakukan oleh orang lain agar anda dapat beroperasi dengan lebih mudah?
		12	Do you want to collect more waste? If yes, why and what do you want to do to achieve it?	Apakah anda memiliki keinginan untuk mengumpulkan sampah lebih banyak lagi? Jika ya, mengapa? Apa yang ingin anda lakukan untuk mencapai itu?
		13	Are there any wish for your work so that more waste can be collected?	Apa harapan untuk pekerjaan anda agar semakin banyak sampah yang bisa dikumpulkan?