Pantai Project

Research into the feasibility of a plastic recycling business on Bali, Indonesia

E. Hermans, B. de Jong, S.R. Kolff, V. Ligthart, S. de Metz, T. Woudstra

Technische Universiteit Delft

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by

E. Hermans, B. de Jong, S.R. Kolff, V. Ligthart, S. de Metz, T. Woudstra

to finalize the multi-disciplinairy project as an elective
at the Delft University of Technology.

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Preface

This report consists of a research done on the plastic pollution problem on Bali and how to stimulate local communities to tackle this problem. This research is done by a multidisciplinary group of master students from the TU Delft as a follow-up on the Pantai Projects research done in September-December 2018 and April-July 2019. Their research inspired our group to contribute to solve the global plastic pollution problem.

Over the course of the project we were supported by several local companies and individuals, which greatly contributed the research. All were enthusiastic about the research project and willing to assist in any way they could. Without the help and support of these local parties the progress made in such a short period of time wouldn't have been possible. Therefore we would like to thank Paola Cannucciari (Eco-Bali), Putu Hermawan (WeDoo), Ketut De Sujana Mahartana (North Bali Reef Conservation), Adhitya Yusuf (Daur Project) and Emma Sparrow (OceanMimic) for providing us with crucial bits of information.
We'd also like to thank Whayu, Bukit and Agus for helping us with translating, conducting surveys and connecting us to the local people.

Besides the local parties involved in this research, the supervisors S.A. Miedema, B. Tighe and B. Steenhuisen supported our group throughout the entire project. We would like to thank our supervisors for their guidance and the time they took for reviewing our research. Their vision and input gave our project group direction and new insights.

E. Hermans, B. de Jong, S.R. Kolff, V. Ligthart, S. de Metz, T. Woudstra
Delft, December 2019

Local support

Summary

Every year large quantities of plastic waste accumulate in Bali's environment. This has a negative impact on Bali's environment, local society and its tourist driven economy. With lacking waste management facilities and local awareness plastic waste enters Bali's rivers, through which the waste ends up in the ocean. A concept small-scale recycling business, aiming to improve local waste management and awareness, is proposed to solve the problem at the source.

The goal of this research is to investigate the technological, social and financial feasibility of the concept recycling business and to find a target location.

The research first aims to choose three potential locations with different social-demographics through a literature study on Bali's regional social-demographics and the results of previous "Pantai" Project researches. Based on this three locations are chosen: Denpasar, Canggu and Pulukan.
For better understanding of the areas of interest, the crucial steps for setting up a business on Bali and its local waste management are investigated. A detailed stakeholder analysis is therefore also conducted. This is researched through participatory observation, literature study and interviews with local inhabitants, local businesses and governmental institutions. Surveys are conducted in the areas of interest to analyze how to Balinese handles their plastic waste, their mentality towards the plastic problem and their willingness to participate in the concept recycling plan. The results of the survey show enthusiasm of the local people towards the concept recycling business in the target areas. However, not all stakeholders are represented in conducted surveys, thus care must be taken when concluding the social feasibility.

To investigate the technological feasibility literature study is done on plastics and different techniques in all steps of the recycling chain. Through this, feasible techniques for all steps of the recycling chain are chosen, regarding the concept recycling business. Plastic waste is to be sorted by hand and processed by easy operable machinery based on the open-source designs of *Precious Plastic*.

A conceptual model of the small-scale recycling business is introduced for better understanding of the plastic and money streams involved in the concept recycling facility.

To investigate the financial feasibility, first the plastic stream is evaluated. In each location households separated and collected all their plastic from the rest of their waste for one week to estimate the composition and quantity of their weekly plastic waste production. From this result the plastic input per location is estimated through calculations.
A model is presented to evaluate financial stability of the concept recycling business. Input values for the model are the results from own waste collection measurements and the values acquired from connected parties. Calculations show, although being a rough estimate, financial feasibility. However more in-depth market study has to be performed for more detailed results.

Taking everything into account it can be concluded that it is indeed feasible to start a small-scaled recycle business on Bali in Pulukan or similar areas, which is determined by a multi criteria trade-off. However close consideration of local conditions should always be taken into account.

Contents

1 Introduction

1.1. Research background and problem statement

The total plastic waste generation and disposal in the world has increased during the last 65 years [1]. In 2015, a total cumulative amount of 7.82 billion tons of plastic production was measured. If we make a projection of historical measurements for the future, we find that in 2025 the total cumulative amount of generated plastics will be around 27 billion tons (see figure 1.1).

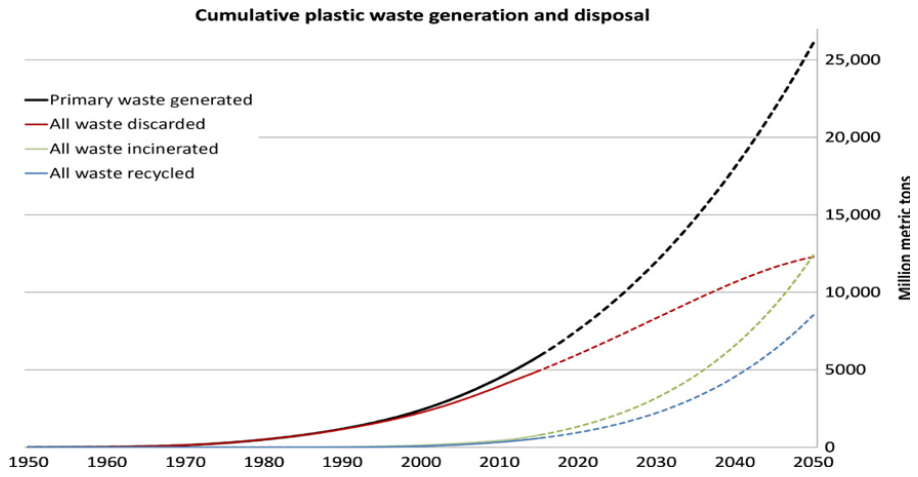


Figure 1.1: Cumulative plastic waste generation and disposal. Historical trend and future expectations [1]

Indonesia is massively contributing to plastic pollution. Four of the twenty most polluting rivers of the world belong to Indonesia [2]. Although Indonesia does not produce most of the plastics themselves, the beaches and rivers are extremely contaminated with plastic waste. The impact of the micro and macro plastics on the marine life in Southeast Asia is enormous, leading to intoxication and starvation of species [3]. One of the reasons of the plastic waste contamination is the waste management system. 81% of Indonesia's plastic waste is inadequately managed: it is burned or dumped in either open controlled or uncontrolled landfills.

Bali, one of Indonesia's most attractive provinces, faces a big plastic pollution problem. Intensive daily cleaning of beaches and rivers is crucial to maintain the current tourist hot-spot identity and the vibrant ecosystem of the island. Local communities have limited knowledge on how to manage plastic waste. Governmental and non-governmental initiatives have been implemented in parts of Bali, but the awareness of the local communities to handle their plastic waste correctly is insufficient. Without a good waste management awareness of local communities, the plastic waste problem will not be solved.

1.2. Research context and goal

Former research groups of MDP (multi-disciplinary project) students provided insight regarding the plastic waste problem in Bali under the name “Pantai”. The last group has performed a research into 32 polluted rivers on Bali [4]. The results of this research show where the most polluted rivers of Bali are located and provide measurements of the magnitude of plastic waste in these rivers. Moreover, the MDP group gave an advice on what the most feasible catchment devices are to intercept plastic waste in these rivers.

This research project will use the results of the former MDP group to determine the feasibility of a concept small-scaled recycle business that will help to mitigate plastic waste problems and increases the awareness of local inhabitants in particular case areas. This recycle business aims to contribute to a sustainable waste management system and will be elaborated by means of social-, financial- and technical feasibility.

The goal of this business is to produce products that are made of recycled plastics and to give products back to the local community as a reward for the collection of their plastic waste. In this way, not only the local community is stimulated to collect their own plastic waste, but plastic waste is also prevented from ending up in the environment (see 1.3).

To find an adequate location for the concept recycle business three locations will be selected based on former research and socio-demographic factors from own findings. When these three locations are selected, field research is carried out to find what the situation is like in reality. Surveys will be held about the attitude of the locals and through plastic waste collection from households in potential areas, information is gathered about plastic waste generation and composition. Also a financial model is used to provide conclusions about the financial feasibility. From the results of the surveys, waste measurements and the financial model the most feasible location for a recycling facility is selected by means of a trade-off.

Apart from finding a location a considerable amount of companies and individuals that work in the waste management sector need to be contacted. These new contacts could provide us with useful information and might be of aid in future developments regarding this project.

1.3. Concept of the recycling business

The concept of the proposed business is straightforward. Households will be the main target group for this project. People from these households are stimulated to hand in their plastics by rewarding them with money or a product made from recycled plastic. This adds value to their, at present ”worthless”, plastic waste.

The plastics need to be collected, and this will either be done through door-to-door collection or through collection points. The amount of plastic that is brought in is measured and written down per household. It is important to keep track of the amount of plastics handed in, as people get rewarded for it. After this is done, the plastic is sorted, shredded and recycled in a plastic recycling facility.

The products produced in this recycling process can be either sold for money or given as a reward to the participating households. The revenue that comes from selling the products is used partly to pay for the operation of the business and partly as a reward money for handing in the plastics.

In chapter 8 a more detailed explanation is given on this proposed recycling business.

1.4. Objective and research questions

The aim of this project is to map the existing waste handling system, the attitude towards the plastic waste problem and to investigate the possibility to create a small plastic recycle business in parts where it is most needed on Bali to reduce the plastic waste and create an income for the local population. It should be mentioned here that the project group is not looking to make a profit, and this project is purely performed out of social goodwill and willingness to help. Based on this, the following research question is formulated:

How feasible is it to introduce a recycling business on Bali to reduce the plastic waste problem?

With the help of the following sub-questions a satisfying answer to this research question should be found:

1. Which recycle techniques can be used in the business?
2. What are the business related requirements to introduce a business on Bali?
3. How does the current waste management system look like in Indonesia and in particular in Bali?
4. How do potential stakeholders of the business behave and act with regards to plastic waste?
5. Which of the researched regions/cities is potentially the most promising location to introduce a business?
6. Is it possible to create a financially stable business?

1.5. Research method

These sub-questions will be answered in this report in several steps. The first step is to perform pre-study and connecting parties and individuals that could be of assistance. Secondly data will be gathered by means of surveys, interviews and collection of plastic waste at households. And the third part consists of implementing the data gathered in the second part, focusing on the business side of the project as it needs to satisfy economic requirements and finding the most favorable way of recycling and what products can be produced with certain equipment. Each part has its own methodology explained where needed.

Based on the results a consult is given on how and where it would be best suited to set up a small plastic recycling business. A trade-off method will be used to find the optimal location for the potential business. This report can be used as a foundation for setting a up a physical facility or as a base for further research on the matter. Parts of this report can also be studied individually. E.g. the data from the surveys can be interesting for a party that is already operating in the areas where these were conducted.

2

Area study of Bali

2.1. Introduction

Starting a project on Bali requires knowledge of the region for it to be successful. Contact is needed with individuals, companies, municipal administration and others. Therefore you need to know who is in charge and if it is even possible to contact them. Therefore it is important that the governance system is understood.

Part of the project is conducting research on the attitude of the locals towards plastic pollution problem. If just the governance is investigated and the pollution intensity is measured, it does not mean a recycling facility will thrive. It is important to know how people look at plastic waste in their environment as well. Are they willing to do something about it? And what would be an incentive for them to do so?

These questions and more all need answering for the research to progress. Field research and stakeholder analysis will find out what the attitude towards the plastic pollution is in different regions of Bali. However, background information is needed so a variety of locations can be selected and researched with different conditions.

On Bali, and the rest of Indonesia, every area has divergent demographic conditions. Therefore different areas have a different feasibility for success for setting up a recycling business. For this research the location with the highest feasibility for setting up this proposed business needs to be found. Three locations will be selected after the demographic factors have been looked into and research from previous Pantai groups has been consulted.

2.2. Indonesia

The republic of Indonesia, as it is officially called, is a country in Southeast Asia located between the Indian and Pacific oceans. With seventeen thousand islands, it is the world's largest island country [5]. And with over 267 million people, it is the world 4th most populous country. Indonesia is divided into provinces, which are made up of regencies and cities. These provinces all have their own local governments and parliamentary bodies [6].

Indonesia is largest economy in Southeast Asia and is going through an impressive economic growth. The GDP per capita has risen from $823 dollars in the year 2000 to $3,932 in 2018 [7]. This is mainly considered positive, but it comes with a downside. Economic growth means consumption growth. This results in the use of more plastics [4]. The country has a population of around 264 million, and often not a sufficient functioning waste handling system. Every day Indonesia generates 175,000 tons of waste and about 24,500 tons a day of plastics [8]. 81% of waste is unsorted in Indonesia currently, making it difficult to recycle, causing plastic waste to leak into the ocean or end up in landfills instead [8].

Indonesia has the largest Islamic population on earth. However, this does not mean Indonesia only has one official religion. Indonesia presents itself as a nation with monotheistic belief. However based

on the government's guarantee of freedom of religion and right to worship, all citizens of Indonesia are obliged to adhere one of the six official religions, see figure 2.1. Namely Islam, Protestantism, Catholicism, Hinduism, Buddhism and Confucianism. It is not permitted that someone is an atheist or agnostic. Despite all those religions in one country 87.2% of the population is Muslim [9].

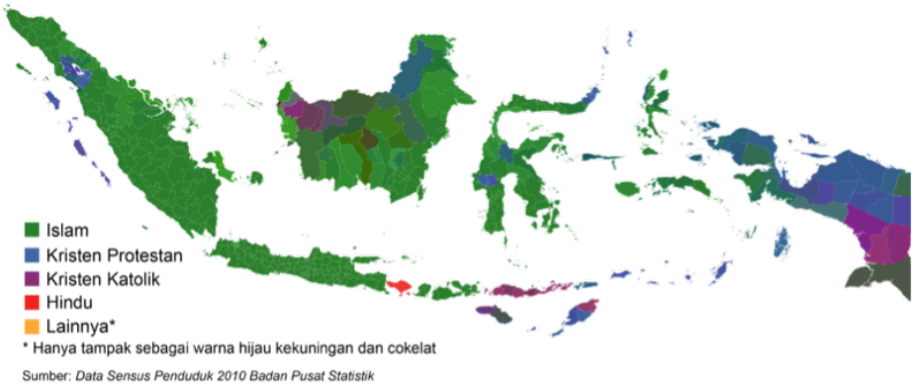


Figure 2.1: Map showing the dominant religion throughout Indonesia [9].

2.3. Bali

2.3.1. General information

The province of Bali is the most western part of the Lesser Sunda Islands, and includes the main island of Bali and three smaller islands. Nusa Penida, Nusa Lembognan and Nusa Ceningan are located between the islands of Bali and Lombok [10]. Denpasar is the provincial capital of Bali and is the second most populated city in Eastern Indonesia with over 800.000 residents [11]. As Bali counts 4.3 million inhabitants this makes up for around 18% of the total population [12]. Bali is the only province where the dominant religion is Hinduism.

The central Statistics Agency (BPS) show Bali as the most popular tourist destination in Indonesia [13]. In 2014 around $3.8 billion foreign exchange was contributed to the Indonesian economy from Balinese tourism alone [14]. Bali itself is known for its unique culture, religion and beautiful nature. Bali is part of the Coral Triangle, the area with the highest biodiversity of marine species. 500 reef-building coral species can be found in this area alone [10]. Therefore much attention is needed on plastic pollution as the effect can be great.

The island of Bali is divided into 9 regencies. These regencies differ in demographic factors as will be discussed later. Figure 2.2 illustrates the regencies.

2.4. Governance

It is important to know what the best ways are to contact communities. Especially if the project calls for communities to change their attitude or to take action. This is definitely the case in Bali as governance and authority work differently in most western countries.

As explained above, Indonesia's governing system works with subdivisions. These subdivisions go from provinces all the way down to villages. Subdivisions are governed by leaders of different levels [6]. It is not conventional and often not possible to speak to someone high in hierarchy directly. Lower subdivisions can however be contacted with reasonable ease.

The lowest level, is called the desa. A desa is the same as a village would be defined in English. A desa can be defined as a body which has authority over the local people in accordance with the acknowledged local traditions of the area [6]. A desa is headed by a head of the village, the desa adat, who is elected by popular vote.

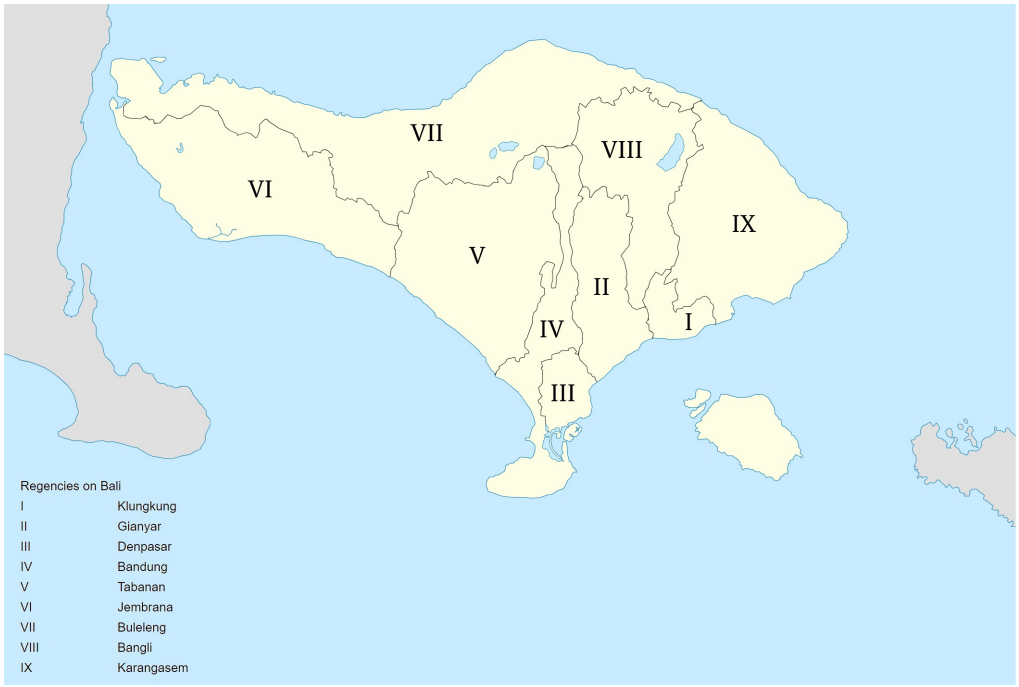


Figure 2.2: The nine regencies of Bali [4].

In a village there are small communities that gather every week to discuss the matters that require attention. These communities are, as well as the location where they meet, called a banjar. These meetings are normally only for men, but once every month there is an extra meeting for the women. These banjars are led by a head of the banjar. These heads of the banjar occasionally come together with the head of the village to discuss the matters at hand.

For this project, it is desirable that small communities can be contacted. This contact is needed so the attitude towards the plastic pollution can be determined. Their cooperation cannot be gained without this contact. Therefore the preferred contacts that can be established are the leaders of banjars and heads of villages. That way surveys can easily be conducted in large numbers and groups of individuals can be informed about the pollution problem as well as the intentions of the project. It can also be convenient to speak with these leaders whenever the help from locals is required as these kind of topics are discussed and handled during the meetings at the banjars.

2.5. Demographic analysis

The coming section will elaborate on the island Bali itself. Research from the past two Pantai project groups will also be consulted in the choice of research area as their work provides a clear overview of the severity of the pollution in the regions.

2.5.1. Population density

One the obvious factors that contributes to the intensity of plastic waste generation is population density. In populous areas there is a much higher concentration of waste than there is in sparsely populated areas. Often a better waste management system is in place in these areas. However this is not always sufficient as the system can be overburdened by the amount of waste [4]. If there is no budget or if it is not found important enough to spend a large part of the budget on the waste handling system, there is a realistic chance the system cannot handle the waste production. In poorer regions there is a higher chance of an overburdened waste management system. This can lead to high intensities of pollution, and therefore large amounts of plastic waste.

Figure 2.3 shows the population density map of Bali with an average density of 743 individuals per squared kilometer. However is clear that the Denpasar regency is far more populous than others.

Denpasar regency has an average density of 7283, which is in in contrast with the least populous regency Jembrana. Only 329 people live here per squared kilometer [15].

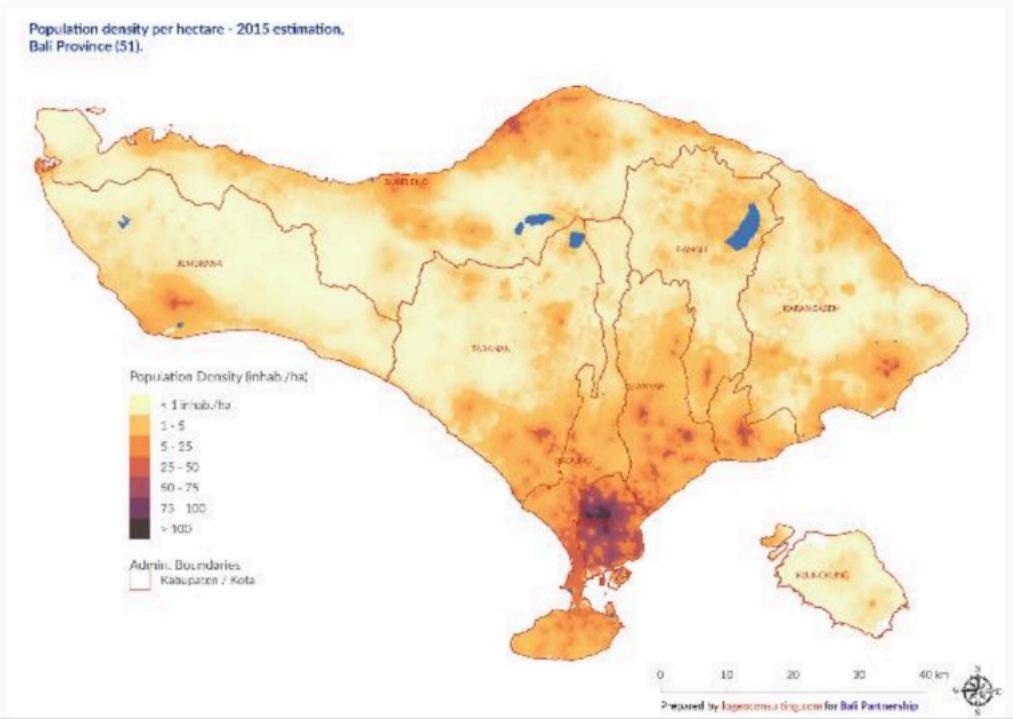


Figure 2.3: The population density in Bali [16].

2.5.2. Income

Individuals with a higher income consume more food and materials than individuals with a lower income [4]. This will automatically result in a higher waste generation. Therefore richer areas are expected to generate more plastic waste as well. On the other hand, regions with a higher average income are expected to have a better working waste handling system.

The fact that lower income communities generally generate less plastic waste does not mean there is no problem. As lower income areas have a lower budget to spend on waste management systems, high quantities of plastic can still end up in the environment.

It is expected that people with different incomes think differently about plastic pollution. Lower incomes will likely care less about plastic laying around as people with a higher income. People with a lower incomes tend have a day-to-day mindset as richer individuals have the luxury of thinking ahead. There is a high chance of different mentalities toward plastic pollution for different income levels.

The proposed concept compensates the people who separate their plastics and hand them in. Therefore it can be presumed that people with a lower income have a higher chance to participate with the proposed business.

Figure 2.4 shows the average income level of different regencies based on the APBD and is shown in section 2.5.3. These are closely associated as 80% of Bali's economy is tourism related [10].

2.5.3. Tourism

Bali is known largely as a tourist destination. With 6 million annual foreign visitors [17], it is the main economic income of the island. The contribution to the industry was 48% in the year 2017. Tourism generates 68% of the tax income and absorbs 42% of new labor as well. As stated before, it can be concluded that the tourism industry is heavily linked with the income level. With an exceptional growth

prediction of another 24% it is assumed that this will remain the same in the near future [18].

Despite revenue created by tourism, the industry does not have positive sides only. One tourist generally produces 3.5 times more waste than one Balinese individual [16]. However tourists generally dislike polluted areas, attractions and accommodations, which means a lot of effort has to be done to keep things clean. The revenue that can be created by potential tourism should be an extra incentive to keep the area clean.

Sustainability is trendy amongst loads of western tourists. That is one of the reasons beach cleanups pop up everywhere in touristic areas on Bali. Several hospitality facilities advertise with recyclable or sustainable products as well. So there already is some form of awareness about the plastic pollution in these regions.

The population of Bali living in touristic areas generally has a higher income [4], this could turn out to be non-beneficial for reward model of the proposed business. Figure 2.4 shows the average income per regency.

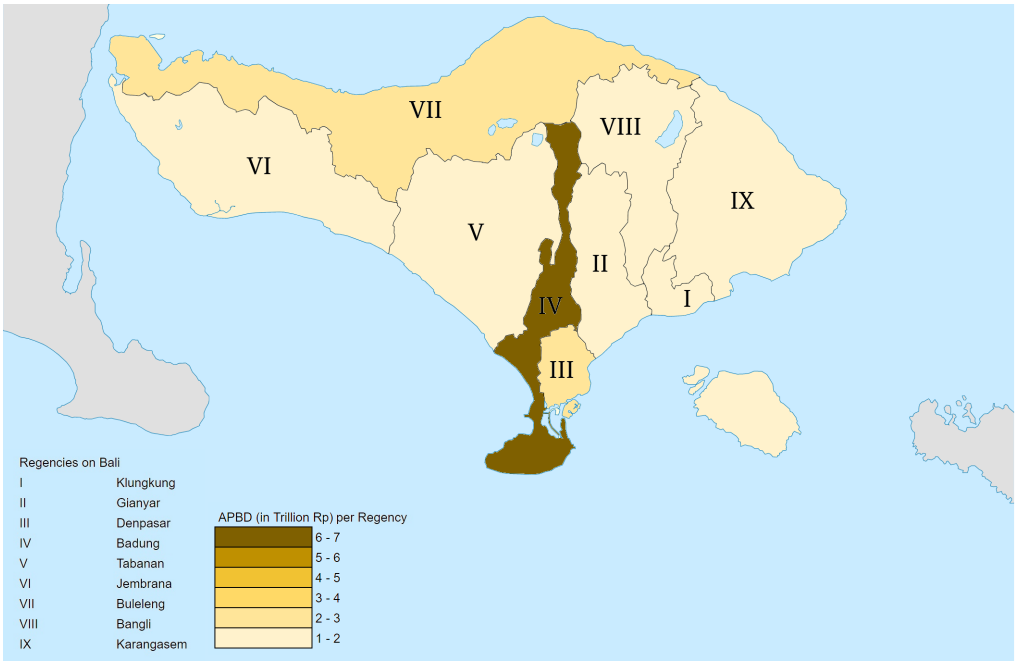


Figure 2.4: APDB per regency [4].

2.5.4. Education

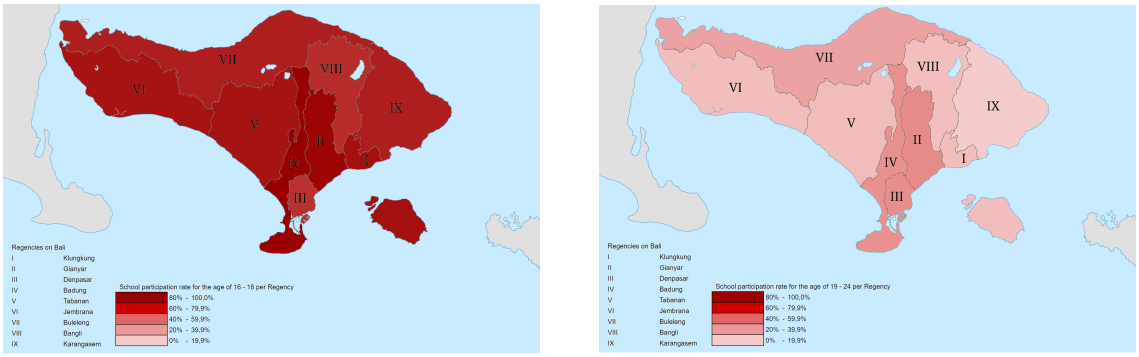
Statistics shows that on Bali the level of education is higher than the rest of Indonesia on average. The percentage of individuals following primary level of education is not special compared to Indonesia with 96.19% , which is somewhere mid-range. The upper secondary level of education however is the highest in the whole of Indonesia with 73% [19].

In 2019 Bali has 14 recognized higher-education institutions. These universities offer undergraduates and postgraduate degrees. But the quality of these universities is not of a very high level. Universitais Udayana is the highest ranked university of Bali in 2019 [20]. However this university is ranked 1128th in the world. It is difficult to find if the universities of Bali greatly are focusing on the plastic pollution problem. The previous Pantai project group spoke to a student that did measurements [4], however no information on future research can be found.

It is important to take the education level into account when selecting the areas for field research. There should be a difference in attitude if there is knowledge about the consequences of plastic pollution [4].

If people understand the consequences they can start to feel responsible. This feeling of responsibility should be beneficial for the feasibility of setting up a recycling business on Bali.

Figure 2.5a and 2.5b show the school participation rate per regency.



(a) (b)

Figure 2.5: a) Regional school participation between the age of 16 and 18 b) Regional school participation between the age of 19 and 24 [4].

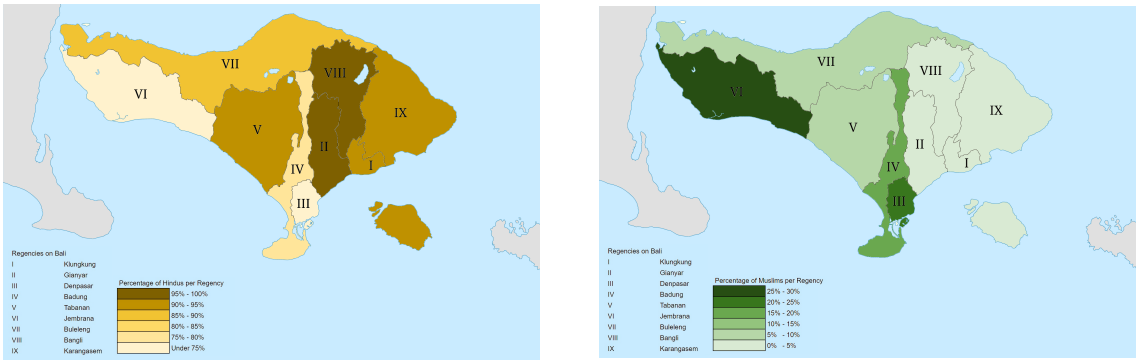
2.5.5. Religion

Bali is the only Indonesian island where the majority of its people are Hindu. Measurements in 2010 show that 83.4% of the population has Hinduism as their religion [21]. As Indonesia is the country with the largest Muslim population in the word, it is rather remarkable only 13.6% if Bali shares that religion. Denpasar and Jembrana are the regencies with the highest percentage of muslims with respectively 28% and 26% [21].

There is a chance that different religions have diverging views on what to do with waste or what waste even is. For example Hinduism is known for its close relationship with nature and emphasizes respect for the environment. For Islam and Christianity, the next two main religions on the island, it is difficult to determine the environmental empathy. Therefore it is possible that communities with a specific religion have another attitude towards plastic waste than communities with a different believe [4].

It is also possible that people with different religious backgrounds look differently at the rewards that are offered to them. For example, there is a change some individuals view recycled products still as waste due to their beliefs.

Figures 2.6a and 2.6b show the percentages of Hindus and Muslims



(a) (b)

Figure 2.6: a) Regional percentage Hindus b) Regional percentage Muslims [4].

For more detailed information about the socio-demographic factors, previous research by Pantai project groups can be consulted [4].

2.6. Selection locations of interest for research

A selection of diverse locations is wanted so research can be done under different conditions. These regions preferably differ substantially in demographic conditions for relevant results. However it is not possible to target a large number of areas, as there is simply no time. A large number of areas do not necessarily improve the results as it can even become more chaotic. Therefore three locations are found appropriate, as this is the maximum number of areas with contrasting socio-demographics that can be researched correctly in this short time frame. It is expected that different areas would result in different outcomes in the research that is carried out.

Besides the fact that the chosen regions need to differ as much as possible, there is one thing they all need to have in common. All the selected areas need to have a plastic pollution problem. That is why the three locations are not solely picked by these socio-demographic factors, but also by applying the research that has been carried out by previous multidisciplinary project groups in the last year. Their research has shown the locations where plastic pollution is the most severe, see figure 2.7a. The places where the plastic inputs from rivers are highest are the assumed areas where it would be most useful to carry out field research.

(a) (b)

Figure 2.7: a) Plastic discharge by rives as measured by the previous Pantai group. CITE b) The locations of interest.

The three locations also needed to be in range of the accommodation, as research areas need to be visited often. Canggu is where the original Pantai project took off and has been the location of the second project group as well. Therefore the area has been selected again this time. So unless necessary, the northern polluted areas are not the first choice, as they are located too far away for frequent visit. This does not mean they are not visited during the research.

The selected three locations where visited accompanied by translators before deciding these where the correct areas to perform the research. The three chosen locations are Pulukan, Denpasar and Canggu, see figure 2.7b.

2.6.1. Pulukan

The first location that has been selected is called Pulukan. The area of Pulukan, is located in the subdisctrict Pekutatan, which in turn is located in the regency Jembrana. Pulukan is one of the locations where research for this project will be done. Pulukan is indicated by the number 1 in figure 2.7b.

Jembrana regency has the highest percentage of Muslims in Bali, and this is something that makes this area interesting as a research location. As indicated before, muslims are expected to have a slightly different view of plastic waste and potentially recycled products. It should be stated that even though the Muslims have a location where they gather, namely the Mosque, the way of governing is the same as it is in the rest of Bali. So locals also attend banjar gatherings every week to discuss matters that

need attention.

The Jembrana regency is one of the regencies where the level of income is lowest. So the costs of a potential business would be relatively low compared to areas where the income is higher. This could result in a better possibility of a financially feasible business.

The last reason why Pulukan is an area with potential for this project is that there is no waste management system in place. Together with the fact that the data from the previous project groups shows a significant level of pollution in the rivers, it makes Pulukan an interesting location to do field research.

2.6.2. Canggu

One of the most touristic areas of Bali is the Canggu area, indicated by the number 2 in figure 2.7b. Coincidentally the beaches of this region are affected by the plastic pollution the most during the rainy season. This is the reason the first Pantai project group settled here a year before this project took place.

Canggu is located in the sub-regency North Kuta. This is located in the Badung regency. Badung is the regency with the highest income. This is due to the fact that almost all mayor tourist attractions are located in this regency. Even though the income level is high and there are several individual companies that handle waste in the Canggu area, it is still an interesting location to conduct field research. This is because the presence of tourist also brings opportunities for a recycling facility. One of the reasons for this is that tourists generally do not like visiting polluted areas. So locals that work in, or are dependent on, the hospitality industry have an extra incentive to keep the areas they work clean. In combination with the fact that one tourist generates 3.5 times more waste than an average local inhabitant [16] this could lead to the local population supporting this project.

Not only is a support from the community expected in touristic areas. It could also be beneficial financially. It is true that the costs of a business would be surpassing those in remote areas. However tourists could be a potential market for recycled products if needed. So if giving products back to the community directly does not seem financially lucrative, products could easily be sold in to tourists, hotels or catering industry.

2.6.3. Denpasar

Denpasar, indicated by the number 3 in figure 2.7b, is the capital of Bali and the only large city on the island. The city has a very high population density and over 600.000 inhabitants. This results in a high waste generation and is therefore a location of interest for this research project.

There are factors that would make it more difficult to set up a plastic recycling business in Denpasar. The fact that there is some sort of waste management system in place, the area price is high and the average income is not very low do not contribute to a high feasibility of the potential recycling facility.

However the pollution measured by the previous project groups shows that the most polluted rivers in Bali are located in the area of Denpasar. So there is plenty of plastic waste that can be collected for recycling, it is expected it will not be difficult to find individuals willing to operate a recycling facility and manufacturers of equipment are located close by. These factors do contribute in a successful business model.

3

Plastic

This chapter gives us an insight the different classes and the most common types of plastics together with some of their applications, chemical and physical properties. Knowledge on this matter is essential before addressing recycling.

3.1. Classes of plastic

Plastics are materials made of synthetic polymers or organic compounds, which are mainly produced from petrochemicals. Since the discovery and use of the first synthetic plastic, in the early 1900s, many different kinds of plastics have been developed. Given the vast range of different polymers used in plastic materials it's convenient to subdivide the plastic materials into different classes. There are many different ways to classify all plastics. Plastics can be classified based on different physical or chemical properties. The most comprehensive classification however is based on the plastic's ability to be reshaped, from its initial shape, after sufficient heating. All plastics can, on account of this property, be grouped into two classes: thermoplastics and thermosets [22].
Thermoplastics are the plastic materials which can be reshaped after reaching its melting point, without changing its properties. This class is of much importance given that thermoplastic materials are generally recyclable and that they're the most prevalent plastic materials globally [1]. Thermoplastics will be discussed in more detail in the next section.

3.1.1. Thermoset plastics

Thermosets on the other hand can't be melted and reshaped after its initial production process. When producing a thermoset plastic its resin, a viscous material consisting of either monomers or prepolymers, must undergo a curing process. The curing process initiates a chemical reaction creating a strong 3D cross link system between the plastic's polymers [23]. The cure of a thermoset resin is initiated by either heat treatment, photo\electron-irradiation or by introducing a hardening agent to the resin, which is a reactant or a catalyst [24].
During the curing process the plastic is still soft and malleable. Afterwards the plastic has hardened and has acquired its initial and also final shape, as it can't be remolded due to the strong molecular bonds. The process of curing is schematically represented in figure 3.1.
As a result of the 3D cross link system thermosets are, compared to thermoplastics, durable materials with a high decomposing temperature. Given these properties thermoset plastics find their application in for example the building, defence, electronics and aerospace industries [25].
Although more research focused on producing recyclable thermoset plastics is emerging, the thermosets that are produced at present are considered non-recyclable materials as thermosets can't be reshaped after production [26–28].
Given the above statement about thermosets being considered non-recyclable together with the fact that they're not as abundant in the global plastic production and the global primary plastics waste generation compared to thermoplastics, the chemical and physical properties of several prominent thermoset plastics won't be discussed in further detail [1, 29].

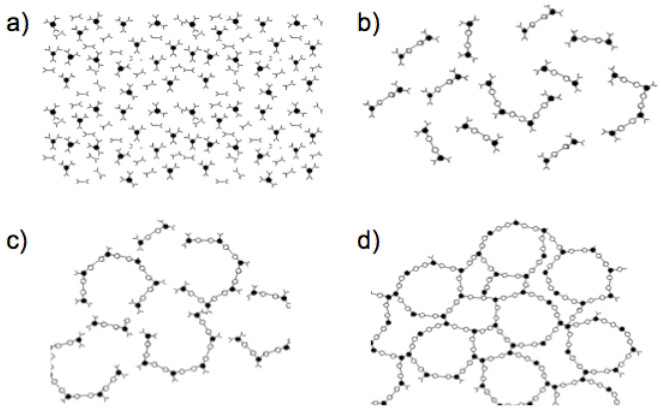


Figure 3.1: Schematic overview of a curing process of a thermoset: a) separate monomers b) growth of polymer c) formation of branches and cross-linked network d) cured thermoset.[30]

3.2. Thermoplastics

In contrast to the thermoset plastics, thermoplastics don't have a strong 3D cross link system between the polymers and cross link bonds also don't form when heating a thermoplastic. The absence of these bonds cause the intermolecular forces to decrease rapidly upon heating [22]. When heated sufficiently the material becomes malleable, this process could be repeated over and over again. This property makes thermoplastics generally suitable for recycling as mentioned before. Bear in mind that not all thermoplastics are recyclable (yet), despite their ability to be reshaped upon heating.
Over the years many thermoplastic polymers have been developed each specifically engineered for different applications. So within the realm of thermoplastics different categories of polymers can be distinguished based on their physical and chemical properties, which will be discussed in the next subsection.

3.2.1. Types of thermoplastics

Thermoplastics can be divided in two main groups, on the basis of their underlying ordering of the polymer molecules: *amorphous* and *semi-crystalline* thermoplastics.
In amorphous thermoplastics the polymer molecules are randomly arranged and don't have an ordered crystalline structure to them. The macro molecules are thus arranged randomly twisted, kinked and coiled [32], see figure 3.2. Due to the absence of a crystalline structure amorphous thermoplastics don't have a well defined sharp melting-point, but it rather softens gradually as temperature increases. In order for a amorphous thermoplastic to become malleable it must be heated to or above its glass transition temperature. Heating the material above the glass transition causes the thermoplastic to lose their strength quickly. Amorphous thermoplastics are typically transparent, have a good impact resistance and are prone to stress cracking, they have poor chemical resistance and have a low shrinkage rate when molding as they are isotropic in flow and are easy to mix with additives [33–35]

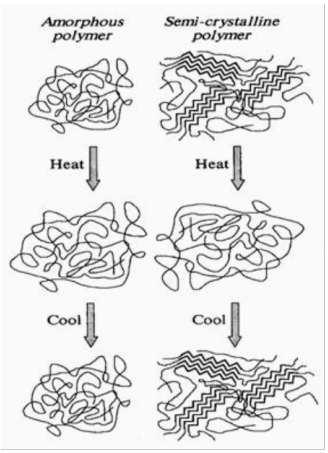


Figure 3.2: Schematic representation of the molecular structure of both amorphous and semi-crystalline plastics and the effect of heating and cooling.[31]

The strings of molecules in semi-crystalline thermoplastics on the other hand are partly arranged in a crystalline ordered fashion, see figure 3.2. In semi-crystalline thermoplastics only a part of the molecules, between 10% and 80, form crystals, the rest of the polymers are randomly arranged (just like the amorphous materials) [36]. Due to the formed crystals the material does have a well defined sharp melting-point. Although semi-crystalline thermoplastics also have a glass transition temperature they become malleable and lose their crystalline structure when heated above its melting-point. Semi-crystalline thermoplastics are typically opaque and compared to the amorphous materials they have a

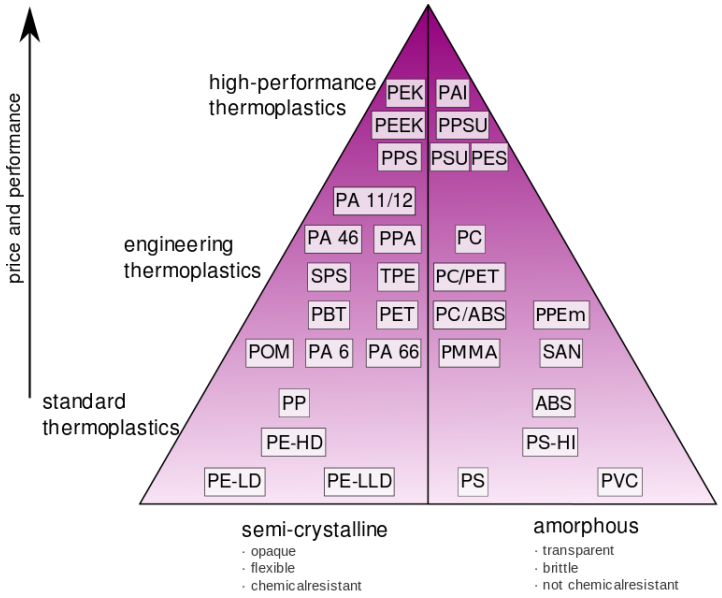


Figure 3.3: Different kinds of plastic sorted based their molecular structure and performance qualities [38].

better fatigue resistance but they lack impact resistance , they have a better chemical resistance and have a higher shrinkage rate when molding as the they're anisotropic in flow and it's harder to mix in additives [32, 34, 35, 37].
It must be noted that some plastics can be produced as an amorphous material as well as a semi-crystalline material, for example PET (see figure 3.3) [37].

Within the classes of amorphous and semi-crystalline plastics three performance categories are defined: standard (or commodity), engineering and high performance thermoplastics, see figure 3.3.
The standard thermoplastic are low in cost, have low strength and have low temperature resistance. These thermoplastics usually find their application in the packaging industry, toys and in non structural application in housing (like piping) [32].
The engineering thermoplastic are moderate in cost, have moderate strength and have moderate temperature resistance. These thermoplastics are typically applied in packaging, electrical components, automotive components, factories, chemical industry and mechanical parts (like gears) [32].
The high performance thermoplastics are the highest in cost and highest in strength, temperature resistance and chemical resistance. They are predominantly applied in electrical components, the automotive industry, the aerospace industry, chemical industry and the nuclear industry [32].

Looking at figure 3.3 it must be noted that the majority of the presented plastics only account for a small fraction of the annual plastic (waste) production. The most abundant thermoplastics in both production and waste generation are: PET, HDPE, PVC, LDPE, PP and PS [1, 29]. These materials will be discussed in more detail in the coming subsections.

3.2.2. Resin Identification Coding System

Before addressing the six most prominent thermoplastics, a system to identify which plastic polymer is used in a material is introduced. The different kinds of thermoplastics can be identified by the so called *Resin Identification Coding* (RIC) *System* developed by the Society of the Plastics Industry in 1988.
The RIC system subdivides and codes all plastics into seven categories based on the plastic resin the material is made off. Six of the seven categories are used for the most common resin types and the last one covers all other resins as well as mixed and layered materials. The categories, with number and abbreviation, are: 1) PET, 2) HDPE, 3) PVC, 4) LDPE, 5) PP, 6) PS and 7) OTHER [39]. The RIC as shown in figure 3.4a is printed or molded onto plastic materials, it's however not globally compulsory to label plastic materials, where the X is a number between 1 to 7 and Y the corresponding abbreviation of the category the material belongs to.

(a) (b)

Figure 3.4: The RIC used on materials, with X being a number from 1 to 7 and Y the abbreviation of the plastic resin. a) shows the old coding and b) the revisited coding

The RIC system was originally developed to provide a universal system to facilitate recycling of post-consumer plastics by means of simplifying sorting plastic waste [39]. However the design of the RIC with the three arrows forming a triangle, as seen in figure 3.4a, might imply that the coded product is recyclable and/or is recycled after use. This is however not the case. Again, the coding is solely there to identify the plastic resin used in the manufactured product. To solve this the coding design was revised in 2013 by ASTM International. The the three arrows forming a triangle is replaced by equilateral triangle and the rest is kept the same, see figure 3.4b. Although this change being made back in 2013 both old and new designs are still printed or molded onto manufactured articles [40].

3.2.3. 1 PET(E)

Polyethylene Terephthalate, abbreviated by PET or PETE, is a synthetic polymer consisting of monomers of $C_{10}H_8O_4$ and its RIC number is 1, see figure 3.5. PET is a low cost engineering plastic and can be produced in both semi-crystalline form and amorphous form.
PET has high mechanical strength, high dimensional stability and it has good chemical resistance (except for alkaline chemicals). PET forms a good barrier for gasses and moisture. It is however a hygroscopic material, meaning that it absorbs water from its surroundings. This limits the service temperature of PET as the absorbed water will cause a hydrolysis reaction, this occurs around 100 °C ,which degrades the plastic and makes it brittle [23, 32, 41]. PET becomes pliable between its glass temperature (∼75 °C) and melting temperature (∼260 °C), thus when shaping PET one must ensure the PET is properly dried and the environment is not too humid to avoid hydrolysis.

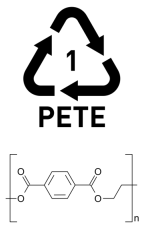


Figure 3.5: RIC and monomer of PET.

PET is predominantly applied in the synthetic fabric industry (∼60% of all PET), in food and drink containers, most notably the PET bottle, (∼30%) and for industrial use (∼10%) [41].
At present PET is recyclable and is recycled globally on a large industrial scale.

For more physical properties of PET please refer to [23].

3.2.4. 2 HDPE & 4 LDPE

Polyethylene, abbreviated by PE, is a synthetic polymer consisting of single units of ethylene: C_2H_4. Polyethylene covers a class of plastics classified by their density and molecular weight, the two most common PE plastics are: high density polyethylene abbreviated by HDPE and has RIC number 2 and low density polyethylene abbreviated by LDPE and has RIC number 4, see figure 3.6.
HDPE and LDPE are commodity plastics that are semi-crystalline. LDPE has a highly branched molecular structure and it's not highly crystallized. LDPE is a bad gass barrier, has low water absorption and a good chemical resistance (except for oxidizing acids). It's a flexible material with relatively high strength and its relative transparent. LDPE can continuously maintain its desired properties up to ∼80 °C and becomes malleable

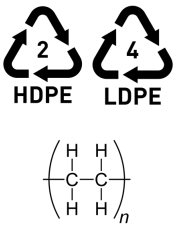


Figure 3.6: RIC and monomer of PE.

around its melting point of ∼110 °C LDPE is most predominantly produced as film and is then applied in the (food) packaging industry, but is also used in toys, playgrounds and as an electrical insulator.
HDPE also has a low water absorption and a good chemical resistance (except for oxidizing acids). But on the other hand it has a linear molecular structure and is highly crystalline, making it a less flexible material with higher strength compared to LDPE. It's an excellent electrical insulator. HDPE can continuously maintain its desired properties up to ∼80 °C and also maintains its toughness at low temperatures down to ∼-50 °C. It becomes malleable around its melting point of ∼130 °C Due to its crystallinity HDPE is more prone to mold shrinking, which should be considered when producing products with HDPE Both HDPE and LDPE degrade by UV radiation giving them a low weather resistance [23, 32, 42].
HDPE finds its application in wide variety of products. It's mainly used in packaging and containers for food, drinks and chemicals. But it's also used in piping systems, consumer goods like bins and toys, furniture, insulating sheets for electrical cables and more [32, 42].
Both LDPE and HDPE are recyclable. HDPE is recycled on a large scale, LDPE on a smaller scale.

For more physical properties of LDPE and HDPE please refer to [23].

3.2.5. 3 PVC

The polymer of polyvinyl chloride, abbreviated by PVC or V and also known as vinyl, consists of monomers of vinyl chloride: C_2H_3Cl and is given RIC number 3, see figure 3.7.
PVC is a commodity plastic with an amorphous molecular structure. On its own PVC is a light and rigid material with a good overall strength, but a low impact strength. It has a good chemical, UV and water resistance and is very durable. PVC becomes very brittle around ∼5 °C and its continuous service temperature is ∼50 °C and thus doesn't have a high heat resistance. PVC has good flame retardancy and is self extinguishing. PVC becomes malleable at its glass transition temperature of ∼87 °C.[23, 32, 43]

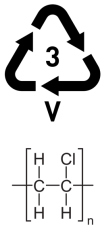


Figure 3.7: RIC and monomer of PVC.

The "raw" PVC resin is very unstable mostly due to the low thermal stability of PVC, it thus needs to be modified before being applied in a product. Additives are mixed with the PVC to enhance and modify its properties, see section 1.5 for additives. With these additives PVC becomes a versatile plastic with many different applications. It's mainly applied in building materials as piping, floors, windows and sidings. But it's also used as cable insulation, in medical applications such as blood transfusion bags, clothing and non-food packaging. [23, 32, 43]
Although it being a recyclable plastic, it is at present not commonly recycled. As recycling PVC was not as economical favourable in the past and due to the environmental risks that the recycling process might impose. But at present more parties are starting to recycle PVC [43].

For more physical properties of PVC please refer to [23].

3.2.6. 5 PP

Polypropylene, abbreviated by PP, is given the RIC number 5 and the synthetic polymer consists of monomers of propylene: C_3H_6, see figure 3.8.
PP is a semi-crystalline commodity plastic. It's properties are quite similar to PE. It thus has good chemical resistance (except for oxidizing acids), it's a good electrical insulator, a good barrier for water, it's prone to mold shrinking and it also has poor UV resistance. PP has better fatigue strength and is lighter than PE. PP continuous service temperature is ∼120 °C and will become brittle when subject to temperatures lower than ∼-20 °C , which is around its glass transition temperature of ∼-15 °C. It becomes malleable around its melting point of ∼170 °C [23, 32, 44].

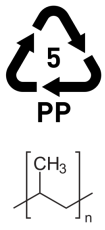


Figure 3.8: RIC and monomer of PP.

PP is applied in many different areas. It's mainly used in packaging both food and non-food. It also finds its application in the automotive industry and consumer products such as furniture, toys, luggage and tableware. PP is also produced as fibre and is for example used in ropes, carpets and sports clothing [32, 44].

PP is recyclable and is at present recycled on a large scale.

For more physical properties of PP please refer to [23].

3.2.7. 6 PS

Polystyrene, abbreviated by PS, is build up of monomers of styrene: C_8H_8 and is given the RIC number 6, see figure 3.8.
PS is a commodity plastic with amorphous molecular structure. PS has high stiffness, low impact strength and thus being hard and brittle material. It forms a bad barrier for oxygen but is an excellent water barrier. The material is chemically inert. PS has a continuous service temperature of ∼60 °C and becomes malleable around its glass transition temperature of ∼95 °C. Due to its amorphous nature PS has excellent dimensional stability. PS is prone to mechanical stress cracking and becomes brittle after UV exposure [23, 32, 45].

Figure 3.9: RIC and monomer of PS.

PS is produced either solid form or foamed (consists of ∼98% air) form and has different application based on its form. The solid form finds its application for example in packaging (food and non-food), disposable cutlery and cups and toys. The foamed form is applied in packaging (food and non-food), as packaging peanuts, in buildings as an insulator, and even in chairs. [32, 45].
PS is recyclable and is recycled, although not on large enough scale. This is mainly caused by the foamed form of PS, as it's not economical to collect and transport the low density foam [45].

For more physical properties of PS please refer to [23].

3.2.8. 7 OTHER

Number 7 of the RIC system is used for products made out of any plastic resin other than the resins corresponding to number 1 to 6 in the coding system. Popular resins with RIC number 7 are acrylonitrile butadiene styrene (ABS), polycarbonate (PC) and polymethyl methacrylate (PMMA). See figure 3.3 for more resins. It also covers products containing a mixture of different plastic resins (also if one or more of the resins of RIC 1 to 6 are used in the mixture) or when different resins are used in a multi-layered fashion (such as crisps bag or juice cartons).
Products with RIC 7 are not recycled.

Figure 3.10: RIC code 7.

3.3. Additives

In the previous subsections it can be seen, that when addressing properties of the different kinds of plastics there is an uncertainty in the values of these properties. The properties of the plastics varies upon the production process. The polymerisation reaction to produce the resin, the mold temperature or the pressure the plastic is subject to during processing for example influences the molecular structure of the plastic, which can alter certain properties (for example the density) [22].
But the properties of materials also change upon the use of additives in the production process. Additives are chemicals which incorporated in the plastic which alter the bulk properties of the material. Additives that are commonly used are: fillers, altering the plastics mechanical properties such as its tensile strength and hardness. Plasticisers, increasing the plastics flexibility and softness. Anti-aging additives, such as antioxidants and UV absorbers which decelerate the degradation of the molecules. Flame retarders, increasing the fire resistance and colorants, of course altering the plastics color [22].

4

Recycling

This chapter discusses the different steps in the recycling process as well as different recycling techniques used at present. The techniques used in each step of the recycling chain, which are thought to be most feasible to apply in a recycling facility on Bali will be discussed in more detail. Methods to recycle the ”non-recyclables” will also be discussed.

4.1. The recycling chain

With the growing plastic waste production and with landfills starting to overflow, recycling is needed more than ever. At present many techniques have been developed to recycle plastic waste, these recycling techniques can be divided into two main categories based on the way they re-process the plastic waste. The two categories are: chemical and mechanical recycling. They all re-process the plastic on a different way, but the steps in the recycling process are essentially the same: collection, sorting, size reducing, cleaning and processing, see figure 4.1.

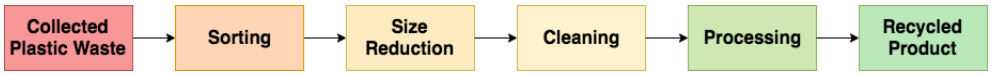


Figure 4.1: Steps from waste to recycled product

4.2. Collecting and sorting

Recycling starts with collecting and properly sorting plastic waste. There are several ways to properly collect plastic waste each with its pros and cons. The collection of waste will extensively be discussed in chapter 6 Waste management.

With sorting being the first step in the recycling chain it is the most crucial step in the recycling process, regardless of how efficient the processing method is. As a good sorting system ensures the removal of contaminants (such as glass, metal, paper etc.) and separation of the different kinds of plastics, resulting in non contaminated single polymer flow for reprocessing (not necessary if one requires a multi polymer flow). Recycled products are of a higher quality if they’re produced out of a high purity single polymer flow.
Many sorting techniques, both manual and automatic, have been developed based on different physical or chemical properties of waste to be sorted, such as density, electrical and magnetic properties, size, shape, color or RIC.

Some of the widely applied techniques are:
Sink-float: Plastic waste is dumped in a container holding a liquid with a well chosen density. Plastics with a density higher than the liquid will sink, the ones with a lower density will float [46].
Jigging: The plastic waste is dumped in a fixed bed where a water stream can be send through. The plastics are again separated by their densities, but are aided by a pulsating water stream. By a carefully chosen pulsation frequency and amplitude of the water stream stratification of the plastic waste occurs

along the height of the bed, based on their density. Highest density on the bed lowest density at the highest point of the pile of plastic waste [46].
Hydrocycloning: This technique sorts the plastic waste based on their density, aided by centrifugal (and thus centripetal) forces. Plastic waste is mixed with a fluid (most likely water) to form a slurry and the slurry is fed to a cyclone. Inside the cyclone the slurry will perform a rotational fluid motion, the centrifugal force will push the high density plastic particles downwards and these will exit the cyclone via the bottom. The materials with the lighter density than the fluid are moved to the vortex created in the center and exit the cyclone via the top [46].
Electrostatic separation: This sorting method separates the different plastics based on the triboelectric effect and are thus separated on the surface charge of the plastic waste particles. The plastic waste particles are introduced to a rotating drum, which charges them. After leaving the drum the waste stream falls down in a container while subject to an external electric field. The positively charged plastic particles move to the negative electrode and the negatively charged plastic particles move to the positive electrode [46, 47].
Magnetic density separation: The plastic waste is suspended in a ferrofluid. The plastic waste feed than flows horizontally while subject to a vertically oriented external magnetic field, which varies exponentially in the vertical direction. As a result the ferrofluid's density varies in vertical direction as well. The plastic particles will move inside the ferrofluid to a level where the ferrofluid's density is very close or the same as the density of the plastic particle [46].
Sensor based sorting: These techniques of sorting rely on the use of sensors, mostly light (both visible and invisible) detecting sensors. There are many different techniques but all techniques have the following sorting sequence. Plastic waste is fed in the system on a conveyor belt, runs past the sensor. The sensor send data of the waste stream to a computer, which analyzes the data. The computer then controls, based on the analyzed data, a mechanical sorting system, like an air gun or mechanical arm [46].
Auxiliary separation technologies: These are separation methods to separate the metallic contaminants from the plastic waste stream rather than separation the different kinds of plastics. The plastic waste feed is mostly moved on a conveyor belt, where the waste stream is subject to magnetic fields (either moving or static) to remove the metallic contaminants. These techniques are mostly applied directly after collecting the waste or after the different kinds of plastic are already separated in single polymer streams, to refine the purity even more [46].

For a detailed information on these techniques and more sophisticated sorting methods please refer to [46].

4.3. Size reduction and cleaning

After sorting the plastic waste, it's to be reduced in size. The process of size reduction aims to make the plastic waste more useful for further processing. Depending on how the plastic is handled afterwards the plastic is reduced to either flakes, powder or pallets, see figure 4.2. This is achieved by cutting techniques such as shredding, milling or grinding the plastic [47].

Cleaning or washing of the shredded plastic is the next step. This step aims to remove the last remaining contaminants out of the (single) polymer stream. Removing the impurities results in better processing of the plastic into higher quality products and leads to less maintenance to the processing machines [28].
The shredded plastic waste is thoroughly washed with water and if need be it can also be chemically washed, to get rid of for example paint or glue [47]. The water with contaminants is then filtered out.
Washing can either be done by hand (given of course only water or non toxic chemicals are used) or by machinery (from both small scale to industrial scale).
After cleaning the shredded plastic must dry, as the presence of water when processing the plastics can cause damage to the plastic, through hydrolysis, lowering the products quality.

It has to be noted that some recycling chains perform a pre-wash after sorting, thus before the size reduction. To make sure even fewer contaminants are present in the plastic waste stream.

Figure 4.2: Plastic after size reduction [48].

4.4. Processing

As stated in section 4.1 there are two main recycling categories: mechanical recycling and chemical recycling. There is however another way of handling plastic waste, which is often referred to as recycling. This is energy recovery by means of incineration. With this technique one acquires energy by burning plastic waste, which can be used to generate electricity using for example a steam turbine, leaving us with more residual waste for the landfill [47]. This of handling plastic waste is only preferred when other recycling processes fail, as it ends the cycle of the plastic. As this process ends the plastics cycle rather than recycling it, it won't be discussed in further detail.

So in this section will only address mechanical recycling and chemical recycling.

4.4.1. Mechanical recycling

Mechanical recycling techniques are based on the property of thermoplastics to be heated and reshaped. In all these techniques the size reduced plastic waste is heated until malleable, then a force is applied and it's formed to its new shape.
Mechanical recycling techniques are only efficient with single polymer streams, mixing of different kinds of plastic will lead to very low quality products. This ends the plastics cycle.
The way of applying the force to shape the malleable plastic distinguishes the different techniques from each other.

Some widely applied techniques are:
Extrusion molding: With this technique malleable shredded plastic is extruded with an extrusion screw through a die, which forms the plastic in long continuous shapes, after which it's cooled and takes on its final shape [47]. Sheets, pipes, 3D printing filament and plastic pallets for further molding processes are for example made with this technique.
Injection molding: With injection molding the malleable shredded plastic is formed by injecting it, with high pressure, into a mold, which for better results. After injecting the mold with the still malleable plastic is cooled and the plastic solidifies to its new shape [47]. Bottle caps, buttons, bumpers, toys and furniture are for example created with this method.
Blow molding: The process of blow molding first require a parison to be made with either injection molding or extrusion. The parison, which is hollow, is then loaded into the mold, heated and then inflated with air so it takes on the shape of the mold [47]. Plastic bottles and other hollow objects are produced through blow molding.
Vacuum molding: The malleable shreds of plastic are first molded to a film or sheet via extrusion. The film or sheet of plastic is heated until malleable and is positioned over a mold. The film or sheet is then forced on the mold by creating a vacuum, thus taking on the molds shape [47].
Compression molding: The shredded plastic waste is placed in a molding cavity and is then heated.

When malleable, the plastic is compressed inside the mold where it fills up the molding cavity thus acquiring its shape [49].

For more detailed information about these techniques and more mechanical recycling techniques please refer to [47, 49, 50].

4.4.2. Chemical recycling

Chemical recycling techniques crack the polymers of plastic waste into other smaller molecules, which are again useful in the production of new plastics or the production of petrochemicals, through different chemical reactions. An advantage of chemical recycling is that a mix of plastics, as well as multi-layer plastic, can be used in contrast to the single polymer streams required in mechanical recycling [51]. Thus only non plastic contaminants have to be separated from the plastic waste stream, thus lowering time and cost on the sorting of the plastic waste feed. Chemical recycling techniques are however only applied on large industrial scale and consist advanced technology processes working at very high temperatures [47].
Most chemical recycling plants make use of thermolysis schemes, which mostly produce gasses and oils used for new petrochemicals. Thermolysis schemes perform chemical cracking of plastic polymers into smaller molecules by applying heat under controlled temperatures without the use of catalysts [47].

The three most applied thermolysis techniques are:
Pyrolysis: Thermolysis scheme using a chemically inert atmosphere in the reactor, creating a high calorific value gas or oil.
Gasification: Thermolysis scheme using air (or other gases which are not chemically inert) inside the reactor, creating a high calorific value gas.
Hydrogenation:Thermolysis scheme using hydrogen inside the reactor, creating a high calorific value oil.
All methods do however leave solid wast, in form of for example char, which is disposed on landfills.

Another method which is used for creating monomers only is *hydrolysis*, which applicable for polymers that were produced with condensation polymerization, for example PET. Hydrolysis reactions break down the plastic polymers in monomers by applying heat in the abundant presence of water.

For more detailed information about these techniques and more chemical recycling techniques please refer to [47, 52, 53].

4.5. Feasible for a recycling facility in Bali

With several prominent techniques from the different steps of the recycling chain now briefly discussed, it must be considered which of these techniques can successfully be applied in a recycling facility on Bali, as described in chapter 1. The choice between the different techniques in each step should be based on several criteria: - Initial investment of required machinery (of importance for chapter 11 Financial feasibility).
- Scale at which the technique is efficiently applied.
- Degree of difficulty of handling (both processing and maintenance) the machinery. The initial investment or the machinery should be relatively low, which will be of importance for the financial feasibility of the business (see chapter 11). The techniques should be able to be efficiently applied at a small scale as it's virtually impossible to set up industrial scale factories on Bali given the high land costs of the island, setting up a large factory would thus result in a higher initial investment (see C.1). As is known from chapter 2 the Balinese are mostly low-educated, so the techniques must not be too complex and only require little extra education. The machinery should also be easily operable and maintained.

In this section a choice is made for the most feasible technique in each step of the recycling chain. These techniques will be discussed in more detail and their choice will be justified, based on the criteria.

4.5.1. Sorting

Many of the high-end sorting methods, described in section 4.2 are only efficient when applied on a large industrial scale [46]. These techniques thus require sophisticated machinery, which are not easily operated and maintained and are quite expensive. These techniques are thus not feasible for a recycling facility on Bali. So they won't be discussed any further.
The sorting methods that do meet the requirements are the ones done by hand as there is no need for machinery and thus require no maintenance, they're easy for the Balinese to learn and are quite efficient on a small scale. In existing facilities on Bali waste is always separated by hand.
The main sorting method to be used in small-scale recycling facility will be sorting based on RIC, with assistance of sorting based on different physical properties also done by hand, which will now be discussed in more detail.

Sorting by RIC

To this day many recycling industries still sort their plastic stream by hand. This is however only possible when the plastic stream consists of macro objects, if the plastic stream consists of small flakes of plastic this practically impossible. Collected post-consumer plastic waste mostly consist of macro object thus making this technique feasible for the small-scale recycling business.
Sorting by RIC starts with removing the large non plastic contaminants, after which plastic is sorted and stored based on the RIC that is printed or molded on the plastic object, see figure 4.3a. Plastics that don't have a RIC on them, as it originally wasn't printed on the object or as it's faded away through usage, are to be sorted on basis of different, not too accurate, techniques such as a sink-float test (which will be discussed hereafter), investigating how the plastic rips, sounds when wrinkled and acts when burned. If then the resin of a plastic object is still undefined it's to be it's stored as if it carries RIC number 7. For the sorting system in the recycling facility one needs seven containers to store each of the different RI codes.
There are however some problems with sorting waste by hand: it can be time consuming and labor-intensive [46].

Sink-float separation

With sink-float separation the waste is dumped in a tank filled with a fluid. This fluid, which shouldn't chemically react with the plastics, is chosen with a density such that a part of the waste will float and a part will sink, of course based on their densities.
This method works well when the waste materials have a significant difference in density. It thus is more effective to sort the plastic waste from non-plastic waste, compared to sorting the different kinds of plastics as they have densities which are close to each other.
With this technique, when using water, one can for example sort PVC and PET from PP, LDPE and HDPE but one can't sort PET from PVC and PP from LDPE and HDPE, see figure 4.3b. The use of additives in the plastics, the presence of contaminants and the presence of air bubbles on the surface of the plastic can influence the efficiency of the sorting process [46].
For this sorting system in the recycling facility one requires containers with different (non toxic) fluids.

(a)

(b)

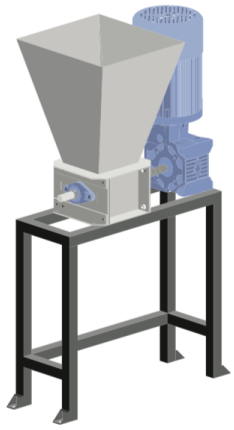
Figure 4.3: a) RIC printed om plastic product [54]. b) Schematic representation of a sink-float set-up [46].

4.5.2. Size reduction

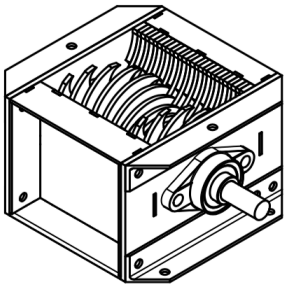
The size reducing techniques, whether it's milling, grinding or shredding, are all feasible techniques: they can be implemented on a small scale, the machinery is cheap, easy to maintain and operate. The choice of technique to be used for size reduction process solely depends on the size of the plastic particles required for processing. The choice for this step in the recycling chain falls on a shredding machine as this machine delivers a flake size of plastic waste small enough to be used in the chosen feasible process techniques, which will be evident from section 4.5.4.

Shredder

A purposed design of a possible shredding machine is shown in figure 4.4. The machine consists of a hopper, a shredder with rotating circular shredding knifes and motor. This particular machine uses one row of rotating circular shredding knifes to reduce the size of the waste, one can of course use two or more rows for quicker shredding. The row of rotating circular shredding knifes is attached to an electrically powered motor with ∼2 kW power and rotation speed of ∼70 RPM [28].
The rotating row of blades captures the plastic waste and cuts them into smaller pieces. Underneath the shredder a mash is placed so that only parts with the required size fall through, shreds of plastic that are too big are introduced in the shredder again. This machine allows the plastic to be cut up into ∼5-10 mm flakes.
For more detailed specifications and drawings of this machine please refer to [28].



(a)



(b)

Figure 4.4: a) Shredding machine [28]. b) Detail of the shredder [28].

4.5.3. Cleaning and drying

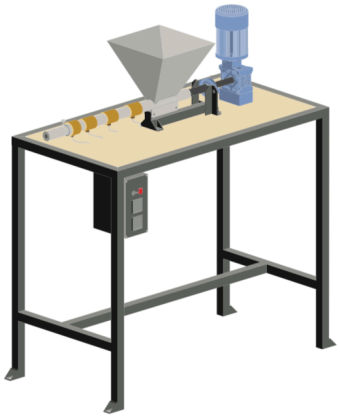
The cleaning process can be, as stated in section 4.3, done by hand and machinery. A feasible option is washing the waste by hand with water or using a washing machine (as simple as a laundry washing machine), as these techniques require cheap or no machinery, they're easy for the Balinese to learn and are quite efficient on a small scale.
After cleaning the waste must be dried for better processing of the waste. The plastic can easily be air-dried on racks on which the cleaned wast can be deposited. One should not dry the waste in direct sunlight as some plastics have low UV resistance. Another feasible option is to make use of the centrifuging function of the washing machine to dry the plastic.
Thus for a potential cleaning and drying system in the recycling facility one could use only a container to wash the plastic and racks for air-drying or another option is make use of a (laundry) washing machine for cleaning and drying.

4.5.4. Processing

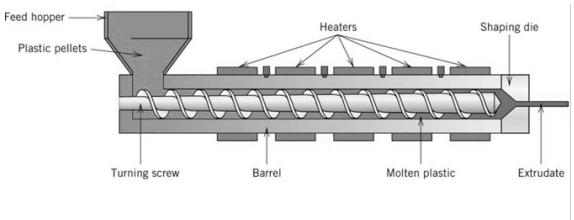
All chemical recycling techniques require sophisticated machinery and are only applied in large factories [47]. Making chemical recycling methods not feasible for a recycling business on Bali, thus limiting the choice to mechanical recycling techniques.

Many of the mechanical recycling techniques can be applied in cheap, effective on a small scale and easy to operate machinery. The techniques that are most commonly used in small scale recycling businesses are extrusion molding, injection molding and compression molding. One of the reasons for these techniques being so popular might be due to the existence of the online global plastic recycling community called Precious Plastic. The team behind this community shares open-source blue prints and designs for an extrusion, injection and compression machine as well as the shredder design in section 4.3, which are used by many small scale recyclers globally. Their machines have proven to work very well, can be produced at low costs (see appendix C.9 for a price indication) and are easily operated and maintained. Making them very interesting for the conceptualized recycling business on Bali. These design can thus directly be implemented or used as an inspiration to make altered and improved machinery.
So for processing step extrusion, injection and compression molding are all considered to be feasible techniques. But if one were keen to implement only one of these three techniques, one must make their choice based on the recycled products one wants to make. As each of the techniques is more suitable for the production of different goods.
The three techniques will now be discussed in more detail.

Extrusion molding
A purposed design of a possible extrusion machine is shown in figure 4.5. The machine consists of a hopper, an extrusion barrel, adjustable heating system and a motor. Plastic, in shredded form (it doesn't have to be powdered) is fed to the hopper, where it enters the extrusion barrel. The extrusion barrel is shown in figure 4.5. The barrel is heated (heating system requires around ∼1 kW) to the desired temperature to make the plastic malleable. The shredded plastic is transported through the barrel by the extrusion screw, which rotates using a motor (∼2 kW power and rotation speed of ∼70 RPM). The gaps of extrusion screw become smaller along the direction of motion of the plastic, building up pressure. With the plastic being malleable (through the heated barrel) together with the built up pressure, the plastic can flow through the shaping die acquiring its new shape.
Extrusion molding is especially used when producing long continuous shapes, such as pipes and 3D printing filament (see section 4.4.1).



(a)



(b)

Figure 4.5: a) Extrusion machine [28]. b) Detail of the extrusion barrel [55].

Injection molding
A purposed design of a possible injection machine is shown in figure 4.6. It consists of a hopper, an injection barrel, an adjustable heating system and a lever with a press. The plastic waste, shredded plastic suffices, arrives in the barrel through the hopper. The barrel is heated (heating system requires around ∼1 kW) to the desired temperature to make the plastic malleable. A mold can be attached to the nozzle of the injection barrel. When the plastic is malleable the lever is pulled down manually to inject the malleable plastic in

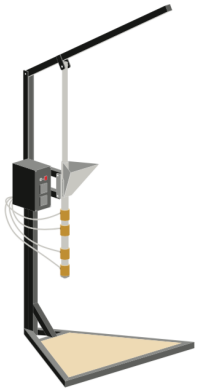


Figure 4.6: Injection machine [28].

the mold, acquiring its new shape. The mold with the hot plastic inside then is cooled by either air or water to release the product out of the mold.
This injection machine is limited to producing smaller objects such as small tiles, key chains and phone cases, due to the size of the barrel and due to the machine being man powered (through the lever). A more sophisticated injection machine (with for example a hydraulic press and a larger barrel) is able to produce bigger and more complex objects.

Compression molding
A purposed design of a possible compression machine is shown in figure 4.7. The machine consists of an oven with its electronics and a press. Plastic in again shredded form is introduced to a mold and the filled mold is placed inside the oven on the pressing platform. The oven is set to the required temperature for molding. When the plastic is malleable the press (in this design a simple carjack is used) is used to move the platform up to compress the mold against the ceiling of the oven. After compressing the platform is lowered and the mold is taken out of the oven and cooled by either air or water to release the product out of the mold.
With a compression machine one can produce larger objects like flowerpots, sheets of plastic to make furniture or clip-boards.
The process of compression molding is however more time consuming, due to the heating process of oven and mold, compared to the other two techniques.

(a) (b)

Figure 4.7: a) Compression machine [28]. b) Detail of compression machine with its press [28].

4.5.5. Usable resins and mixing
The machines described in section 4.5.4 are compatible with the polymers: PET, HDPE, LDPE, PP and PS. With PET on must always properly dry the shredded plastic, more carefully than the other plastics given it hydrolyses quickly in the presence of water (see section 3.2.3).
Do not use PVC in these machines as PVC contains toxic chlorine which can escape during processing.

As the machines, which are thought to be most feasible for the conceptualized recycling business, recycle mechanically it's very important that plastic waste is sorted correctly and not mixed in the machine. As this will end the plastics cycle and results in bad quality, brittle and phase shifted products [28].

4.6. Recycling the non-recyclable plastics
A large part of post consumer plastic waste consist of materials labeled with RIC number 7, i.e. the non-recyclables. These materials are at present mostly brought to landfills or littered in the environment and are not recycled.
Finding a solution for the non-recyclable plastics, to avoid them from ending up in a landfill, proves to be challenging. Although with the development of chemical recycling products of mixed polymers or layered plastic materials can now be recycled, however this is not yet done on a large scale [51]. For layered plastic/non-plastic products (such as crisps bags), heavily degraded plastics and other not recycled plastics people have to find more creative solutions.

The majority of these creative solutions are based on using these non recyclables as a filling agent in other products. Extensive research is done on the use of non-recyclable plastics as a filling product in the production of cement and brick. Although the use of non-recyclable plastics in bricks and cement is still in its experimental phase it shows the great potential of this solution [56–58].
The use of non-recyclable plastics in bricks can be interesting way of recycling on Bali, as during the groups stay on Bali many small-scale brick-making facilities were found all over the island.

4.7. Conclusion

To conclude: many techniques of the different steps in the recycling chain have been reviewed.
For each step feasible techniques for the conceptualized recycling facility on Bali were chosen. Sorting should be done by hand based on the RIC and other assisting techniques (such as sink-float, ripping the plastic or wrinkling plastic etc.). Size reduction should be done with a shredding machine. Cleaning an drying can either be done by hand and dried on racks or washed and dried by a (laundry) washing machine. Processing the plastic waste should either be done using an extrusion, injection or compression machine, which can be inspired by the open-source designs of Precious Plastic [28].
All plastic products with RIC 1,2,4,5 and 6 are usable in this recycling chain, although extra care should be taken with handling PET (RIC 1).
More creative solutions for ”recycling” the non-recyclable plastics are being found, many of them use the non-recyclable plastic waste as a filling agent in other products, such as cement or bricks. Which can provide a solution in Bali, as there are small-scale brick producers all over the island.

5

Setting Up a Business in Indonesia

In this chapter the most important elements which are required to start a business in Indonesia are discussed. In section 5.1 the introduction is given. In section 5.2 the most necessary visa's are discussed and in section 5.3 the negative investment list is treated. Moreover, in section 5.4 the different possible legal entities for the potential business are discussed and in section 5.5 nominee stakeholders are considered to help with some of the hurdles that arise with starting different entities. Lastly, the foundation is treated in section 5.6 and then this chapter will be concluded with the conclusion in section 5.7.

5.1. Introduction

The most important thing to start with before starting a company in Indonesia is to execute an extensive preliminary investigation. This entails everything possible that arises when starting a company, it is advised to contact a company that is familiar with the local rules and regulations that are involved when starting a business such that there are no surprises in store for example with things such as visa's and permits. Thus when starting a company it is good to go in bed with a local business set up specialist, consultant or law firm/agency that has good references and is legally registered to process and prepare government documentation and applications and has proper connections with the different departments of the government. Hence, most necessary paperwork and the required permits and documents for starting a business will be accounted for and troubles with respect to the unfamiliarity of the business law and language are solved. Moreover, the facilitator can also be requested to arrange for working and living visa's while the formation of the company is underway just as well as during the operational phase of the company [59].

Furthermore, it is of course also of big importance to know in what industry the business is going to be active as it might be on the negative investment list and cannot be owned by foreigners, this is also the case if the paid-up capital is too low. As a result, you must find 'local' partners such that the business can be run in Indonesia, more about the negative investment list and nominee shareholders can be found in section 5.3 and 5.5. Moreover, in addition to these restrictions it is also very important to know what type of legal entities there are and which one best fits the needs of the potential business. If all of this is known and done the starting of the business can commence. Although it is also important to know the rough timeline that is accompanied with the start of a business as during this time you can not work or do business, the usual time it takes to start a business from scratch can take approximately 2-6 months depending on the circumstances [60].

5.2. Most important VISA'S

When starting a business in Indonesia with foreign owners or employees it is of course very important to know what sorts of permits and visa's need to be arranged to accommodate the performance of the company. Using a local facilitator is the optimal way to obtain any visa and all the correct paperwork. As usually most of the work for obtaining a work visa or permit is done by the company the employee is going to work for. Nevertheless, in this case you are the investor and have to arrange for all the paperwork yourself and therefore a local facilitator is advised. Below an explanation will be given of

the different VISA's and work permits in Indonesia.
The most used VISA in Indonesia is the temporary stay permit called KITAS and finally the holy grail under the VISA's in Indonesia is the KITAP.

5.2.1. KITAS

The first VISA is the KITAS. Having a temporary stay permit (KITAS), or also known as working visa, is an absolute requirement when one works in Indonesia. A working visa must be sponsored by an Indonesian entity, a sponsorship by an individual citizen of Indonesia is not possible. This entity can be every one of the entities mentioned in section 5.4.
Also the position at the future company needs to be confirmed as the KITAS is issued based on the approval of the work permit which required specific details about the job title and location. On its turn the length of the KITAS will depend on the job title. For example, jobs such as commissioners and directors are guaranteed to receive a 1-year KITAS which is extendable. Managers and people with advisory roles are also eligible for a 1-year KITAS, however this will be subject to the immigration official's decision, but more often than not they are granted a non-extendable 6 month KITAS [61]. The sponsoring company should propose a job title that satisfies the regulations that are issued by the Ministry of Manpower, this will be dependable on the business classification of the company. In general, the positions that can fulfilled by foreign employees are mostly jobs such as but not limited to: commissioner, director, manager or advisory roles.
In figure 5.1 a global oversight is given of the requirements that need to be fulfilled by foreign employees to apply for a KITAS and also include the sectors in which foreigners cannot hold a job.

Figure 5.1: Requirements that need to be fulfilled by foreign employees to be eligible for a job in Indonesia as well as the sectors in which they are not allowed to work. [62]

It has to be noted that temporary work permits are also available with a validity between 2 to 6 months, such a work permit is applicable for industries such as trading, services an consulting. This also applies to workers in sectors such as installation of machinery and maintenance. Lastly, urgent/ emergency work permits are also available, these have a validity of maximum 1 month. Urgent jobs that need immediate action generally use such a permit. This permit is allowed in order to prevent any detrimental consequences to a company or society as a whole [62].

5.2.2. KITAP

The KITAP or in other word the permanent stay permit allows a foreigner to stay in Indonesia for 5 years consecutively at a time. This is the visa that is commonly used by expats that live in Indonesia

for long term or even plan to stay for the rest of their lives, this is also usually the most chosen VISA by investors. A person is an eligible candidate for a KITAP if he/she is a [63]:

- Foreigner with an Indonesian spouse.
- Foreign investor, director or commissioner in an Indonesian company that has worked in the same Indonesian company for at least 4 years and is in the possession of a KITAS.
- Retiree.
- Indonesian regaining its citizenship.

The extension of the KITAP is automatic if the current position of the KITAP holder is not changed. Thus unless you have a status update during the 5 year validity of the KITAP, the next submission is just simply to re-apply and the KITAP will be extended automatically.

5.3. Negative Investment List

The Negative Investment List (NIL) is a list that is used by the Indonesian government to protect its local businesses that would be vulnerable for competition by foreign investors. For example, it targets the restaurant and guesthouse entrepreneurs, where the maximum foreign ownership is in the range of 49-51%. The mindset behind this is that it forces foreigners to seek out local partners [64].
Thus, the maximum allowed ownership by foreigners depends on the business classification of the company. It could be 100% open to foreigners or 100% closed to foreigners. In short, the negative investment list is a list basically regulates the amount of possible foreign ownership in a company. This comes down to that when an industry falls under the NIL that the foreign investors need to have a local partner. Due to these restrictions, a lot of investors look for alternative solutions to start a company with the desired amount of control [65].

However, due to these restrictions investments have lead to be stagnated a bit. Thus in order to boost foreign and domestic investments in Indonesia, the government decided last year to update the Negative Investment List. These investments will contribute to the consistent and reformative progress in the country. Of course this was also a consequence of that the amount of foreign investments were much lower than expected in certain sectors and that the current national deficit needs to be decreased as it has hit US$8.8 billion (3.7% GDP) in 2017, and foreign investments play a big role in this [66].

The amount of industries opened up for different businesses are represented in figure 5.2.

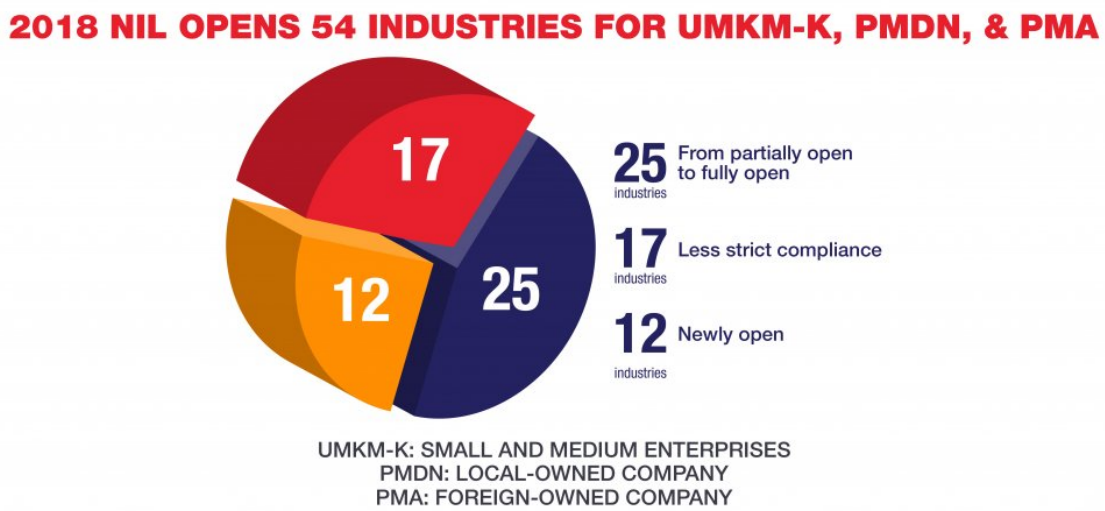


Figure 5.2: Changes in the Negative Investment List [66].

To continue stimulating the market, the negative investment list will be shortened, especially in the

remaining sectors in which investments have stagnated, as well as industries that need to be further expanded. The updated list will open up 54 business activities, and full ownership by foreigners is going to be allowed for 25 business activities in 8 different sectors. It has to be noted that not all the 54 fields of business are suitable for a PT PMA as it requires capital of IDR 10 billion.

Concluding, the negative investment list has a significant influence on the development of the economy in Indonesia and the amount of investments made by foreign entities that flow into the market. Moreover, it is also very important for investors to be aware of the latest developments in this list to not be surprised by sudden changes. Of equal and maybe more importance is to know in what kind of business category the potential business of the investor will be active, to ensure that it is not suddenly impossible to start/conduct business in the wanted business field.

5.4. Business Classifications

There are multiple ways to start a company on the island of Bali where generally the same rules and regulations are applied as for the rest of Indonesia. To start a company it is important to know what sort of size category exist and in with which of these sizes your potential company will be categorized. In short, companies can be classified in the following sizes [67]:

- A micro company, has a net worth up to IDR 50 million.
- A small company, which has the net worth between IDR 50 - 500 million.
- A medium company, which has a net worth between IDR 500 million - 10 billion.
- A large company, Which has a net worth of more than IDR 10 billion.

It is important to know what kind of category the company is classified as for multiple reasons. One of them is that each company has a minimum paid-up capital requirement as well as a minimum capital investment plan, for example a large company has to hand in a minimum capital investment plan of at least IDR 10 billion. On top of that the paid up capital that the company owns should be 25% of the authorized capital or more than IDR 2.5 billion. Due to recent changes in the regulations of Indonesia, the company is even obliged to have legal proof of the paid up capital that should be turned over to the Indonesian Minister of Law and Human Rights.[67] This policy is enforced such that the company is financially healthy and capable to run its business operation well based on the regulations and law that are practiced in the country. Once this is in order the registration of the business can be finalised.

Besides the size of the company, a company can be divided into different types of legal entities. Hereafter, explanations of the main sort of legal entities will be explained such as the limited liability companies (LLC) in Indonesia. A PT is an acronym for Perseroan Terbatas which is used in Indonesia to represent the term of a limited liability company and from here on forward will be used to indicate an LLC. The companies that will be discussed are:

- **PT (local)**
- **PT PMA**
- **Representative Office**
- **Non-profit Organisations**

5.4.1. PT

Firstly, the PT is generally the most popular sort of entity in the Indonesian business world as a PT can be active in many business fields in Indonesia. A PT (PMDN) is a local company and can only be founded by people that have the Indonesian nationality, which means that foreigners cannot start a PT or have any shares in the company. Therefore, it has to be noted that a PT is usually classified as a micro to medium company. This is due to the fact that if the company is classified as large, the company is usually a PT PMA and in such company foreign ownership is allowed. However, this does not mean that a large company cannot be locally owned, because a PT can have options to extend its business to a PT PMA. The company then has to apply for the change to the Indonesian government but this is accompanied with a lot of paperwork, time and money. Thus, a local started PT can also remain a local company due to the fact it chooses not to change into a PT PMA. Another factor to take into account is the fact that a PT can’t hire foreigners unless it is minimally classified as a medium sized

company, which requires a larger net worth and a larger paid-up capital. More information about the paid-up capital and conditions to hire foreigners for a local company can be found in section 5.5.

5.4.2. PT PMA

In a PT PMA, the PMA stands for Penanaman Modal Asing. Such a company is often referred to as a foreign investment company, as this company is allowed to be founded by foreigners or depending on the negative investment list to be fully/partially owned by a foreign entity or person. However, for investors and business entities that want to start a PT PMA a few hurdles have to be tackled such as the negative investment list and the minimum capital requirement which is often far too high for start-ups, investors and business entities that want to invest in a company in Indonesia. That is why a lot of start-ups, investors and business entities decide to 'by-pass' the restrictions of a PT PMA and start small and go into bed with a nominee shareholder, more information about the nominee shareholder can be found in section 5.5. For the profit companies as the PT and PT PMA usually a global corporate structure hierarchy can be established, this hierarchy can be seen in figure 5.3.

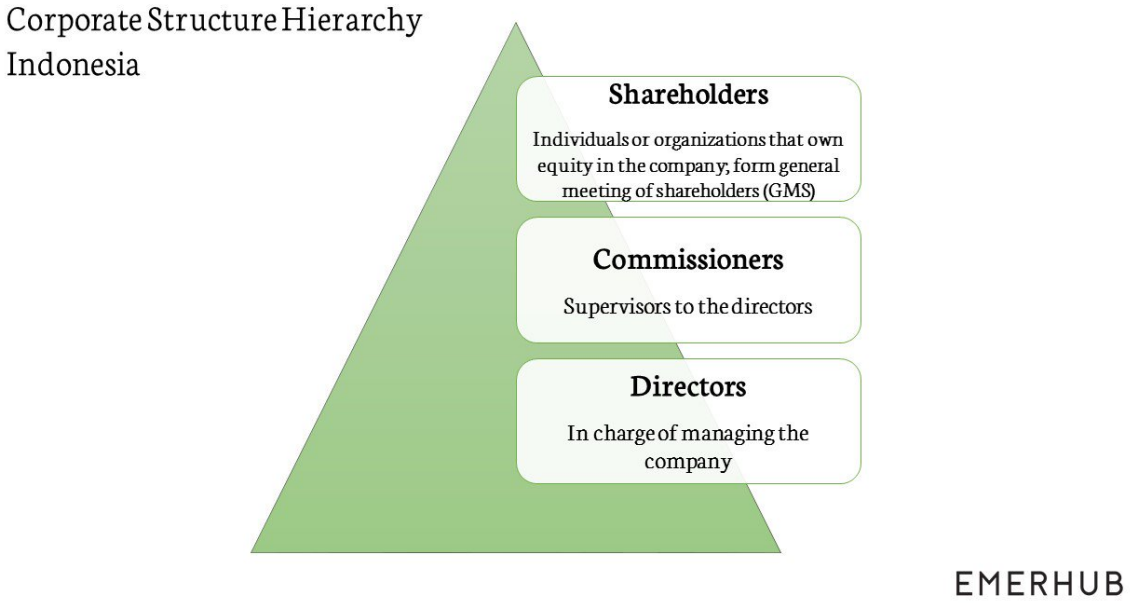


Figure 5.3: Global oversight of the corporate hierarchy in Indonesia [65].

5.4.3. Representative Office

An alternative to a PT PMA is a representative office (RO), these offices don't need to comply with the ownership and capital restrictions like a PT PMA. An RO is often used by foreign companies to gain a market presence in Indonesia. However, it has to be noted that an RO can only be used to conduct promotional activities, market research and act as a country buying/selling agent for the mother company [68]. Besides the work field restrictions the RO's purpose is to represent the foreign company, thus it cannot earn any revenue in Indonesia. Moreover, the country of Indonesia does actually not allow any foreign business to form a branch office in the country. As a result it is impossible to change the representative office into a branch and as such the foreign entity has to register a PT PMA in Indonesia to conduct commercial business.

5.4.4. Non-Profit Organisations

The laws in Indonesia can set restrictions on the sort of non profit organisations as well on the body that created them. A non-profit organisation in Indonesia can be a company that has a legal or non-legal status. When the NPO is a legal entity it can be a foundation (yayasan) or an incorporated association. Nevertheless, an association without a legal entity can also be created [69]. Regarding a foundation, it has to be noted that this is the only societal organisation that is open to foreign entities and has a

low starting equity requirement of IDR 100 million (approx. 6.435 euro). In which the latter could be a company that focuses on profits as well. On the other hand an association can be either incorporated or ordinary. Regardless if the association is incorporated or ordinary, it will be membership-based. As a membership based organisation, the existence of one will depend mostly on the participants. The participants will have the power to dissolve the company as long as such a decision would be within the confines of the law. Moreover, the participants could also receive sections of the assets they have provided to the company in case a dissolution takes place [69]. Concluding, due to the benefits that come with a foundation with respect to the foreign ownership and non-membership possibilities it has been decided to only look into the foundation (yayasan) further, the foundation will be further discussed in section 5.6.

5.5. Nominee company

In Indonesia's present-day market of starting businesses a trend can be observed that is constantly increasing. Namely, the trend in which nominee companies/persons are used by foreign entities to start a business in a foreign country. The definition of a so called nominee entity or in other words nominee shareholder is defined by Emerhub as [65]:
"A nominee shareholder is a person or a company that is the registered holder of shares of a company on behalf of the real owner. However, the ownership is simply ostensible and the nominee shareholder is essentially a name on the documents."

There are basically three main reasons to choose for a nominee company or person. The first one is due to the Negative Investment List (DNI), thus the business classification of the potential company as explained in section 5.3. Due to the fact that you want to operate in a certain classification it could be impossible to be the owner of the company. Therefore a nominee company/person is used such that the investor can start a company with the desired amount of control.
The second main reason to use a local nominee is that it saves a significant amount of time with the registration of the company. With the strategy of implementing a local shareholder a company can reduce the corporation timeline of a PMA with 2 months [68]. This is often a recommended approach when a company has an urgent need to become legally operational in order to close business deals or secure contracts that are time sensitive. This option can also of course be used if a company simply wants to speed up the registration time.
The third main reason is the minimum capital requirement for foreign entities. As explained in section 5.4 to set up a company in Indonesia that is foreign owned (thus classified as a large company), an investment plan needs to be submitted for at least IDR 10 billion to be able to show that the company is sustainable. This is just a plan for the future and does not have to be invested immediately, in figure 5.4 a small oversight of a basic investment plan for a foreign owned company can be seen.

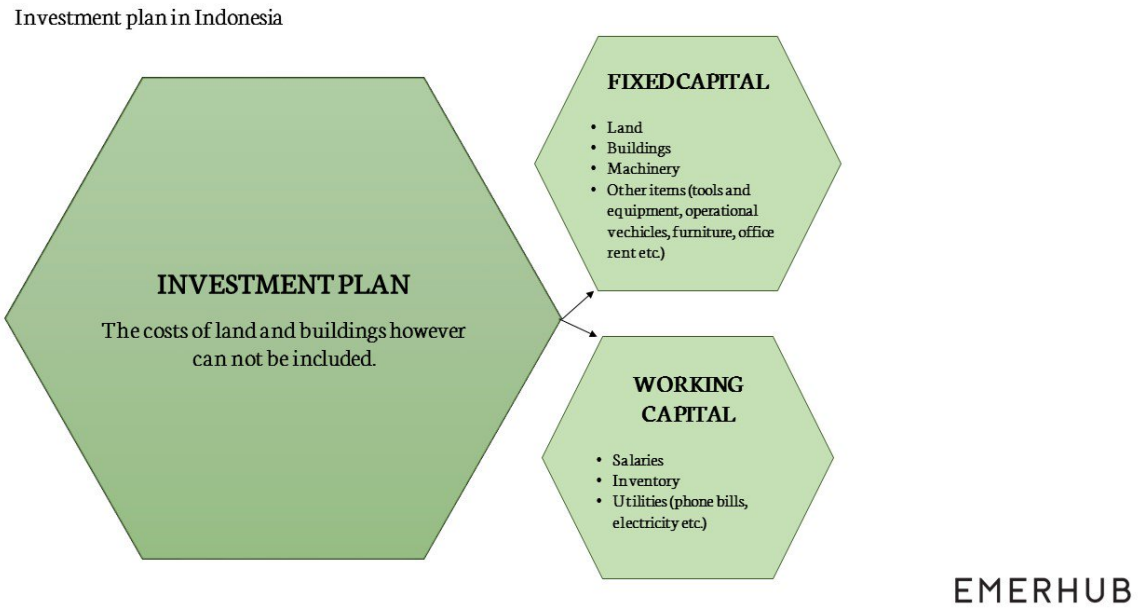


Figure 5.4: Investment plan for a PT PMA [70]

However, according to law a start capital of IDR 2.5 billion does need to be injected into the company by the shareholders immediately when starting a foreign owned company. This can be done in the form of cash into the company's bank account or other assets. If the capital is invested in the form of cash, then the funds are exchanged in the form of shares and these will be issued to the shareholders in the company. If the start capital is put in in the form of assets then the value of these assets is based on the current market prices [71]. These invested capitals can then be used for the day to day business of the company. These huge investments are for smaller companies and small entrepreneurs naturally much to high and therefore other solutions like a nominee company need to be found.

If all shareholders in the company are Indonesian residents then the requirements for the capital injection and requirements are a lot lower. As a result of these hurdles and possible benefits a lot of entities decide to get involved with local nominees. As setting up a local company requires a minimum paid up capital of IDR 51 million [65], it has to be noted that this is the amount in case only local employees are hired. If the company wants to hire foreign employees as well as local employees then the paid up capital requirement goes up drastically, as the company would have to be classified as a medium sized company at least [72]. Another restriction is set with respect to hiring foreign people for companies based in Indonesia. Namely that companies are obligated to prioritize the recruitment of local workers, and only when the jobs cannot be fulfilled by a local person a foreign worker can be recruited for a fixed period of time [73]. The Ministry of Labor also wants to see proof that this vacancy cannot be fulfilled by a local person. Although in reality this means that commissioners and directors of the company get their limited stay permits (KITAS) very easy, while the hiring of the foreign employees is increasingly hard [64].

Taking all these factors into account especially with respect to the minimum paid-up capital a nominee arrangement is often the go to choice for small companies. However, a nominee arrangement where a local person owns the company on paper for the full 100% is never safe. Because using a local nominee shareholder, especially with the lack of a legal set of agreements, could end up to be very risky. As doing this means you do not have full control over the assets, thus essentially the deal would be based on blind 'trust' with the local nominee and would not hold up in court. This is due to the fact that the Indonesian Investment Law does not acknowledge the concept of 'trust' in the Indonesian law system. For example, it is stated in the Articles of Association(AKTA) of a limited liability company (LLC) that the owner of the shares is the simultaneously the beneficial and the legal owner, thus no

distinction between the two. Concluding, the right kind of nominee agreements is a set of complex legal agreements that protect your assets and is drafted by professionals [65].

It is very important to have a professional company draft an agreement in which you can have control or security with respect to the assets and earnings. In which the contract with the nominee shareholder ensures the investor matters such as:

- that all signed agreements will adhere to Indonesian laws.
- the risk is minimized in comparison with individual nominees.
- that all agreements will be respected in court.

There are multiple options to do this, such as [74]:

- Loan Agreement between Local Shareholder and Investor
- Letter of Indemnity.
- PoA to Vote and Sell.
- Cooperation Agreement.
- Call Option Agreement.
- Pledge of Shares Agreement.
- Director Appointment Letter.

As can be seen there are a lot of ways to achieve the 'ease of mind' for the investor. As example, the first option is taken namely the loan agreement option. For this option the relations amid the beneficiaries and nominee shareholder will be commercially governed in the form of a loan agreement in which the nominee purchases the shares in the company using a loan that is provided by the beneficiary. Since these shares are acquired in the means of a loan, they are pledged back to the beneficiaries for total control [65]. For the complete explanation per option we would like to refer to the website of Cekindo [74]. In short, these options will ensure that the business can be ran in a restricted sector without breaching any laws and moreover having a local partner that is governed by legal agreements. A schematic overview of certain forms of legal agreements can be seen in figure 5.5.

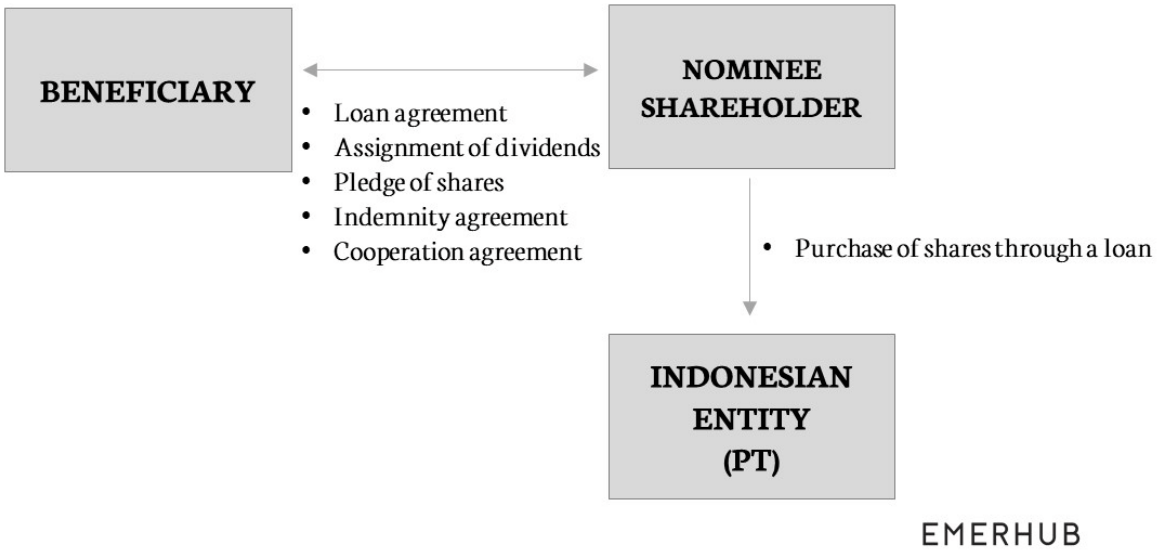


Figure 5.5: An example of agreements between a beneficiary and a nominee shareholder. [65]

	PT PMA	Nominee Company
Legal entity type	Foreign owned (PT PMA)	locally owned (PT)
Maximum percentage of foreign ownership	0-100% depending on Negative Investment List	0%
Required paid-up capital	IDR 2.5 billion	• In case of hiring only locals: IDR 51 million. • In case of hiring foreigners as well as locals: IDR 1 billion.
Legal owner according to the law	The investor	Local nominee (which can be regulated via contracts)
Control over assets	Director of the company	Director of the company (can be the investor)
Change shareholders whenever deemed necessary	Yes	Yes, but only when the other shareholders are also locals

Table 5.1: Summary of the biggest difference between using a nominee company and a PT PMA [65].

5.6. Foundation (Yayasan)

A foundation, or as the Indonesian people call it a yayasan, is defined by multiple regulations. For instance if we take Law No 16 of 2001 of Foundations(amended: Law No. 28 of 2004) [75]. Then a foundation can operate in three main fields:

- Social
- Religious
- Humanity mission

Hereby, it has to be noted that when a foundation sets up its own company the business activities must be related to the statuary purposes of the foundation. The foundation is defined as a non-membership legal entity, which is established based on the separation of assets. Nevertheless, a foundation can still benefit the public or the stakeholders of the organization.

As mentioned in subsection 5.4.4 a foundation is the only non-profit organisation in which can be founded by foreigners. A foundation is able to be founded by one or multiple legal entities/individuals. In figure 5.6 the stages to set up a foundation can be seen.

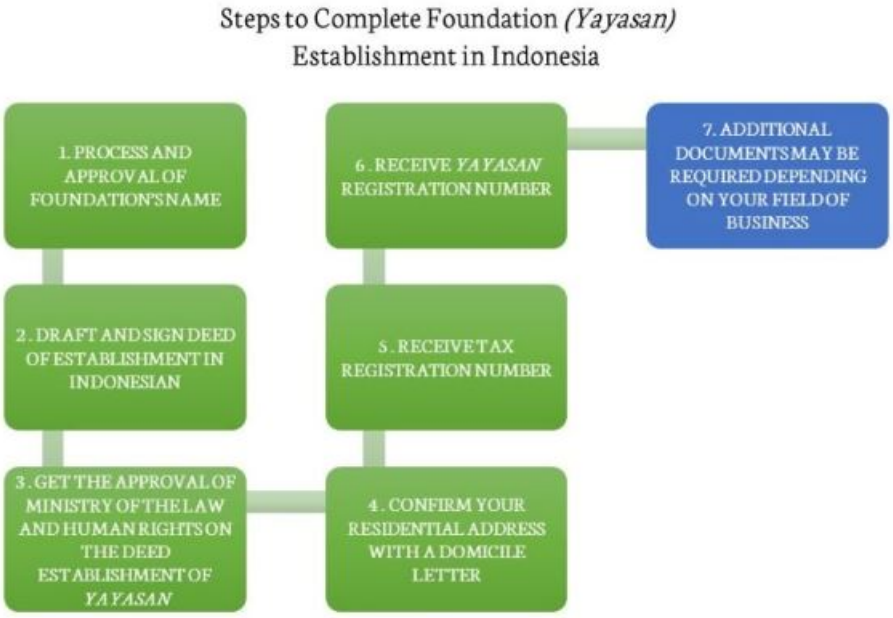


Figure 5.6: Steps to successfully complete the set-up procedures for a foundation [75].

5.6.1. Hierarchical structure of a Yayasan

In this section the structure of a yayasan will be discussed, focused on the hierarchical organisation. In a foundation at least one founder needs to be present, the founder can exercise control through its ratification authority. Furthermore, if this foundation has a foreign founder or even multiple foreign founders they need to have at least one Indonesian citizen as a board member. With respect to the board, the board consists of multiple functions and should at least include one of each of the following:

- Chairman
- Secretary
- Treasury

It has to be noted that each foreign board member needs a permanent stay permit (KITAP) and a working permit (IMTA). If the executive does not have both permits he/she is not allowed to perform the specific function. The board members are responsible for the day to day operations of the foundation. In addition to board members the foundation also consists of supervisors. The supervisors are responsible for supervising and advising the board members and should consist at least one of both:

- Advisor
- Supervisor

5.6.2. Paid-Up Capital and Wages

For all starting entities in Indonesia initial equity requirements are present. For the PT an PT PMA this has already been discussed in their respective sections. However, how does this work for foundations. For a foundation, the paid-up capital depends on the nationality of the founding entity. For example [75]:

- Indonesian entities, the paid-up capital shall be a minimum of IDR 10 million.
- Foreign entities, the paid-up capital shall be a minimum of IDR 100 million.

Furthermore, when it comes to dealing with the income of the foundation, the foundation is allowed to pay salaries from it. It has to be noted that if you are a member of the executive, supervisory or governing board you must be a volunteer. This basically comes down to that these persons are prohibited from benefits and can therefore not receive wages, salary or honoraria, with exemption from

reimbursement of expenses. Although in the latest revision of the law, executive board members receive compensation under the following circumstances [75]:

- Working for the foundation directly and full-time.
- They are not the founders of the foundation.
- There is no association present with the founders, the supervisory board or the governing board.

5.6.3. Reporting Requirements and Tax Regulations

For a foundation it is very important to keep track of their annual report and to timely report it. This is due to the fact that a foundation does not only have to file their periodic reports to the (local) government but also have to publish them to the public, this must be done via an Indonesian language news media. An oversight of the report is given in figure 5.7.

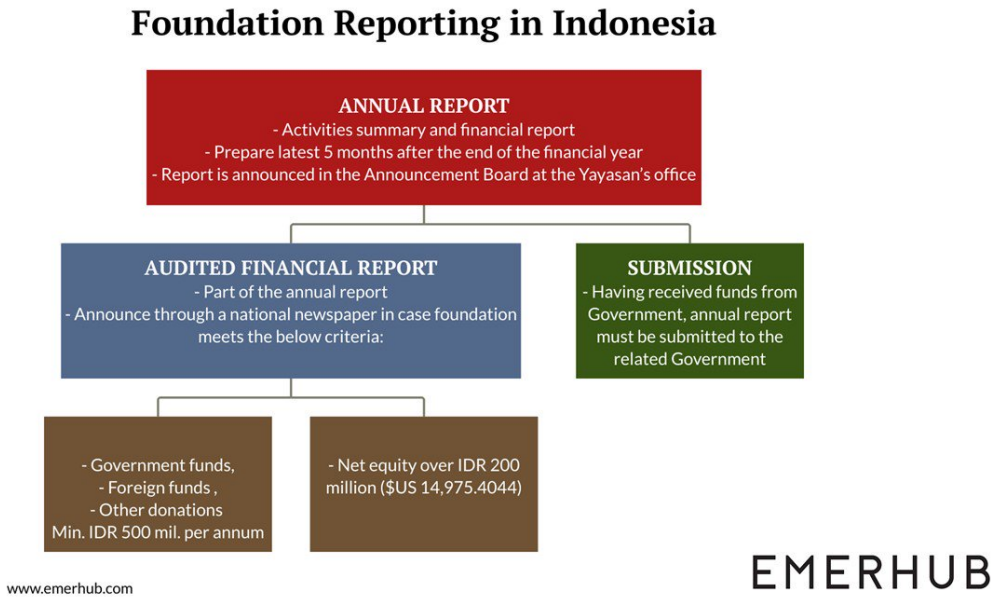


Figure 5.7: Annual report that has to be published to the government and public by a foundation [75].

Conditions that are also present in the report are things such as tax exemption. A non-profit organisation such as a foundation is subject to income tax in Indonesia. However, in comparison with profit focused companies a foundation is eligible for tax exemption in case:

- The foundation uses the income to provide scholarship funds.
- The income of the foundation is reinvested in its work, which would only be the case if the foundation is active in area of research and development or education

5.7. Conclusion

The possible legal entities for the Pantai business have been discussed extensively in this chapter. The big recurring problems were that starting a business in Indonesia for a foreigner requires a very large paid-up capital, or the industry is on the negative investment list or that the foreigner has to have an Indonesian nationality to start a PT with a smaller capital. Nevertheless, there are some ways to work around these road blocks, one of them is to get into bed with a nominee stakeholder. These nominee stakeholders are not without risk but can be managed through the use of a set of complex legal agreements drafted by professionals and would therefore protect your assets. Furthermore, focused specifically on the Pantai project a choice has been made with respect to the most suitable legal entity that will accompany the recycling business. It should be noted that the Pantai group is not looking to make a profit, and this project is purely performed out of social goodwill and willingness to help.

Based on this the Pantai group has decided that the most suitable legal entity for the recycle business is a foundation or in other words a yayasan. This is due to the fact that the initial paid up capital is far lower for a foundation than for a PT PMA namely, IDR 100 million (6,400 euro). Also a yayasan would help the recycling business to grow faster due to tax exemption on income that is reinvested back into the company, which helps us more in our endeavour to a plastic-waste free Bali. In addition to these advantages we also hope that starting a foundation instead of a PT would create goodwill and compassion under the local inhabitants of Bali. As then it can be seen that we do this for the people and not to fill our own pockets.

6

Waste Management

6.1. General introduction

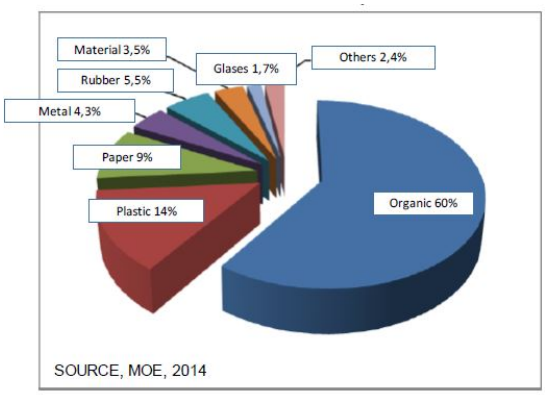
This chapter starts with a description of the integrated solid waste management system in Indonesia. Moreover, the waste management system in Bali is described. The waste management system of Bali can be divided in a governmental and a non-governmental system. Additionally, a non-organised informal waste sector is present which operates separately from the governmental waste management system. The aim of this chapter is to provide an overview of how severe the waste problem in Bali actually is based on key facts and figures.

6.2. ISWM in Indonesia

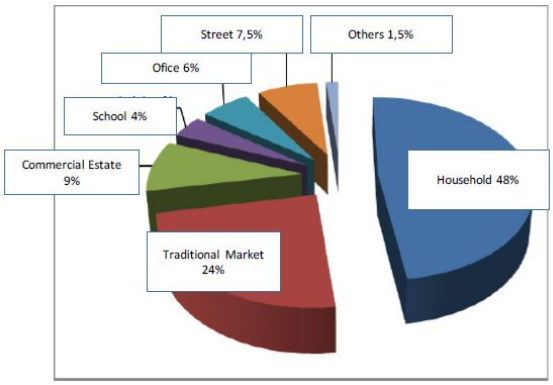
The Integrated Solid Waste Management (ISWM) in Indonesia is divided in the following categories: waste output, waste collection and the system, current and future policy and management methods and waste-banks. These five parts are described in detail in the next subsections. The foundation of waste management is realised by the national government, therefore it is important to understand the national system before describing the provincial system of Bali.

6.2.1. Waste output

In 2017, the total waste output in Indonesia was 65.8 million tonnes reported by the Ministry of Environment and Forestry [76]. The average waste output, with a total population of 264 million inhabitants was 0.68 kg/pppd (kilograms per person per day). 14% Of the total waste composition consists of plastics (Figure 6.1a). The average waste generation in urban areas is around 0.75 kg/pppd. The municipal solid waste is estimated to increase 2 to 4% every year. The main source of this waste are households, responsible for 48% of the solid waste output generated in Indonesia (Figure 6.1b).



(a) Waste composition in Indonesia [77]



(b) Sources of solid waste in Indonesia [77]

Figure 6.1: The waste composition and sources of solid waste in Indonesia

6.2.2. Waste collection

The waste collection at households, hotels and restaurants is carried out by municipal services. A big difference can be noticed between urban areas and big cities (Figure 6.2). In the poorer parts of the country, only 10-20% of the waste is being transferred or recycled by municipal services. This indicates that the presence of waste collection services are regional dependent.

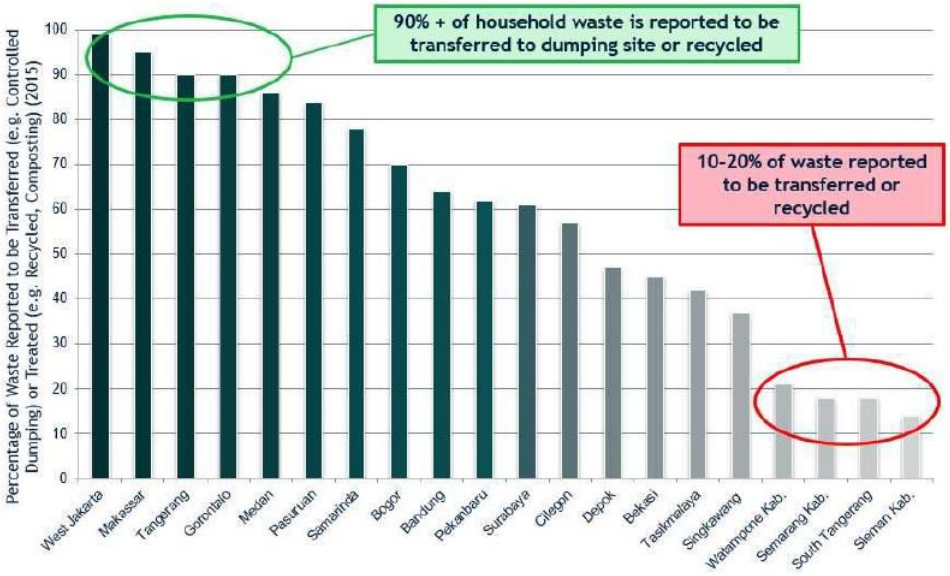


Figure 6.2: Percentage of municipal waste collected in Indonesia [76]

The waste management system in DKI (Daerah Khusus Ibukota) Jakarta is visualised in Figure 6.3. This waste management system is rather simplistic. Four different waste flows can be distinguished. Households drop their garbage at a collection point in the neighbourhood after which waste trucks collect the waste directly, or via a transfer station. Waste originating from the second group of waste producers (apartments, offices etc.) is dumped into containers and transported with hook-lift trucks. The third and fourth waste flow originates from open spaces such as parks. This waste is indirectly transported to landfills.

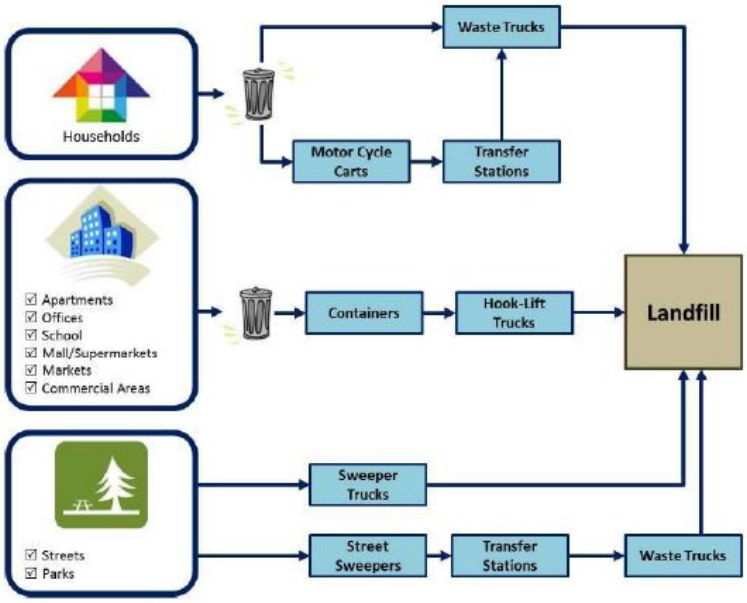


Figure 6.3: Waste collection system in DKI Jakarta, according to [76]

Generally, there are four ways to collect waste that can be found in Indonesia and in the rest of the world.

House collection (door-to-door)
The municipal service is focused on collecting garbage from door to door. This is an expensive method and takes a lot of time. However, this method is very specific and measurable.

Contracted service
The contracted service, can be done by both non-governmental and governmental organisations, will schedule waste collection moments. The pick-ups will take place according to date and time.

General bins
Each household is responsible to put their waste in general bins in the local neighbourhood. This method is hard to control.

Self delivery
The households bring their garbage to a central point of collection or directly to a landfill. This is an unorganised way of delivery and hard to measure.

6.2.3. Waste management policy

The Indonesian Ministry of Environment and Forestry has recently developed a Solid waste management policy and national strategy (2017-2025) [76]. The focus is shifted towards circularity of materials. Currently, there are two laws in Indonesia with regards to waste management: Law No. 18/2008 and PP. No. 81/2012. An overview of the shifting paradigm can be seen below (Figure 6.4). The legislation seems promising, but in reality the enforcement and implementation lags behind [77]. Most of the waste is still found anywhere in villages, on the beaches and in riverbeds.

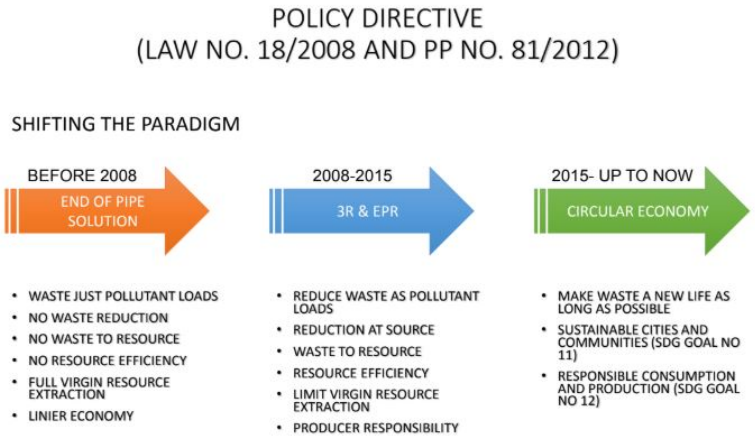


Figure 6.4: The shifting paradigm of the Indonesian governmental policy [77]

6.2.4. Waste management methods

A division of waste management methods can be seen in Figure 6.5. The biggest contribution to the pie is the waste disposed at landfills: 69%. Only 45% of this 69% are controlled landfills, the remaining 55% is uncontrolled by means of open dumping [77]. The real values of these waste management methods are hard to measure and location dependent. According to Kyle Osborne, project manager of The North Bali Reef Conservation (appendix C.3): Tianyar, one of Bali's most northern areas, does not have any form of waste management system organised by the government. Waste originating from local households is not transferred to any facility, resulting in extremely high incineration rates of plastic waste.

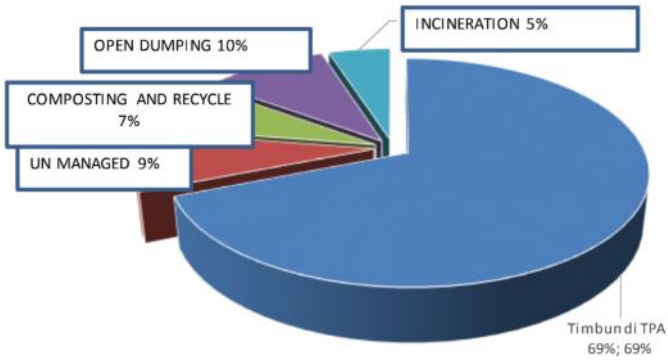


Figure 6.5: Waste management methods in Indonesia, MOE 2014 [77]

6.2.5. Waste banks

Eco-Bali, one of Bali's well known NGO's, functions as a waste bank (Indonesian Bank Sampah). The principle of waste banks is the same as for a regular bank. The local community can hand-in their garbage and get, in return, monetary value. The general idea of waste-banks is to stimulate the inhabitants of Indonesia to collect and save their waste, and is initially set-up by the government. However, most of the waste banks in Bali are not regulated nor controlled [77]. That is why many organisations in Bali claim to be a waste bank. The Bank Sampah seems to overrule the Pumulung's (scavangers and waste collectors) business, explained in 6.3.

In Bali, 26% of the households sell their waste directly to a waste bank. Important to note is that waste banks only "cherry-pick" the valuable plastics. A visualisation of the amount of waste banks active on Bali and the potential recycling businesses currently active can be seen in figure 6.6.

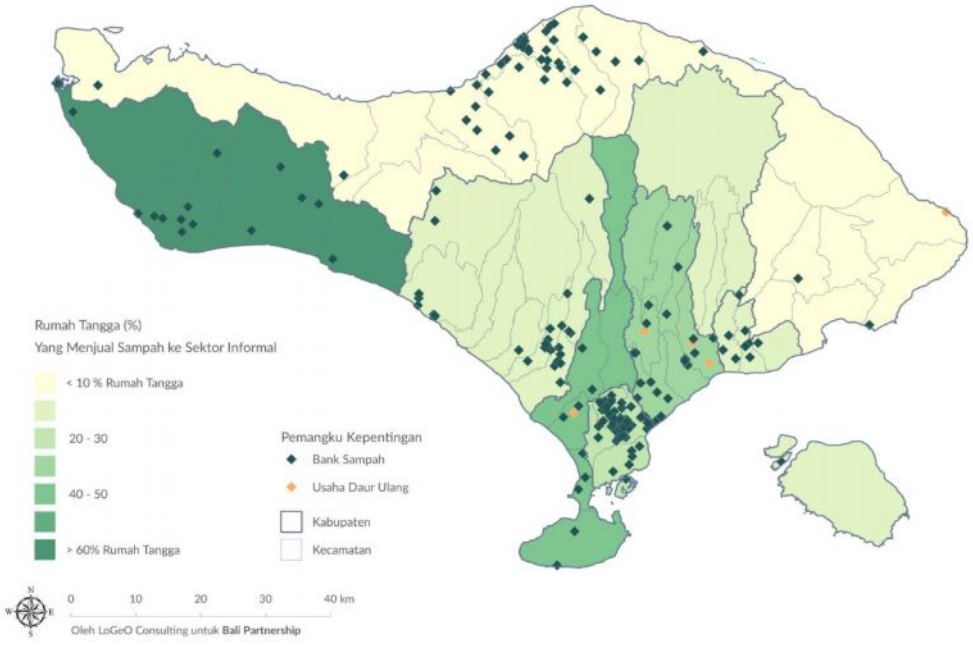


Figure 6.6: Waste banks and activity on Bali. A Kubupaten is a regency, a Kecamatan is a district. The darker green the area is, the more inhabitants sell their waste to waste-banks. [16]

Prices which are payed to collectors differ per material. PP plastic cups (Type 5) plastics are most valuable and are sold for around 4.000 IDR/kg (0.28 USD/kg). More price indications can be found in Table 6.1. These prices measured through a market research in Jakarta. The actual prices in Bali are lower because of the fact that plastics are not recycled on the island itself.

Material	IDR/kg	USD/kg
Plastic bottle	3.500	0.25
Plastic bottle caps	2.500	0.18
Plastic cups	4.000	0.28
Newspaper	1.400	0.1
Cardboard	1.100	0.08
Metal	2.500	0.18
Glass	200	0.01
https://www.xe.com/currencyconverter/convert/?Amount=1&From=USD&To=IDR		1 USD = 14.119 IDR

Table 6.1: Waste bank rates Mekar Sari, South Jakarta [76]

6.3. ISWM in Bali

The ISWM in Bali in described in detail in this subsection. As noted in the introduction of this chapter there is a distinction between governmental and non-governmental organisations. Moreover, we provide facts and figures with regards to waste output and generation in the three research areas: Pulukan, Canggu and Denpasar.

6.3.1. Governmental waste management

Bali counts nine regencies with nine different regional authorities. The available budget for waste management services is divided over the regencies by the national government [78]. Additionally, regional revenues can provide extra budget for waste management services. Badung, the most touristic regency of Bali, generates extra budget by tax incomes. The tax which tourists pay in addition to their bills are directly transferred to the regional budget. Eventually, the Banjars (smaller communities with a local Desa Adat) are responsible for their own waste management. Recently the government of Bali has put more effort into waste management systems to take their responsibilities on the plastic waste problem.

The regencies of Bali have a local DLHK (Dinas Lingkungan Hidup dan Kebersihan). This agency is controlled by a provincial institute named DLH which is controlled by the Ministry of Environment and Forestry (Figure 6.7). The DLHK manages two types of facilities: the TPST and the TPST3R facilities. The 3R relates to reuse, recycle and reduce. The TPST is a collection point where no separation takes place. Waste is immediately transported to landfills.

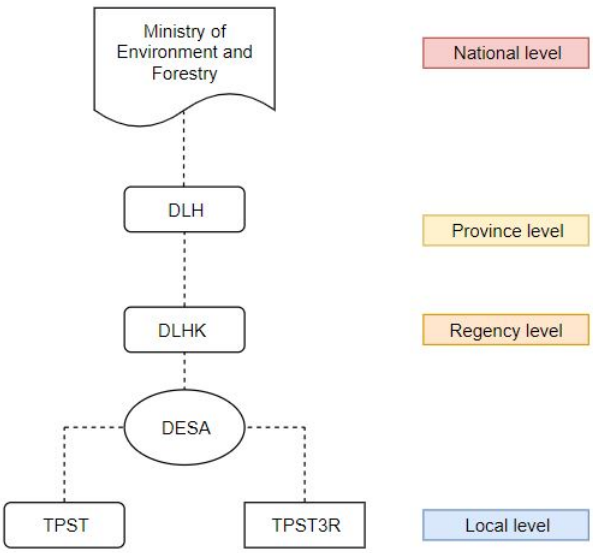


Figure 6.7: The governmental waste management system, overview

The TPST3R do separate plastic waste from other waste, the non-recyclables are send to a landfill and organic waste is composted. Recyclable plastics are transported to recycle facilities on Java. The waste is collected from local collection points and delivered to the TPST(3R) facilities by the Desa service (Desa means village in Indonesian). The Desa provides garbage trucks and equipment to collect waste. The service provided by the Desa is location dependent and not always present. The fees with regards to waste collection services differs per region. In the richer regions, i.e. Seminyak, households do have to pay for the service. It is directly payed from the local Banjar budget (around 40.000 IDR/month)
Generally, there are a few challenges to be faced if it comes to proper waste management in Bali. First of all, there is regionally a limited budget for waste collection services. Secondly, there is limited expertise with regards to sustainable waste management. This has to do with the local understanding of recycling. Third and lastly, the social attitude of the local community highly affects the way in which waste is managed. These socio-cultural differences make it hard to create one common view to solve the waste problem in Bali. This is described in detail in Chapter 7.

6.3.2. Non-governmental waste management

The Non-governmental waste management system of Bali can be divided in a formal and informal waste management system. The formal system is connected to the local government. The informal system works on itself and is initiated by individual local communities.

Formal waste management

On top of the governmental waste management service from DLHK, there are multiple private organizations operational on Bali. These non-governmental organizations (NGO's) can be divided in a profit-driven and a non-profit driven group. The profit driven group, e.g. Eco-Bali, collect waste by their own service. Eco-Bali has close contact with governmental agencies and is therefore not just a private party. On top of their waste collection and separation service, they provide education programmes and workshops [79]. The fee that households, restaurants and hotels pay for their service starts from 115.000 IDR/month. This is rather expensive compared to the services provided by the government. EcoBali is located in Badung regency.

Since a few months, The North Bali Reef Conservation (NBRC), has started a small recycle plant. The NBRC is an example of a Non-profit organisation which works with volunteers. The aim of the organisation is to recover the North Bali's coral reefs. On top of that, they focus on education programmes and awareness of plastic waste in the northern area of Bali, Karangasem regency [80]. Many non-profit organisations are located on Bali. A big global community named Precious Plastic stimulates people to fight against plastic waste in Bali. This community has their own workspace and machinery on Bali and is therefore an important stakeholder within this research. An overview of the parties we interviewed on Bali can be seen below.

Figure 6.8: Non governmental formal waste sector of Bali

Informal waste management
The non governmental waste sector consists of global communities and initiatives like Eco-Bali. On top of that there is a strong flexible presence of individuals which contribute to an informal sector. The informal actor system is organised as follows:

Pemulung
These are scavangers and informal waste collectors. In Bali, most scavangers are Javanese migrants. They sell the recyclables to Pengepul. More than two million of inhabitants work as Pemulung in Indonesia.

Pengepul
Pengepul are Middlemen. They collect waste in an organised manner and organise the transportation of waste to small factories/depots.

Pengilingan
Pengilingan sort the recyclables into over more than 50 different classifications. The majority of the workers are Javanese migrants and the processes waste is sold to factories in East-Java.

According to [77] the Pengepul and Pengilingan have a great impact on the determination of prices and the logistics of waste. Employment and income levels are constantly changing. The market prices at local level are influenced by national and regional prices for materials. "The international commodity prices have a profound impact on even local decision making of the Pemulung." as stated in [77].

6.3.3. Facts and figures
The data in this subsection is of essential importance for further developments of our intended plastic recycling business. The data originates from the Bali Partnership Assembly [16] which obtained data from the following primary data sources: 949 waste behaviour surveys, 234 waste characteristics studies, 10 landfill trackers and 100 litter assessment trackers. Moreover, it used secondary data from institutes and databases.

Waste generation and output
The biggest source of waste are households, responsible for 51% of the total waste generation on Bali. The average household waste generation is 0.5 kg/pppd, this is three times less compared to the waste generation of tourists: 1.7 kg/pppd. The total waste generation per day is around 4,281 tonnes, which is generated by Balinese residents (4.2 million) and tourists (16.4 million per year). Around 50% of all waste is being generated by three regencies: Denpasar, Badung and Gianyar.

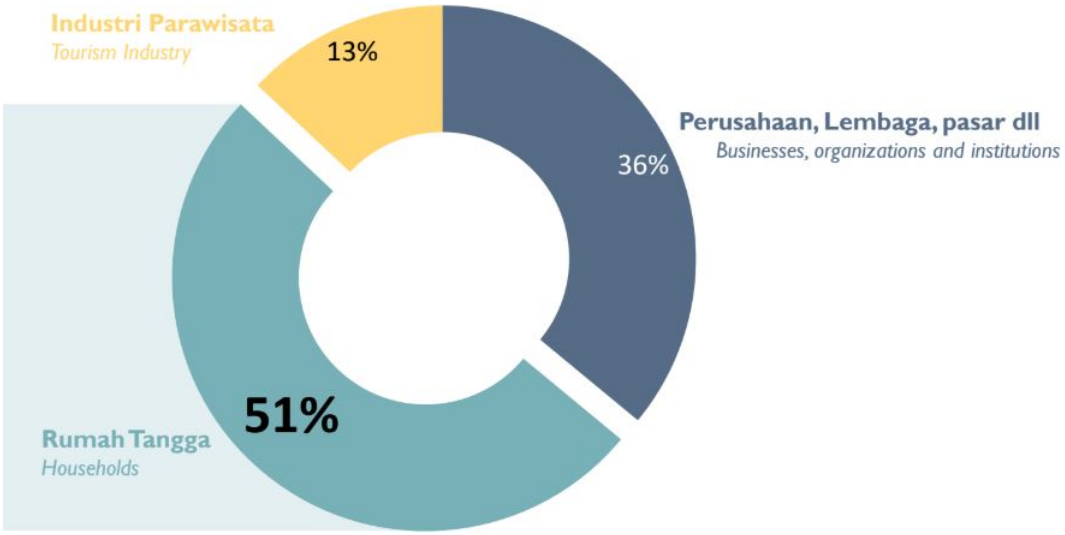


Figure 6.9: Waste generation and sources according to The Bali Partnership Assembly, 2019 [16]

Waste composition and management methods

The waste composition of Bali (Figure 6.10) is different than the Indonesian composition (Figure 6.1a) in a few ways. Paper and plastic form a bigger part of the total pie, respectively 11% and 20% of the total waste composition are paper and plastic materials. The organic materials are equal (Figure 6.10).

Figure 6.10: Waste composition in Bali, according to The Bali Partnership Assembly, 2019 [16]

The plastic waste generated output in Bali has been measured by ISWA: the International Solid Waste Association (ISWA). The results show that the highest contribution to plastic waste are plastic wrappings (Figure 6.11).

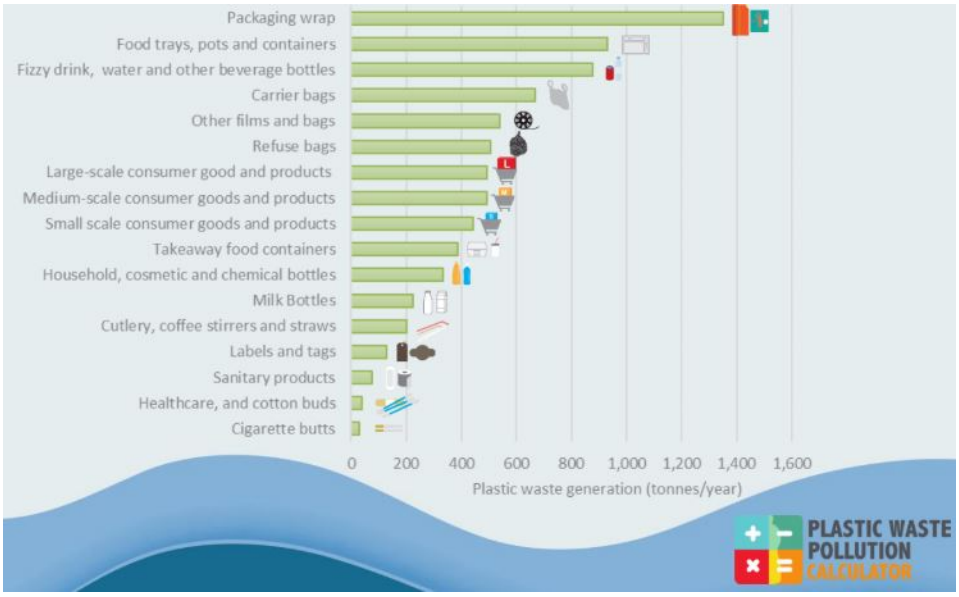


Figure 6.11: Composition of plastic waste according to the ISWA, 2019

Responsibly managed versus mismanaged waste

More than half of Bali's generated waste is not managed properly. This means that it is either retained in the environment or burned. The total recycling rate of Bali is just 4% (Figure 6.12).

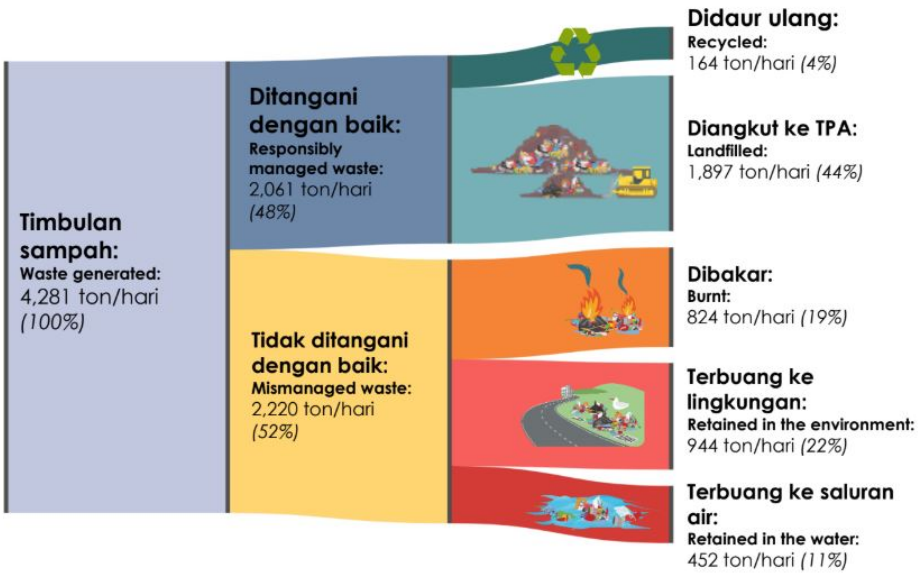


Figure 6.12: Mismanaged and responsibly managed waste in Bali

6.3.4. The three case areas

The ISWM in Bali finds it ways in the three case areas of this MD project: Canggu, Denpasar and Pulukan. These regions show different characteristics if we look at the waste generation and output. To validate if the results from our plastic collection measurements are in line with the actual waste values, we acquired new information from the Bali Partnership Assembly [16] during the stay in Bali. An overview of the most important characteristics are presented.

Critical areas

The parties involved in the policy and management of Bali's waste management system, i.e. private organisations, governmental agencies, NGO's, community leaders, had come up with a critically assessment of the areas in Bali which are to be found most impacting on the plastic waste problems (Figure 6.13).

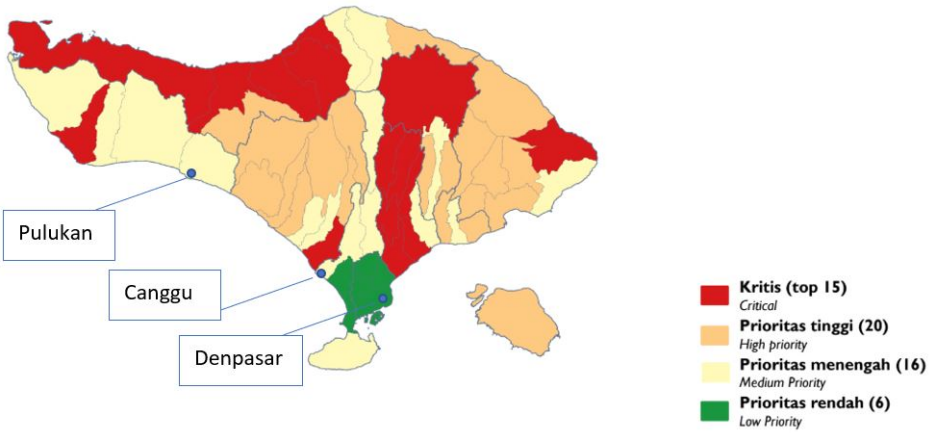


Figure 6.13: Overview of critical waste management areas in Bali, according to The Bali Partnership Assembly, 2019 [16]

Noticeable is that these areas are assessed based on their population density and waste collection rate (see next page). As these two variables are very location dependent we can not simply assume that the whole regency needs more attention than others. The recycling rates in Pulukan, Denpasar and Canggu are significantly low, up to at most 6%.

ISWM in Pulukan

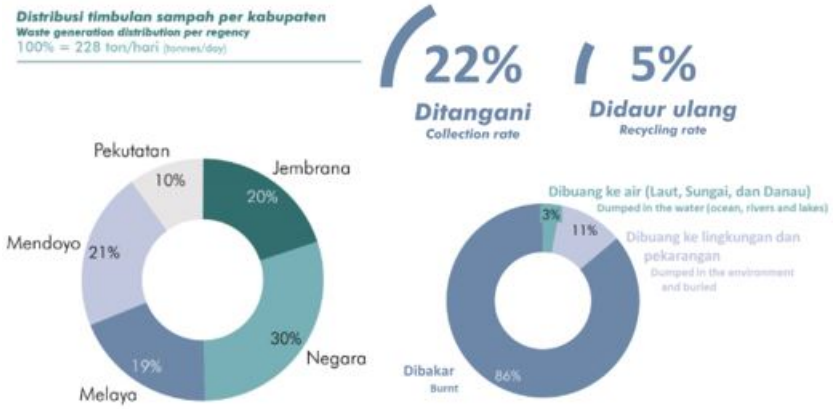


Figure 6.14: Key statistics of Jembrana. Pulukan is part of the district Pekutatan [16]

ISWM in Denpasar

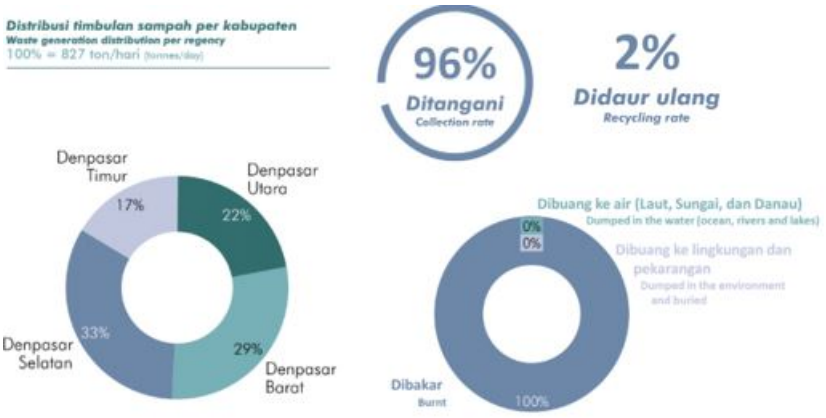


Figure 6.15: Key statistics of Denpasar [16]

ISWM in Canggu

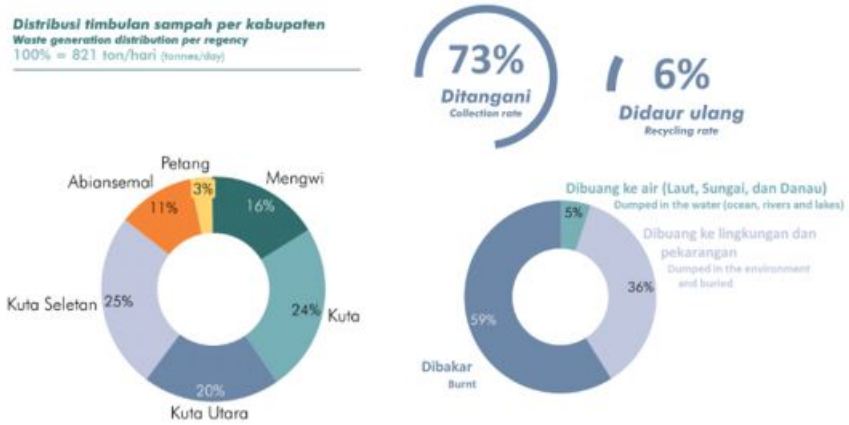


Figure 6.16: Key statistics of Badung. Canggu is part of the district Kuta Utara [16]

7

Stakeholder Analysis

7.1. Introduction

A recycle business on Bali will affect different kind of stakeholders. Freeman [81] defines stakeholders as: "…any group or individual who can affect or is affected by the achievement of the organization's objectives". As we initially research the feasibility of a business on Bali, we have to identify and investigate the behaviour of these stakeholders. Each stakeholder has its own interests, attitudes and powers.

Initial perceptions about what we could expect from these stakeholders were solely based on imaginations, hence we searched for a better understanding of the stakeholder network by performing desk research, interviews, surveys and participatory observation on Bali. How exactly we performed this stakeholder analysis is described in more detail in the methodology section.

The goal of this stakeholder analysis is to provide insight in the Balinese culture and stakeholder network. This forms the foundation for successful implementation and further development of the new recycle business. The stakeholder analysis is instrumental and will be helpful to find a broad stakeholder support for our business intentions. We define support as the willingness of a group of local inhabitants within a Balinese Banjar to actively participate in the delivery of plastic waste to a collection point or service.

As a result, this stakeholder analysis is input for the "Trade-off". The Trade-off will determine which of the three researched regions is the most promising location for a recycle business on Bali.

7.2. Methodology

The results from the stakeholder analysis will be used to answer sub-question 4 and provides input for the answer to sub-question 5: 'Which of the researched regions/cities is potentially the most promising location to build a recycling facility?'. The three regions will be assessed based on a few criteria as a result from this analysis (see Chapter 12). To provide the criteria we searched for an answer to the following questions:

- Which stakeholder aspects make it hard to realize a business on Bali?
- Is there a difference in actor perceptions, thoughts and behaviour towards a business when waste management systems are already in place?
- What are the main cultural views, habits and values of Balinese people and how does this reflect in their way of thinking with regards to waste management?

The stakeholder analysis follows a structured approach, based on the 4-staged model by Mason and Mitroff [82].

Step 1
We start with a short description of the initial understanding of the stakeholder network. We used this

initial understanding throughout the report to reflect on our own perceptions and to prevent a biased outcome. We want to make sure that the stakeholder analysis is carried out from a neutral point of view.

Step 2
The second step of the stakeholder analysis is to map/visualise the involved stakeholders. The stakeholders are categorised in a pie diagram to target specific groups of stakeholders. The size and scope of our business is not fully defined which means that the stakeholder network could be expanded in the future. However, we also set a boundary to our analysis: we primarily focus on the community, waste management facilities and governmental organisations. Additional stakeholders, which could play a role in further development of the business, are not described in detail and are part of further research.

Step 3
The third step of the stakeholder analysis describes the attitudes and views of stakeholders related to four different aspects:

- The presence of waste management
- The presence of education
- The awareness of plastic waste management in general
- The impact of culture on waste management

We think that these four aspects form the basis of the rather complex socio-cultural and political-economic environment of Bali [83] & [84]. Step 3 consists of a broad description of theory and results from the participatory observation. We link these observations to the theoretical background.

Step 4
With the results of step 3 we can eventually conclude this chapter. In the conclusion we will reflect on the the findings and their importance for the trade-off. The conclusion will contribute to our own understanding of the stakeholders and how it may deviate from what we initially thought, but it also helps future Pantai project groups to understand the environment and the involved actor system. It is important to understand that during this stakeholder analysis assumptions are made which are sensible to personal understanding and feelings. Do note that these assumptions must be critically assessed during every stage of the Pantai project now, and in the future.

7.3. Step 1: Initial understanding of the situation

Initially, we created our own image of the first steps of initiating a business on Bali. We imagined how stakeholders could react and which parties we should contact.

We initially wanted to find local partners and start on the bottom of the community in order to work ourselves up in the governmental hierarchy. With local partners we meant EcoBali, because we found out that they were already active in our regency and they could provide us a lot of knowledge on the subject. Moreover, we thought of contacting local inhabitants around our guesthouse in order to find a way to get in contact with more and more people.

We started our research in Badung area, where tourism is the main source of income and earlier research [78] showed us that this area is well developed with regards to waste management. It seemed to be the best location to get stakeholders on board for our business: we assumed that the local community was well informed about waste disposal, which may lead to a positive attitude towards the new business.

7.4. Step 2: Stakeholder inventory

The stakeholder inventory serves as a visualisation of related stakeholders (Figure 7.1). These stakeholders are categorised to provide more detail about where we can find these stakeholders within a broad network. The 'community', 'waste management facilities', and 'governmental organisations' will be the most important target groups. The additional two target groups 'miscellaneous' and 'selling market' will only take part in the stakeholder network in specific situations, this is described in the conclusion of this chapter. This inventory is set up by the use of desk-research and further elaboration of the network by participatory observation. Moreover, a few interviews with some facilities , NGO's and village leaders (Desa Adats) contributed to the inventory (see Appendix C).

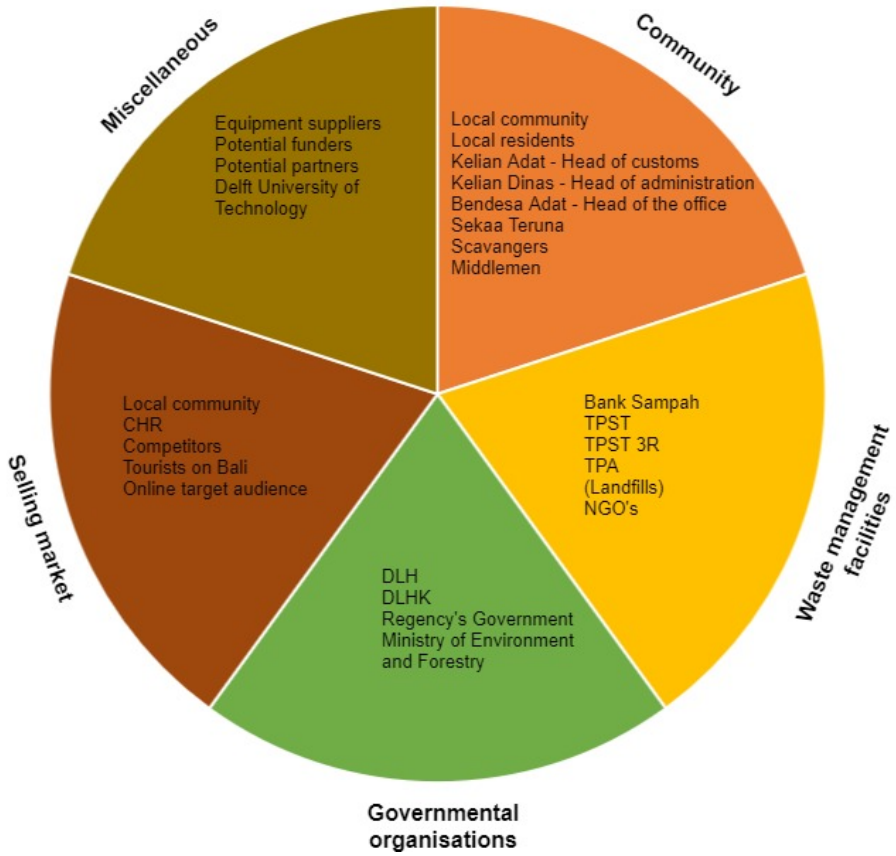


Figure 7.1: Pie chart of related stakeholders

Stakeholder	Description
	Community
Local residents	The group of people who live directly or very close to the new recycle facility.
Local community	The group of people who are part of a so called local Banjar and are indirectly related to the new recycle facility.
Scavengers	A group of people which collect waste and sell it to Middlemen/ Pengepul independent from the governmental system.
Middlemen	Individuals who work together with scavengers to collect waste and sell it to recycle facilities. These people mainly use motorbikes as their pick-up service.
Kelian adat	Head of customs. This man is responsible for the customs within a Banjar and takes important decisions for the Banjar. He is the one who oversees all affairs related to governmental issues and religion. He has a great influence on the way in which people behave and act in a community.
Kelian dinas	Head of Administration. This man is responsible for the administration within a Banjar.
Bendesa Adat (Village leader)	The man who is in charge of multiple local Banjars and supports the Kelian adat with decisions. Can be seen as the Governor of a village.
Sekaa Teruna	A unique youth organisation (teenagers) at a Banjar. The Sekaa Teruna provides a forum where young individuals can come together.
Banjar	A place where local communities meet and where local communities are assigned to since their birth. Only a few exceptions exist, mainly people who are already assigned to an other Banjar or Non-Hindu believers. The Banjar has a local gathering place. Generally, the men of the Banjar meet every month but this is very regionally dependent.
	Waste management facilities
Bank Sampah	A collection facility where delivered waste can be rewarded with monetary value. Individuals can deliver their organic and non-organic waste. If seperated, then a fee will be given as a reward. The non recyclables are transported to landfills.
TPST	A governmental facility where waste is collected and afterwards being transported to a landfill.
TPST3R	An ”upgraded” TPST facility, where waste is collected, separated and transported to recycle facilities on Java. The non-recyclables are transported to landfills.
TPA	The TPA is a landfill. There are various landfills in Bali. The most well known is the Suwung Landfill in Denpasar. The TPST3R facility use their trucks to dispose the non-recyclables into this landfill.
NGO’s	Some Non governmental organisations do sometimes function as a waste collection facility. An example of a NGO is EcoBali. These NGO’s work apart or in contact with governmental organisations.
	Governmental organisations
DLH	The main institute of Bali which organises the waste management system. The DLH organises meetings with regional DLHK representatives to discuss and distribute the latest waste management updates.

DLHK	A regional institution which is in charge of the waste management in a particular regency. The DLHK use the guidelines provided by the DLH to interpret and elaborate their own waste management system.
Regency's government	The Bendesa Adat is directly in contact with the Regency's government. Bali consists of 8 regencies, each with their own government. The Regency's government directly controls detailed spatial plans and is responsible for permits of new facilities and other land-use.
Ministry of Environment and Forestry	The MOE is responsible for national environmental policy and planning in the country. The Ministry coordinates policy implementation, provides technical guidance, and supervises environmental management of sectoral ministries and provincial environment authorities. The main office is found in Jakarta, Java.
	Selling market
Local community	The local community can be a focus group if we need additional revenues for the business.
CHR	The CHR: Besides households, hotels restaurants and cafes are also producers of plastic waste. We may sell products to them and collect their plastic waste in return.
Competitors	Since the goal of this research is to realize a recycle facility, there is a chance of a competitive market. Especially because Bali has an underdeveloped waste management system.
Tourists on Bali	Bali is a very popular location for tourists. If the recycle facility needs additional budget, it may be obtained by selling products to tourists locally.
Online target audience	Plastic products produced can be sold locally or given back to the local community as a reward for their collection. However, if there's need for additional budget, it may be possible to target an online audience. This can be nationally or internationally orientated.
	Miscellaneous
Equipment suppliers	The products produced by the recycle facility need specialised equipment. This equipment may be made locally or bought from suppliers. These suppliers are stakeholders since there is a business relation.
Potential partners	On Bali there are multiple initiatives like OceanMimic who use local people to help them gather waste. These initiatives may serve as partners if it is required for the additional inflow of plastic waste.
Potential funders	Additional revenues may be created by the help of online fundraising activities. A good example of a fundraising organisation is the North Bali Reef Conservation.
Delft University of Technology	The research is done in collaboration with the TU Delft. The University of Technology could provide additional scientific input. On top of that, the business could be realized in close contact with the University to provide new data. The project may serve as a pilot project.

7.5. Step 3a: Theoretical background

This section gives a brief overview of the current literature of stakeholders in Bali. It is divided in two parts, the first part describes the aspects that complicate the implementation of waste management businesses or systems. The second part describes the different cultural aspects by Hofstede, to provide more insight in the Balinese community and their habits.

7.5.1. Bali: an atypical case

Bali, Indonesia's most attractive touristic islands, is an atypical case and serves as a very interesting learn environment for solid waste problems in south-east Asia. The production of solid waste in Bali is hard to trace and still increasing. The awareness of locals in Bali seems to be unmistakably connected to social aspects and culture [84]. The typical problem of realizing a waste management system are social-cultural and political factors rather than economic or technical factors. The development which Bali has gone through in the last years led to further deterioration of the solid waste problems.

The initial treatment of waste in Bali was focused on pollution management rather than waste management. Mostly, waste was just moved out of the way by periodic sweeping, to be eaten by animals or to decompose. The waste that was seen as "ritual" pollution was burnt. Most waste would eventually decay over time since these materials were easy to digest. Nowadays, with the increased presence of plastics in the solid waste stream, waste can not be solely handled by sweeping. The initial understanding and awareness of waste by local inhabitants need to be drastically changed which seems to be a challenge on itself.

Solid waste is in the traditional Balinese religion a form of impurity. This means that solid waste is not something to be considered as handled or treated, it must be taken out of the way. Back in the days, the local communities used organic materials for a wide variety of purposes: from building to packaging. After the use of these products, the organic materials could simply be thrown away in the environment since they would disappear in a relatively short period of time. Besides, The larger bulks of waste were burnt. Nowadays, plastic waste is more and more present in the daily waste output of households, however changing the mindset of many local communities to set aside their old habits of waste disposal seems to be very hard [78].

The successful implementation of a business on Bali seems to be an intermediate scale between industrial and community based principles. An opportunity would be to combine recycling and composting. Past projects that were successful had an often difficult income structures where the Balinese Banjars played a huge role. The social coherence with these Banjars and the relationship with influential local business persons were key aspects [83]. Needed is a balancing act between the insider and the outsider: not to be totally included in the local community, maintaining enough space to manoeuvre in the political landscape. The information flows are key in successful implementation of a business on Bali [84]. The better the understanding of social and cultural factors, the better implementation of the business in the community.

7.5.2. The impact of culture

The way people think and act indirectly relates to the way people handle their waste. It is therefore important to find the cultural differences of Balinese people in contrast to the Dutch principles. Geert Hofstede developed his 6-dimensional model for the description of cultural differences and how to cope with these [85] (Secondary source: [86]). Because we operate in Bali, we need to take into account that there are various differences compared to The Netherlands (Figure 7.2).

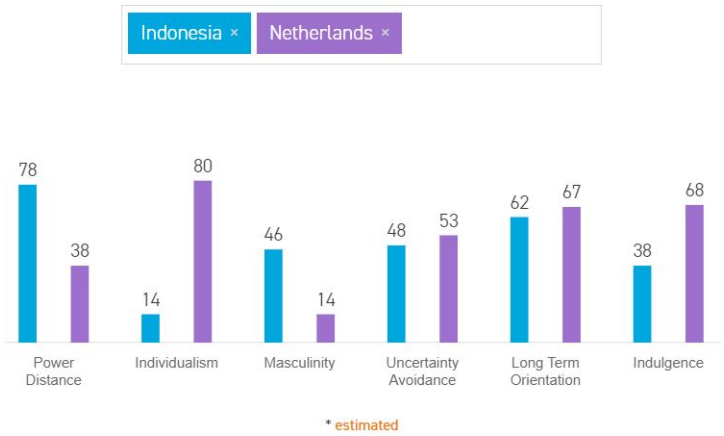


Figure 7.2: The 6-D model bij Hofstede, comparing the Netherlands vs. Indonesia. Note: these differences can be applied nationally, not on an individual level

Power distance index (PDI)

The power distance index describes how equal power is distributed over different people. The higher the index, the higher the distance between people in a hierarchy. Or as Hofstede quotes: ”the extent to which the less powerful members of institutions and organisations within a country expect and accept that power is distributed unequally” [86]. As can be seen, the distance in Indonesia tend to be much higher than the Netherlands.

Individualism

Individualism describes how people tend to work and how independent they live in general. A high score on Individualism means that people tend to work alone, rather than in groups and prefer of taking care of themselves and close family members. There is more need for a hierarchical structure than a network structure.

Masculinity

The third dimension is Masculinity, better known as the need in society for achievement, heroism and material reward for success. A Masculine community is ”though” whereas a Feminine community tends to be ”tender”. Hofstede describes this as: ”The fundamental issue here is what motivates people, wanting to be the best (Masculine) or liking what you do (Feminine).”

Uncertainty Avoidance

The uncertainty avoidance index is pretty comparable between The Netherlands and Indonesia. Typically, this index describes how we try to regulate our future and how we control changes that occur. The higher this index, the more people tend to minimize risks and future changes in their lives. For Indonesian people it is common to have an inner and outer self. What we mean here is that they never show anger or emotion externally.

Long Term Orientation

The fifth dimensions describes the Long Term Orientation of a community. This indicates how people stick to their past and traditions and how eager they are to find out new possibilities and technologies in their future lives. The higher the Long Term Orientation, the more people are willing to change. Indonesia has a relatively pragmatic culture: The truth is depending on time, situation and location. The Indonesian is able to show courage and thrift to save and invest for the future and can maintain perseverance to achieve results.

Indulgence

The last dimension is the Indulgence index. The direct opposite of Indulgence is Restraint. An Indulgent community such as The Netherlands do not hold themselves back to control their desires and impulses. Indonesians on the other hand feel the need to control their inner self. They do not put a lot of emphasize on free time and tend to be pessimistic and cynic at the same time. The way in which an Indonesian is raised most likely determines the way in which they will behave and are really eager to maintain this behaviour.

7.6. Step 3b: In practise

In addition to the literature review, we decided to perform this stakeholder analysis in practise. Participatory observations helped to provide an insight in the complex stakeholder environment of Bali. this section provides useful insides of our research on the stakeholder values, perceptions and attitudes towards a potential recycling business on Bali.

7.6.1. The presence of waste management

This subsection describes the first aspect: the presence of waste management and its relation to stakeholders. A lot of local inhabitants were questioned during the project by conversing with them and by handing out surveys. These conversations and survey results are used to show how we arrived at certain assumptions.

The community

For the local community one could say that when waste management is put in place the community can clearly see the positive effect waste management has on their surroundings. There is less plastic in the streets and gutters and less plastic waste is burned. Therefore, it can be imagined that the community would definitely encourage projects like Pantai which helps improving the living conditions. Especially because the initial idea of the Pantai project is to collect the plastic waste for free and even give a product in return. This reward system could be seen as awarding in contrast to the current situation in which the community has to pay for the waste collection service provided by TPST3R.

It should be noted that Pantai does not pick up any waste next to the plastic waste. This could lead to a more reserved reaction of the local community to the plastic waste pick up service as they will be left with the other waste. However, it should be noted that in Appendix C.4 it is said by Komang Rudith Hartawan that the TPST3R facility would be open for collaboration and thus maybe something could be arranged by combining the waste collection of TPST3R with the plastic collection of Pantai.

On the other hand one could say that due to the fact that waste management is readily available to the people that they don't need any extra service in the neighbourhood. As they are already satisfied with the waste collection now and don't want to go through the extra hassle of separating their plastic waste from their normal waste, especially when they are already paying money for the pick-up service. In addition this could be an awareness/education issue as the local community might not properly know the effects of plastics on the environment.

When there is no waste management system present then the people are in general very open to the ideas of having a service that comes to pick up their plastic waste and give a product in return. This is based on many surveys that were handed out in the area of Pulukan as well as in many conversations with the local people of Pulukan in which they told us that they would be happy to hand in their plastic as now there is not really an option to do that. Although it has to be noted that there actually is an opportunity to do this but most people would have to travel more than 2 kilometres to hand in their waste. This unfortunately is not an option for many of the inhabitants of the Pulukan area. In a conversation with a couple of the locals it was even discovered that according to them most locals just drop their waste in the nature very late in the evening or very early in the morning when nobody can see them. Moreover, it was said that basically every location that is not a house, a yard or is a property of a person/entity is seen as a place where they can drop their waste.

Waste management facilities

When no waste management facilities are present it is hard to make assumptions about the attitude of waste management facilities towards the Pantai project. Because when they are not present the Pantai project will not be a competition for the waste management facilities and therefore it is hard to see any objections from this group. Unless of course they are planning to expand to that area. However, after talking with the head of the TPST3R facility we see no plans of that in the researched regions except Canggu for the foreseeable future. Thus as we pursue the same goal, the waste management facilities would probably welcome the Pantai project in regions they are not active.

When waste management is actually present one could say that the waste management facilities have a competitive conflict with the project. Thus being against the presence of a plastic recycling service as then revenue would be taken out of the hands of the company. On the other hand it could be said that we both pursue the same goal and they would welcome any company that could help the area of getting rid of their plastic waste. Moreover, in interviews with the manager of the TPST3R facility (see C.4) he mentioned that he would definitely be open to a collaboration. Also he recommended us to start the project in an area where less or even no waste management is present, this is due to the fact for example in the Badung area everything is pretty well managed already. In addition to this he also said that in such an area you should contact the local Desa Adat as he would give the project a chance if the Pantai group arrives with a good plan. In this manner the TPST3R facility was started by the local banjars with the implementation of a local initiative.

Governmental Organizations
The governmental organizations are very important in the waste management sector as they nationally organise the waste management sector. Only it is assumed that they do not take part in the precise execution of the waste management in Bali, this is done by the waste management facilities. In addition governmental organisations like DHL and DHLK provide the waste management facilities with updates when for example new technologies have developed as well as keep the government updated about the latest waste management developments on Bali. In addition the government can also be supportive when they find that a project is an addition to society, just like they support the TPST3R facility with a new building and truck.

In places where no waste management is present these specific governmental organisations have a small influence in the area as waste management is barely present. Nevertheless it is assumed that when a project is started it helps the society like the current waste management facilities in the Badung area. We think that governmental organisations will definitely be benevolent towards the project.

7.6.2. The presence of education
Education is very important in today's society and the presence of this is assumed to have the most influence on the local community. This is due to the fact that the presence of education is assumed to not have a noticeable effect on the way of thinking for the groups: waste management facilities, governmental organisations, selling market and miscellaneous with respect to the idea of setting up a recycling factory. Therefore in this subsection the point of view with respect to education will be done for just the local community.

The Community
Education is an important pillar in the world's society through education we can inform and teach the people such that they will receive the knowledge and skills that can be required in life. It gives a person knowledge of the world around us and changes the perspective someone looks at life. Also it helps a person to have points of views on different things in life.

Therefore it is assumed that the regions that are properly educated about harmful things such as plastic are more aware of the problems, through education awareness is stimulated. Outside the assumptions that are made with respect to education and awareness the same is also published by high-standing newspapers like The Guardian [87]. Awareness itself and the effects of this will be tackled more in the next subsection. Moreover, according to Global Education Monitoring (GEM) education has substantial power to help human beings reconsider environmental damaging lifestyles and behavior. Furthermore, an analysis of the Global Warming Citizen survey in the USA showed that the higher the education level

of a respondent, the larger the respondent's activism in terms of environmental participation and environment friendly behaviour [88].

In addition, it can be seen that most people in Bali still burn their plastics. It is assumed that this is mostly the effect of improper education about the effects on the environment by burning plastics. Another one of the 'bad' habits a lot of people in Bali have is one in which they throw the plastic waste in the nature where it remains for many years as plastic is not biodegradable Although we assume this it has to be noted that some people know of the effects but still choose to this due to circumstances such as distance that needs to be travelled to the landfill or have other concerns such as putting food on the table. Another effect of education is for example good reasoning skills, during the participatory observation it was found out that a lot of people in the region of Pulukan throw their plastic waste in the river that floods towards the ocean. This is due to the fact that most local people think that due to the fact that 4ocean is active in the region (a company that cleans the beaches from plastic waste) that what they do doesn't hurt the environment. Thus it is assumed that proper education with respect to plastic waste enables the people to be more aware and conscious of their decisions such that these habits can be strongly reduced.

7.6.3. Awareness of waste management

During the research, a lot of local inhabitants were questioned (by the use of surveys and chatting on the street) about their opinion/awareness with regards to managing their plastic waste. It is found that this deviates per regency and even on a local level. We focus on the Community, Desa Adat and Sekaa Teruna.

The Community

The local community is the most important stakeholder to describe here. The system of interest and specifically the 'field of forces' in which local communities act can change from day to day. On one hand, We can imagine that if a recycling facility is build, the awareness of local inhabitants towards plastic waste may change positively because they directly see what happens to plastic and consider it as a useful product. Specifically, this means that the awareness may increase and more and more people may become aware of the environment and good plastic waste management. However, on the other hand it does not have to change the attitude of the people. The plastic recycle facility can also solely function as a utility for the people to retrieve a new product.

During the interview with Kyle Osborne and Ketut from the North Bali Reef conservation (See Appendix C.3) we discovered that there is a minimal awareness of waste management of the local community in Tianyar. Even though they started recycling this year, the local residents around the facility do not bother to deliver their waste to this facility. This illustrates even more that just realizing a business does not always change or alter the awareness of people towards good waste management.

Moreover, the conversations with Bukit, our local man in Tumbak Bayuh, Badung Regency, showed us that although Badung is well organised with regards to waste management there are still different awareness levels to be observed. For instance, Bukit told us that even though there is a waste pick-up service, some people (note: we have no idea of the amount of people) still burn their waste because they simply do not want to pay for any pick-up service. This illustrates that the mindset of people is really situational dependent.

Finally, we have to take in consideration that the local community may have a broad system of interest. With broad we simply mean that the local community has other interests which they value more in life. Very poor communities have their own daily problems like getting enough food on the table. Their awareness is not solely affected by the way in which they are informed or concerned with a plastic recycling business.

The role of the Desa Adat

The awareness of the local community is also directly affected by the decision arena. The decision arena in this manner are the Banjar meetings where the men of the community together with their leader, the Desa Adat, will decide whether a new facility will be build or not. The interview with Mr. Ru-

dith Hartawan gave us new insights into this decision arena. Mr. Hartawan told us that the Desa Adat has a lot of power and makes the decisions within a Banjar. The local community seem to follow every rule that the local Desa Adat imposes. Therefore, we assume that the effort that the Desa Adat takes to stimulates people to handle their waste properly will increase the awareness of local communities towards plastic waste management.

The Sekaa Teruna
A large group of younger people in the local Banjars seem to be a very nice target group to realize awareness under the younger generation. During the interviews and visit at the North Bali Reef Conservation, we found that awareness and participation during education really helps to create awareness amongst kids. Especially if the kids can experience the way in which plastic can be processed by equipment which is easy to use. We think that the shared emotions of kids towards their parents and grandparents also helps creating awareness amongst the older people of a Banjar. We can assume that awareness is found easier to develop amongst the younger people. However, we also need to keep in mind that not all kids have the possibilities to develop themselves.

7.6.4. The impact of culture
The impact of culture by means of the dimensions of Hofstede are also found back in practise during interviews and participatory observation. The high power distance index of Indonesia can be validated with the participatory observation that every man and women in a Banjar follow the rules set by the Bendesa- & Desa Adat.

From the individualism point of view we see that The Netherlands is really the opposite of Indonesia. This may indicate that in a business environment, Indonesian people tend to work together as a group: we already saw this by the decision making process of Balinese Banjars. We assume that the social framework is very important and to successfully implement a recycling business we have to realize a strong social framework where people feel the loyalty towards the business.

We have seen during participatory observation that Indonesia is in many ways a more Masculine country than The Netherlands. This can indicate that people may be less willing to cooperate in a recycling facility because they don't feel that there is any achievement to be obtained, or that they show off like they are very interested but in fact there are not. This means that acting with due care is necessary. The outward appearance of Indonesian people (they call this "Gengsi" in Indonesia) is perhaps different from their inner feelings.

This inner and outer feelings also reflect to the uncertainty avoidance index. We already encountered this during our conversations with various people: they always say yes we can do this or they agree to certain actions, but taking these actions is something wholly different. In a business relationship this can be misleading. On the other side, this personality trait is very useful to maintain work place harmony.

The last index, the long term orientation is of course very useful for new businesses. New businesses can have a bright future and can be successful if and only if the community is fully dedicated and concerned with this business. When people are concerned in Indonesia, the chance is high that they will be closely involved.

7.7. Step 4: Conclusion
Step 4 is the final conclusion of the stakeholder analysis and in this section we will use the large problem space that was created in step 3 to answer the sub-questions from the methodology, which in turn will help in the trade-off of chapter 12 to decide in which location the new recycling business should be started. This conclusion is based mostly on participatory observation with respect to the presence of the aspects in the researched regions. As the research done with respect to available sources on the internet often ended up falling short, we experienced that we found out much more about what really happens and how it happens by going to the specific region. In the specific region we would observe the activities related to the selected aspects as well as conversing with local inhabitants about their

problems with respect to plastic recycling and how they see it. Moreover, we had many of the local inhabitants fill in surveys with the use of a translator. In addition we have interviewed many locally active companies such as EcoBali, Oceanmimic, 4Ocean, The Daur project, The North Bali reef Conservation and the TPST3 facilities, helping us gain many valuable insights.

The aspects discussed in step 3 will be used in the trade-off to decide which region is the best to start a plastic recycling business from the stakeholder's point of view. It has to be noted that the last two groups (Selling Market and Miscellaneous) from step 2 in the stakeholder inventory are not discussed this is due to the fact that we assume that these groups are not bounded by the chosen area. Therefore, although they are still very important stakeholders it is assumed that this will be in a later stage of the plastic recycling factory, namely when products need to be sold or in the actual building phase of the factory. This means that they still have a large effect in the realisation of the business but not on the location where the recycling business will be set-up which is the main focus of this specific stakeholder analysis.

With respect to the first question "Which stakeholder aspects make it hard to realize a business on Bali?". We start with the initial understanding and awareness of waste by the local inhabitants, as this needs to be changed drastically. At the moment the understanding and awareness of plastic waste is very low among the Balinese people. However we feel that this can be much improved by starting at the schools of the Balinese children and by offering more educational programs to the local people which in turn will make them more aware of the environment and on how they should handle their plastics. Another big obstacle is that solid waste is seen as something that should not be handled or treated by Balinese religion. Therefore plastics are often treated in environmental damaging ways such as burning of plastics and discarding plastics into the nature. Furthermore this could form problems for the implementation of the business as our initial idea of doing business was offering recycled plastic products in exchange for their plastic waste. Moreover with respect to the implementation of business it is very important to find the right combination between industrial an community based principles. As social coherence with the banjars is very important but also having a good relationship with influential business partners who might be more focused on making money instead of preserving the environment, thus finding an optimal combination between those two can be very difficult.

With respect to the second question "Is there a difference in actor perceptions, thoughts and behaviour towards a business when waste management systems are already in place?". There is definitely a difference when waste management systems are in place. As for the perception it was clear that when no waste management system was in place the local neighbourhoods were filled with rubbish and litter way more than an area that had a proper waste management system. Which results in a deteriorated living environment and could lead to a positive change in the thoughts and behaviour of the people towards a waste management business. As the people living in these areas would like an environment just as clean as the regions with a waste management system in place. In the sense of the general thoughts and behaviour when a system is already in place, one can say that the local community has a more reserved reaction to a new business as there are already waste management systems in place and the Pantai project would only take the plastic waste and leave them with the other sorts. While places with no waste management would be very open to the Pantai project. With respect to the competitive waste management facilities one can say the facilities have a competitive conflict with new waste management businesses and have a negative attitude towards the project. Nevertheless, all companies are pursuing the same goal and may therefore be open to collaborations.

With respect to the third question "What are the main cultural views, habits and values of Balinese people and how does this reflectin their way of thinking with regards to waste management?". When we have to introduce a recycling facility on Bali we have to infiltrate in a rather difficult social-cultural environment. As described in the literature review, the typical problem of realizing a waste management system on Bali is a social, cultural and political issue rather than a technical or economic issue. This is directly coupled to the cultural habits and values of the Balinese local community.

The impact of the power distance index, in particular the distance of the community with regards to their local leader (the Desa Adat) is a crucial factor for the implementation of a business. The strong

social connection within Banjars and the decision making makes it hard to really push through new ideas and new concepts of waste management services. Additionally, it is very difficult to fathom the real behaviour of local communities due to their inner and outer self which occurred to be sometimes completely opposites. People tend to be very enthusiastic about new ideas, but only if they really feel that it can be an achievement for themselves by means of material rewards. To make sure that a business implementation is successful, a balance has to be found between a small community based focus and industrial purposes. A standard list of ingredients does not exists. In order to realize a new facility, a thorough understanding of local circumstances and cultural behaviours is necessary.

From interviews and participatory observations we learned that the collaboration with other NGO's is something worth considering for initiation of the business. These initiatives contribute to the understanding of the local difficulties. Moreover, most of the times these NGO's already organised for implementation of new ideas with the Banjar head. This realizes an opening in the difficult political system of Bali. Moreover, some NGO's like the North Bali Reef Conservation have put in place educational programmes. These programmes do trigger locals to be more aware of their environment. This stimulates the younger generations to handle their waste, which in return stimulates the older generations.

It should also be noted that during our research and participatory observation with respect to stakeholders we came to new understandings and a major change was observed with respect to our initial understanding. Namely at first we would try and start at the bottom of the community in order to work our way up in the governmental hierarchy to realize a recycling facility. However, after the research we came to the understanding that working bottom-up is not necessarily needed. This is due to the fact that we found out that it is quite possible to instantly contact a head of a banjar or in some cases even the bendesa adat instead of starting at the bottom. However, it can never hurt to get the the support of the members of the banjar as they in turn can also help you or even exert some pressure on the decision making process of the community.

8

Conceptual model

A conceptual model is introduced to visualize and clarify the project proposal. The conceptual model will attain all the processes that take place surrounding the proposed plastic recycling business.

8.1. Processes

In this section, all the processes presented in the conceptual model (figure 8.1) will briefly be discussed. In the figure, the blocks represent the processes, the bold arrows the flow of plastic and the thin arrows the flow of money.

Households
Households represent the group of people that participate. They are stimulated to hand in their plastic waste either with a plastic product or with money.

Collection
This represents the collection of plastic from the households. Collection through collection points and through door-to-door collection are the two collection methods that will be discussed in this report. These are the most obvious methods of collection and are both already occurring on Bali. Keeping track on how many kilograms of plastic every household already handed in will also be a part of the plastic collection.

Sorting
Sorting of the plastic input, collected from households, in the seven types of plastic. The sorting takes place at the recycling facility.

Shredding
Shredding the plastic in smaller parts is essential for the recycling process.

Recycling
Recycling represents the formation of products from sorted and shredded plastics. The recycling techniques used are discussed in section 4.5.4.

Products
After the recycling process, the products can either be sold to generate revenue or used to stimulate the households to separate and hand in their plastic waste.

Sell
Products are sold to finance the proposed project. A part of the generated revenues is used to pay for the operation of the business (arrow 9.) and the other part is used as a reward to stimulate the households to separate and hand in their plastic waste (arrow 8.).

8.2. Conceptual model

Figure 8.1 presents a schematic of the conceptual model. Below the figure all the streams of either plastic or money are described.

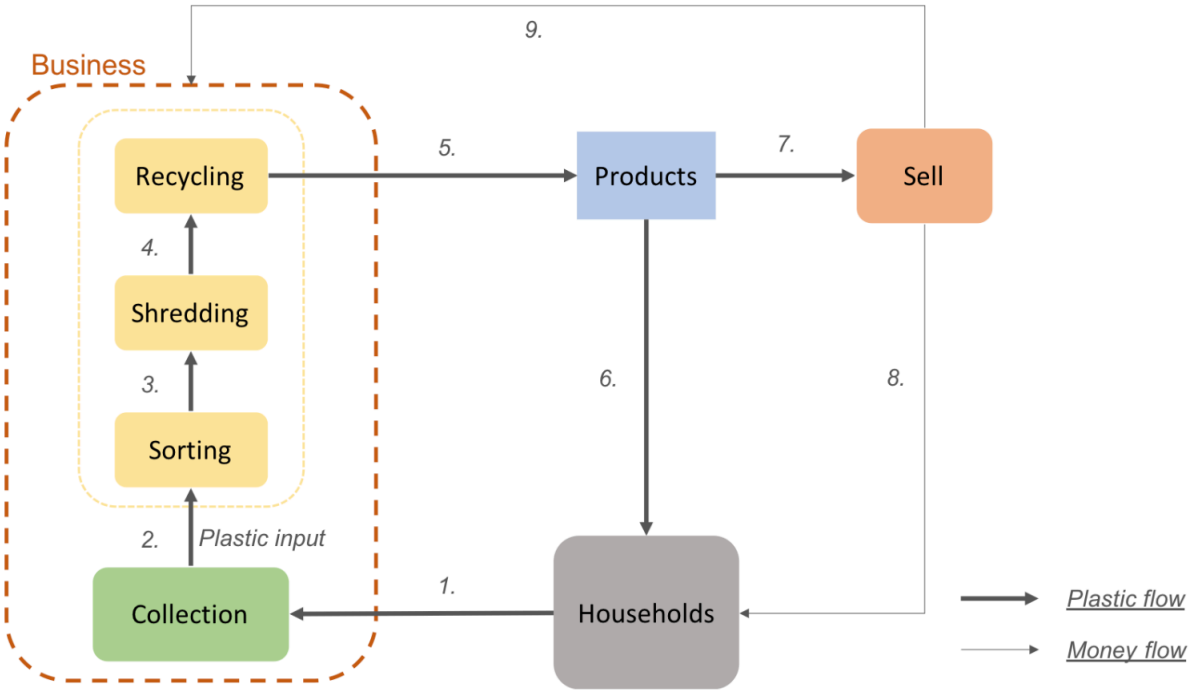


Figure 8.1: Conceptual model

1. The plastic from the participating households.
2. The plastic input: The plastic collected from the households and taken to the recycle facility.
3. The plastic input is sorted into the seven types of plastic.
4. The shredding plastic still separated into the seven types of plastic.
5. Plastic products made out of one pure plastic type.
6. Plastic products given back to the households as compensation for handing in plastic.
7. Plastic products that are sold for generating revenue.
8. Money given back to households, if they want to receive money instead of plastic products as compensation.
9. Money earned by selling products to keep the business financially stable.

9

Methodology

9.1. Introduction

The methodology explains the overall approach to the research done at the three selected regions on Bali. Quantitative and qualitative methods were used to gain insight into the processes presented in the conceptual model and eventually help to answer the research questions. The research done on Bali is divided into three parts that will be discussed in this chapter.

In the first part, the fieldwork that was carried out in the three chosen regions on Bali is described. The fieldwork was divided into three methods that were conducted simultaneously.

1. Plastic collection measurement
2. Surveys
3. Interviews and visits

Plastic collection measurements were conducted to estimate the composition and quantity of plastic waste produced by households. With surveys, interviews and visits, location-specific information about the local people was collected as well as other general information about the regions. The section ends with a description of how the total plastic input is calculated.

The second part of the projects' methodology is determining the balance between selling the produced products and stimulating households. From the findings a assessment about the financial feasibility of the proposed project was made.

Finally, the third part of the methodology describes how the location for the small-scale plastic recycling facility was determined making use of the trade off method.

9.2. Part 1: Fieldwork

Part 1 describes how the plastic collection measurements, the surveys and the interviews and visits were conducted. The chapter ends with an explanation about the method used for the estimation of the plastic input (see arrow 2. in figure 8.1).

9.2.1. Plastic collection measurement

To estimate the composition and quantity of the plastic garbage produced by households, plastic collection measurements were carried out. In each region, ten households were asked to separate and collect all the plastic from the rest of their garbage for one week.

Requirements

Prior to conducting the plastic collection measurements, some requirements were defined that ensure their reliability and correctness of the results.

- Make sure that the households where the measurements are conducted fully understand how to separate the plastic from the rest of their garbage.
- The people from the households should be adequately motivated to separate plastic from their

garbage by explaining why the measurements are conducted and what sort of a positive influence this could have on their future.
- The households need to understand that they should only collect the plastic waste from their own household.
- The households need to realize that they should not add plastic waste produced in the the week(s) before the week of the measurement.
- There needs to be a way to communicate with the people who do not speak English for when they have questions or when the purpose of the measurements needs to be explained.
- The households should be provided with a convenient way to collect and store the separated plastic garbage.
- Basic information about the households where the measurements are conducted should be collected.

Inform households
The plastic collection measurements were conducted in three regions: Pulukan, Canggu and Denpasar. For all three regions, the setup and approach remained relatively the same.

To make sure that clear communication with the local people was possible, the first step was to find a local guide who understood the project and was willing to help conduct the measurements. Each of the households participating in the measurements was given a collection bag with enough volume and made of sufficiently strong material so that it would not rip during collection. Furthermore, the participating households were given three documents for instruction, motivation and information purposes:
1. A document that explains how to separate plastic and why these measurements are conducted (see appendix A.2 and A.3).
2. A document with example photos of the products that could be produced from their plastic garbage (see appendix B.4).
3. A survey (see appendices B.2 and B.3)

The local guide was informed about the necessary procedures to achieve the proposed requirements. At every participating household, the local guide gave a small introduction about the project, an additional explanation about the requirements and helped with answering the questions the local people had.

Some households already handed in some of their plastic waste and received a compensation for doing so. When this was the case, those households were offered a comparable compensation to make sure that they saved all their plastic during the measurement.

Analysis of the plastic waste
The plastic collection measurement was carried out with ten households per region. For one week, the households were asked to separate their plastic waste. The desired output of the measurements was the average weekly production of the seven types of plastic (PET, HDPE, PVC, LDPE, PP, PS and Other) per person. In order to validate the plastic collection measurement, data found in literature and data obtained from interviews with waste management organizations located on Bali was used.

From each household, the plastic collection bag was weighted before the content was separated into the seven different types of plastics. An eighth group was added for the non-plastics due to separation errors made by the households. The sum of the weights of the seven plastics gave the total plastic production (without non-plastics). A spring scale (figure 9.1) was used for the purpose of weighing the plastics.
The plastic separation process was done by hand (see figure 9.2). To ensure the separation was done correctly, extensive research had to be carried out on the properties of the seven different types of plastic. The six methods used for the separation were:

Figure 9.1: Spring scale.

1. Separation based on visual aspects
2. Separation based on how the plastic feels
3. Separation based on how the plastic rips
4. Separation based on the sound when wrinkling the plastic
5. Separation based on the way the plastic acts when burned
6. Separation based on the Resin identification code (RIC) when visual on the plastic product

Figure 9.2: Separating the collected plastic waste from households into the eight groups

9.2.2. Surveys

Survey data was collected from local people living in Canggu, Pulukan and Denpasar in order to find answers to some of the research questions proposed in the introduction of the report.

Requirements

Some requirements were set up prior to creating and conducting the surveys. These requirements ensure the reliability and correctness of the results.

- Surveys must be clear and easy to understand for people with different educational backgrounds.
- There needs to be a way to communicate with the local people who do not speak English for when they have questions regarding the survey.
- Surveys have to be translated into Bahasa Indonesian.
- Surveys must contain mostly closed answer questions for speed, clarity and easy evaluation of the results.

Survey execution

The surveys were handed out to the local people at the three selected locations (see appendices B.2 and B.3). In the same manner as with the plastic collection measurements, a local guide assisted with the execution of the surveys. Banjar meetings (see figure 9.4) were a very convenient place to conduct surveys because everybody could be instructed at the same time. However, a lot of the surveys were conducted going door-to-door (figure 9.3).

Figure 9.3: Conducting survey at household Pulukan

Figure 9.4: Conducting surveys at women Banjar meeting Canggu

The surveys were also available online, with a very clear explanation about the project itself, to improve the number of surveys. The online surveys were made with Google Forms.

Apart from the survey itself, every survey participant was given a document with example photos of the products that could be produced from their plastic garbage (B.4) to show how they could be rewarded for handing in their plastic.

The goal was to conduct as many surveys as possible per region to get the most precise representation of the local population. Language barriers, long driving distances and money restricted the conduction of surveys. A total of 60 surveys per region were conducted. More than 60 surveys per region were, with respect to time, very difficult to accomplish. Because the operating area of the proposed project will be relatively small the 60 conducted surveys are considered as sufficient.

Survey purpose
The survey started with questions about the respondents' background. From these results, a relation between the respondents' background and the answers given in the remainder of the survey could be established.

For the new plastic recycling business, it is essential to know what happens with all the garbage nowadays at the three different locations. How is the garbage handled? Is there a waste management system in place or do people have to deal with their waste in an environmentally unfriendly way? When there is a waste management system in place, is the garbage picked up at the households themselves or do people have to bring their waste to collection points?

In some regions, people are already separating some plastics from the rest of their garbage. The surveys asked about which plastics people are already separating, why they are doing it and what they do with the plastic once it is separated.

For the final calculation of the plastic input that can be expected, there needs to be an estimation of how many people are going to separate and hand in their plastic waste. In the surveys, the people were asked if and under which conditions they would separate and hand in their plastic. Would the survey participants do it for free, for money, for recycled plastic products or are there other ways to ensure that they will separate and hand in their plastic waste? The percentage of people that would be willing to separate is needed for the estimation of the plastic input.

A goal of the project is to stimulate the local communities to separate and hand in their plastic waste by rewarding them with recycled plastic products. The surveys contained questions that help determine what kind of products the local people would like to receive. For this purpose, the local people were given a list of options where they could choose from or were asked to give a product suggestion them self.

The collection method of the plastic garbage is also a topic where the surveys helped gain insight. By asking how far people would be willing to bring their plastic garbage, conclusions can be drawn on what the best way of collection will be. Will it be possible to use a number of central collection points or do the surveys point out that the plastic waste should be picked up at the households themselves? Are the household members going to bring their plastic waste for free or do they need to be motivated by either money or one of the recycled plastic products?

Analysis of survey outcome
In order to analyse the survey data, an overview was made in Excel. For each question, the number of given answers was counted and percentages were determined.

9.3. Interviews and visits

The interviews and visits were an important part of the research done on Bali. They did not only give information that is not available on the internet, but also verified if the information found on the internet was correct. Talking with the local people, organizations concerned with waste management, government and other stakeholders of interest did not only answer specific questions, but it also helped to develop a better general understanding. A better understanding of how certain processes work on Bali, how people feel and think and how daily life works for the people of Bali.

When in Bali, the aim was to get in contact with multiple stakeholder groups: Leaders of the local communities, waste management facilities, government and people who could assist in setting up a recycling facility.

First contact was made with the local partners of the previous Pantai groups: Eco Bali, Ocean Mimic and 4Ocean. Through contact with these organizations, stakeholder analysis, literature study and participant observation other stakeholders of interest were defined.

In order to understand how the communities operate, how new regulations are implemented and how a project like the one proposed in this reports fits into the community, it is essential to talk with the leaders of the so-called Banjars. In all three regions interviews were conducted with Banjar leaders.

There are several types of waste management facilities on Bali as explained in chapter 6 waste management. Local Bank Sampahs, bigger recycling facilities (TPST3R), sorting facilities and other waste management modules like collection points and dump sites were visited. These visits were essential because of three reasons: To gain insight into the way they handle the waste, how they finance the facility and to get an idea about what the future plans are for the region with respect to waste management.

Visiting companies who can help with setting up a small scale recycle factory provided other key information. Companies that can build recycle machines or can share their experience in setting up a small business.

When a meeting with an organization of interest was scheduled, the organization's available literature was reviewed and a detailed list of questions was prepared. The conversations were recorded and written down after the interview.

9.4. Calculation of plastic input

The total amount of products produced per week can be calculated using the plastic input. When the weight per product is known and the plastic input, the amount of products that can be produced can be calculated.

The plastic collection method has a big influence on the plastic input. In this methodology, the calculation of the plastic input related to two methods of plastic waste collection are discussed. One of the two methods is chosen in chapter 11.

9.4.1. Collection through collection points

To calculate the total plastic input when using collection points, it is necessary to estimate how many residents will participate and the amount of plastic that can be expected per participating resident.

The collection area is viewed as a circle with at its centre the collection point as shown in figure 9.5. The range of the circle is the distance people are willing to take their plastic garbage R_n, with $n = 200, 400, 800, 1300, 2000, 3000\ m$.

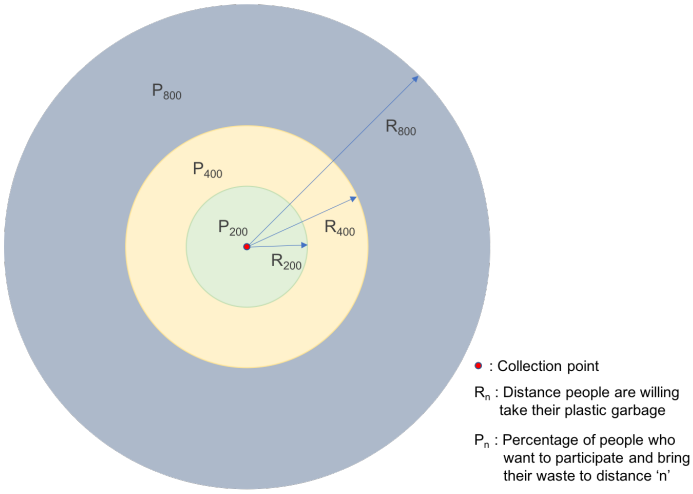


Figure 9.5: Collection area when using collection points

In the survey, local residents were asked if they are willing to participate and how far they would be willing to take their plastic waste to a collection point if compensated. With this information, the percentage of people who want to participate and bring their waste n meters is determined. This value will be indicated by P_n and is the product of *the percentage of people willing to separate* and *the percentage of people willing to bring their plastic n meters*. Together with the number of people living in the range of the circle, the amount of participating residents per collection point can be calculated using equation 9.1.

$$Participating\ residents = \sum P_n * \pi * R_n^2 * Population\ density \tag{9.1}$$

Now the number of participating residents per collection point is known, together with the results from the plastic collection measurement, an estimation is made for the total amount of plastic input that can be expected. Equation 9.2 shows how the total plastic input is calculated with: $type = PET, HDPE, PVC, LDPE, PP, PS, Other$.

$$Total\ plastic\ input = \sum Participating\ residents * \left(Plastic\ in\right)_{type} \tag{9.2}$$

9.4.2. Collection through door-to-door collection

The calculation of the plastic input is different for door-to-door collection than in the case collection points are used, because the amount of participating residents is determined in another way.

For calculating the amount of participating residents through the door-to-door collection the number of households from which plastic will be collected had to be estimated. For this estimation, first the scope of the door-to-door collection needs to be established. In this case one garbage truck is considered to collect the plastic waste for five days a week, with a working day of nine hours ($Work_{hr/week}$). Also the plastic garbage is picked up every week at the households. This for the reason that the amount of separated plastic for more than one week can cause storage issues in a household.

The calculation of the amount of participating residents is done in equation 9.3. The number of households one garbage truck can handle per hour ($N_{households/hr}$) is known through an interview with the

TPST3R facility (section 10.4.3). This facility picks up waste from 350 households in five hours using three trucks, so one truck collects waste from 23 houses per hour. However with the collection method for the recycle business the plastic has to been weighted when picked up. Assuming this takes one minute per household, the $N_{households/hr}$ is 16. The average amount of people per households ($N_{people/household}$) is known through survey data (see table 9.1).

	Denpasar	Pulukan	Canggu
$N_{people/household}$	3,88	4,41	5,50

Table 9.1: Average number of people per household, derived from survey data

$$Participating\ residents = N_{houses/hr} * N_{people/household} * Work_{hr/week} \tag{9.3}$$

When the number of people from whom their plastic waste is going to be picked up is known, together with the results from the plastic collection measurement, an estimation is made for the total plastic input using equation 9.2.

9.5. Part 2: Trade-offs

To determine which of the three evaluated locations is the most promising, the trade off method is used. Information obtained from literature and results from the fieldwork described in 9.2 was used to evaluate a list of selected aspects that are deemed of importance when selecting the region.

A detailed descriptions about the selection of the region using the trade off method and the results are described in chapter 12.

9.6. Part 3: Financial feasibility

To stimulate the local people to hand in their plastic they are rewarded with either money or recycled plastic products, but to keep the business running, a part of the produced plastic products needs to be sold. This means that the participating residents have to hand in more plastic than is needed for one product in order to receive a reward.

Part 3 describes the evaluation of the feasibility of the project. Is the amount of products that need to be sold realistic, how long do people have to hand in plastic before they receive a reward and how many people will be participating? An estimation about these questions is made using a Matlab program and is described in detail in chapter 11.

10 Results

10.1. Introduction

In this section, the results from methodology Part 1: Fieldwork is discussed. This section starts with presenting the results from the plastic collection measurement, followed by discussing the results from the conducted surveys and finally, the main findings concluded from the interviews and visits. The results from the three parts of the fieldwork are used to calculate the plastic input in the last paragraph of this chapter.

10.2. Plastic collection measurement

The complete results from the plastic collection measurements are included in appendix A.1. The complete results show the production of plastic per household per week divided over the seven types of plastics. Table 10.1 shows the amount of plastic produced per person every week on average.

	Average plastic produced per person per week [kg]								
	Total Plastic	PET	HDPE	PVC	LDPE	PP	PS	Other	No plastic
Pulukan	0.51	0.13	0.04	0.02	0.04	0.12	0.02	0.02	0.11
Canggu	0.43	0.05	0.08	0.01	0.10	0.05	0.02	0.06	0.05
Denpasar	0.14	0.06	0.03	0.00	0.02	0.02	0.00	0.01	0.07

Table 10.1: The average plastic production per person per week divided over the seven types of plastic

Because one of the households in Canggu did not collect their plastic waste, the average of nine households is calculated in that region (see appendix A.1).

The data shows that the total average production of plastic per person per week in Pulukan and Canggu is quite similar. However, the value found for Denpasar is significantly smaller. As mentioned in chapter 6 about waste management, the average production of waste per person on Bali is 0.5 kg/pppd, according to the study done by The Bali partnership Assembly [16]. 20% of this waste is plastic, which means that on average 0.7 kg of plastic is produced per person per week. This value is similar to the values found in Pulukan and Canggu but the value in Denpasar is much lower.

10.3. Surveys

All the data obtained from the surveys are included in appendix B.1. In this section, the data that directly relates to the survey purposes discussed in the methodology are presented.

10.3.1. Current handling of plastic waste

How waste and plastic waste in particular is managed, is an important factor in the determination of the region where the proposed project would succeed. For this purpose, the survey contained questions

that asked the local residents what happens to their garbage at the present time. In this paragraph, the results from questions regarding this topic are discussed and compared with the literature discussed in section 6.3.3.

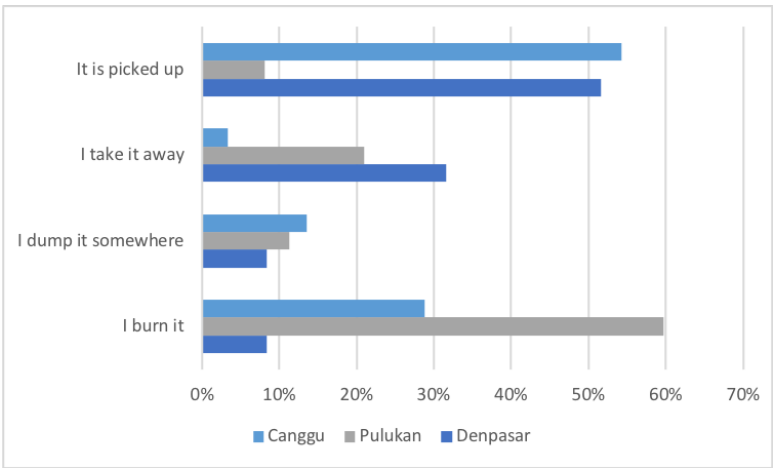


Figure 10.1: What do you do with (the rest) of your garbage? (Survey qn. 10)

Figure 10.1 presents the findings to the question: “What do you do with (the rest) of your garbage”. The data show that waste is especially mismanaged in Pulukan, 60% is burned and 11% is dumped. These results tie well with the previous study done by The Bali Partnership [16], discussed in chapter 6.3.3, wherein was concluded that only 22% of all generated waste is picked up in the Jembrana regency (figure 6.14). Figure 10.1 shows that in Canggu and Denpasar, the pickup rates are much higher, which also reflects the data presented by The Bali Partnership (figures 6.15 and 6.16).

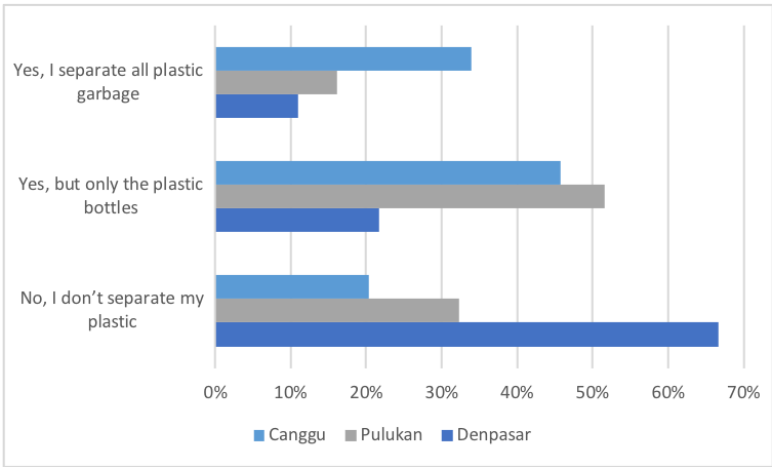


Figure 10.2: Do you already separate plastic? (Survey qn. 6)

The surveys point out that some local people are already separating plastics, especially in Canggu and Pulukan. Figure 10.2 shows how participants answered the question if they are already separating their plastic. Some participants indicated that they separate all their plastic. During conducting the surveys it became clear that this is very unlikely because there are no options for handing in all types of plastic and that only plastic bottles are separated. These bottles are picked up by local collectors who sell the bottles to Bank Sampahs.
From question 8 and 9 can be concluded that most of the plastic, from people that indicated that they separate their plastic, is picked up by local collectors. The remaining people claim that they take their plastic waste somewhere. Also, approximately half of the people who separate do this for free, the other half receive a compensation for doing so (see appendix B.1).

10.3.2. Willingness to separate and hand in plastic waste

Figure 10.3 demonstrates that in all three regions almost all people are willing to separate, may it be for different reasons. In Canggu the participants that would separate predominantly want to be compensated while in Denpasar and Pulukan the distribution is approximately fifty-fifty. By means of participatory observation, it was noticed that in Pulukan people were really enthusiastic about the idea and seemed really willing to collaborate. The fact that all the participants from Pulukan want to separate reflects this observation.

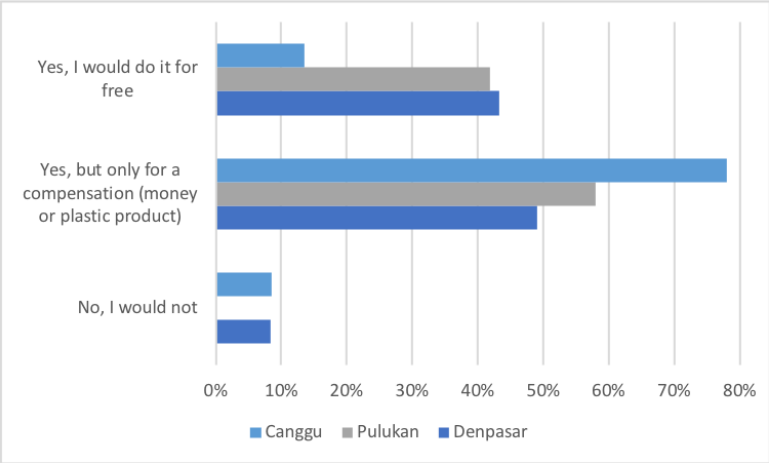


Figure 10.3: The willingness to separate plastic waste. (Survey qn. 14)

A very interesting result from the survey is that when the Banjar recommends or obliges to separate plastic waste all the participants in each region would obey this recommendation or obligation.

10.3.3. Plastic waste collection

The decision on how plastic waste is going to be collected from the households depends partly on the answers given to questions 16, 18 and 19. Figure 10.4 represents the outcome to the question: “Would you be willing to bring your separated plastic to a collection point?” What is interesting to notice is that in Pulukan and Canggu the participants are willing to take their garbage to a collection point, if compensated. In Denpasar, a lot of participants would do it for free.

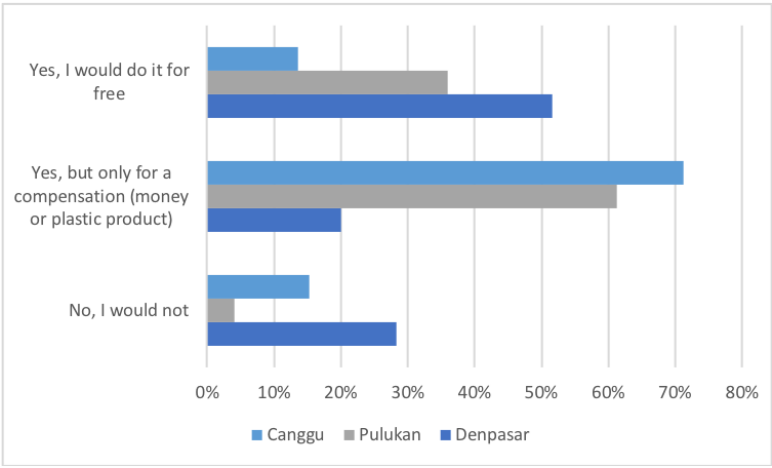


Figure 10.4: Would you bring your separated plastic to a collection point? (Survey qn. 16)

Survey participants were also asked how far they would be willing to take their plastic waste, either when they would receive nothing in return or when they would be rewarded for doing so. When rewarded, a significant increase can be observed in the distance participants are willing to take their plastic garbage

	Denpasar		Pulukan		Canggu	
	No reward	*Reward*	*No reward*	*Reward*	*No reward*	*Reward*
0 - 200 [m]	60%	32%	61%	47%	49%	34%
200 - 400 [m]	9%	22%	6%	34%	15%	24%
400 - 800 [m]	3%	17%	5%	11%	9%	24%
800 - 1300 [m]	3%	6%	0%	3%	2%	2%
1300 - 2000 [m]	0%	3%	0%	0%	0%	3%
2000 - 3000 [m]	0%	0%	0%	2%	0%	0%
I would not take my plastic garbage anywhere	25%	20%	28%	3%	25%	13%

Table 10.2: Distances participants would be willing to take their plastic waste.

and a decrease in participants that would not be willing to take their garbage anywhere. Table 10.2 shows the outcomes to both questions.

10.3.4. Compensation/motivation

The aim of the project is to reward the participating households, for handing in their plastic waste. Figure 10.5 represents how people from the different regions would prefer to be rewarded, either with money or with a recycled plastic product. The figure shows that the responses of the participants are fairly divided. Only in Pulukan they lean more to the reward in the form of a plastic product.

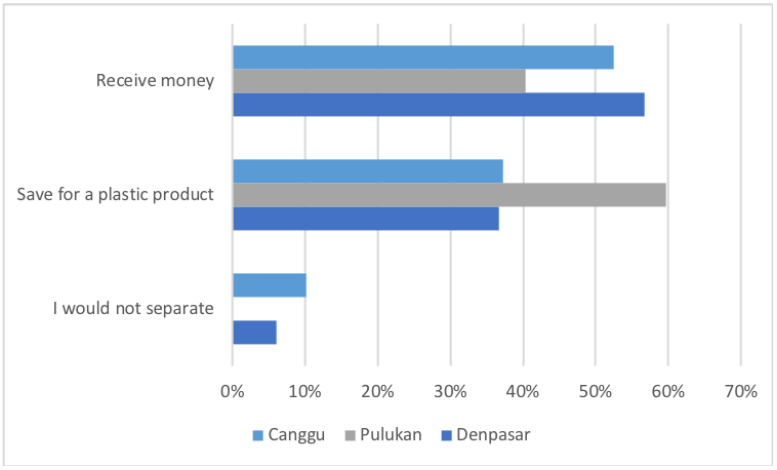


Figure 10.5: How people would prefer to be rewarded for handing in their plastic waste. (Survey qn. 15)

Multiple plastic objects can be given as reward. In all regions, the results demonstrate that people are predominantly interested in furniture and compost bins, as can be seen in figure 10.6.

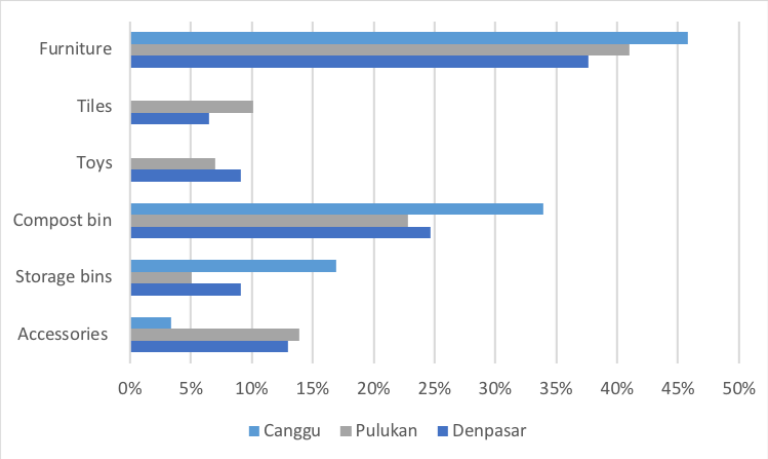


Figure 10.6: Plastic products participants would prefer to receive. (Survey qn. 17)

10.4. Interviews and visits

The interviews and visits that were conducted during the duration of the project helped with establishing the bigger picture. They assisted in gaining a general understanding of the people, organizations, government, culture, habits and geography. This knowledge is difficult to put into words but is essential when starting a project like the one presented in this report. Apart from this, the interviews and visits helped answer some important questions. The answers to these questions and other important results derived from the interviews and visits are presented in this paragraph. Complete transcripts of the interviews are included in appendix C.

10.4.1. Communities

In all three regions interviews were conducted with a leader of one of the Banjars. They were asked questions about how the Banjar is organized, how waste is managed and how they think about the proposed project.

New regulation is discussed at Banjar meetings which are conducted approximately once or twice per month in every region. Men and women have separated Banjar meetings with the leader of the Banjar leading the meeting. New regulations from the government are passed down to the leader of the Banjar and he discuss at the meeting or new regulation can come from the Banjar itself. When a new regulation is proposed it is put to a vote and democratically determined if the regulation will pass or not. There is no direct contact between the government and the Banjar leader, but goes through the head of the Banjar office (Bendesa Adat)

The community is strong on Bali, this means that people listen to their Banjar, actively attend meetings and know what goes on within their community. When agreed upon regulations are ignored within the Banjar, financial and social penalties are imposed. This is also apparent from the survey answers where almost all the participants indicated that they would separate their plastic garbage from the rest of their garbage if the leader of the Banjar recommended it.

In Canggu and Denpasar waste is managed in a similar way. The waste is collected from the households by a service organized by the Banjar office (Bendesa Adat) itself. Residents pay in both regions an amount of Rp 40.000 for this service per month. Such a service is nonexistent in Pulukan. This is because these services are organized from within the Banjars which means that in regions where Banjars have less money, there is less money available for waste management. Because Pulukan is a poor region, the only form of waste management are some centralized TPST collection points organized by the government (the DLHK of the regency). The problem is that those points are too far away and local people rather burn or dump their garbage somewhere else.

From the interviews and visits, a general idea was formed on how people think about the proposed

project per region. In Pulukan people were very enthusiastic. Just like with 4Ocean in Pulukan, they would be very happy with another organization that is going to reduce pollution and create a few jobs. Also, the fact that the project tackles the problem at the root instead of only the symptoms (like 4Ocean), was positively received. In Pulukan they were especially enthusiastic about the plastic products, this is also reflected by figure 10.5.

In Denpasar, the head of the Banjar who was interviewed was less enthusiastic. He thought it was a good idea but that it was better to do it in other parts of Bali because, according to him, waste was already properly managed.

In Canggu, they liked the idea a lot. After presenting the project at the women Banjar meeting immediately a head of plastic recycling was appointed and they proposed to bring their separated plastic waste to the Banjar meetings in the future.

10.4.2. Bendesa Adat

The Bendesa Adat (Village leader) of Kerobokan, which is the village next to Canggu, has been interviewed. He is the head of one of the biggest Banjar Offices in Bali, overseeing fifty Banjars. The Bendesa Adat is in direct contact with the regency Badung, this contact is about new regulations formed by the government or by the Banjars themself.

The Bendesa Adat of Kerobokan is in charge of the waste management in Kerobokan together with the fifty Banjar leaders. They make the regulation for the waste management in Kerobokan. Garbage trucks from the Banjars pick up the waste from households and bring it to big landfills from the DLHK (regency). The recyclable waste from hotels and restaurants is picked up by EcoBali, this is mandatory for all hotels and restaurants in Kerobokan by the Bendesa Adat. A collaboration like this is a very good example for the recycle business proposed in this report. The Bendesa Adat also pointed out that the Pantai recycle business without working together with the Bendesa Adat will be difficult to succeed at every region in Bali.

When the Desa Adat was asked about the Indonesian government's Solid waste management policy and national strategy (see section 6.2.3), he said that he knows about this initiative from the government. However at the moment it is only a plan, nothing is done with it as far as he knows.

Figure 10.7: Meeting with Bendesa Adat of Kerobokan

10.4.3. Waste management

Several types of waste management facilities were visited to collect information about how waste is handled, about how they finance their facility and what their future plans are. It became clear that none of the facilities is recycling plastic themselves they only separate it and that at every facility the separation is done by hand.

TPST3R Facility Seminyak, the oldest TPST3R of Bali, is an initiative of the Banjar office of Seminyak. Seminyak is a village next to Canggy. This facility collects all types of waste via door-to-door collection at households, hotels and villa's with garbage trucks. They earn money because households, hotels and villa's have to pay for this pick up service. For households the cost is Rp 40.000 per month. In the case of hotels and villa's the cost varies between Rp 500.000 and Rp 6 million, depending on the amount of waste as shown in appendix C.10.1. In the Seminyak area it is mandatory by the Banjar to use this pick up service. To collect all waste at the 350 households in Seminyak, three trucks are needed for a timespan of five hours. Another way how they earn money is by selling the recyclable waste to large recycle factories in Java. Appendix C.10.2 shows the amount of money they get for their recyclable waste including plastics. The amount of waste this facility recycles is around 60%. For this reason the Badung regency have a new regulation for waste management, in every village they want one TPST3R facility. At the moment 36 TPST3R facilities are active in this regency. This is possible because the Badung regency has a lot of money due to tourism.

EcoBali is operating in the same way as the TPST3R facility. Asking money for the door-to-door pick up service at households, hotels and villa's and selling the recyclables to Java. However comparing with the TPST3R facility also differences can be noted. This pick up service for households is way more expensive, namely Rp 150.000 per month. For this reason only the wealthy people who care about the environment use this service. But for the pick up service for hotels and restaurants they work together with some Banjar offices (like Kerobokan). So for this hotels and restaurants it is mandatory to use this pick up service. Also the waste they pick up is different compared with the TPST3R, because EcoBali

only picks up recyclables like glass, paper and plastics.

4Ocean-medewi is a small plastic collecting and separation facility in Pulukan region. They collect plastic waste from beaches and than separate the plastics at their facilities. This facility is completely financed by 4Ocean. 4Ocean transfers every month Rp 27 million to this facility to pay 14 people who work seven days a week. The plastic they separate goes to the head office in Negara.

Figure 10.8: Conducting interview with the manager of 4Ocean Bali-Medewi

Bank Sampah's are spread out over whole Bali (as shown in figure 6.6). They collect high valuable recyclables (paper, glass and plastics) at households with a motorbike (figure 10.9) and receive money in return. Only PET bottles are collected as valuable plastic. The collectors weigh the plastic with a spring scale and pay around Rp 3000 per kilogram (PET). After collecting the bottles at households, all plastic is sold in big quantities to the large recycle factories on Java. With selling to Java they are able to finance their business.

Figure 10.9: Motorbike of a plastic collector

10.4.4. Companies of interest

One of the bigger investments when starting the small scale plastic recycling facility will be the costs for recycling machines. A visit to the company WeDoo gave an indication of the costs of such machines and the time-frame in which they could be built. In the APPENDIX an invoice is included for the machines and molds (molds are for a stool, see section 11.3) WeDoo thinks are needed to realize the proposed project. The total costs for the machines and molds would be Rp 60 million and the time to complete the machines would be 2 months.

10.5. Calculation of plastic input

The calculation of the plastic input depends on the collection method. As described in the methodology, either collection through collection point or collection via door-to-door collection is discussed.

10.5.1. Collection through collection points

For the calculation of the plastic input when using collection points equations 9.1 (participating residents) and 9.2 (plastic input) are used. Data from figure 10.3 (willingness to separate) and table 10.2 (distance people would take their plastic) is used to calculate P_n and the population densities can be found in table 10.3. The amount of participating people (equation 9.1) per region is presented in table 10.5. The Matlab script used for the calculation is included in appendix D. Because of the lower population density in Pulukan the number of participating residents and therefore the plastic input is significantly lower than in Denpasar and Canggu.

Region	**Population density** [people/m^2]
Denpasar	49,97 *10^{-4}
Pulukan	1,10 *10^{-4}
Canggu	13,55 *10^{-4}

Table 10.3: Population density

10.5.2. Collection through door-to-door collection

The results from equation 9.3 (participating residents) are shown in table 10.5 and results from equation 9.2 (plastic input) are presented in table 10.4. In the appendix D the Matlab script for the calculation is included. For door-to-door collection, the plastic input only depends on the difference of produced plastic per person per week and the average amount of people per household in each region. Which is why Canggu with an average of 5,5 people per household (see table 9.1) has the highest plastic input. In Denpasar the plastic input is relatively low because the plastic production per person per week is small.

	Collection point * [kg]			Door-to-door collection ** [kg]		
Plastic type	**Denpasar**	**Pulukan**	**Canggu**	**Denpasar**	**Pulukan**	**Canggu**
PET	327,7	16,8	70,4	167,6	412,8	158,8
HDPE	163,9	5,2	112,6	83,8	127,0	316,8
PVC	0	2,6	14,1	0	63,5	39,6
LDPE	109,2	5,2	140,8	55,9	127,0	396,0
PP	109,2	15,5	70,4	55,9	381,0	198,0
PS	0	2,6	28,2	0	63,5	79,2
Other	54,6	2,6	84,4	27,9	63,5	237,6
Total	**764,7**	**50,4**	**520,8**	**391,1**	**1238,3**	**1426,0**

Table 10.4: Plastic input, * For one collection point, ** For one collection truck

Region	**Collection point * [people]**	**Door-to-door collection ** [people]**
Denpasar	5462	2497
Pulukan	129	3175
Canggu	1408	3960

Table 10.5: Number of participating residents, outcome of Eq 8.1 and Eq. 8.3, * For one collection point, ** For one collection truck

11

Financial feasibility

11.1. Introduction

In order to evaluate if the project is financially feasible there needs to be a balance between selling products to cover the costs of running a recycling facility (arrow 9 from figure 8.1) and rewarding the households to make sure they hand in their plastic garbage (arrow 6 and 8 from figure 8.1). This balance is used to determine if it is feasible to stimulate the local community in Bali to stop dumping their plastic garbage in the environment, by making use of a plastic recycling facility.

Whether the project is financially feasible is judged by reviewing how many products need to be sold in order to generate enough revenue and the time participants have to hand in plastic to receive a reward. Only a rough estimation of these two values is calculated in this chapter, but it gives a good primary check if the proposed project has any chance of success.

11.2. Methodology

A Matlab program was made to help determine the balance. The most important values that needed to be found were the amount of time an average household has to safe in order to receive a product and the number of products that need to be sold for financial stability. These values are directly related to the operational cost. The parameters used to determine the balance are:

- Plastic input per week per plastic type (table 10.1): Depends on the average plastic production per household, the chosen collection method and the intensity of the collection (how many collectors).
- Number of participants (table 10.5): Depends on the collection method, collection intensity and the percentage of people that would be willing to separate and hand in their plastic.
- Plastic per product: Depends on the amount of plastic needed to produce the product.
- Price per product: Average of the prices of similar products sold in western online stores.
- Reward distribution (figure 10.5): Percentages of the people that would rather receive a plastic product or money as a reward.
- Operational costs: Labour cost, space rental cost, a percentage of the initial investment have to be paid back monthly and the money it costs to reward the people who would rather receive money instead of a plastic product.

11.3. Product

The choice of the product depends on the results shown in figure 10.6. From the figure, it is clear that furniture and compost bins are popular products. Throughout the rest of this reports a stool (furniture) is chosen as the product produced in the small scale recycling facility. This choice was made because during house visits it became apparent that stools are a popular form of furniture. Apart from that, they are relatively small and easy to produce.

An average stool is estimated to cost around 8 liters of plastic. As mentioned in chapter 3 the stools can be made from PET, HDPE, LDPE, PS or PP.

From comparing the prices of similar stools and other recycled products that are sold online, a sales price of 100 euros is estimated. This price is intended for selling on the western market.

11.4. Operational costs

For calculating the operational cost (table 11.1) only the major expenses are taken into account. The major expenses consist of labour cost, space rental cost, reward cost and a percentage of the initial investment that has to be paid back monthly.

The labour costs depend on the number of employees and the area. Just like at the 4Ocean sorting facility, around four employees for the sorting of the plastic are expected to be needed. In addition to that: two employees for operating the machines and two for collecting the plastic. This gives a total of around eight employees, which is a rough estimation and time will tell if more or less employees are needed. For the calculation of the financial feasibility, eight employees working for minimum wage will be used. This minimum wage varies per region [89].

The cost of land rental varies a lot between the selected regions. In the Pulukan area, the price is lower compared with Denpasar and Canggu. The estimation of the monthly rent has been done by visiting similar properties when in Bali. Table 11.1 shows the estimated price for the rent of a piece of land of 2500 m^2.

Assuming the initial investment has to be paid back in time, a percentage of this investment will be added to the monthly operational cost. The initial investment consists of the cost of recycling machines and the garbage truck, which is a rough estimation. The total costs for the machines would be Rp 60 million as mentioned in section 10.4.4 (WeDoo visit). For the garbage truck the costs are around Rp 30 million [90]. This means that the total initial investment is roughly Rp 90 million. When considering a pay back time of four years, two per cent has to be paid back every month, this results in a monthly cost of Rp 1.8 million which is around 115 euros.

The participating households are rewarded with either money or plastic products. For the calculation, the households are rewarded per kilogram of handed-in plastic waste, with the price they would receive for PET bottles if they handed it in at a Bank Sampah. This relatively high price for plastic is used to make sure the participating households hand in all plastics and not only the low valuable plastics. The total monthly costs for rewarding the participants that would rather receive money are presented in table 11.1.

	Denpasar [Rp/month]	Pulukan [Rp/month]	Canggu [Rp/month]
Labour cost (8 pers.)	20.424.000	18.852.472	21.602.376
Land rental	25.000.000	3.000.000	30.000.000
Payback	1.800.000	1.800.000	1.800.000
Reward cost, collection points	5.560.000	242.000	3.680.000
Reward cost, door-to-door	2.850.000	5.940.000	10.354.000
Total, collection points	**52.784.000**	**23.894.472**	**57.082.376**
Total, door-to-door	**50.074.000**	**29.592.472**	**63.756.376**

Table 11.1: Operational cost per month per region

11.5. Evaluation of financial feasibility

To determine if the concept discussed in this report is financially feasible, the following parameters are reviewed:

- Number of participants
- Total plastic input
- Amount of products that need to be sold
- Average amount of time the participants have to hand in plastic before receiving a plastic product

Tables 11.2 and 11.3 show the results calculated with the Matlab program (appendix D) for the two

collection methods.

Collection through collection points			
Parameter	**Denpasar**	**Pulukan**	**Canggu**
Number of participants [pers.]	5462	129	1408
Total plastic input [kg]	764,7	50,4	520,8
Products that need to be sold	34	15	37
Time before reward [weeks]	29	26	17

Table 11.2: Feasibility parameters, collection points

Collection through door-to-door collection			
Parameter	**Denpasar**	**Pulukan**	**Canggu**
Number of participants [pers.]	2497	3175	3960
Total plastic input [kg]	391,1	1238,3	1426,0
Products that need to be sold	32	19	41
Time before reward [weeks]	33	12	15

Table 11.3: Feasibility parameters, door-to-door

The ultimate objective of the proposed project is to prevent as many kilograms of plastic from ending up in the environment. The plastic input can be seen as a representation of this objective. When the plastic input is high, more people participate and less plastic ends up in the ocean.

It is desirable that the number of products that need to be sold are as low as possible because this makes it easier to reach the required revenue and puts less pressure on the business.

The time before participants receive a reward should be as short as possible for the obvious reason that when people have to wait too long they lose interest and will stop separating and handing in the plastic waste which results in a lower plastic input.

In Pulukan, when using door-to-door collection, the aspects discussed appear to be most optimal. Only 19 products need to be sold every month and the time before a reward is 12 weeks. The plastic input is relatively high, which causes the ratio between plastic input and products sold to be: 65 kg of plastic input per product sold. The ratio in Pulukan is the largest when comparing with Denpasar and Canggu respectively 22 kg/product and 35 kg/product in the best case. The value of the ratio between plastic input and product sold are also of interest for marketing point of view, because for buying one product, the customer saves 65 kg of plastic from ending up in the environment.

11.6. Choice of collection method

The choice for the collection method is area specific and based on the parameters presented in tables 11.2 and 11.3.
In the Denpasar area, collection with collection points is the most promising because the plastic input is higher compared to the door-to-door collection. The reward time as well as the products that need to be sold are similar for both methods. The plastic input is high with a collection point for two reasons. First of all, the population density in Denpasar is very high and secondly, the residents in Denpasar are relatively willing to take their plastic to a collection point.
In the Pulukan area, the door-to-door collection method appears to be the best option, because the plastic input is significantly larger than when collection points are used and the reward time is more than two times smaller. An undesirable difference is the amount of products that need to be sold, however this difference of four products is small.
In Canggu area the plastic input is the highest with the door-to-door collection method and the other two parameters are quite similar in both cases. For this reason the door-to-door collection is the selected collection method in Canggu.

12

Trade-Off

In this chapter the trade-off method, organization and rationale will be presented. With this, a trade off table can be constructed and used to compare the three possible regions: Pulukan, Denpasar and Canggu, such that a definitive region can be selected.

12.1. Trade-Off Method

For the trade-off a number of aspects will be selected and each aspect will be assigned a weight in terms of importance. Each region is thus graded for each of the chosen aspects and then the total score is used to decide on the final location of the recycling business. When this method is used it is ensured that aspects that have a bigger influence on the location will have a bigger effect on the total score. As will be seen in section 12.2, the final trade-off will be based on 9 important criteria. Each trade-off criterion will be graded from 0 to 1 based on the judgement of the Pantai group of how important that aspect is to the possible performance of the recycling business in that specific region. Furthermore, the sum of the weights assigned to the criteria is set to a value of 100. In this way, when one of the criterion's weight is adjusted, the other criteria have to be adjusted as well in order to maintain the total sum of 100. This forces the Pantai group to constantly weigh all criteria relative to one another.

12.2. Trade-Off Criteria

In this section each of the trade-off criteria will be discussed individually in their respective subsection. After which all results will be summarized in the trade-off table to decide on the final region. It has to be noted that not all criteria can be expressed in terms of numbers/values on which the grading can be based. As a consequence some criteria will be graded subjectively by means of participatory observation, hands on experience and interviews with companies and local inhabitants. In this section the motivation and rationale behind the criteria will be explained and in table 12.2 the grades of all the respective criteria in combination with their weights can be seen.

12.2.1. Current waste handling (presence of waste management)

The impact the proposed recycle project will have on the selected area also depends on the current waste handling. If the waste is already handled in a satisfactory manner, a direct result will be that a lot of plastic is already picked up and thus will not end up in the environment. Therefore regions with proper waste management are of less importance for this project. The waste management in Canggu and Denpasar are organised better than the management in Pulukan. As can be seen in the data in subsection 6.3.4 in Pulukan only 22% of all the waste is picked up, the other 78% is burned or dumped. In Canggu and Denpasar this pick up rate is much higher, namely 73% and 96% respectively. This data is also corresponds more or less with the data of the conducted surveys as subsection 10.3.1 current handling of plastic waste shows and moreover interviews with the Banjar leaders confirm these results. For this reason the current waste handling is the best in Denpasar and is directly followed by Canggu and then Pulukan.

12.2.2. The future handling of plastic waste

The future handling of plastic waste is an important criteria for the same reason the current waste handling is an important criteria. If the waste will be handled in a proper manner in the foreseeable future this will mean that the proposed recycle project will have less of an impact on the specific region. The future plans are regency dependent. Area Canggu is in the Badung regency, in this regency the aim is to build one TPST3R facility per village according to the manager of the TPST3R facility in Seminyak. In Denpasar the waste is already handled in a relatively good manner and for this reason they have no concrete plans to improve the waste management. In Pulukan no plans are known to improve the waste management according to Agus who is the head of one of the local Banjars. Due to this reason the future waste handling in Canggu is the best followed by Denpasar and then Pulukan. Which means that for this criteria Pulukan scores best as there is most room for improvement followed by Denpasar and lastly Canggu.

12.2.3. Support of the banjar leaders

To make sure the Pantai recycle business will succeed, the community will have to hand in their plastic. They all will hand in their plastics if the Banjar supports the project as said in subsection 10.3.2 willingness to separate and hand in plastic waste. So the head of the Banjar's willingness to support the project is of great interest, because he can influence the Banjar, which is also pointed out by the Bendesa Adat of Kerobokan in subsection 10.4.2 Bendesa Adat. Results from interviews with the Banjar leader per region are mostly used in the rating and grading of the different regions within this criteria. In Pulukan and Canggu the Banjar leaders were very enthusiastic about the project plan and would want to help realize it if it comes that far. In Pulukan the leader thinks this project can make a big difference in his area and for this reason he was very helpful. In Denpasar the Banjar leader would support the project just as the other similar projects in Denpasar but according to him other places in Bali are a better option than Denpasar as the waste management is already handled relatively well and parts of the Banjars are already satisfied. The same is said by the manager of the TPST3 facility in Seminyak about the Canggu area as there as well are already many organisations managing the waste in the area like Ecobali and the TPST3R facility itself. Therefore Pulukan would be the best also due to Agus the leader of one of the local Banjars as he is still in close contact with us and would very much like to realize this project. In the second place is Denpasar together with Canggu as banjar support is good, however in both areas people with significant knowledge about the problem have expressed concerns that the influence of such a business would be greater if done in another region.

12.2.4. Plastic Input

The more plastic input into the recycle facility the better, because more plastic is saved from dumping in the environment and more recycled products can be produced. The plastic input is calculated in section 10.5 Calculation of plastic input. The plastic input varies per region and per collection method. The collection method per region is determined in 11.6 Choice of collection method. The door-to-door collection method is used in Pulukan and in Canggu with a plastic input of 1238 kg and 1426 kg respectively. The collection through collection point is used in Denpasar, because the population density in Denpasar is very high. In Denpasar the plastic input is 764 kg, which is lower compared to Pulukan and Canggu because the average plastic input per person is much lower in Denpasar (see table 10.1).

12.2.5. Operational Costs

The operational costs differ per region because for example aspects such as labour cost and land rental are region specific. The difference in the operation costs and how these are determined can can be seen in section 11.4 Operational costs. The minimum wage in Pulukan is the lowest as well as the cost for land rental. In Canggu the labor cost and land rental are the highest. If everything is combined we have the lowest operational cost for Pulukan with an amount of 29.593.472 IDR per month. The second lowest operational cost corresponds with Denpasar and comes down to 52.784.000 IDR per month. Lastly the highest operational cost corresponds with Canggu and results in a sum of 63.756.376 IDR per month.

12.2.6. Financial feasibility in terms of products

Financially the most feasible place is of great interest, however this criteria has some connections with the previous two criteria, namely operational cost and the plastic input. Due to this reason and that this criteria is therefore slightly incorporated in the other two criteria the weighting of this criterion will be a bit lower in connection with the other two. Nevertheless, to make sure the business is financially feasible, plastic recycled products have to be sold. The area where the least products have to be sold to stay financially stable is in Pulukan, in this region only 19 products have to be sold as is calculated in section 11.5 Evaluation of financial feasibility. In comparison with Denpasar and Canggu this amount is a lot higher, namely 32 products and 42 products respectively. Also the time participants have to separate and hand in their plastic before they are rewarded with a plastic product is the lowest in Pulukan with a timeframe of 12 weeks. In Canggu the time before being rewarded with a plastic product is also relatively low with a time of 15 weeks, which would stimulate the participants to hand in their plastic. However, in Denpasar this time is much longer with 33 weeks, so the participating residents will be motivated less to hand in their plastic.

12.2.7. Community based support

One of the Trade-off criteria focuses on stakeholder participation and involvement. The goal of the recycle business is to incorporate local inhabitants which have their own ideas, values and habits with regards to plastic waste or waste in general. The three regions do not differ drastically on cultural aspects. However, the willingness to handle plastics has been measured with surveys. This is the first very important criteria and the results of the surveys can be found in subsection 10.3.2. With respect to this criterion in first place comes Pulukan as there all of the respondents are willing to hand in their plastic waste for free or for a compensation. In second place comes Denpasar as there approximately the same amount of respondents has indicated that they would not separate their plastics. However, a bigger percentage of the respondents that does want to hand in their plastics would do it for free in comparison with Canggu. Therefore, Canggu comes in third.

12.2.8. Awareness of the local inhabitants

This criteria focuses on the awareness of the local inhabitants. This awareness is focused on the problems caused by plastic waste. A high awareness means that people are already active or well informed about the consequences that plastic waste brings to the environment. The awareness is assumed to be stimulated by education and the presence of a governmental/non-governmental waste management system. It is assumed in the stakeholder analysis that the education level is equal throughout Bali as the school-system follows the same educational program imposed by the government. Moreover, the presence of waste management in the area stimulates the awareness more than when its not present. In addition the presence of NGO's and their additional education programs that are carried out at nearby schools and communities in the area definitely improves the awareness as well. This means that Canggu comes in first as here the most waste management facilities and NGO's with educational programs are present as well as Balli's only green school. With Denpasar coming in second and Pulukan last with almost no waste management facilities and presence of NGO's.

12.2.9. Presence of non-competing NGO's

The last criteria describes the way in which collaboration could take place between nearby NGO's. The presence of NGO's which are not influencing the plastic waste streams can be seen as a positive factor for our business purposes. These NGO's do have knowledge on the stakeholder network and can provide essential insider information. For this reason Canggu comes in first for this criteria, although there are many competing NGO's in this area there are also by far the most non-competing NGO's present. These non-competing NGO's can thus be used for important data exchange just like the data the Pantai group received about waste management from Ocean Mimic as can be seen in subsection 6.3.4. In second place comes Denpasar this is due to the reason that not so many non-competing NGO's are present in this area. However, In pulukan there are almost no non-competing NGO's present and that is the main reason why Denpasar comes in second and Pulukan last.

12.3. Trade-Off

In this section the weighting of the criteria will be given as well as the explanation of the final trade-off.

12.3.1. Weighting Criteria

In section 12.2 an elaborate explanation of every criteria used in the trade-off is given. The assigned values of the different criteria can be seen in the trade-off table. In this subsection these explanations and values are used to deduce weights for all the criteria that are going to be used in the final trade-off. In table 12.1 the criteria are shown with their respective weights.

Criteria	**Weights (%)**
Current waste handling	15
Future handling of plastic waste	10
Support of the Banjar leaders	10
Plastic Input	20
Operational Costs	15
Financial feasibility	5
Community based support	10
Awareness of the local inhabitants	5
Presence of non-competing NGO's	10

Table 12.1: Trade off Criteria and weight

12.3.2. Trade-Off Table

In table 12.2 the actual trade-off can be seen, of which the method is explained in section 12.1. The outcomes of the trade-off, the solution scores, are depicted in table 12.3. The solution scores are the sum of the weighted grades for all regions. The actual grades in the trade-off table have been determined using the method in which the values are weighted with respect to the highest possible value for that specific criterion, thus dividing the value by the maximum value. This way all numerical values are determined objectively and weighed with respect to the best possible value that can be achieved. For the criteria in which the lowest value is the best possible value the minimum value is divided by the value of the criteria. Thus:

- For the criteria where the highest value gives the best grade: $grade = \frac{value}{maximum}$
- For the criteria where the lowest value gives the best grade: $grade = \frac{minimum}{value}$

It has to be noted that just as mentioned in the trade-off method that not for all criteria numerical values could be derived. Therefore these criteria are graded by the use of things such as participatory observation, hands-on experience and interviews and visits. Furthermore, in table 12.2 there are two letters represented. The first letter (R) represents the grade for that specific criterion of that region, the right letter (W) represents the weighted grade (grade*weight).

Area / **Criteria**	Weight (%)	Canggu (R:W)	Denpasar (R:W)	Pulukan (R:W)
Current waste handling	15	0.35 : 5.25	0.05 : 0.77	1.00 : 15.00
Future handling of plastic waste	10	0.38 : 3.80	0.63 : 6.30	1.00 : 10.00
Support of the Banjar leaders	10	0.87 : 8.70	0.87 : 8.70	1.00 : 10.00
Plastic Input	20	1.00 : 20.00	0.54 : 10.72	0.87 : 17.40
Operational Costs	15	0.46 : 6.96	0.59 : 8.86	1.00 : 15.00
Financial feasibility	5	0.45 : 2.26	0.59 : 2.97	1.00 : 5.00
Community based support	10	0.90 : 9.00	0.91 : 9.10	1.00 : 10.00
Awareness of the local inhabitants	5	1.00 : 5.00	0.67 : 3.33	0.22 : 1.11
Presence of non-competing NGO's	10	1.00 : 10.00	0.69 : 6.90	0.25 : 2.50

Table 12.2: Trade-off table

	Total score (100 MAX)
Canggu	70.83
Denpasar	57.54
Pulukan	85.97

Table 12.3: Total score per location.

In table 12.3 the total score of all the locations that were used in the trade-off can be seen. There it can be seen that Pulukan came back from the trade-off as the best location to start the recycling business. This means that in future research and recommendations the region of Pulukan will be used as reference, as the focus of the Pantai group will be on that location. Furthermore, for future groups that would want to continue the research of the current Pantai group Pulukan is given as recommendation as well.

13

Discussion

After thorough research into the technical-, social and financial feasibility of a small-scale plastic recycling business in Bali, this chapter provides the most remarkable points of discussion.

13.1. Areas of interest

The selection of the three case areas in this study is based on a thorough research on particular socio-demographic factors, such as population density and income level . in combination with the results from previous Pantai projects.

During the research, the group has found an interesting study from the Bali Partnership Assembly (BPA). The study divides the province of Bali into priority areas, each labeled from low- to high priority (see figure 6.13). The level of priority is based on the plastic waste output of that area and the consequences for the environment.

As a result from our own research we found that Pulukan, although it is not part of a high-priority area based on research of Bali Partnership Assembly, is still facing huge problems with regards to plastic waste pollution. This suggests a more specific division of priority villages or priority districts instead of targeting a whole area. Waste problems are severely location dependent and can even change drastically on a very local scale.

13.2. Stakeholders

Assumptions were made to determine the influence of the existing waste management system on the behaviour of stakeholders. It is difficult to find whether there is an increase in awareness about waste if a waste handling business is initiated. Customs and religion are considered fundamental which is why awareness is not expected to change easily. Educational programs are possibly needed for a change in attitude toward the plastic waste problems. This applies for a large variety of factors because the support for a potential business depends on a lot of elements. In this case, only awareness, level of education and existing waste management system were taken into account. Aspects like demography, corruption, propaganda, marketing and infrastructure however can also play an important role.

The influence of waste banks on the proposed business can be significantly large. Think about scavengers that pick-up the valuable plastics from the streets before they arrive at the facility. It is important to gain a clear view of these activities. It is challenging to estimate how active these people are and what their influence is. These practices might impact the waste input of the facility profoundly. Not only the scavengers, but the development of local waste banks themselves are sometimes difficult to specify. It would be beneficial to carry out more focused research to get a better understanding of these matters.

13.3. Results of collection measurements

The values obtained from the evaluation of the collected plastic of the households, give us a good indication on the quantity and composition of the plastic waste. However, there are factors that lead to uncertainties in the measurement results. Locals have been asked to gather and separate all their plastic waste from the rest and save it over the course of a week, so we could examine it. One week might be too short for this research, which could lead to different values. If the period of this research would be extended to a longer period, we believe that the composition and quantity can be measured with higher accuracy. Not only does this allow locals more time to get used to the program, but it improves the understanding as well. It would also make sure that no waste from last week or from close by has been collected. The amount of plastic produced during a week is needed to find the input for the facility. Collected plastic litter is not wanted in the results, as the input of plastic litter isn't continuous and is probably contaminated.

We experienced difficulties with clearly explaining the locals what was expected of them for our research. Even with the help of translators, it is challenging to make locals understand the objective of separating their plastic for a whole week or even what plastic is. The fact that the local population of Bali tends to give satisfactory answers does not help either. Sometimes individuals say they would like to help, but in fact, they don't want to or aren't able to cooperate at all. This is definitely something to keep in mind for further research.

Some side notes need to be added about comparing the results from the plastic collection as well. If you look at the plastic that was gathered in Denpasar, we believe the locals did not receive the message clearly as the quantity was very low. Contrarily in Pulukan the amount of plastics gathered of some households was suspiciously high. This makes us believe that explaining the assignment to participants encountered some miscommunication.

The last remark on the plastic collection is that we have compared our measured input with the input values provided by The Bali partnership. It is expected that their data is reliable. However, it is not clear how Bali partnership measured the results. It would be valuable for us to know how they conducted their research and calculated the plastic waste production per person per week of 0.7 kg.

13.4. Results of surveys and interviews

For reliable survey results, a sufficient amount is needed. In practice, this minimum amount required turned out to be difficult to obtain. A lot of time and effort has been put into conducting plenty and reliable surveys, but we do not believe the amount of surveys meets the requirements for perfect results. The main reasons it was difficult to obtain large amounts of reliable surveys are: lack of time, difficulty in communication and problems encountered with arrangements. For more accurate results it is possible to hand out more surveys. It should however be seen if it's worth the effort, as the results gathered from the survey already give reasonable indication. For further research it is advised that the focus only lies on one small area with potential like Pulukan. This way more surveys can be conducted and plastic waste collection measurements can take place. The data gathered would be more specific and reliable, as no time would be wasted on non-interesting areas.

13.5. Financial feasibility

From the survey output, it is evident that the local people preferred furniture as a reward. For simplicity, one piece of furniture was chosen for the determination of the financial feasibility, namely a stool. However, only one product would not be sufficient for a business in the long term. First of all, not everyone is content with a stool. They would prefer other products, which would result in these individuals being less motivated about the program. Secondly, when enough stools have been gathered by people there needs to be another incentive for them to stay interested and keep collecting their plastic waste.

The output of the financial model is an approximation for the financial feasibility of the proposed business. This model is based on the plastic collection measurements, surveys and the operational cost. As explained above, the results of the plastic collection measurements and surveys can contain some

inaccuracies. The operational cost is an estimation and more in depth research is required before setting up the proposed recycle business. Still the financial model gives a reliable estimation on the financial feasibility and gives a good indication on the possibility of the business.

In the surveys, individuals were asked if they would hand in their plastic waste for a reward, or if they would hand it in for free. 40% of the participants in Pulukan and Denpasar answered that they would hand in all their plastic for free if there were an opportunity. Nonetheless in the created financial model, it is assumed everyone receives a reward as trouble could arise if people are not treated equally. Giving several individuals rewards and not giving anything to others could result in conflicts. It should be kept in mind that in practice, it is also possible that people want to help or just want to get rid of their waste, without requiring any form of reward.

13.6. Trade-off

The criteria for the location trade-off are picked based on what we find to be the most important aspects. These criteria will be graded subjectively by means of participatory observation, hands-on experience and interviews with companies and local inhabitants. Therefore, some discussion arises about the results, as they cannot be 100% refuted due to our personal judgment. This is due to the fact that for some criteria the judgment (and thus the grading) is subjective, as it cannot be backed up by solid data. In addition, the same can be said for the weighting of the criteria as the weights were assigned based on what we ourselves think are the most important criteria to base the trade-off on. Therefore, discussion will always be present as everybody has his or her own personal opinion on the matter. Nevertheless, to reduce discussion as much as possible in the future it might be a good suggestion to use criteria that can be backed up by solid data as much as possible. Sometimes this might not be doable but it is definitely something important to take into account.

13.7. Future reference

The research done for this project shows what the feasibility is of setting up a recycling facility, and gives a suggestion for the preferred location to start this business. It should be kept in mind that estimations were done to do so. If follow-up research would take place, we suggest to focus the research on one small area, preferably areas like Pulukan. The results gained from our research are very satisfying for Pulukan, but this way more solid data can be gained for a better understanding of the local circumstances.

Collaboration with Bendesa Adat and Banjars seems to be the key to success. We have found that if a Banjar forces people to participate, everyone will do so. The best way to make this happen is to convince the Banjar leader of the project and its opportunities.

The concept devised by our project group can be further developed. The manner in which the plastic is collected and the way the quantities of the plastics are measured need further thought. How do you keep track of who hands in what? And how do you determine what percentage of the plastic that is handed in is useful?

Lastly, it could be interesting to research the possibility of not only collecting the plastic waste of households. Hotels, villas and restaurants all produce plastic waste and are required by law to get rid of it in an acceptable way. These establishments need to pay to get rid of their waste at the moment. This could be an opportunity to work together, as we do not require payment for collecting the plastic waste.

14

Conclusion and Recommendations

The first initiations to realize a recycling business on Bali have been carefully investigated during this multi-disciplinary “Pantai” project. Particular parts have been elaborated in detail which results in a broad and ambiguous research that provides an addition to the current extensive knowledge base of the plastic waste problems in Bali. Moreover, the project includes an understanding of local circumstances by means of the results from interviews and surveys.

The sub-questions from the introduction of this report are used to provide a comprehensive conclusion of the project. Together they create the possibility to answer the main research question of this report:

‘How feasible is it to introduce a recycling business on Bali to reduce the plastic waste problem?’
Each sub-question is covered in the next subsections of this chapter. A short final conclusion can be found at the end of the chapter.

14.1. Recycling techniques and their application

During the research different non-governmental organizations have been contacted and visited to talk about the potential techniques and the use of equipment to recycle plastic waste on Bali. In addition, a thorough literature study is performed. From the results of the interview with EcoBali, the land-use in Bali is specifically open for touristic functions and large industrial purposes are not welcomed. Most of the plastics are shipped and recycled on the island of Java.

This suggests to start a small-scale facility with easy to use equipment. With easy to use we mean mechanical equipment, since chemical methods to recycle plastics are more suitable in large industrial facilities. ’The North Bali Reef Conservation (NBRC)’, the ’Daur Project’ and ’Wedoo’ already made use of mechanical equipment provided by an open source community named ’Precious Plastic’. On a local and small scale a distinction can be made between useful recycling equipment: injection machines, shredding machines, extrusion machines and compression machines. The types of plastics that can be used are thermoplastics which are characterized by their Resin Identification Code 1 (PET), 2 (HDPE), 4 (LDPE), 5 (PP) and 6 (PS). Code 3 (PVC) can not be recycled due to the release of toxic gasses during the heating process. The non-recyclables form a special group of plastics. There are ways to use these plastics for instance as a fill for concrete. A proper way to deal with non-recyclables has not been found yet. An additional in-depth study in the future is found necessary.

14.2. Business related requirements

A comprehensive study has been performed on the business related content of initiating a business in Bali. To introduce a company in Bali as a foreigner, there are few important recurring problems that could occur. These can be distinguished as: Large required paid-up capital, the industry is on a negative investment list or there is a need of an owner with the Indonesian nationality.

The best possible way to introduce a company in Bali is to work with a local nominee. In this way it

is easier to embed in the social and political network and it provides possibilities to fund the business. The most suitable legal entity for a recycle business is found to be a Yayasan: a foundation. The initial costs are IDR 100 mil. (6,400 euros). The additional advantage of this type of entity is the exemption of tax on income which can be reinvested in the company. In addition, the foundation could create goodwill and compassion with the local inhabitants.

14.3. The Waste Management System in Bali

The waste management system in Bali is rather complex, based on the waste collection and processing by governmental and non-governmental organizations. As stated, the households and their waste production form the most important issue in Bali and the biggest problems lie in the collection of plastic waste. The concept of the recycling facility will reduce this problem significantly, especially at places where no waste-management system is implemented yet. During the research new insights arose about the current developments of waste-banks in Bali and the potential of these waste-banks.

By means of the interviews with local inhabitants, waste management agencies and non-governmental organizations we can conclude that the actual application of waste-banks is not yet sufficient which increases the potential of a new recycle facility. Moreover, the new purposes of the ”Pantai” business to reward local inhabitants by giving back recycled products and to accept all kinds of plastics is more valuable since the current waste-banks “cherry-pick” the better earned plastics. What remains is the usability of non-recyclable plastics in the business. Initially, the business intends to use one plastic type per product to increase the life cycle of the product and to make sustainable products. For additional revenues, the non-recyclable plastics could be used but is not the intention and goal of the business. Therefore, we can conclude that further research is necessary to find solutions for the non-recyclables.

14.4. Stakeholder behavior, interests and thoughts

The stakeholder network has been researched in detail and many of the surveys and interviews which were carried out provided new insights. Bali is and stays an atypical case with regards to waste management. We can conclude that the technical and economic feasibility on one hand should be closely connected to the social-cultural feasibility on the other hand. Local circumstances could drastically change the attitude of inhabitants towards a recycle business. The group found in the field that repelling waste is deeply rooted into the minds of people. Plastic is often seen as an impure product that is ritually seen as something that could and must not be used for new purposes.

We also found that the willingness and awareness of people could be very location dependent. Especially when waste management systems are already in place, in general people seem to have a better idea of what recycling means and what the impact of recycling could mean for their environment. However, there are still exceptions to the rule. We discovered that the initiation of a business does not directly attract inhabitants to use the services. Education is the best way to stimulate children from a young age to handle plastics in a sustainable way.

At last, the support of the local ‘Bendesa Adat’ seems to be essential for a grounded support base of the business. Almost all locally organized businesses on Bali which developed quickly in the past were directly connected to a local powerful person. We discovered that it is hard to engage such a person, or better to say the Balinese inhabitant in general. They need to be treated with a careful approach and local believes need to be incorporated. Direct contact is possible but a carefully written business plan is essential to convince leaders in a rather complex political system.

14.5. Trade-off criteria and results

By means of a trade-off matrix and a grading system the most potential region has been selected to start a business on Bali. The trade-off consists of a broad variety of input values, both social aspects (from the stakeholder analysis), waste inputs from own measurements and economic aspects are considered. As a result **Pulukan**, a village in the western part of Bali is found to be the most promising location for a facility. A combination of factors determined the final result. The most important factors that scored high in the ranking were: The relatively high plastic input, the absence of already properly introduced

waste management systems, the lower operational costs and the high willingness of local inhabitants to deliver plastic waste to the facility. For further research one might look for Pulukan or villages in Bali which are similar in socio-demographic aspects as well as its current waste handling system.

14.6. Financial stability

To find out whether the recycle facility could be financial stable a model is presented in this report. It uses as input values the results from own waste collection measurements and the values acquired from connected parties. The product that local inhabitants in Bali value most is furniture. We used a stool to conceptually find the financial feasibility of a particular product. This information is used to calculate how many input of plastic is needed and how long a particular person would have to spare to receive a stool. The feasibility has been measured based on two ways of pick-up service: collection points and door-to-door collection. In Pulukan, which is found to have most potential for a recycle facility, the door-to-door collection seemed to be most optimal way of collection. 19 products need to be sold every month and the time before a reward is 12 weeks. The reward time is 2 times faster than collection by collection points. For further research an in-depth market study has to be performed to find the most valuable product for the business.

14.7. Final conclusion and recommendations

According to the previously stated aspects all sub-questions provided in the introduction of this report are now answered. We can conclude that it is indeed feasible to start the proposed small-scaled recycle business on Bali but close consideration of local conditions is essential. Three types of feasibility have been considered: technical-, social- and financial feasibility.

The use of mechanical equipment is found to be most applicable in Bali. The mechanical equipment can be provided by the ”Precious Plastic” community and is found from experience to be very useful on a small-scale. Most plastic types can be recycled, however to realize a sustainable product it is essential to use one type of plastic per product. Non-recyclables still form the biggest treat in the waste system of Bali, therefore we highly recommend to perform additional research on the handling of this type of plastics. In example to use non-recyclables in the production process of concrete or bricks.

For future ‘Pantai’ projects it is important to really dive into the local circumstances and to collaborate with a local partner or local powerful person which understands the political system of Bali. Collaboration with the ”Bendesa Adat”, the local leader of a Banjar, is an essential step to root the business in the political system. We realized during our stay that these powerful persons are easy to be contacted but a comprehensive business plan is necessary to succeed with the actual realization of a business.

The ideal combination of the business should be medium in scale, which means that additional revenues are important to expand and exploit the business. A way to do this is to incorporate the recycling of compost or to sell products to an international target group. Especially tourists who are coming in large amounts to Bali every year could be an attractive target group. A different way of creating additional revenue is to focus on hotels and villas. The successful implementation of TPST3R facility in Seminyak provides a good illustration of the success of a local organised and initiated recycle business.

A

Plastic collection measurements

A.1. Data, plastic collection measurements

Denpasar region

				1	2	3	4	5	6	7	
Household	# Household members	Total received	Total plastic	PET	HDPE	PVC	LDPE	PP	PS	OTHER	NO PLASTIC
1	4	0,26	0,26	0,09	0,04	0	0,02	0,04	0	0,07	0
2	4	0,45	0,45	0,1	0,13	0	0,2	0,01	0	0,01	0
3	2	0,36	0,36	0,04	0,07	0	0,11	0,05	0	0,09	0,005
4	4	2,19	1,69	1,37	0,19	0	0,01	0,11	0	0,01	
5	4	0,2	0,2	0,07	0,02	0	0,06	0,05	0	0	0
6	2	0,18	0,18	0	0,04	0	0,1	0,03	0	0,01	0
7	6	3,43	0,76	0,14	0,18	0	0,11	0,24	0,02	0,07	2,67
8	4	0,51	0,51	0,03	0,15	0	0,16	0,14	0,03	0	0
9	4	0,32	0,32	0,21	0,04	0	0,02	0,05	0	0	0
10	2	0,41	0,41	0,27	0,04	0	0,03	0,05	0	0,02	0
Total per week	36	8,31	5,14	2,32	0,9	0	0,82	0,77	0,05	0,28	2,675
Total per person per week		0,23	0,14	0,06	0,03	0,00	0,02	0,02	0,00	0,01	0,07

Pulukan region

				1	2	3	4	5	6	7	
Household	# Household members	Total received	Total plastic	PET	HDPE	PVC	LDPE	PP	PS	OTHER	NO PLASTIC
1	4	0,82	0,81	0,58	0,14	0	0,08	0,01	0	0	0
2	6	7,97	7,97	2,02	0,97	0,13	0	1,96	0,43	0	2,46
3	4	1,25	1,21	0,42	0,23	0	0,18	0,15	0	0,23	0
4	6	5,5	5,44	0,76	0,3	0,92	0,12	1,82	0,04	0,46	1,02
5	6	3,48	3,36	0,88	0,06	0	1,02	1,02	0,3	0,02	0,06
6	4	0,37	0,35	0,01	0,07	0	0,05	0,05	0	0,04	0,13
7	4	1,08	0,95	0,54	0,04	0	0,11	0,15	0	0,11	0
8	4	0,98	0,95	0,27	0,05	0	0	0,07	0,24	0	0,32
9	4	1,52	1,43	0,18	0,09	0	0,09	0,13	0	0,07	0,87
10	3	0,58	0,48	0,07	0,05	0	0,13	0,07	0	0,09	0,07
Total per week	45	23,55	22,95	5,73	2	1,05	1,78	5,43	1,01	1,02	4,93
Total per person per week		0,52	0,51	0,13	0,04	0,02	0,04	0,12	0,02	0,02	0,11

Canggu region

				1	2	3	4	5	6	7	
Household	# Household members	Total received	Total plastic	PET	HDPE	PVC	LDPE	PP	PS	OTHER	NO PLASTIC
1	3	1,49	1,22	0,3	0,2	0,16	0,1	0,08	0,06	0,18	0,14
2	2	1,12	1,11	0,07	0,47	0	0,26	0,02	0,24	0,02	0,03
3	4	0,72	0,63	0,06	0,08	0	0,08	0,12	0	0,09	0,2
4		0	0	0	0	0	0	0	0	0	0
5	5	1,98	1,96	0,12	0,2	0	1,07	0,29	0	0,13	0,15
6	2	1,52	1,49	0,05	0,18	0	0,27	0,37	0,04	0,29	0,29
7	3	1,54	1,34	0,13	0,32		0,37	0,11	0,02	0,25	0,14
8	3	1,52	1,38	0,05	0,41	0,2	0,2	0,15	0,03	0,23	0,11
9	4	1,71	1,49	0,45	0,23	0	0,05	0,18	0,09	0,32	0,17
10	2	1,6	1,36	0,26	0,17	0	0,41	0,14	0,06	0,13	0,19
Total per week	28	13,2	11,98	1,49	2,26	0,36	2,81	1,46	0,54	1,64	1,42
Total per person per week		0,47	0,43	0,05	0,08	0,01	0,10	0,05	0,02	0,06	0,05

A.2. Collection instruction English

Pantai - Plastic recycling Bali

Dear Sir/Madam,

We are a non-profit organization called Pantai Recycling Bali. Our goal is to start a small recycling business to help reduce the plastic pollution problem here on Bali. Before we start our business, we are doing some research and we were hoping you could help us with that.

We have two questions:

1. Would you be willing to separate the plastic from the rest of your garbage and save up that plastic for one week? At the end of the week we will come to pick it up. We want all the plastic waste from your household (or restaurant). This would really help us to gain insight about how much plastic waste is produced per week. We will provide you with collection bags where we would like you to store your plastic waste. This means that we want you to put every piece of plastic you would normally throw into the garbage bin into one of our collection bags.
2. Would you be willing to fill in a survey? This survey is a list of questions about plastic waste. This will not take more than five minutes.

We want to thank you in advance for your help. Your help will really help us and hopefully we will be able to have a positive influence on the island of Bali.

On the next page we have some pictures of the kinds of plastic waste we would like you to separate from the rest of your garbage.

The types of plastic we would like you to collect and put into our plastic collection bags:

(If you are not sure if something is made of plastic and you can't find it in one of the pictures below, please put it in the collection bags anyway. We will separate it later, thank you!)


CHAMPAGNE
KEGLEVICH
Fresh
Gaffel
JACK DANIEL'S
DERMASEL
LAVIVA
Aptamil
Nuss-Schinken

A.3. Collection instruction Bahasa Indonesian

Pantai - Plastic recycling Bali

Kepada tuan dan nyonya,

kami adalah sebuah organisasi nirlaba yang bernama Pantai Recycling Bali. Tujuan kami adalah untuk memulai sebuah bisnis daur ulang guna membantu mengurangi permasalahan polusi plastik di Bali. Sebelum kami memulai bisnis kami, kami akan melakukan beberapa penelitian dan kami harap anda dapat membantu kami dalam hal tersebut.

Kami memiliki dua pertanyaan yaitu:

1. Maukah anda memisahkan sampah plastik anda dari sampah-sampah yang lain dan menyimpan sampah plastik tersebut selama satu minggu? Di akhir pekan kami akan menjemput sampah plastik tersebut. Kami ingin semua sampah plastik dari rumah tangga anda (atau restoran). Ini akan sangat membantu kami dalam mendapatkan gambaran seberapa banyak sampah plastik yang dihasilkan per minggunya. Kami akan memberikan anda tas untuk mengumpulkan sampah sampah tersebut sehingga kami berharap anda akan menyimpan sampah plastik tersebut. Ini berarti bahwa kami menginginkan anda untuk menaruh setiap sampah plastik yang biasanya anda buang ke tempat sampah, ke dalam tas penyimpanan sampah plastik tersebut.
2. Maukah anda untuk mengisi survei? Dalam survei ini terdapat sejumlah pertanyaan mengenai sampah plastik. Ini tidak akan membutuhkan waktu lebih dari 5 menit.

Kami ingin mengucapkan terima kasih sebelumnya atas bantuan anda. Bantuan anda akan sangat membantu kami dan semoga kita akan dapat memiliki pengaruh yang positif terhadap pulau Bali.

Pada halaman berikutnya kami memiliki beberapa gambar jenis-jenis sampah plastik yang kita ingin anda pisahkan dari sampah sampah yang lain.

Jenis jenis sampah plastik yang kami ingin anda kumpulkan dan taruh dalam tas pengumpulan sampah plastik adalah sebagai berikut:

(Jika anda tidak yakin apakah sampah tersebut terbuat dari plastik dan anda tidak bisa mengetahuinya Dari gambar di bawah ini, maka mohon masukkan saja benda tersebut ke dalam tas pengumpulannya. Kami akan memisahkannya nanti, terima kasih)


CHAMPAGNE
KEGLEVICH
Fresh
Gaffel
2 FOR 1
Aptamil
Nuss-Schinken

B

Surveys

B.1. Data survey outcome

			Percentages and averages		
Nr.	**Question**	**Answers**	**Denpasar**	**Pulukan**	**Canggu**
1	What is your gender?	Male	47%	21%	31%
		Female	53%	79%	69%
2	What is your age?		32.4 yr	36.1 yr	39.0 yr
3	What is your education level?	No study	0%	0%	0%
		Primary school	0%	21%	14%
		Middle school	7%	24%	17%
		High school	43%	44%	64%
		Post-secondary education	50%	11%	5%
5	How many people live in your household?		3.88 pers	4.5 pers	5.5 pers
6	Do you separate your plastic garbage from the rest of your garbage?	Yes, I separate all plastic garbage	11%	16%	34%
		Yes, but only plastic bottles	22%	52%	46%
		No, I don't separate my plastic	67%	32%	20%
7	Why do you separate your garbage? *	Because I care about the environment	35%	31%	71%
		Because I can make money by handing in my plastic garbage	65%	69%	29%
		Because it is mandatory by the Banjar	0%	0%	0%
8	Is your plastic picked up or do you bring it to a collection point? *	Picked up	65%	71%	92%
		Bring away	35%	29%	8%
9	Do you pay for the disposal of your plastic? *	Yes, I pay	10%	2%	4%
		No, it is free	40%	38%	65%
		No, I get paid	50%	60%	31%
10	What do you do with (the rest) of your garbage?	It is picked up	52%	8%	54%
		I take it away	32%	21%	3%
		I dump it somewhere	8%	11%	14%
		I burn it	8%	60%	29%
11	What is the reason you do not separate (all) the plastic from the rest of your garbage?	There is no place where I could hand in my plastic waste	58%	62%	36%
		I have to pay for my plastic waste	5%	0%	4%
		It is too far away to hand in my plastic	5%	19%	7%
		It takes too much effort	27%	13%	19%
		I separate all my plastic	5%	6%	34%

			Percentages and averages		
Nr.	**Question**	**Answers**	**Denpasar**	**Pulukan**	**Canggu**
12	Would you separate your plastic if the Banjar recommended that you do it?	Yes	100%	100%	100%
		No	0%	0%	0%
13	Would you separate your plastic if the Banjar made it mandatory?	Yes	100%	100%	100%
		No	0%	0%	0%
14	Would you be willing to separate your plastic garbage?	Yes, I would do it for free	43%	42%	14%
		Yes, but only for a compensation	49%	58%	78%
		No, I would not	8%	0%	8%
15	Would you rather receive money for separating the plastic garbage from your normal garbage or would you rather have the opportunity to save for a valuable plastic product?	Receive money	57%	40%	53%
		Save for a plastic product	37%	60%	37%
		I would not separate	6%	0%	10%
16	Would you be willing to bring your separated plastic garbage to a collection point?	Yes, I would do it for free	52%	35%	14%
		Yes, but only for a compensation	20%	61%	71%
		No, I would not	28%	4%	15%
17	What kind of plastic products would you prefer to save for?	Furniture (table, chair, closet)	38%	41%	46%
		Tiles	6%	10%	0%
		Toys	9%	7%	0%
		Compost bin	25%	23%	34%
		Storage bin	9%	5%	17%
		Accessories	13%	14%	3%
		I don't want any recycled products	0%	0%	0%
18	How far would you bring your plastic garbage if you get nothing in return?	0 - 200 meter	60%	61%	49%
		200 - 400 meter	9%	6%	15%
		400 - 800 meter	3%	5%	9%
		800 - 1300 meter	3%	0%	2%
		1300 - 2000 meter	0%	0%	0%
		2000 - 3000 meter	0%	0%	0%
		I would not be willing to take my garbage anywhere	25%	28%	25%

			Percentages and averages		
Nr.	**Question**	**Answers**	**Denpasar**	**Pulukan**	**Canggu**
19	How far would you bring your plastic garbage if you are compensated (with plastic product or money)?	0 - 200 meter	32%	47%	34%
		200 - 400 meter	22%	34%	24%
		400 - 800 meter	17%	11%	24%
		800 - 1300 meter	6%	3%	2%
		1300 - 2000 meter	3%	0%	3%
		2000 - 3000 meter	0%	2%	0%
		I would not be willing to take my garbage anywhere	20%	3%	13%
20	How many times do you have a Banjar meeting per month?		1	2	1
21	Would you hand in your separated plastic garbage at each Banjar meeting if it is mandatory by the Banjar?	Yes	100%	98%	98%
		No	0%	2%	2%
22	Do you know how to separate the plastic form the rest of your garbage?	Yes	78%	95%	97%
		No	22%	5%	3%
23	Do you know of any organizations that can collect plastic from you?	Yes	24%	18%	59%
		No	76%	82%	41%

* Only people that answered yes to question 6 were asked to fill in this question.

B.2. Survey English

Pantai - Plastic recycling Bali

DISCLEAMER Survey Nr: …….

The purpose of this survey is to gain inside on the willingness of people to separate and hand in their own plastic waste.
Your response will be strictly confidential and remains anonymous.
These results will be used for a non-profit student project, Pantai Project.
Please fill in these results as accurate as possible.

1. What is your gender?

☐ Male ☐ Female

2. What is your age?

…… years old

3. What is your education level?

☐ No study ☐ Primary school ☐ Middle school
☐ High school ☐ Post-secondary education
☐ Other: ……..

4. What type of work do you do?

Please specify:

5. How many people are there in your household?

…… people

6. Do you separate all your plastic garbage from the rest of your garbage?

☐ Yes, I separate all plastic garbage
☐ Yes, but only the plastic bottles
☐ No, I don't separate my plastic

7. *ANSWER THIS QUESTION ONLY IF YOU ANSWERED '**YES**' TO QUESTION 6:*
Why do you separate your plastic garbage?

☐ Because I care about the environment
☐ Because I can make money by handing in my plastic garbage
☐ Because it is mandatory by the Banjar
☐ Other: ……..

8. *ANSWER THIS QUESTION ONLY IF YOU ANSWERED '**YES**' TO QUESTION 6:*
Is your plastic picked up or do you bring your plastic to a collection point?

☐ Picked up ☐ Bring away
☐ Other, specify: ……

9. *ANSWER THIS QUESTION ONLY IF YOU ANSWERED '**YES**' TO QUESTION 6:*
Do you pay for the disposal of your plastic?

☐ Yes, I pay …… IRD/month,
to the following organization: ……..
☐ No, it is free
☐ No, I get paid by …….. to hand in my plastic

10. What do you do with (the rest of) your garbage?

☐ It is picked up by ……
☐ I take it away to ……..
☐ I dump it somewhere
☐ I burn it
☐ Other: ……..

11. What is the reason you do not separate (all) the plastic from the rest of your garbage?

☐ There is no place where I could hand in my plastic waste
☐ I have to pay for my plastic waste
☐ It is too far away to hand in my plastic
☐ It takes too much effort, because ……..
☐ As said before, I do separate all my plastic

12. Would you separate your plastic if the Banjar recommended that you do it?

☐ Yes ☐ No

13. Would you separate your plastic if the Banjar made it mandatory?

☐ Yes ☐ No

Please read:

The plan of the Pantai Recycling organization is to recycle plastic on Bali to create valuable products. You would be able to save up for such a valuable product by handing in your plastic garbage.
When you have handed in enough plastic you would receive a valuable product like a piece of furniture, tiles, a compost bin, a storage bin, accessories or something else we produce.
This way your plastic garbage is not garbage anymore, but it will have worth. This means that it would be a shame to throw away.

14. Would you be willing to separate your plastic garbage?

☐ Yes, I would do it for free
☐ Yes, but only for a compensation (money or plastic product)
☐ No, I would not

15. Would you rather receive money for separating the plastic garbage from your normal garbage or would you rather have the opportunity to save for a valuable plastic product?

☐ Receive money
☐ Save for a plastic product
☐ I would not separate

16. Would you be willing to bring your separated plastic garbage to a collection point?

☐ Yes, I would do it for free
☐ Yes, but only for a compensation (money or plastic product)
☐ No, I would not

17. What kind of plastic products would you prefer to save for?

☐ Furniture (table, chair, closet)
☐ Tiles
☐ Toys
☐ Compost bin
☐ Storage bins
☐ Accessories
☐ Other: ……
☐ I don't want any recycled plastic products

18. How far would you bring your plastic garbage if you get noting in return?

☐ 0-200 meter ☐ 200-400 meter ☐ 400-800 meter
☐ 800-1300 meter ☐ 1300 – 2000 meter ☐ 2000 – 3000 meter
☐ I would not be willing to take my plastic garbage anywhere

19. How far would you bring your plastic garbage if you are compensated (with plastic product or money)?

☐ 0-200 meter ☐ 200-400 meter ☐ 400-800 meter
☐ 800-1300 meter ☐ 1300 – 2000 meter ☐ 2000 – 3000 meter
☐ I would not be willing to take my plastic garbage anywhere

20. How many time do you have a Banjar meeting per month?

…… per month

21. Would you be willing to separate your plastic and hand in the separated plastic at each Banjar meeting, if it is mandatories of the banjar?

☐ Yes ☐ No

22. Do you know how to separate the plastic form the rest of you garbage?

☐ Yes ☐ No

23. Do you know of any organizations that can collect plastic from you?

☐ Yes ☐ No

24. In which city in Bali do you live?

B.3. Survey Bahasa Indonesian

Pantai - Plastic recycling Bali

PENAFIAN (*DISCLAIMER*) Nomor survei: …….

Tujuan dari survei ini adalah untuk mendapatkan informasi mengenai niat dari orang-orang sehingga mereka mau untuk memisahkan dan menyerahkan sampah plastik mereka kepada kami.
Respon yang anda berikan akan tetap terjaga kerahasiaannya dan kami juga akan tetap merahasiakan nama anda.
Hasil dari survei ini akan nantinya digunakan untuk tugas mahasiswa nirlaba, dengan nama Pantai Project.
Tolong jawab pertanyaan- pertanyaan di bawah ini seakurat mungkin

1. Apa jenis kelamin anda?

☐ Pria ☐ Wanita

2. Berapa umur anda?

…… tahun

3. Apa pendidikan terakhir anda?

☐ Tidak sekolah ☐ SD ☐ SMP
☐ SMA ☐ S1
☐ Lainnya: ……

4. Apa jenis pekerjaan anda?

Mohon dijelaskan lebih spesifik:

5. Berapa orang yang tinggal bersama anda dalam rumah tangga anda?

…… orang

6. Apakah anda memisahkan sampah plastik anda dengan sampah yang lainnya?

☐ **Ya**, saya memisahkan semua sampah plastik saya.
☐ **Ya**, tapi hanya botol plastik saja.
☐ **Tidak**, saya tidak memisahkan sampah plastik saya.

7. *JAWAB PERTANYAAN INI JIKA ANDA MENJAWAB '**YA**' PADA PERTANYAAN NOMOR 6:*
Kenapa anda memisahkan sampah plastik anda?

☐ Karena saya peduli dengan lingkungan
☐ Karena saya bisa menghasilkan uang dengan mendonasikan sampah plastik saya.
☐ Alasan Banjar, Karena diharuskan oleh Banjar
☐ Alasan lainnya: ……..

8. *JAWAB PERTANYAAN INI JIKA ANDA MENJAWAB '**YA**' PADA PERTANYAAN NOMOR 6:*
Apakah sampah plastik anda diambil oleh organisasi pengumpul sampah plastik atau apakah anda membawa sampah plastik anda ke suatu tempat pengumpulan sampah plastik?

☐ Diambil oleh pengumpul sampah
☐ Membawa sendiri ke tempat pengumpulan sampah
☐ Alasan lainnya: ……

9. *JAWAB PERTANYAAN INI JIKA ANDA MENJAWAB '**YA**' PADA PERTANYAAN NOMOR 6:*
Apakah anda perlu membayar sejumlah biaya untuk membuang sampah plastik anda pada organisasi tertentu?

☐ Ya saya membayar biaya iuran sampah sebesar Rp ..... per bulan
Kepada organisasi yang bernama: .....
☐ Tidak, ini gratis
☐ Tidak, Saya malah mendapatkan sejumlah uang dari …… jika menyerahkan sampah plastik saya.

10. Apa yang anda lakukan dengan sisa sampah anda yang bukan plastik?

☐ Diambil oleh .....
☐ Saya membuangnya ke .....
☐ Saya taruh sembarangan di suatu tempat tertentu
☐ Saya membakarnya
☐ Alasan lainnya: .....

11. Apa alasan anda untuk tidak memisahkan (semua) sampah plastik anda dengan sampah yang lain?

☐ Karena tidak ada tempat dimana saya bisa membuang sampah plastik saya
☐ Karena saya harus membayar sejumlah uang untuk membuang sampah plastik saya.
☐ Karena jarak yang terlalu jauh ke tempat pembuangan sampah
☐ Terlalu menyusahkan, karena .....
☐ Seperti yang sudah dijelaskan sebelumnya, kami sudah memisahkan semua sampah plastik

12. Apakah anda akan memilah sampah plastik anda jika Banjar menyarankannya?

☐ Ya ☐ Tidak

13. Apakah anda akan memisahkan sampah plastik anda jika Banjar mengharuskan anda melakukan hal tersebut?

☐ Ya ☐ Tidak

Mohon dibaca:

Rencana dari organisasi Recycling Pantai di Bali adalah untuk mendaur ulang sampah plastik di Bali untuk menghasilkan produk yang bernilai tinggi. Anda dapat Menyimpan sampah plastik anda untuk mendapatkan produk-produk bernilai tinggi yang akan ditukarkan dengan sampah plastik anda.
Ketika anda menyerahkan sejumlah sampah plastik dalam jumlah tertentu anda akan menerima produk yang bernilai tinggi seperti mebel, keramik lantai, tempat penyimpanan sampah plastik organik yang bisa merubahnya menjadi kompos, kotak tempat penyimpanan, Aksesoris atau sesuatu lainnya yang kami produksi.
Dengan cara ini sampah plastik anda tidak akan menjadi sampah lagi, akan tetapi bernilai tinggi. Ini berarti bahwa sangat disayangkan jika anda membuang sampah plastik anda dengan percuma.

---

14. Akankah anda mau untuk memisahkan sampah plastik anda?

☐ Ya saya akan melakukannya dengan cuma-cuma.
☐ Ya saya akan melakukannya tapi hanya jika diberikan kompensasi (uang atauproduk plastik).
☐ Tidak, saya tidak akan melakukannya.

15. Apakah anda lebih suka untuk mendapatkan sejumlah uang ketika anda menyerahkan sampah plastik anda atau anda lebih memilih untuk mendapatkan produk produk berbahan plastik yang bernilai tinggi dan mahal?

☐ Saya lebih suka untuk menerima uang
☐ Saya lebih memilih produk berbahan plastik yang bernilai tinggi dan mahal.
☐ Saya tidak akan memisahkannya.

16. Maukah anda untuk membawa sampah plastik anda ke tempat pengumpulan sampah plastik?

☐ Ya saya akan melakukannya dengan cuma-cuma.
☐ Ya saya akan melakukannya tapi hanya jika diberikan kompensasi (uang atauproduk plastik).
☐ Tidak, saya tidak akan melakukannya.

17. Produk jenis apa yang ingin anda dapatkan jika anda menyerahkan sampah plastik anda kepada kami?

☐ Mebel (Meja, kursi, kloset duduk)
☐ Keramik lantai,
☐ Mainan
☐ Tempat penyimpanan sampah organik yang bisa merubah sampah menjadi kompos
☐ Kotak tempat penyimpanan
☐ Aksesoris
☐ Atau barang barang lainnya.....
☐ Saya tidak menginginkan produk daur ulang plastik.

18. Seberapa jauh anda mau membawa sampah plastik anda jika Anda tidak diberikan imbalan?

☐ 0-200 meter ☐ 200-400 meter ☐ 400-800 meter
☐ 800-1300 meter ☐ 1300 – 2000 meter ☐ 2000 – 3000 meter
☐ Saya tidak akan mau membawa sampah plastik saya ke manapun juga.

19. Seberapa jauh anda mau membawa sampah plastik anda jika Anda diberikan kompensasi (dengan produk dari plastik atau uang)?

☐ 0-200 meter ☐ 200-400 meter ☐ 400-800 meter
☐ 800-1300 meter ☐ 1300 – 2000 meter ☐ 2000 – 3000 meter
☐ Saya tidak akan mau membawa sampah plastik saya ke manapun juga.

20. Berapa sering Anda memiliki rapat di Banjar perbulannya?

……. per bulan

21. Apakah anda mau memberikan sampah plastik anda disetiap Banjar jika hal tersebut diharuskan oleh Banjar?

☐ Ya ☐ Tidak

22. Apakah anda tahu bagaimana caranya untuk memisahkan sampah plastik anda dengan sampah sampah yang lainnya?

☐ Ya ☐ Tidak

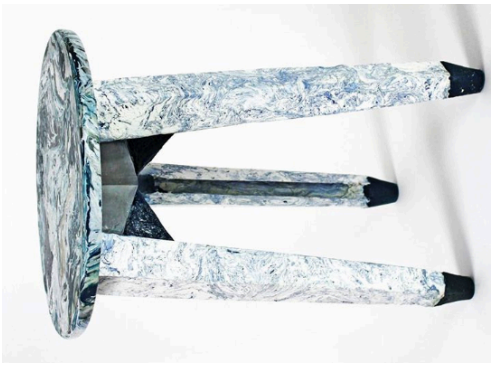
23. Apakah anda tahu perusahaan-perusahaan yang bisa mengumpulkan sampah plastik anda?

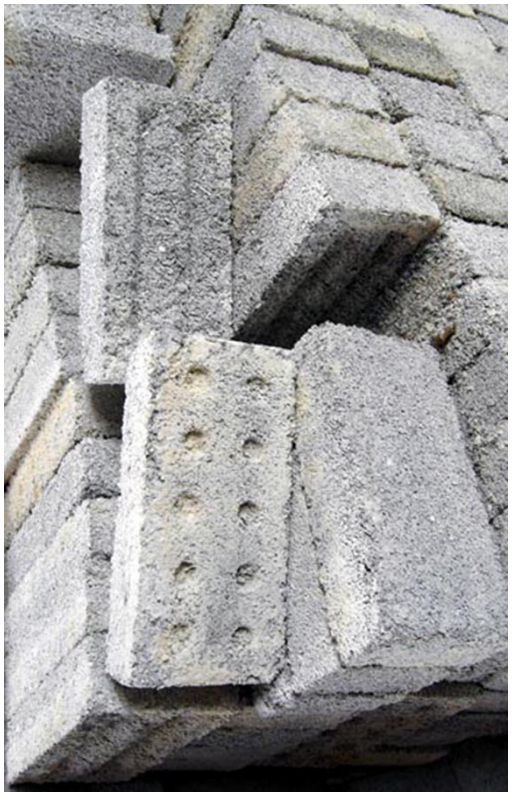
☐ Ya ☐ Tidak

24. Di kota mana anda tinggal di Bali?

Terima kasih banyak

B.4. Example products





C

Interviews

C.1. Eco Bali

Institution	Eco Bali
Date	September 12^{th}, 2019
Interviewers	Vincent Lighthart, Ewoud Hermans & Bart de Jong
Interviewee	Adhitya Yusuf (Founder)
	Start of interview
	...Introductory talk...
Interviewers	Thank you so much for showing us the facility of Ecobali. It is all very interesting. But why do you have to ship-off the sorted materials? Why is there no place on Bali where a recycling facility can be made?
Respondent	So there is a reason why Bali does not have recycling facilities, and that is because the island is designated for tourism. And land is expensive compared to other areas. Also the amount of plastic you have on this Island is small compared to islands like Java. You have factories that only handle PT. So of the global amount of PT here is not so much. Than how do you justify it economically to have a big factory here?
Interviewers	So you don't think there is enough plastic waste here for a facility?
Respondent	It depends on the size of the facility. But there have been people who tried in the past and did not succeed for a variety of reasons. Probably because this is not an industrialized Island and the land is expensive.
Interviewers	And if we are talking about small scale facilities, like the size of two containers?
Respondent	Well again it depends what we are talking about. If we are talking about informal sector. There are places where they take plastic and shred it, sort it, and send it over to the factories in Java. But they do not process it up to a finished product. You have these small projects that work with simple equipment. You might know these kinds of project.
Interviewers	Yes we know about the precious plastic machines, and the way they work. That is the equipment we believe is the most effective to start a recycling business with.
Respondent	Yes I know about precious plastic, but I think there is a lot of mixing of materials and what you do after that, then the material will not be part of the mainstream recycling. There is no recycling done in Bali, but there is a lot of collection of plastic waste now going on in Bali. They ship it to Java for recycling. Like us at Eco Bali, but there are also others.
Interviewers	Is there any data available for the collection of plastic waste throughout Bali?
Respondent	It is difficult to get a clear number of the actual waste. Because this (Eco Bali) is the formal sector. And we report it to the government. But there also is an informal sector, which I doubt shares any information. Nobody likes to share their data, even in Europe, that is a very common thing.

Interviewers But we are researching something like the precious plastic idea, maybe a little bit larger. So not selling the material to Java, but making products and selling them for revenue or giving them as a reward to the local people when they bring their own plastic. So they save up for a reward.

Respondent I think that requires a lot of research, as I do not think any of us (waste management companies) have that kind of knowledge and data. No one has any expertise on that part. I think it really depends on what is going to be produced I think. And again, in my point of view. So if you use different kinds of plastics they can be contaminated or other structure. Than if you make a bowl for soup out of bottles created to hold detergents. This would not work.

Interviewers Yes we know about that.

Respondent This has always been my issue. There has always been a hype about this, but some people don't know what to do with the plastic. Sometimes they want to use toxic plastic to create plates and cups. So one is to determine what product you would want to make. And two is to see if the community would be interested in having those kinds of items. And three is to see how complicated it is to have it all done.

Interviewers Yes we have done research already on these issues. So when we chose a product, we should really think about if it is dangerous for people to use the product we would produces. But that is part of the research. We want it to be useful for the community.

Respondent It is all very interesting what you are researching. There is a lot of attention of the plastic waste now, and people are willing to handle it. There are waste banks now. It is not a kind of building, but a form of exchanging money for goods. So waste is not waste anymore, but a material. And therefore it is tradable.

Interviewers Yes we have heard about the waste banks, but we have heard different stories. Like that there is no money involved, only goods. But that doesn't seem very likely.

Respondent No no no. We have 33 waste banks, and there is money involved. You can thrust me on this. The way it works, is that a community forms a group. Like a management group. This is also organized by the government. But this groups like for example a banjar. And I'm sure that you now know about the banjar system. The banjar is the ultimate sub community so to speak. So there is a list of materials. Clean, contaminated, colors and different kind of plastics. But usually it is categorized by products, like bottles and stuff. So for example, a family saves their plastic PET bottles for a week. And they come a specific day, and then the plastic material is weighed by the management team. Let's say they have 1 kg and they can get around 1800 for example. That goes into a book, and that is why it is called a waste bank. And we come in to collect this plastic and we pay money. And with the book, the people know exactly what their balance is for bringing the plastic. So when they know their balance is 200.000, they can go to that place, and claim that 200.000.

Interviewers So is this happening everywhere one Bali?

Respondent Well…… Yes, in some way. It is not all the same but in this regency, Badung and Denpasar regency it is working-ish.

Interviewers So in the richest parts of Bali, this system is working.

Respondent Yes, you say that. These parts are not only the most rich, because of the tourists. But also the most populated.

Interviewers This looks a lot like what we want to research. But then people get rewarded with products and not with money.

Respondent But this is a national plan and the government is in the process of enforcing this. The regent actually tells communities to set up the waste banks.

Interviewers Is it compulsory to be part of such a management system?

Respondent It will become, yes. But also cardboard and metal and that stuff.

Interviewers So we would need to find a way to give the locals a reward with more value for them?

Respondent Yes, well or you could create something that produces a certain amount of materials out of it, and give them back for a special price.

Interviewers This sounds like they are going to solve the plastic pollution problem of Bali. With all the plans for the future waste management.

Respondent Well, in theory yes. But we are still far away from that. I need to be honest. But for example the precious plastic machines, they only use the most recyclable plastics. For which there are plenty of factories already. So for us they do not create a big problem. But what is happening now, you see that a massive amount product sold in pouches and satchels. And that is where the problem lies. Because nowhere in the world, there is a real thing to do with that. They have made a factory on Java that is doing trials with that. You can google it, and it will come out. But they still need to create a whole system. A whole value chain to actually catch some money out of this. But there is no full recycling option yet. They put the bags in some chemicals, to get some other things out. We are still in the trials. And the half of the population, half of the things they are buying is packed in satchels.

Interviewers But we heard that Bali is restricting all the single use plastics, or that they already did. Like the plastic bags and the straws.

Respondent Yes well, these are not the main problem. These are the problem (shows wrappers from candy and bags of crisps). These things with laminate, metal inside. These are the things you need to find a solution for. The majority of the products is packed in these. Also it is not always indicated what kind of plastic it is. This makes it hard for simple techniques to separate all kinds of plastics. Sometimes the plastic contains the toxic PVC for example.

Interviewers Well we are looking for a way to collect all kinds of plastics. And find a solution for all of them. So they will not be thrown away in nature or burned. And in a waste bank you can only get money for the valuable plastics. So people will still throw away their other waste. That is one of the reasons we think it is important to come up with a financial model that allows us to buy all the plastics. Not only the valuable ones.

Respondent What would you do with the plastics you cannot recycle?

Interviewers We would probably dispose of it at landfills. Until another solution is found. But the plastics wouldn't end up in the environment.

Respondent How sustainable would that be? Who is going to take care of that when you leave?

Interviewers Well that is part of our research. We do not have all the answers before the research has started.

Respondent Don't get me wrong. I'm just testing you. For example we could not afford to do that with our business model. We would have to go to the landfill and pay.

Interviewers That is because you sell your plastic in bulk, so you get a kilo price. But if we'd produce a final product. In theory we could sell it for more.

Respondent Okay I do not want to discourage you. In the past we have also seen similar ideas. Like: give me all your plastic for free and we will give you a variety of things. Unfortunately nobody has come forward with a model that allows to do what you are saying. And then I'm talking purely economic. Because that is where sustainability is. So I recommend that you serious test an economic model.

Interviewers A waste bank doesn't give any money for the non-recyclable plastics, correct?

Respondent No, of course not. They don't even accept it.

Interviewers Well that is what we find the waste bank is lacking. As you say yourself, the real problem is the other plastics.

Respondent Yes, but we need to pay for the collection service and the facility and so on. And that is why worldwide we need more producer responsibility. Where they produce better product.

Interviewers For the financial part we could also sell product in Europe. We know that with the right marketing you can sell products quite easily for a high price.

Respondent Yes that is true, but consumers are more sophisticated nowadays. They demand higher quality products. And I'm not sure of you can produce these here with the simple techniques you are suggesting. You don't want to go into the Flintstone area. I know I'm saying a lot of demotivating things, but from all the years working in waste management we are big fan of circular economy, but one of the most important thing is that you do not try to create value for something just because it is created out of something that is recycled. But because they look good, costs less and work well regardless.

Interviewers	That is indeed something we are looking for. It should be of high quality, look good and be functional.
Respondent	Absolutely and there are definitely companies that can do that.
Interviewers	So you think the first step for us, is to find a good product that we can produce easily with high quality?
Respondent	No I'm not telling how to do the research. You should start brainstorming. If it was doomed to fail I would definitely tell you. It is not, but it will be challenging.
Interviewers	Okay thank you very much for the feedback, is there anything you would like to ask us?
Respondent	Not really, but I hope you will find some new insights. But it is going to be difficult. I have contacts that can be useful for you and I'm willing to help, but you first need to think further on what you want, and how you want to do it. I'm interested in results that you gather.
Interviewers	Well I think that was it. Thank you very much for showing us Eco Bali and taking the time to speak to us. It was all very interesting and helpful.
Respondent	You are welcome.
End of interview	

End of interview

C.2. The Daur Project

Institution	The Daur Project
Date	September 24^{th}, 2019
Interviewers	Bart de Jong & Thom Woudstra
Interviewee	Adhitya Yusuf (Founder)
Note	Interview through Skype

Start of interview

...Introductory talk...

Interviewers	Through our research of similar projects/NGO's/companies, we stumbled upon the Daur Project. There are some similarities with your project and we want to start in Bali. Can you tell us a bit more about the Daur project?
Respondent	Our idea is as follows: we'd like to create awareness now in both Lombok and Gili Air. We do this by collecting plastics like the common practice of the "Bank Sampah" and recycling them on a small scale. By recycling we try to add more value to plastic waste than the "Bank Sampah". The recycled products are then sold and the revenue created is returned to the local community.
Interviewers	We've indeed heard about a concept called the "Bank Sampah" (waste bank), which is supposed to be implemented over whole of Bali (Eco Bali) as people are supposed to separate their plastic. Are the Bank Sampahs common in Lombok and Gili Air?
Respondent	It's very common practice in Indonesia; we have it in Lombok also in Java.
Interviewers	Is it correct that the Bank Sampahs only accepts the "good" (i.e. recyclable) waste?
Respondent	Yes this is correct, as their source of income is the selling of recyclables to big recycling factories on Java. Which we actually try to avoid with our team as we want to keep it in the local economy. As we can add more value by recycling it ourselves.
Interviewers	What does one get for their waste at "Bank Sampah".
Respondent	Per kilo around 2500 ruppiah. As you can see it's not big money.
Interviewers	Our idea is to produce recycled goods that are beneficial for the local people, building materials etc. From your website we see that you produce key chains and coasters. These aren't, on their own, products that are beneficial for the local community as they're focused on tourists. Have you thought about producing those kinds of products as well?

Respondent Yes, our team has thought about it, but we had a problem with the scale and production rate of our machines, the precious plastic machines. But they're currently improving their design to tackle this issue. I've also seen cases of people making bricks and paving stones with plastics, not made by the precious plastic machine though. It is possible to create these bricks. But I wonder if people need these kinds of products. As they might not trust these "alternative" building blocks.

Interviewers I've also got a question about how you require your plastics for your recycling facility. Do you only use plastics from both Lombok and Gili Air?

Respondent Yes they're from these specific islands.

Interviewers And how do you get the local people to hand in their plastic waste? Do people hand it in and get money or do you collect plastics through organized (beach) cleanups? And what do you do with the non-recyclable plastics?

Respondent What we're now doing in Lombok and Gili Air, we work together with certain villages. And we collect plastic through our local partners on the island. They help us with the supply of plastics through their business. In one village*, we get help from the local "Bank Sampah". So we buy the collected material from the "Bank Sampah". We don't get non-recyclable plastics, as we buy the recyclables from the "Bank Sampah". *I think on Lombok.

Interviewers Which plastics do you use for your products?

Respondent HDPE and PP (#3 and #5). We don't work with PET (#1) this does however provide most money at the "Bank Sampah". If you find a way to recycle PET let me know!

Interviewers If we know the solution for PET we'll definitely let you know!,I'd also like to know more about the "Bank Sampahs". Is there any government involvement with the "Bank Sampahs" or are those privately owned businesses?

Respondent It is not government organized, all just local businesses.

Interviewers We heard (EcoBali) that the government is starting a program to stimulate the start up of more "Bank Sampah", what do you know of it?

Respondent At the moment, there's awareness of the government. Especially after the viral video about the plastic on the beaches in Bali. And as they know that Indonesia is the 2nd largest plastic polluter on the world. I think that the central government is supporting start up of new "Bank Sampahs", at least in Lombok.

Interviewers How do they stimulate this?

Respondent It's not really clear, but every village has their own money. And the government probably suggests them to use a certain amount of it for "Bank Sampahs". But I am not 100% sure.

Interviewers We're also interested in how many products do you actually sell.

Respondent We don't work on a daily basis actually. Because the group that we work with have their main job as well. It's a part-time job for them. So our activity is order based. After we get an order people will start to work on it. Mostly around 4 people at a time, it's really small scale as you can see.

Interviewers Is this due to the amount of plastic you can collect to make the product or because of the amount of orders?

Respondent It's solely due to the orders. We're still working on promotion etc.,We try to get around a 100 products a month.

Interviewers And that is enough to keep the business running?

Respondent Yes.

Interviewers Your vision is to spread through Indonesia. Will you stick to the same products or then design new products for new customers?

Respondent The idea is to make a different product in every place we'll recycle. For example the turtle key chain in Gili Air and in Saribaye, Lombok the coasters. They're always inspired by the location they're produced in.

Interviewers Which machines do you currently have in your facility?

Respondent We have 4 machines, 2 in Gili Air and 2 in Lombok. 1 shredder 1 injection machine. We want to work with a compression machine, but we don't have it yet.

Interviewers We're of course researching the possibility of setting up our own organization. Is it as a foreigner really tough to start an organization like this?

Respondent	The easiest way to start this up is to collaborate with an already existing local NGO. As setting up a new NGO it requires a lot of paperwork etc. An organization that already works with precious plastic machines is Kopernik and also DuaKala, it might be interesting for you. Make sure you work with the locals (with power in a village), but it might be hard to build the trust with the locals it can be very time consuming.
Interviewers	As we now know that there are many parts on Bali where there is no proper waste management, we wonder what the quality is of the waste management in lets say Lombok.
Respondent	Well a lot of places in Indonesia don't have proper waste management.At most of the places where there is waste management trash gets picked up and just dumped in a landfill that's it.
Interviewers	Is there a government based pick-up system through whole Indonesia?
Respondent	No, actually lots of villages don't have this option. And have to handle their waste themselves. Throwing is in rivers and burning it. For example in Lombok I conducted a survey, in which I asked the people why they're still littering the nature with their plastic waste. They said it's caused by the government not providing them with a proper waste management system. They can only bring it to a collection point several kilometers outside of the village.
Interviewers	But you said that there are "Bank Sampahs" on Lombok, why don't they bring their waste over there?
Respondent	Well the "Bank Sampah" is mainly used and run by the very poor/ poor communities. For the higher income communities it doesn't feel profitable.
Interviewers	Given our research is it best to target a poor regency, as people might be more willing to collect their waste for a reward?
Respondent	Working with the low-income communities will make more sense for them as it can generate some income. But you must make sure that there is no type of waste management or "Bank Sampahs" in that region. But selling recycled product in these regions will be very hard. As there are not many tourists and for the local people they don't really believe in recycled products. There is a stigma on recycled products as they're made from "waste". They still view it as waste and not a new product.
Interviewers	Would this also be the case for the earlier mentioned building materials? As in poorer regions these might be improving their living conditions.
Respondent	Well it probably depends on the community. The easiest way to get people to hand in their waste is an economic incentive. But it doesn't mean that all communities just think about money. You can always try. Surveys are a good way to get an insight in this matter.
...Some talk about single use plastic ban that should be in full effect in Bali right now..	
Interviewers	Is the single use plastic ban only in Bali?
Respondent	Not only in Bali also in some cities on other islands as well.
Interviewers	How about on Lombok?
Respondent	It's not there yet hopefully it will be implemented on Lombok as well.
Interviewers	I got one last question, as your now in the US. Who's running the recycling facilities right now?
Respondent	It's run by people of my organization, most of them are students. Another reason to work together with local NGO is that you're more certain that your facility still runs, as it should, when you're not around. It might be interesting for you to work with the youth organization of a village; the "karang taruna". They do all kinds of activities also the ceremonial activities in the village.
Interviewers	Thank you, we didn't know about the "karang tarun"! And we'd want to thank you for you time, it was really interesting and helpful. Can we keep in contact if we stumble upon any questions?
Respondent	Of course you can contact me, that will be no problem!
End of interview	

C.3. The North Bali Reef Conservation

C.3.1. Interview Kyle Osborne

Institution	The North Bali Reef Conservation
Date	September 25^{th}, 2019
Interviewers	Bart de Jong, Vincent Ligthart & Thom Woudstra
Interviewee	Kyle Osborne (Conservation Project Manager)
Location	Tianyar, Karangasem Regency

Start of interview

...Introductory talk...

Interviewers	What are all activities of the North Bali Reef Conservation?
Respondent	Our main focus is of course the conservation of the reef. With our artificial reef structures we've actually increased the biodiversity of our reef by 7 times and the natural reef starts to grow as well. Aside from the reef conservation we're also conserving the population of the Olive Ridley turtles. Last year we've helped 400 hatchlings to reach the sea, this year 500. And since February 2019 we also have a running recycling facility.
Interviewers	That's all very cool. Given our research of course, the recycling facility is most interesting for us and we'd like to know more about it. Now that we're here, what are the machines that you're using in your facility?
Respondent	We're using machines by the design of precious plastic. In our recycle facility we have 3 machines, 1 shredder and 2 injection machines.
Interviewers	If I may ask, what is the cost of these machines?
Respondent	I am not really sure, as these machines we're funded and installed by a group of high school seniors from Canada.
Interviewers	Did you actually assemble the machines yourself or did you buy them?
Respondent	No we didn't make them ourselves; through the fundraiser we were able to buy these machines from a machine builder, based in Bali in the Denpasar regency. He's also made our injection molds.
Interviewers	Do you by any means still know his name or name of the workshop?
Respondent	No I am sorry, I'll have to look it up for you.
Interviewers	How many people are running the facility?
Respondent	One person actually, he is a local from Tianyar.
Interviewers	Only one person, how is that possible given that the plastic has to be washed, sorted and then shredded and injected?
Respondent	Well we use our facility for educational purposes. Another part of our initiative is concerned with a free school for kids of Tianyar. Through this school we try to educate the kids on the plastic and general waste problem. We hope to make them more aware about the consequences of plastic pollution. We let the kids collect their plastic waste at home and bring it to the school. We then have two classes a day, with our "recycling manager", our volunteers and the school children. They all then separate the plastics, which are gathered by the kids themselves and from beach cleanups, and then they cut them up and wash them. Then the plastic is ready for recycling.
Interviewers	Which plastics are you able to process now in your machines?
Respondent	Right now we're able to work with HDPE, PET and PP. HDPE we use on its own and we mix PET and PP to make the products more durable.
Interviewers	What do you do with the non-recyclables?
Respondent	We pile them up in big bags, hoping to find a way to use them. When the pile grows too large we sadly have to burn some of the plastics. But this is still better than throwing it away in nature.
Interviewers	In what kind of products are they then recycled to?
Respondent	We're quite limited by our molds; we're able to make big "Lego" bricks, tiles and small beams. Our focus is now on making the tiles.
Interviewers	Does the local community use these building materials?

Respondent	We wished they could be used, but we're not able to produce enough of them and we're not sure if they're actually useful and durable. The tiles are now piled up and we want to use them eventually to decorate our place.
Interviewers	Have you ever thought about selling the products?
Respondent	No, we don't want to make the kids more aware of the problem through an economical point of view.
Interviewers	Could you give us an indication on how much plastic you collect in a week, by how many households this is collected and what the composition of the plastic waste is?
Respondent	At this moment I cannot give you estimation on any of your 3 questions. But I will try to figure this out for you. I'll try to keep you updated on this matter and send you this via e-mail.
Interviewers	I got some questions about the tiles: how much HDPE do you need to produce one tile and what are its dimensions?
Respondent	We use about one PET bottle filled with bottle caps, around 0.8 L. The dimensions are 15 cm by 15 cm by ?1 cm?.
Interviewers	One last question, as we were riding through the village we saw a lot of plastic litter even very close to your facility. What do you know about the waste management system in Tianyar?
Respondent	Well as you have observed there's a lot of trash everywhere. People who come here for the first time say this a lot. I got kind of used to it now… But as far as I know there is no waste management in this village whatsoever. Everyone either throws it in nature and riverbanks or burns it.
Interviewers	Isn't there a landfill in this regency?
Respondent	Not that I know of, I think Ketut our co founder knows more on the matter.

End of interview

C.3.2. Interview Ketut De Sujana Mahartana

Institution	The North Bali Reef Conservation
Date	September 25^{th}, 2019
Interviewers	Bart de Jong, Vincent Ligthart & Thom Woudstra
Interviewee	Ketut De Sujana Mahartana (Co Founder)
Location	Tianyar, Karangasem Regency

Start of interview

...First we had a talk about our project, ideas and future plans. Ketut was at first critical...
...He asked us some very striking questions.But after a while he became very excited...

Interviewers	At your school you learn the kids about the (plastic) waste problem, how do you do this?
Respondent	Our classes are of course partly about the plastic problem. And we encourage our student to separate and collect their plastic waste. They hand it in at the start of each day. We also do beach clean ups. And we of course now have the recycling center.
Interviewers	Have you seen a difference in the mentality of the kids?
Respondent	Well yes and no. At school they're excited and they're really engaged in the whole thing and lots of them actually bring all their plastics. But when they get home, they get a totally different example. Their parents are still burning their plastics and throwing them away. So they see two totally different ways of handling waste, which makes it harder for the kids to know what's right or wrong.
Interviewers	As we've discussed before with Kyle, we indeed saw a lot of (plastic) waste on the streets and riverbank. A lot more plastic than we're used to in Badung regency. Can you give us some information about the waste management in the Karangasem regency?
Respondent	Well for whole Karangasem I am not sure. But for Tianyar I know the situation. And sadly that is that there is no waste management whatsoever. People here are forced to either burn their waste or to throw it away in nature.
Interviewers	So there is also no pick up service by the government as we've seen in the Badung regency?

Respondent	No, there is certainly no pick up service.
Interviewers	We've done some research ourselves as well and there is supposed to be at least one landfill in every regency. Isn't it possible to let people bring their waste to the landfill?
Respondent	The landfill is very far away from Tianyar, so that's not really an option.
Interviewers	Does the regional government have any plans regarding the waste collection?
Respondent	Well sometimes they say that they want to improve it. For example: a while ago they told us that they were going to help us pick up the plastic waste. A lot of people of the village separated and collected their plastics. We collected a really big pile of plastic waste. We then had to wait for the government to pick it up. We've waited a long time. And we then realized that they would not come and pick up the waste. So we were eventually forced to burn the whole pile…
Interviewers	What about the Banjars in the village, which have a certain budget right, aren't they concerned about all the waste?
Respondent	Well there of course is a certain budget, I don't know how much. But I guess there is either not enough money or there is no solid plan for proper waste management. But recently the head of the village is really interested in starting a waste collection point for recycling purposes. And I've started talks with him.
Interviewers	Well that sounds like somewhat like what we want to accomplish don't you think?
Respondent	Yes indeed and together with what we've discussed at the start of the conversation, I am really excited about what you're trying to do. I can't believe that our student here don't do these kinds of projects… I think it might be of both our interest to arrange a meeting with him, you and me.
Interviewers	That would be really nice. But before we make an appointment with the leader of the village we need to gather our results first so we can present a better and more solid plan to him. So we've asked Kyle to help us gather some data from the recycling facility. And we'd also like to conduct a survey here to the local people, would this be possible? We've printed some out and we also have it online.
Respondent	Okay, I understand. I'd try to help you with conducting the survey. We'll see how the locals will react to them as some times in the past they were a bit reluctant about filling in a survey.
Interviewers	That would be really helpful. Thanks a lot. We have to keep in contact, as we'd love to meet the head of the village to show him our plan.
Respondent	Yes we keep in contact!
	End of interview

C.4. TPST3R Facility Seminyak

Institution	TPST 3R Waste facility Seminyak, Bali
Date	October 9^{th}, 2019
Interviewers	Reneke Kolff & Vincent Ligthart
Interviewee	Komang Rudith Hartawan
Location	Seminyak, secretary office, Badung regency
	Start of interview
	...Introductory talk...
Interviewers	Okay so first of all, what is your function. You are the boss here?
Respondent	Ah no no.. The owner of this uhh.. We call Kepesti. This is the Desa Adat, you know the Desa Adat?
Interviewers	This is the most important man of the Banjar, am I right?
Respondent	Yes that is right, I work for the Banjar and my function here is a manager.
Interviewers	So this facility belongs to only one Banjar, or how does this work?
Respondent	No, this facility belongs to Seminyak area. The boss is the Village leader, in Bali we call this area Banjar. You know Banjar right?
Interviewers	Yes we do. We know about the system, so Banjar is the smallest one.

Respondent Okay so let me explain. We have the province of Bali, then regency Badung, then district Kuta and village Seminyak. In Seminyak we know four different Banjars. We collect in Seminyak from around 350 households, we have small restaurants, restaurants, villa. We have no more than 500. Restaurants we call Warung here.

Interviewers Ok so you have a lot of restaurants. You collect the plastics from this restaurants, right?

Respondent Yes, uhh no, all waste. Not only plastic, we collect all waste.

Interviewers Ok good to know, and ehm.. how many people work here in this facility?

Respondent Uhh.. all is 42.

Interviewers Alright, and you seperate here?

Respondent Yes, seperating is 6 people. And then for the truck we have 17 truck. We have a new one (interviewers: this is one more than previous year!), Yes Yes! Very good. Next year we have plan to buy two more truck. Uhh... because in Banjar (other man joins the interview and provides input as well) a new Banjar wants to join us, Banjar Segara. Because they have problem there with waste. We want to start there with the households, next month we start from small restaurants, small bar, next month we start with all hotel.

Interviewers How many households and restaurants will that be?

Respondent Uhh.. (chatting with friend) I think this will be 200.

Interviewers So this is from the Banjar, not from the government? You organise this by yourself?

Respondent Yes I do, but all in close contact with the Banjars.

Interviewers But, you have contact with the government right, because we read from the group last year that the TPST3R is also a governmental organisation. You have contact with regional government and national government right?

Respondent Yes yes, they know about what we do. They support us to do this. They support us with one truck as well. And then from Jakarta, they gave us a building; this one. That one is from Badung (points at other building).

Interviewers Ok very good. And how many days is this facility open, how many days do you work?

Respondent Oh uhh.. all day. In Bali, we only have one day, you know? Everybody is free, no light, some people no eat. Nobody go out of their house. (Komang searches for the date of the year when this is happening this year).

Interviewers Ok and so, the waste comes from the Seminyak area. Does the government pick up some waste as well?

Respondent No but uhh... In Seminyak area our government only picks up waste at the main street. Because they only have the big truck, they dont have the small one. Only the people who live near the street can put their waste beside the main street.

Interviewers Okay, and is this service free?

Respondent No, this is not free. They also have to pay.

Interviewers Do you know how much waste is coming in every day?

Respondent Okay so maybe better to explain English. We have data about how many waste we pick up, how many waste we process, how many residue we have. The residue we bring to the Denpasar landfill, we call it Suwung. Our residue is 40%. 60% we already process now, garden waste, kitchen waste. We get it from kitchen in hotel. The kitchen waste we give to pigs. The people have pigs at the landfill. We give this waste to this people and in return we can deposit our waste residue in the landfill.

Interviewers Ah, so this is the fee you pay for dropping your waste in the land fill?

Respondent Yes that is correct.

Interviewers What happens with the other waste?

Respondent So everything we can use, so bottle, paper, metal, glass, and garden waste. So we bring compost to hotels, we sell it. But the other materials are going to Surabaya. This is on Java.

Interviewers Ok very good, and do you know the amounts you have?

Respondent Yes, ok so we don't have kilograms. It is in kubic meters. We can provide you the information (respondent talks with secretary, women prints out data). Ok and then, we give you more information. We have contract with hotel. We can show you (ask for more prints from the secretary).

Interviewers Now our next question is, how do you collect? Do you collect at houses or do they bring it to a point where you collect?

Respondent We collect at the houses, they put it in front of their doors. And we collect there. We start at 3 'o clock in the morning. The rubbish we collect is done at 8 o'clock in the morning. We use three trucks for all the households. The waste from households is not as much as it is from hotels and villas, you know. All the waste needs to be clean in Seminyak, because it is a very tourist area. We also have security from pandrapi, it is the local police.

Interviewers Ah ok, so this Banjar in Seminyak is very well organised am I right?

Respondent In our area we have a very good control. The first why the tourist come to our village is because it is clean. It needs to be secure. If you feel secure, you come to Seminyak, right? It is all organised to support tourism.

Interviewers So you pick up all the waste by yourself, are there are no other companies involved in the area?

Respondent No indeed.

Interviewers Okay and than another question about the trucks. How are they financed, do you pay yourself? So in the beginning, how did you manage to buy 16 trucks?

Respondent From the beginning the Desa supported us. We had only one small truck this was in 2003. And then when the government supported us because of the idea. It really just happened. (suddenly the respondent changes topic) The households pay 40.000 IDR for waste pick up for one month. But for big villa's and hotels they pay more. Can be up to 6 million IDR for big hotels (respondent shows contract and explains it, he also shows how this is controlled (by 5 people from the Banjar and the TPST3R facility). We give this big hotels compost back if they give us the waste. We need to give them 500 kg of compost in return per month. If we do not give 500 kg, they don't have to pay the full amount of 6 million IDR. Afterwards the respondent gives us information about the facility, the trucks, the amount of waste they collect and amount of workers (interviewee and respondent read the document together because it is in Indonesian language).

Interviewers So where is the plastic in this data?

Respondent The plastic is here (respondent shows it). We separate the plastics as well. So we have PET, caps, bags and other plastics. For compost we need 8 tonnes of compost to give back. We do not always get 8 tonnes so we buy some. This is because our facility is too small. (respondent shows the amount of money they need to earn every month).

Interviewers Okay, so where does the money come from?

Respondent So the first part is from the fees that households, hotels etc. pay us. Sell the compost and sell the un-organic waste like plastics.

Interviewers Okay interesting, and to who do you sell this?

Respondent Uhh.. we have a partner. For PET we have special partners (we didn't understand the name of the partner). They buy our plastics and they sell it to the big recycling facilities on Surabaya, Java. We work together with 5 companies.

Interviewers Do you also know how much money you get for one kg of PET?

Respondent Uhh.. yes! (respondent asks his secretary). We have a price list we can show you (respondent shows the data and explains the data). We have PE, and we have the bags, we also separate the bags per color.

Interviewers So there are two columns on the list, what is the difference?

Respondent Sometimes in our households they already separate. Then we will pay them for collecting because we don't need to separate anymore. We can make them aware that they can separate, so they are more aware of the environment. (now the respondent takes us outside to explain a bit about the separation and the types of plastic).

Interviewers Okay, so now we have some other questions. Everyone who live in this area are obliged to hand in their waste right?

Respondent For us it is not hard to get people help us, because we have the rules from the government and the Desa Adat. So they will do it.

Interviewers Do you also work with the DHLK, because that is something we encountered during our research?

Respondent Yes yes we do. They sometimes have new technology and they tell us.

Interviewers Previous month we lived in Tumbak Bayuh, there we had a head of the office. They had 7 small Banjars, and they had like 3 trucks. They had to divide those trucks over the 7 Banjars.

Respondent Yes that is not much eh..

Interviewers I have one more question about the Banjars and the Desa Adat. Is it true that the Desa Adat has connections with the higher government. Like is there a leader who stands above the Desa Adat?

Respondent Our chief of the Banjar is the Desa Adat. Above him we have the Bendesa Adat. They work together. The Bendesa Adat is the village head and has contact with all Desa Adats. The government sometimes needs information about Seminyak area, they have a good relationship. The chiefs have a meeting every month.

Interviewers We went to the west, to Jembrana regency. We saw that there is no waste collection or whatsoever. We went to the village Pulukan. What I wonder is: why can you get money from the government and they can not?

Respondent Now we have special regulation for Badung. One village one TPST3R.

Interviewers Okay, so previous year you said these TPST3R were already being build. How far is this developed now?

Respondent Now from our government, every year there is a new TPST3R. This is for Badung regency. All because of tourism money we can do this. This is the very first TPST3R, started in 2003. And it is now a pilot project for the government of Jakarta. They wanted to know how they can improve the waste management in touristic area. We always give education about how to do it. This facility also has a classroom where we can teach new TPST3R facility members how to start from the beginning.

Interviewers How many new TPST3R facilities are build now in the previous year?

Respondent I know that in Badung there are already 36 TPST3R facilities now. But step-by-step.

Interviewers We also see a lot of Bank Sampah here. They drive around with scooters to collect waste.

Respondent Uhh... We have Bank Sampah also. This TPST3R picks up garbage from the source and customers pay us. Bank Sampah only works for households and they sell to TPST3R. They come here, I check what they bring, write it down and give money if they deliver enough. But only for household.

Interviewers Are you open for a collaboration with us?

Respondent Yes, but our problem is really the 40 % residue. We would like to bring it down to 10-20 %.

Interviewers I would like to ask you a bit more about the Banjar and the budget. We heard that in other areas there is not as much budget for waste management as there is here. Is the budget managed by the Banjar or by the government?

Respondent Yes by the Banjar. Because we have many restaurants we get more money because tourists pay tax. This tax we get for our budget. We don't get subsidy by the government. The Banjar works on itself.

Interviewers Does this system work the same for Java? Is it part of the religion here that you work with Banjars?

Respondent No, Java is different. This is part of our culture and religion.

Interviewers Okay. The last question about the plastics: could you give us some data about the amount of plastic you get per plastic type?

Respondent Uhh yes.. per month? We can give you the table (gives the table and explains).

Interviewers Thank you so much, that is awesome. Do you know if the waste inflow is always the same or does it change over the year?

Respondent There is very much waste in high season. Because of the tourists. The households are almost the same during the year.

Interviewers You do pretty good administration!

Respondent Yes (laughing), we do our best.

Interviewers Why is there no plastic recycling facility on Bali?

Respondent	I don't know... I can not give a good answer on that.
Interviewers	Do you think that our idea, of creating value out of products, will be more effective here or in the North for instance?
Respondent	You should go there (to the North or West), because here is pretty good organised. You should contact the Desa Adat because he will give you a chance if you come up with a good plan.
Interviewers	Okay very nice. Now we only would like to ask you one more favor. Could you get us in contact with the DLHK and the Bendesa of this village?
Respondent	Yes! Of course. I want to go to the Bendesa with you, because if you talk about us we would like to be there. Every five years there is a new one and this one is only here for two months. So we would like to be there with you. I will write down the numbers.
Interviewers	Now the last, maybe strange question: Do you feel there is corruptcy in the government?
Respondent	Yes but not in the Banjar. But in the government yes.
Interviewers	Okay, I think that this is it. Thank you very much for your time, we really appreciate it. Have a nice day!

End of interview

C.5. 4Ocean

Institution	4Ocean Bali-Medewi
Date	October 12 th, 2019
Interviewers	Reneke Kolff & Ewoud Hermans
Interviewee	Bisrri (Manager of 4Ocean Bali-Medewi facility)
Note	Interview at sorting facility near Pulukan

Start of interview

...Introductory talk...

Interviewers	What is your function at 4Ocean?
Respondent	I'm the manager or boss of this facility in Medewi. I organize which beach will be cleaned in this area. And I pay the people who work here.
Interviewers	How many people work at the Medewi facility of 4Ocean and do you know how many people work in total on Bali for 4Ocean?
Respondent	No, I don't know how many people work on Bali. There is a big facility in Negara (called 4Ocean Bali-Jembrana) and also in Denpasar (called 4Ocean Bali) but I don't know how many people work there.
Interviewers	And how many at these facility in Medewi?
Respondent	At this facility we work with 14 people. 4 people separate the plastic as you can see (pointing to the man's next to us, who are separating the plastic) and the others are picking plastic from the beach. They are rotating from job, so 1 day you have to separate and then 2 days you have to pick plastic.
Interviewers	If I may ask, what is the salary per month for a picker?
Respondent	They earn the minimum salary, which is Rp 2.300.000 per month.
Interviewers	And how many days per week do they work?
Respondent	7 days per week, we start every day at 7 o'clock in the morning and stop at 4 o'clock in the afternoon.
Interviewers	As you said before you pay the 14 employees. How do you get enough money to pay the 14 employees? Do you get money by selling the recyclable plastics or do you make and sell the 4Ocean bracelets?
Respondent	No, no, we only separate al the 7 different plastic types (again pointing to the separation part of the facility) here at this facilities. And we transport our separated plastics to the big facility of Negara. The money we would get for the plastic if we would sell it, is far not enough. No, the money to pay the pickers, I get from the boss of the Negara facility. He pays me every month Rp. 27 million so I can pay them.
Interviewers	So this Rp. 27 million per month is fixed. It does not depend on how many plastic you take from the beach?
Respondent	Yes, exactly. In the raining season we have much more plastic than in dry season.

Interviewers	Where does the boss of Negara facility gets the money to pay you? Does he sell the recyclable plastic to Java for example, or are they at this bigger facility recycle the plastics and make the 4Ocean bracelets?
Respondent	The boss gets money from Amerika. And yes they also sell the plastic to Java, but this is not enough to pay us.
Interviewers	If we know the solution for PET we'll dAnd do you know if they recycle the plastic at this big facility in Negara?
Respondent	No, I don't think so. I don't think they make the bracelets in Bali.
Interviewers	Ok, thank you very much for your time. We are finished with the questions.
Respondent	Of course, if you have any questions you can contact me.
	End of interview

C.6. Interview Banjar Denpasar

Institution	Banjar Denpasar
Date	September 28^{th}, 2019
Interviewers	Reneke Kolff, Ewoud Hermans & Bart de Jong
Interviewee	Made (Banjar leader Denpasar)
Note	Interview at house of head of Banjar Denpasar
	Start of interview
	...Introductory talk...
Interviewers	What is your function within the Banjar?
Respondent	I am the leader of one Banjar. I oversee the Banjar meeting and I am in contact with the office. This is an office that oversees 7 Banjars.
Interviewers	How many times does the Banjar come together?
Respondent	Normally once every month, but now more for example, because we are choosing a new Banjar leader. So it can be different sometimes. It depends on what is happening within the community.
Interviewers	Ok, so a new Banjar leader will be selected. How does that work?
Respondent	Members of the Banjar can be candidate for the new leader. And then the new leader will be voted by all the other members of the Banjar. This is every five years, so I am almost five year leader now.
Interviewers	What kind of things are discussed during a meeting?
Respondent	All kinds of things. Taxes for example or when something is broken in the community like a hole in the road. Sometimes other things like school, crime or garbage for example.
Interviewers	Is waste a common topic of discussion?
Respondent	Not a lot at the moment.
Interviewers	How do you make decisions about new regulation?
Respondent	By voting, this is done during the meeting of the Banjar.
Interviewers	How is waste managed in your area?
Respondent	You put your waste outside and then it is picked up by a garbage service. This is also regulated by the Banjar. You have to pay the Banjar every month Rp. 40.000 for this service.
Interviewers	Where does this money go?
Respondent	It goes to the Banjar, as I said, the Banjar is in charge of the garbage trucks and stuff.
Interviewers	Do you know what happens with the picked up waste?
Respondent	I know a little bit. I think a lot goes to the landfill, but some also goes to the TPST3R facility I think. This is not far from here. There waste is more recycled.
Interviewers	For what reason is not all the waste going to the TPST3R facility?
Respondent	Because they cannot handle all the waste at the moment.
Interviewers	Do you know if there will be a new TPST3R facility, so it can handle all the waste your Banjar produces?
Respondent	Yes, I heard one time they were planning to build a new TPST3R facility. But I don't know when.

Interviewers	Are people already separating their plastic waste and can they hand this in somewhere?
Respondent	Yes, but only for the collectors mostly. So I think only plastic bottles. Maybe other people do more, but I don't know. People can make money with the plastic bottles. And the collectors bring the plastic to the Bank Sampah.
Interviewers	Ok, so not all plastic is separated at the moment. What do you think of our project? Because we want to collect all plastic from the households and compensate them with plastic product or money.
Respondent	Yes, I think this is a very good project. Everybody who is doing something against all the waste in Bali is good.
Interviewers	And what do you think for your community, will this work within your Banjar.
Respondent	Yes, I think so. But as I said we will using a TPST3R facility in the near future, so maybe a other place is better. But yes it could work if the people get good compensation.
Interviewers	Ok, thank you for being honest. What do you think will be a better place for this project?
Respondent	That will be north Bali or Java maybe.
	End of interview

C.7. Interview Banjar Canggu

Institution	Banjar Canggu
Date	September 19^{th}, 2019
Interviewers	Reneke Kolff & Ewoud Hermans
Interviewee	Wayan Akut (Banjar leader Canggu)
Note	
	Start of interview
	...Introductory talk...
Interviewers	What is your function within the Banjar?
Respondent	I am the Banjar leader of one Banjar in the Canggu area.
Interviewers	How many Banjars are connected to your Banjar office? And can you make an estimation how many people that will be?
Respondent	We are with five Banjars at the same office. And I think around hundred families per Banjar. So I think around 2000 people, but I do not know exactly. You can find it at the office.
Interviewers	How many times does the Banjar come together?
Respondent	For the man it is around once or twice a month. And there is also a Banjar meeting for the woman, that is once a month.
Interviewers	As Banjar leader what is the connection with the government?
Respondent	I'm not in contact with the government. The Bendesa Adat who is the head of the Banjar Office is in contact with government. The Bendesa Adat is in contact with the regency Badung. And I think twice a year all the Bendesa Adat of Bali have a meeting with the government of Bali.
Interviewers	For the Banjar leader, is it possible to make own regulation for your Banjar?
Respondent	Yes it is, we vote with the people from the Banjar. But the Banjar Office has to know about the new regulation.
Interviewers	Are this regulations for your Banjar also concerning waste management?
Respondent	The waste management is done by the Banjar Office.
Interviewers	How does that work?
Respondent	The Banjar Office has three garbage trucks for the five Banjars. So every Banjar can use the truck two days a week. For our Banjar the truck picks up the waste on Tuesday and Friday.
Interviewers	Do you have to pay for this pick up service?
Respondent	Yes every household from the Banjar have to pay Rp. 40.000.
Interviewers	Do you know what happens with the waste?
Respondent	I think they bring it to Denpasar, but I am not sure.

Interviewers	If people from the Banjar do not follow the rules of the Banjar. So for example they dump their waste on the street instead of using the pick-up service. Are they penalizes? And what type of penalties will this be?
Respondent	Yes, if you not follow the rules you get a punishment. For example people from the Banjar will not talk to you, and sometimes they have to pay money.
Interviewers	Do you know if people from your Banjar separate plastic waste already?
Respondent	Yes, some people give plastic to Bank Sampah. The Bank Sampah is very close from here.
Interviewers	We learned from literature that the government of Indonesia is going to introduce a new policy that will improve the management of waste as it is, have you heard anything about that?
Respondent	I know about the TPST3R facility in Seminyak and they want to build more in Badung. But when and where I do not know. And I also do not now about the new policy from the government.
Interviewers	Ok the final question, what do you think of our plan. To collect all plastic waste from households and reward the people with plastic recycled products (we showed plastic products that could be produced)?
Respondent	I think it is a very good plan and people will hand in their plastics for this products.
	End of interview

C.8. Interview Banjar Pulukan

Institution	Banjar Pulukan
Date	October 3^{th}, 2019
Interviewers	Ewoud Hermans, Reneke Kolff & Skip de Metz
Interviewee	Agus (Banjar leader Pulukan)
Note	Interview at house of leader Banjar Pulukan
	Start of interview
	...Introductory talk...
Interviewers	What is your function within the Banjar?
Respondent	I am the leader of one of the Banjars in Pulukan, but I also manage a small hotel and I have some houses that I rent to tourists, mostly to surfers.
Interviewers	So you are the leader of the Banjar, is this a fulltime job?
Respondent	No, there is a Banjar meeting only twice every month, but I also see everybody from the Banjar every morning when we go to the Mosque. At the meeting I sort of make sure the meeting runs smoothly and I lead the voting about new rules and stuff like that.
Interviewers	So it does not take a lot of time?
Respondent	Exactly
Interviewers	How do you get the function, Banjar leader?
Respondent	We are chosen by voting once every four years. The people from the Banjar vote.
Interviewers	Ok, and with the Banjar. How are you in contact with the government?
Respondent	There is an office were all the leaders of the Banjars from Pulukan are connected to. The head of the office is in contact with the government.
Interviewers	How is this head of the office nominated?
Respondent	The head of the office is the Desa Adat. He is also voted by all the members of the Banjars.
Interviewers	As Banjar leader, do you get regulations for your Banjar by the regency?
Respondent	Yes, but the regulations go to the Banjar office. And the Banjar office communicate that with us.
Interviewers	Are the regulations by the regency also concerning waste management?
Respondent	No, they only give us a place where we can dump our waste. But they do not care what we do with our waste.
Interviewers	The regency make some regulations, but not a lot for waste management. Is it also possible to make your own regulations for your Banjar?

Respondent	Yes, we can decide everything for our self. The Banjar does not only do what the government wants.
Interviewers	How is the waste managed in your Banjar?
Respondent	People have to bring their waste to a collection point (the dump organized by the regency), but as you can see there is a lot of waste everywhere. this is because people don't want to take their plastic far away. This is why people wait until it is dark and dump or burn their waste in secret. There is no pickup service like in other parts of Bali, I think this is really unfair.
Interviewers	Why is this unfair?
Respondent	Because this region is poorer than the other regions where there is more tourism. This is why there is no waste management. This is unfair to us and the government should do something about this.
Interviewers	This is because this regency, Jembrana, has less money than for example Badung? Because of tourism money?
Respondent	Yes, correct.
Interviewers	Are there Bank Sampahs here?
Respondent	Yes there are. You have people that collect plastic bottles from the houses and they sell it to the Bank Sampahs. But this are only plastic bottles and not everybody collects them so a lot of plastic still ends up in the ocean and in the fields.
Interviewers	We learned from literature that the government is going to introduce a new policy that will improve the management of waste as it is, have you heard anything about that?
Respondent	No, but it would be very good if the government is going to improve the garbage management, but I haven't heard anything about that. To me it looks like it is not going to happen
Interviewers	What do you think of our plan. To collect all plastic waste from households and reward the people with plastic recycled products?
Respondent	It think this would really be a good idea! This would work here because people don't want to throw their waste into the nature but they also don't want to walk far to bring away their plastic waste. That is the problem now. This is why they just throw it everywhere.
Interviewers	So you think we have to pick up the plastic waste instead of using collection points?
Respondent	Yes, definitely. They will not bring their waste unless it is very close, like 100 meter.
Interviewers	Is it possible to work together with the Banjar (office) for this plan in the future?
Respondent	Sure, if we can somehow help for collecting waste it is only useful for our community.

End of interview

C.9. Wedoo - Invoice machines

WEDOO

WEDOO WORKSHOP
BALI

Jl Subita no 17A Kelurahan sumerta denpasar timur 80235
Phone: 081238898603
Email: info@wedoo.id

INVOICE # : 10165
DATE : 14/10/2019

INVOICE

CUSTOMER

NAME	edwoud
ADDRESS	
PHONE	+31641147750
FAX	

DUE DATE 28/10/2019

NO.	DESCRIPTION	QTY	UNIT PRICE (Rp.)	AMOUNT (Rp.)
1	compression oven - compression oven working area 50x50x50cm precious plastic design 1500w	1 Unit	25.000.000,00	25.000.000,00
2	Plastic Shredder Machine - medium size plastic shredder 2.2kw 1 phase	1 Unit	27.000.000,00	27.000.000,00
3	custom moulding - custom mold according to the drawing provided	2 Unit	4.000.000,00	8.000.000,00
			Subtotal	60.000.000,00
			TOTAL	**60.000.000,00**
			Balance Due	60.000.000,00

MESSAGE
our term of payment is 50% deposit and 50% before delivery

PAYMENT DETAIL

BANK NAME:	Bank Mandiri
BANK BRANCH:	Denpasar
BANK ACCOUNT NUMBER:	9000040180276
BANK ACCOUNT NAME:	Putu Hermawan

AMOUNT IN WORD
SIXTY MILLION RUPIAH

Putu Hermawan
Founder & CEO

C.10. TPST3R documents

C.10.1. Costs for hotels and villas

DATA NILAI KONTRAK HOTEL & VILLA
TPST-3R DESA ADAT SEMINYAK

No	Perusahaan	NILAI KONTRAK (Rp)			Produksi Kompos
		Harga Baru			
		Total	Jasa Angkut	Kompos	Kg
1	Ahimsa Villa	500,000	300,000	200,000	133
2	Amala Villas	400,000	300,000	100,000	67
3	Anantara Hotel	1,500,000	1,000,000	500,000	333
4	Anora Villa	300,000	200,000	100,000	67
5	Artemis Villa	400,000	300,000	100,000	67
6	Bali Agung Villa	400,000	250,000	150,000	100
7	Cocoon	1,750,000	1,000,000	750,000	500
8	Courtyard Marriot	1,800,000	1,200,000	600,000	400
9	Daluman Vila	400,000	300,000	100,000	67
10	Dapur Sunda	800,000	500,000	300,000	200
11	Down Town	800,000	500,000	300,000	200
12	Fave Hotel	1,000,000	750,000	250,000	167
13	Galaxi Hotel	200,000	200,000	-	-
14	Grand Mas Hotel	1,500,000	1,000,000	500,000	333
15	Green Room Villa	400,000	250,000	150,000	100
16	Harris Hotel Seminyak	1,000,000	1,000,000	-	-
17	Heliconia	300,000	300,000	-	-
18	Horison Seminyak	500,000	300,000	200,000	133
19	Kanishka	350,000	250,000	100,000	67
20	Kresna Villa	600,000	400,000	200,000	133
21	Kumpul-Kumpul Inn	350,000	200,000	150,000	100
22	Lata Liana Vila	600,000	400,000	200,000	133
23	Le Jardin	400,000	300,000	100,000	67
24	Luna Villa	300,000	200,000	100,000	67
25	Paradiso Hotel	300,000	200,000	100,000	67
26	Pelangi Hotel	1,000,000	800,000	200,000	133
27	Private Luna	300,000	200,000	100,000	67
28	Puri Cendana	600,000	400,000	200,000	133
29	Puri Saron	1,200,000	800,000	400,000	267
30	Sarinande Villa	400,000	250,000	150,000	100
31	Savoya Vila	500,000	500,000	-	-
32	Seminyak Icon	400,000	300,000	100,000	67
33	Seminyak Suite	600,000	350,000	250,000	167
34	Sienna Villa	400,000	300,000	100,000	67
35	Starbuch	350,000	200,000	150,000	100
36	Sun Island	700,000	400,000	300,000	200
37	The 101 Legian	1,300,000	900,000	400,000	267

38	The Breezes	2,000,000	1,200,000	800,000	533
39	The Club	350,000	200,000	150,000	100
40	The Haven	1,300,000	1,000,000	300,000	200
41	The Haven-1	1,000,000	800,000	200,000	133
42	The Royal Beach	2,200,000	1,200,000	1,000,000	667
43	The Kasih Villa	400,000	400,000	-	-
44	The Seminyak Beach	2,500,000	1,500,000	1,000,000	667
45	The Harvest Restaurant	300,000	300,000	-	-
46	The Tune	1,000,000	900,000	100,000	67
47	Vila Aya	300,000	200,000	100,000	67
48	Vila Kunti	150,000	150,000	-	-
49	Villa seminyak	1,000,000	600,000	400,000	267
50	W Bali Hotel	2,500,000	1,500,000	1,000,000	667
51	Pepers Seminyak Bali	6,000,000	5,500,000	500,000	200
52	Indigo Bali Seminyak	4,000,000	3,700,000	300,000	200
53				-	
54				-	-
55				-	-
56				-	-
57				-	-
58				-	-
59				-	-
60				-	-
61				-	-
62				-	-
TOTAL		**49,600,000**	**36,150,000**	**13,450,000**	**8,833**

total Rp. for pick up service

Rp. for the pick up at ~~house~~ villa and Hotel

Rp. for compost

compost in kilogram

C.10.2. Cost plastic at TPST3R

JENIS BARANG	HARGA		KET
	pak sugik	bssb	
Majalah	1000	900	kg
ARSIP-kertas warna	600	500	kg
CETAK-kertas putih	2000	1900	kg
OMPLONG-kaleng besi	1500	1900	kg
AL Campur-\AL1 dan AL2-botol farfum aluminium & kaleng minuman soft drink aluminium	12000	13500	kg
BOX-kardus karton	1200	1300	kg
DP-kertas tebal Papier	400	300	kg
PE-plastik kresek bening doorzichtig kraloon	1500	1400	kg
EMBERAN-plastik tebal verpakking	1500	1400	kg
PET-botol air mineral	3000	2900	kg
Tutup PET-tutup botol air mineral Dop	4500	4900	kg
HD-plastik kresek warna gekleurde zakjes	500	500	kg
Koran	2000	1900	kg
pet bersih	4500		
JERIGEN :			
Jerigen putihan witte jerrycans	6000		bj
Jerigen warna gekleurde jerrycans	1200		bj
BELING:			
BL-beling bening	450		kg
BK-bir kecil	450		bj
KK-kecap kecil	200		bj
BB-bir besar	1200		bj
KB-kecap besar	500		bj
AL kaleng farfum	6000		
CD	1200		
Besi 1 (besi plat)	3500		
Besi 2	2000		

plastics

D

Matlab code

```
1
2  % Matlab script that supports the determination of the financial
3  % feasibility of the proposed project. The outcomes are caluculated for the
4  % collection through collection points (method 1) and for collection
5  % through door-to-door collection (method 2).
6
7
8  %% Variables needed for both methods
9
10 % Populaton density per region
11
12 denp_pop_dens = 4997e-6;
13 pul_pop_dens = 110e-6;
14 cang_pop_dens = 1355e-6;
15
16 % Plastic produced per person per week
17
18 % Denpasar
19 denp_PET = 0.06;
20 denp_HDPE = 0.03;
21 denp_PVC = 0;
22 denp_LDPE = 0.02;
23 denp_PP = 0.02;
24 denp_PS = 0;
25 denp_OTHER = 0.01;
26 denp_total = denp_PET + denp_HDPE + denp_PVC + denp_LDPE + denp_PP + ...
27     denp_PS + denp_OTHER;
28
29 % Pulukan
30 pul_PET = 0.13;
31 pul_HDPE = 0.04;
32 pul_PVC = 0.02;
33 pul_LDPE = 0.04;
34 pul_PP = 0.12;
35 pul_PS = 0.02;
36 pul_OTHER = 0.02;
37 pul_total = pul_PET + pul_HDPE + pul_PVC + pul_LDPE + pul_PP + ...
38     pul_PS + pul_OTHER;
39
40 % Canggu
41 cang_PET = 0.05;
42 cang_HDPE = 0.08;
43 cang_PVC = 0.01;
44 cang_LDPE = 0.1;
45 cang_PP = 0.05;
46 cang_PS = 0.02;
47 cang_OTHER = 0.06;
48 cang_total = cang_PET + cang_HDPE + cang_PVC + cang_LDPE + cang_PP + ...
49     cang_PS + cang_OTHER;
```

```
50
51 % The reward distribution, rather money or plastic product
52
53 % Denpasar
54 denp_money = 0.57 / 0.94;
55 denp_prod = 0.37 / 0.94;
56
57 % Pulukan
58 pul_money = 0.4;
59 pul_prod = 0.6;
60
61 % Canggu
62 cang_money = 0.53 / 0.9;
63 cang_prod = 0.37 / 0.9;
64
65 %% Collection through collection points (method 1)
66
67 % Percentages of population that would take their garbage a certain range
68 % for a reward per region
69
70 % Denpasar
71 denp_200 = 0.32;
72 denp_400 = 0.22;
73 denp_800 = 0.17;
74 denp_1300 = 0.06;
75 denp_2000 = 0.03;
76 denp_3000 = 0;
77 denp_would_not = 0.2;
78
79 % Pulukan
80 pul_200 = 0.47;
81 pul_400 = 0.34;
82 pul_800 = 0.11;
83 pul_1300 = 0.03;
84 pul_2000 = 0;
85 pul_3000 = 0.02;
86 pul_would_not = 0.03;
87
88 % Canggu
89 cang_200 = 0.34;
90 cang_400 = 0.24;
91 cang_800 = 0.24;
92 cang_1300 = 0.02;
93 cang_2000 = 0.03;
94 cang_3000 = 0;
95 cang_woudl_not = 0.13;
96
97 % Willingness to separate plastic waste per region (sum of people that
98 % would do it for free and people that want a compensation)
99
100 denp_willingnes = 0.92;
101 pul_willingnes = 1;
102 cang_willingnes = 0.92;
103
104 % Ranges [m]
105
106 R_200 = 200;
107 R_400 = 400;
108 R_800 = 800;
109 R_1300 = 1300;
110 R_2000 = 2000;
111 R_3000 = 3000;
112
113 % Calculation of participating residents per region
114
115 denp_part_res_1 = (denp_pop_dens * denp_willingnes * pi)*(denp_200 * R_200^2 + ...
116     denp_400 * R_400^2 + denp_800 * R_800^2 + denp_1300 * R_1300^2 + ...
117     denp_2000 * R_2000^2 + denp_3000 * R_3000^2);
118 pul_part_res_1 = (pul_pop_dens * pul_willingnes * pi)*(pul_200 * R_200^2 + ...
119     pul_400 * R_400^2 + pul_800 * R_800^2 + pul_1300 * R_1300^2 + ...
120     pul_2000 * R_2000^2 + pul_3000 * R_3000^2);
```

```
cang_part_res_1 = (cang_pop_dens * cang_willingnes * pi)*(cang_200 * R_200^2 + ...
    cang_400 * R_400^2 + cang_800 * R_800^2 + cang_1300 * R_1300^2 + ...
    cang_2000 * R_2000^2 + cang_3000 * R_3000^2);

% Calcualtion of platic input per plastic type per week per region

% Denpasar
denp_input_PET_1 = denp_part_res_1 * denp_PET;
denp_input_HDPE_1 = denp_part_res_1 * denp_HDPE;
denp_input_PVC_1 = denp_part_res_1 * denp_PVC;
denp_input_LDPE_1 = denp_part_res_1 * denp_LDPE;
denp_input_PP_1 = denp_part_res_1 * denp_PP;
denp_input_PS_1 = denp_part_res_1 * denp_PS;
denp_input_OTHER_1 = denp_part_res_1 * denp_OTHER;

% Pulukan
pul_input_PET_1 = pul_part_res_1 * pul_PET;
pul_input_HDPE_1 = pul_part_res_1 * pul_HDPE;
pul_input_PVC_1 = pul_part_res_1 * pul_PVC;
pul_input_LDPE_1 = pul_part_res_1 * pul_LDPE;
pul_input_PP_1 = pul_part_res_1 * pul_PP;
pul_input_PS_1 = pul_part_res_1 * pul_PS;
pul_input_OTHER_1 = pul_part_res_1 * pul_OTHER;

% Canggu
cang_input_PET_1 = cang_part_res_1 * cang_PET;
cang_input_HDPE_1 = cang_part_res_1 * cang_HDPE;
cang_input_PVC_1 = cang_part_res_1 * cang_PVC;
cang_input_LDPE_1 = cang_part_res_1 * cang_LDPE;
cang_input_PP_1 = cang_part_res_1 * cang_PP;
cang_input_PS_1 = cang_part_res_1 * cang_PS;
cang_input_OTHER_1 = cang_part_res_1 * cang_OTHER;


%% Collection through door-to-door colection (method 2)

% Number of households one truck (two persons) can handle per week (with
% hour work days)
truck_speed = 16 * 5 * 9;

% Average number of person per household
denp_household = 3.88;
pul_household = 4.41;
cang_household = 5.5;

% Participating residents per region
denp_part_res_2 = truck_speed * denp_household;
pul_part_res_2 = truck_speed * pul_household;
cang_part_res_2 = truck_speed * cang_household;

% Calcualtion of platic input per plastic type per week per region

% Denpasar
denp_input_PET_2 = denp_part_res_2 * denp_PET;
denp_input_HDPE_2 = denp_part_res_2 * denp_HDPE;
denp_input_PVC_2 = denp_part_res_2 * denp_PVC;
denp_input_LDPE_2 = denp_part_res_2 * denp_LDPE;
denp_input_PP_2 = denp_part_res_2 * denp_PP;
denp_input_PS_2 = denp_part_res_2 * denp_PS;
denp_input_OTHER_2 = denp_part_res_2 * denp_OTHER;

% Pulukan
pul_input_PET_2 = pul_part_res_2 * pul_PET;
pul_input_HDPE_2 = pul_part_res_2 * pul_HDPE;
pul_input_PVC_2 = pul_part_res_2 * pul_PVC;
pul_input_LDPE_2 = pul_part_res_2 * pul_LDPE;
pul_input_PP_2 = pul_part_res_2 * pul_PP;
pul_input_PS_2 = pul_part_res_2 * pul_PS;
pul_input_OTHER_2 = pul_part_res_2 * pul_OTHER;

% Canggu
```

```
cang_input_PET_2 = pul_part_res_2 * cang_PET;
cang_input_HDPE_2 = cang_part_res_2 * cang_HDPE;
cang_input_PVC_2 = cang_part_res_2 * cang_PVC;
cang_input_LDPE_2 = cang_part_res_2 * cang_LDPE;
cang_input_PP_2 = cang_part_res_2 * cang_PP;
cang_input_PS_2 = cang_part_res_2 * cang_PS;
cang_input_OTHER_2 = cang_part_res_2 * cang_OTHER;

%% Calculation of operational costs per month (method 1)

% Labour cost (for 8 employees) [Rp]
denp_labour = 2553000 * 8;
pul_labour = 2356559 * 8;
cang_labour = 2700297 * 8;

% Land rental [Rp]
denp_land = 25000000;
pul_land = 3000000;
cang_land = 30000000;

% Pay back (2% of machine costs and truck costs) [Rp]
pay_back = (60000000 + 30000000) * 0.02;

% Method 1

% Reward cost [Rp]
denp_reward_cost_1 = denp_part_res_1 * denp_money * denp_total * 3000 * 4;
pul_reward_cost_1 = pul_part_res_1 * pul_money * pul_total * 3000 * 4;
cang_reward_cost_1 = cang_part_res_1 * cang_money * cang_total * 3000 * 4;

% Total operational cost [Rp]
denp_op_cost_1 = denp_labour + denp_land + pay_back + denp_reward_cost_1;
pul_op_cost_1 = pul_labour + pul_land + pay_back + pul_reward_cost_1;
cang_op_cost_1 = cang_labour + cang_land + pay_back + cang_reward_cost_1;

% Method 2

% Reward cost [Rp]
denp_reward_cost_2 = denp_part_res_2 * denp_money * denp_total * 3000 * 4;
pul_reward_cost_2 = pul_part_res_2 * pul_money * pul_total * 3000 * 4;
cang_reward_cost_2 = cang_part_res_2 * cang_money * cang_total * 3000 * 4;

% Total operational cost [Rp]
denp_op_cost_2 = denp_labour + denp_land + pay_back + denp_reward_cost_2;
pul_op_cost_2 = pul_labour + pul_land + pay_back + pul_reward_cost_2;
cang_op_cost_2 = cang_labour + cang_land + pay_back + cang_reward_cost_2;

%% Calcualtion of number of products that need to be sold

% Sell price per product (100 euro) [Rp]
price_product = 1550000;

% Method 1

% Number of products needed sold
denp_prod_sold_1 = denp_op_cost_1 / price_product;
pul_prod_sold_1 = pul_op_cost_1 / price_product;
cang_prod_sold_1 = cang_op_cost_1 / price_product;

% Method 2

% Number of products needed sold
denp_prod_sold_2 = denp_op_cost_2 / price_product;
pul_prod_sold_2 = pul_op_cost_2 / price_product;
cang_prod_sold_2 = cang_op_cost_2 / price_product;

%% Calculation of amount of products that can be produced per month

% Volume per product (stool) [m3]
volume = 0.0078;

```

```
% Densities, upper boundaries taken [kg/m3]
dens_HDPE = 970;
dens_LDPE = 930;
dens_PS = 640;
dens_PP = 946;
dens_PET = 1380;

% Weight product [kg]
HDPE_prod_weight = volume * dens_HDPE;
LDPE_prod_weight = volume * dens_LDPE;
PS_prod_weight = volume * dens_PS;
PP_prod_weight = volume * dens_PP;
PET_prod_weight = volume * dens_PET;

% Method 1

% Number of pure products that can be produced per month

% Denpasar
denp_HDPE_products_1 = (denp_input_HDPE_1 * 4) / HDPE_prod_weight;
denp_LDPE_products_1 = (denp_input_PVC_1 * 4) / LDPE_prod_weight;
denp_PS_products_1 = (denp_input_LDPE_1 * 4) / PS_prod_weight;
denp_PP_products_1 = (denp_input_PP_1 * 4) / PP_prod_weight;
denp_PET_products_1 = (denp_input_PET_1 * 4) / PET_prod_weight;
denp_total_products_1 = denp_HDPE_products_1 + denp_LDPE_products_1 + ...
    denp_PP_products_1 + denp_PP_products_1 + denp_PET_products_1;

% Pulukan
pul_HDPE_products_1 = (pul_input_HDPE_1 * 4) / HDPE_prod_weight;
pul_LDPE_products_1 = (pul_input_PVC_1 * 4) / LDPE_prod_weight;
pul_PS_products_1 = (pul_input_LDPE_1 * 4) / PS_prod_weight;
pul_PP_products_1 = (pul_input_PP_1 * 4) / PP_prod_weight;
pul_PET_products_1 = (pul_input_PET_1 * 4) / PET_prod_weight;
pul_total_products_1 = pul_HDPE_products_1 + pul_LDPE_products_1 + ...
    pul_PP_products_1 + pul_PP_products_1 + pul_PET_products_1;

% Canggu
cang_HDPE_products_1 = (cang_input_HDPE_1 * 4) / HDPE_prod_weight;
cang_LDPE_products_1 = (cang_input_PVC_1 * 4) / LDPE_prod_weight;
cang_PS_products_1 = (cang_input_LDPE_1 * 4) / PS_prod_weight;
cang_PP_products_1 = (cang_input_PP_1 * 4) / PP_prod_weight;
cang_PET_products_1 = (cang_input_PET_1 * 4) / PET_prod_weight;
cang_total_products_1 = cang_HDPE_products_1 + cang_LDPE_products_1 + ...
    cang_PP_products_1 + cang_PP_products_1 + cang_PET_products_1;

% Method 2

% Number of pure products that can be produced per month

% Denpasar
denp_HDPE_products_2 = (denp_input_HDPE_2 * 4) / HDPE_prod_weight;
denp_LDPE_products_2 = (denp_input_PVC_2 * 4) / LDPE_prod_weight;
denp_PS_products_2 = (denp_input_LDPE_2 * 4) / PS_prod_weight;
denp_PP_products_2 = (denp_input_PP_2 * 4) / PP_prod_weight;
denp_PET_products_2 = (denp_input_PET_2 * 4) / PET_prod_weight;
denp_total_products_2 = denp_HDPE_products_2 + denp_LDPE_products_2 + ...
    denp_PP_products_2 + denp_PP_products_2 + denp_PET_products_2;

% Pulukan
pul_HDPE_products_2 = (pul_input_HDPE_2 * 4) / HDPE_prod_weight;
pul_LDPE_products_2 = (pul_input_PVC_2 * 4) / LDPE_prod_weight;
pul_PS_products_2 = (pul_input_LDPE_2 * 4) / PS_prod_weight;
pul_PP_products_2 = (pul_input_PP_2 * 4) / PP_prod_weight;
pul_PET_products_2 = (pul_input_PET_2 * 4) / PET_prod_weight;
pul_total_products_2 = pul_HDPE_products_2 + pul_LDPE_products_2 + ...
    pul_PP_products_2 + pul_PP_products_2 + pul_PET_products_2;

% Denpasar
cang_HDPE_products_2 = (cang_input_HDPE_2 * 4) / HDPE_prod_weight;
cang_LDPE_products_2 = (cang_input_PVC_2 * 4) / LDPE_prod_weight;
cang_PS_products_2 = (cang_input_LDPE_2 * 4) / PS_prod_weight;
```

```
cang_PP_products_2 = (cang_input_PP_2 * 4) / PP_prod_weight;
cang_PET_products_2 = (cang_input_PET_2 * 4) / PET_prod_weight;
cang_total_products_2 = cang_HDPE_products_2 + cang_LDPE_products_2 + ...
    cang_PP_products_2 + cang_PP_products_2 + cang_PET_products_2;

%% Calculation of number of products left to give back as reward

% Method 1

denp_left_reward_1 = denp_total_products_1 - denp_prod_sold_1;
pul_left_reward_1 = pul_total_products_1 - pul_prod_sold_1;
cang_left_reward_1 = cang_total_products_1 - cang_prod_sold_1;

% Method 2

denp_left_reward_2 = denp_total_products_2 - denp_prod_sold_2;
pul_left_reward_2 = pul_total_products_2 - pul_prod_sold_2;
cang_left_reward_2 = cang_total_products_2 - cang_prod_sold_2;

%% Calculation of the amount of plastic a participant has to hand in
%before recieving a plastic product (stool)

% The amount of kilos handed in by the participants that want to
% receive a plastic product divided by the amount of products
% left to give as a reward

% Method 1

denp_amount_handin_1 = (denp_part_res_1 * denp_prod * denp_total * 4) / ...
    denp_left_reward_1;
pul_amount_handin_1 = (pul_part_res_1 * pul_prod * pul_total * 4) / pul_left_reward_1;
cang_amount_handin_1 = (cang_part_res_1 * cang_prod * cang_total * 4) / ...
    cang_left_reward_1;

% Method 2

denp_amount_handin_2 = (denp_part_res_2 * denp_prod * denp_total * 4) / ...
    denp_left_reward_2;
pul_amount_handin_2 = (pul_part_res_2 * pul_prod * pul_total * 4) / pul_left_reward_2;
cang_amount_handin_2 = (cang_part_res_2 * cang_prod * cang_total * 4) / ...
    cang_left_reward_2;

%% Time it takes for average person to recieve plastic product [weeks]

% Method 1

time_denp_1 = denp_amount_handin_1 / denp_total;
time_pul_1 = pul_amount_handin_1 / pul_total;
time_cang_1 = cang_amount_handin_1 / cang_total;

% Method 2
time_denp_2 = denp_amount_handin_2 / denp_total;
time_pul_2 = pul_amount_handin_2 / pul_total;
time_cang_2 = cang_amount_handin_2 / cang_total;
```

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