Delft University of Technology

Department of TPM
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Allseas Engineering B.V.

MSc GRADUATION THESIS

A developers framework for riverine plastic recovery system deployment in Indonesia

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Preface

Did you know that plastic pollution is distorting live one earth and may be after air-pollution the most threatening event for our existence and health? Did you know that Indonesia is one of the main polluters of plastics and that their common waste handling is cause of that? During my study I realised the imminent catastrophe is happening on a daily basis. Now, what if these plastics could be catched? Now, what if there would be a business model that would support a way of plastic catching? These questions teased me to diving into a subject of an emerging market: Plastic catching. Now Allseas happened to be a company that was developing business in plastic catching; there I started my journey to discover how profitable it is to catch plastics. In this report I will take you along in my journey and it will get unveiled how to successful exploit plastic catching to make a difference. It is my aim to contribute to fighting the global plastic pollution. Without the highly appreciated support of many people, I would never have been able to conclude and finalise this report.

Starting with Edward Heerema, Eline Heerema, Marijn Dijk, Peter Werner and Allseas Engineering B.V. in general. These people entrusted me with the challenge of this project. I've felt part of the team within Allseas, a team that is fiercely battling plastic pollution. Not only did they provide me with guidance, information, experience and a place to work, I received useful feedback that made me learn to look further than just theory. Taking the time to read my work and present their opinion was not only kind, the points made were an incredible educational part of this project.

I would also like to thank my supervisors at the Delft University of Technology, Victor Scholten and Jaco Quist. Both have been motivating me along the way, despite the challenges that COVID-19 inflicts upon a teacher-student relationship. Both professors put a lot of effort in providing me with useful feedback and direction.

Lastly I'd like to thank my parents for making it possible for me to commence a study at DUT in the first place. Thanks to Elles, who closely followed my every step. Thanks to all the friends who were interested in what I was doing. Thanks to the producers that made the music that helped me focus and to the lovely lady at

the canteen at Allseas, who always caused a smile on my face.

In addition to my gratitude, I would like to emphasize informal relevance shown in articles and sources that did not make the cut for the report. This research relies heavily on actuality, by which I mean that the trend of the plastic pollution issues is key to momentum. Within the research itself, the focus is mainly on academic theory and only a few news articles are referred to. In reality, I have closely followed plastic pollution development in the news, on social media and in advertising. This does not contribute to the academic value of this research, but is essential proof to the relevance of plastic pollution prevention. This miscellaneous inspection continued until the finishing of this thesis, on January the 31^{st} of 2022.

Dear reader, during this research I learned the true value of academic research first hand. I did not expect to get entangled with a subject on the level that I did. Plastics are everywhere and for a good reason: Plastic is a wonder material. But properties that make plastics so useful, come at the cost of pollution risks when not managed carefully. This management starts at an individual. Take a moment to consider what you buy and how you dispose of it, on every level. I hope reading this thesis helps you do so. If so, thanks for taking the time to read this report. Only thinking about something can already make a difference in action. Singing off,

A.S.M. Steenkamp
Delft, January 2022

Executive Summary

Plastic, the material that took the world in the 1950's is nowadays not only seen positively. Plastic is literally everywhere and our modern way of life would not even be possible without it. However, when not managed and treated correctly plastic can affect modern day life significantly posing environmental risks *and* possible human health issues. Awareness and the demand for solutions is growing but trailed by solid regulations and legislation. Moreover, standardization and general tools for organisational deployment are scarce. This disproportion offers few motivating handles to organisations that might want to contribute solving plastic pollution issues. This study finds its origin in that disproportion and aims to create a framework that assist organisations willing to contribute.

The majority of plastic pollution found in oceans is originally from land. The predominant manners of transport used by pollution are: *rivers*. Plastic pollution and riverine plastic emission are most dominant in developing countries, particularly in Asia. Opposed to this, the awareness in these countries is generally low compared to that in developed nations. Despite the fact that the plastic pollution is particularly serious in developing countries in Asia, most of the organisations willing to contribute to solving the problem are located elsewhere. This study focuses on **Indonesian riverine plastic pollution prevention**, with the main research question formulated as follows: *What makes a go-to-market strategy viable for deployment of novel river plastic recovery systems in Indonesia?*

This thesis gathered data from an extensive literature review, a case study and multiple interviews. The literature review is categorised in riverine plastics, riverine plastic recovery technology, market theory and sustainable business model innovation and implementation. Within the literature data is sought on technological aspects that define a riverine recovery system are categorised, benefits and cost of launched systems, general market patterns and sustainable innovation factors. A case study has been set up to monitor assumptions following the literature review. Within this case study, a specific organisation actively recovering plastic from Indonesia rivers is analysed in detail. This is done by using the *Triple Layered Business Model Canvass*.

Parallel to the case study, insights initiate the makings of a framework. The first

versions of the framework posted several implications, which have been discussed with several experts. These interviews provide in-depth insights in the Indonesian business world as a whole and as associated with sustainability. The expert's view on riverine recovery have been discussed as well as the validity of the created framework. The interviews lead to extension of the framework as well.

The answer to what viability is in riverine plastic recovery in Indonesia rises from the combination of the case study and the interviews. The first method is an *economic approach* where an organisation aims to maximise income, resulting in target customer creativity and often western involvement. The second method is a *communal approach* combining environmental with social value. Local involvement is maximised, resulting in a minimisation of cost, both offering views from a different angle. Ideally, a combination of the two approaches is applied, but practically this is not yet viable. These results are analysed and quantitatively formulated in the framework.

The results of this report include both theoretical and practical contributions to the search of solving plastic pollution. Theoretically, the framework closes the gap between available technical literature and the lack of organisational guidance. The practical contribution resides within the easy-to-use design of the framework. It is designed as a quantitative checklist which managers and organisational leaders can use to assess a project for riverine plastic recovery.

In conclusion, riverine plastic pollution poses a serious risk to the environment and to human health. Finding ways to successfully battle this issue proves to be a complex endeavour because of the significant differences in respect of economical and social development stages globally. This prevents organisations, who are in principle willing to contribute, from actually doing so. There are no handles to the decision process, there is no guide. Chapter 6 will provide a framework aiming to provide for this guidance.Finally, Chapter 7 and 8 summarize on the findings.

Keywords: *Riverine plastic; macro-plastics, plastic pollution prevention, triple layered business model, The Ocean Cleanup, Indonesia*

Contents

Abbreviations

Allseas Engineering B.V. te Delft	Allseas
BM	Business Model
BMC	Business Model Canvas
CAP-EX	Capital Expenditures
MLP	Multi-Level-Perspective
PR	Public Relations
RPRS	Riverine Plastic Recovery System
TOC	The Ocean Cleanup
TLBM	Triple Layered Business Model
TLMBC	Triple Layered Business Model Canvas

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Chapter 1

Introduction

1.1 Research Problem

The modern world is one of rapidly accelerating innovation. Where the focus of the 20^{th} century was on industrial development and discovering additions to human welfare, the 21^{st} century is starting to revolve around the long-term consequences of the previous and continuing achievements. Before, within this short-term viewpoint, mankind innovated and developed vigorously to improve human lifestyle, with only little regards for long-term impact. Now, one of the core themes of Western society involves conservation and sustainability. When innovation is induced, a large part of these new ideas consider impact. Researchers explore possibilities of transitioning towards producing and consuming more sustainable. Technologies that were deemed positive when they were invented and got humanity on a way to welfare, are hitherto critically observed from different angles. One of the most addressed examples is the issue around fossil fuels, subject of daily discussion in the developed world and reflected in modern product design. Another topic attracting attention, yet still being underrepresented in society is **riverin plastic pollution**. This study aims to theoretically and practically contribute to riverine plastic pollution recovery.

Plastics, or synthetic polymers, do not easily degrade, if at all (Chamas et al., 2020). Most of the plastic ever made still roams around somewhere on planet Earth, be it in its original function, recycled or as waste. In total and up until 2015 Geyer et al. (2017) have estimated that 8,3 billion metric tonnes [t] of plastics have been produced. Geyer et al. suggest that 6,3 billion of the 8,3 billion tonnes of total produced plastics were reduced to waste. Of that 6,3 billion tonnes, 9% has been recycled, 12% has been incinerated and *79% was accumulated in landfills or the natural environment* (Geyer et al., 2017). In a later study, Geyer (2020) estimated that at the end of 2017 the cumulative produced plastics had risen to 9,2 billion tonnes total, hence an increase of almost **10%** in just two years. Eventually, the majority of plastics dumped in unmanaged landfills ends up in rivers.

When considering plastic pollution, waste management is an important factor. It is regulated differently around the world. The variation of these rules between nations is making international monitoring, processing and controlling very complicated. This leads to plastics ending up in places they are not meant to end up in, one of those being the marine environment. Plastics end up in oceans via different ways of transport, of which this research will analyse the most dominant: ***rivers***. River inputs are a significant source of plastic inputs into the ocean (Ritchie, 2018). Plastic material within any environment can be harmful for its direct surroundings, but when looking at plastics in the marine environment specifically, the consequences potentially have an even larger impact. Apart from the possibility of damaging flora and fauna, plastics can end up in the food system, potentially harming human health (Wright and Kelly, 2017) (Revel et al., 2018).

One specific distinction between oceans and rivers is *accountability*. Where most of the plastic debris eventually ends up in international waters, where no nation is obliged nor willing to claim responsibility, rivers are designated specifically to the national area(s) they reside in. This leads to a more clear selection of responsible entities. At the time this research is done, several organisations are focusing efforts at attacking river plastic inputs. Besides technical problems, there are aspects that need attention, as riverine plastic recovery is a young and turbulent industry. This causes unforeseen errors and complex questions, essentially knowledge gaps.

One such a gap is between viable deployment of a riverine plastic recovery project and the lack of organisational tools and available knowledge. The demands for pollution prevention and a cure are rising (Khan et al., 2019) (Young and Nagpal, 2013), yet action and transition have proven hard to realise. When collecting plastic waste, one only catches trash, a low value substance. Trash is tough to monetise in a sustainable way (Dijkstra et al., 2020). Some organisations use high profile marketing to finance activities, some seek investors or crowd-funding, while others enter the iterating process of committing to local governance or NGO's. One of the biggest challenges is to seek financial sustainability for any possible future project. Another important factor in this eventual transition is a shift in the public point of view on how to handle plastic, spreading information in what the risks are when plastics are lost in the environment and eventually transported to the ocean. The long term destination of this transition is to secure functional plastic waste management on a global scale, where plastics are not released in the environment in the first place. A transition however, is often gradually structured (Geels, 2002), as 'gradual' indicates step-by-step improvements. One step in the right direction is *the recovery of riverine plastics*. When implemented correctly, it prevents plastics from reaching the ocean and potentially transforms public opinion.

Correct implementation is dependent on several variables. One visible pattern is countries that provide a high level of waste management emit fewer plastics into the oceans via rivers than countries with lower waste management rates. There is a strong correlation between the level of development of countries and their waste

management. To envision the importance of location, the geographical continents of Europe and Oceania combined emit less then 1% of all plastics emitted into the marine environment annually, whereas Asia as a whole emits over 81%(Ritchie, 2021). This makes Asia an interesting area for potential research. There are other variables that play a role in aptness for organisational research, such as *progressiveness*. Social and cultural factors within an area require notable development towards awareness of plastic pollution for it to have any use. **Indonesia** is chosen as research area for this study. The archipelago of Indonesia consists of numerous rivers, lagoons and creeks ending up in the surrounding seas. Poor waste management is the standard and Indonesia's inhabitants use a lot of plastic. On the other side, the nation presents several attempts of fighting plastic pollution (Ratnawati et al., 2020) and within a still somewhat conservative public, individuals arise with the goal to change the nation's situation and at the same time reduce plastic pollution.

The main issue with recovery systems to date is not so much technical as it is managerial and implementational. Practical implementation issues show one side of the coin. Research involves the practically preferred manners to remove plastics from rivers or is based on the best selection methods *from a potential customer's point of view*. Yet, to this day there is no large, effective and sustainable business market for these systems, as regulation, whenever present, is in its first stages and differ internationally. One of many examples illustrating same, is that local sustainable processing of plastic can lead to some conspicuous questions at global scale, where countries dispose of their plastic waste by selling it to other countries for a second life, after which it is discarded at just another location, without any concern for sustainability. This is just one of the implications of implementing recovery systems. Although a sustainability transition is hard to characterise, a global tendency towards sustainability is on the rise (Parris and Kates, 2003). Demand for sustainable awareness and incorporation can be identified globally, albeit in varying degrees depending on the area. Although the propagated acceptance and perception of modern solutions are increasing, a viable market is yet to be defined. This research aims to close the gap between both the available information and experience on riverine plastic removal systems from a technical point of view and the lack of knowledge and tools available for companies and organisations willing to implement recovery systems. This is done by analysing a company's riverine recovery activities with a theoretical construct called the *Triple Layered Business Model Canvas* with the knowledge acquired via desk research and interviews. The results of this analysis are transformed into a conceptual framework, which aims to assist companies and organisations that intend to act against riverine plastic pollution, but find the process of determining how to do this most favourably a significant challenge.

1.2 Aim and Question

Several organisations actually have initiated projects, each with particular systems and specific strategies, with a standard lacking in the newly formed industry. **Allseas Engineering B.V.**, a Dutch offshore company, is one of them. Allseas is promoting to scale plastic catching in rivers and oceans worldwide. Working every day at sea, the company sees first-hand how plastic accumulates in the world's oceans. Allseas is committed to the effort of cleaning the oceans by developing technologies and systems to collect the waste in rivers and waterways before it flows out to sea. Within the Innovations Department, a team of engineers is collaborating with national and local authorities across the Benelux to create collection systems tailored to specific waterways. Two pilot systems are already in place, in the Vijfsluizerhaven in Schiedam and in the Port of Antwerp, which intend to prove if the concept is viable to enter the market in large scale. Allseas has secured EU funding to develop models to identify plastic hot spots and predict its movement in rivers. It has established a laboratory to analyse the plastic waste that is caught and teamed up with the chemical and biomedical departments of universities to investigate micro-plastics. Funding, which is temporary financing at the moment, is essential in the first stages of the project and the go-to-market stage. The search for ways of financially sustainable deployment is the core challenge on route. A long-term intent of this transition is to grow awareness of its contribution to the plastic problem so to increase its impact, as public opinion drives business (Lucas Jr and Goh, 2009). This research's main goal will revolve around the analysis of a viable and sustainable manner of deployment of a riverine plastic recovery system in order to advise on the go-to-market requirements. Allseas is a fitting example of a company struggling to find guidelines for contribution to plastic pollution prevention, where it does have a large motivation to do so. This research will elaborate on these challenges, analyse them and propose a framework that will assist organisations in attacking them. In addition, the concept of the Allseas project will be assessed for production and deployment in Indonesia. To underline the aim of the report, a main research question has been formulated as follows:

What makes a go-to-market strategy viable for deployment of novel river plastic recovery systems in Indonesia?

This main inquiry is constructed based on theoretical gaps and uncertainties around the overall implementation of river plastic catchers. A method used to assess viability is sustainable business model analysis, where the building blocks for a suitable go-to-market strategy can be extracted from. In combination with the notion that the riverine plastic industry is vastly different to the core activities of Allseas Engineering B.V., a worldwide offshore company, the question is best defined by using the term 'go-to-market strategy'. A business model or case is one step too far ahead.

To be able to answer this question, some layers of specification will have to be added in the form of the following five sub-questions:

Sub-question one: *What is the current state of research on deployment of riverine recovery systems in developing countries?*

Research is a dynamic pool of information. Fluctuation between what is assumed right, often is correlated to the period a subject has been topical. Riverine plastic pollution and its recovery is a subject that is fairly new to research. Many studies have found results that needed alteration after other studies were published. A current overview is necessary to address relevance.

Sub-question two: *What are the main parameters that influence market potential for riverine plastic recovery systems in Indonesia?*

To start out with, elemental for implementation of recovery are the factors that influence potential of technological solutions. For example, a vast difference in markets and environments of developed and developing countries is assumed, leading to the 'location' possibly being an important variable. Another example interdependent of the location can be found in local development levels, pointing out the variable 'technological complexity'. As a result, a list of constants and variables will be sought are of influence on plastic recovery systems in Indonesia.

Sub-question three: *Who are the stakeholders linked to the riverine plastic recovery in Indonesia and what is their significance?*

The worldwide plastic problem is regarded as a very complex situation, also called a 'wicked problem' (Dijkstra et al., 2021), of which river plastics form an important segment. To understand the impact of riverine plastics in depth, a second question is composed. Different stakeholders have impact or are impacted by plastic pollution and attempts for improvement. In a dramatic sense, each person on earth is a stakeholder in the riverine plastic complex, but without adding specifics, this is not very helpful. The target of this research a deployment strategy for Indonesia, and stakeholders within these boundaries differ significantly from an analysis of the developed world. What is the significance of local communities when it comes to system deployment.

Sub-question four: *Which business strategies do organisations have at their disposal for riverine plastic recovery in Indonesia today?*

Indonesia is known to have multiple projects actively seeking to reduce the plastic impact. Any project that is ongoing and active, has manners of financing their activities, a strategy. When creating a framework, strategic options are at the center of the realisation of a project. Without it, there would be nothing. One of today's most prominent recovery systems will be analysed as thoroughly as publicly available information access allows, in order to come to an overview of the key factors of their financing.

Sub-question five: *Which other factors could be decisive for market entry in Indonesia specifically?*

In order to enter a market, a proper assessment of said market is required. The environment of the envisaged business project is a very important fundament for defining a proper business-model. A market is a broad concept, but when considering river plastic and its recovery, it specifies to a concept being fairly young. This report aims to define this environment and pin-point key factors. The do's and dont's of doing business in Indonesia will be explored and looked into.

1.3 Outline research and report

In order to create structure, the report will follow a predetermined outline which will be quickly illustrated in this section of the introduction. The introduction is followed by a literature research. This literature search aims to cover all theory known in relation to the core concepts, i.e. river plastics, recovery innovations, market theory and sustainable business-models. This should provide a critical overview of the findings, known theory and attempts to address the gap between the theory and implementation, thus forming the foundation for the following chapters.

In the third chapter, the research methods and choices of theory are elaborated on. The framework of the research process shall be formulated in detail via the steps that have been and will be followed. Due to the qualitative nature of business research, fitting research methods are used. The main research method is an in depth **case study**, accompanied by nine **expert interviews**. The interviews complement the case study where needed and validate the concept framework of this thesis. When regarding riverine plastics, there are many possible cases to be studied. A selection procedure led to **The Ocean Cleanup** to be the subject of analysis. This selection process is elaborated, as well as the selection and use of the **Triple Layer Business Model Canvas** and the **Multi-Level Perspective**, being the

theoretical constructs used within the case study. The main aspect involved in the case study is the balance between *economic, environmental and social values.*

The results will be summarised in a conclusion combined with a discussion. This is an important part, as the research problem is part of a very broad global problem. Therefor, further research might be as important as this study, for there is no one solution to wicked problems. In order to accelerate transition, discussion is key. The framework and findings will be summed up.

Finally, recommendations will be made by using the framework created by the author. Allseas Engineering B.V. is invested in this research, as they have designed and are continuously developing a riverine plastic recovery system to be deployed in rivers worldwide, aiming for developing countries. Their recovery system will the first to be assessed. This leads to the recommendations for deployment, identifying strengths and weaknesses, in order to make worldwide impact.

1.3.1 Terminology

This report uses methods and terminology that are intertwined with each other. This subsection has aims to clarify what is meant by the terms used in this specific report and what the aim of this report actually means.

The most important thing is the choice of aiming for a viable 'go-to-market strategy' instead of a business case, even more so when using a business model or business case approach to analyse viability. The reason this is done, is that the riverine plastic recovery environment is so young and turbulent, that it is assumed that there is no unambiguous business case that is the standard, let alone for organisations of which the core activities *do not* concern plastic recovery. A go-to-market strategy is the first part of assessment of a plan, followed by a business case. Because the goal is to ease involvement for existing companies to follow up on a possible urge of sustainability, this terminology is used. The urge represents something new to an organisation, possibly beyond the established network and resources it has.

Secondly, there are several terms within plastic research that are used variably. This research is aimed at *active* project involvement from an organisational point of view, where companies want to get actively involved in the process and set up their own projects. Confusingly, the study focuses on *passive* recovery systems, with which systems that do not require active operation to perform are meant.

The study takes into account the importance of macro plastics as well as micro plastics, but leaves nano plastics out of the scope. Macro plastics are pieces that are larger than 5 mm in size, micro plastics are pieces smaller than that 5 mm, and officially greater than 100 nm.

Chapter 2

Literature Review

2.1 Foundation of theory and framework

The literature review focuses on four main bases of theory that are and shall be used on the journey to answer the research- and sub-questions. It is essential for substantiating any conclusion, as it can indicate a solid foundation of theory and available knowledge. When keeping in mind the broadness of the global plastic pollution problem as a whole, the literature for this report gains all the more importance. It is a necessity to curtail information towards the most applicable pieces. Listed below are essential genres in the literature review:

1. Riverine Plastic
    - Statistics of plastic in rivers
    - Critical rivers and locations

2. Plastic recovery innovations
    - Products and services available today
    - General variables and aspects

3. Developing market
    - Constructs of a (developing) market
    - Perspectives that offer insight in entry

4. Business model innovation
    - Constructs of a business model
    - Business model innovation in a sustainable way

This is a general elaboration on the scope of theory and theoretical concepts. In this chapter, existing motivating research and origins are extensively discussed. General sources of information are the archives and expertise of the Delft University of Technology, the university's repository of theses and the courses *Sustainable Innovation*

and Transitions, SPM9730, *Emerging and Breakthrough Technologies, MOT2421* and *Corporate Entrepreneurship and Start-ups, TPM406A* provide guidelines for application of theories. Moreover, public sources of scientific research are consulted regularly, for example, *Scopus*, *Google Scholar* and *Science Direct*. All findings will be referenced, with the source completely shown in the reference list at the end of this report.

2.2 Literature selection

Literature is an important source of information for any study. The way literature is selected, handled and read, defines information used and consequently also results. A description of the manner of search process and literature collection, contributes to a complete overview and possible validity, as it could provide explanation on how attempts were made to avoid biased research. This paragraph attempts to provide said overview as complete as possible and step by step. Of those steps, the first one is the distinction between database usage. Several sources of data have been consulted, of which two important ones have been named, the Delft University of Technology and online databases alike Scholar and Sciencedirect. In addition to that, Allseas Engineering B.V. has provided limited insight in their archives, set-up to support the company's plastic catching project, for which previous research had been done. The literature review has been divided into four categories and, in order to maintain clarity, this paragraph has been treated similarly. Per category, the most important search keywords used for online research are stated, combined with a process overview. Further on, inclusion criteria, relevance and trustworthiness assessments will be explained.

Keywords Riverine plastics

The first section was designed to create an overview of the riverine plastic environment. The main keywords used in this part of the search process, for starters, revolve around a basis of *"River(ine) Plastic"*, to which extensions were added. The main extensions were *"Pollution"*, *"Litter"*, *Micro- & Macro-*, *"Waste"*, *"Research Overview"*, *"Available Research"*, *Pathways* & *"Characteristics"*. This led to a range of articles and reports that formed the basis of this part, of which sources were analysed and consulted when deemed useful. In addition to this, terms as *"Global AND Plastic Waste Management"*, *"Plastic Pathways to the Environment"* and *Global Plastic Production* were used.

Keywords Efforts and innovations

Where academic literature for riverine plastics was young yet plentiful, it has to be specified to suitability. Information about available technologies is defined by a partial lack of academic backing. Many technologies are basic, making academic

research about the technology itself scarce. Online miscellaneous information about different techniques is available in abundance. Keywords used initially are *"Litter Trap AND Technology"*, *"Plastic ND recovery Systems"*, *"Riverine Plastic AND Recovery/Collection AND Systems"* and *"Marine Plastic AND Collection Systems"*. This mainly led to the best know organisations and their proposed solutions. By adding the keyword *"Overview"*, academic research was found, where several technologies were assessed and compared. Further keywords include *"plastic" AND "remove" AND "waterway" "plastic" AND "collect" AND "waterway"*. In extension of the existing recovery methods, recycling plays a role. The keywords used to research plastic recycling were: *"plastic AND recycling"*; *"Plastic AND waste AND Recycling"*; *"Chemical Recycling AND plastic"*; *"Mechanical Recycling AND plastic"*.

Keywords Developing market & market entry

Reviewing an industry's characteristics from afar is an action to be executed carefully. There is a vast amount of different theories available regarding markets and theories in different situations and environments. Choosing the right one to analyse Riverine Plastic Recovery and the transition arising now is essential. The following keywords were used in this process: *"Market AND Formation"*, *"Developing AND Market"* and *"Sustainable AND Transition"*. As expected, this led to many varying theories,which are briefly for suitability. A general *"Market AND Life Cycle"* is the first step to finding the working of an industry. In addition to that, the mechanisms of a sustainable transition needed mapping, for which the *"Multi-Layer Perspective"* proves best tangible.

Keywords Business Model and innovation

Situation insights only do not provide for a sound set of strategic knowledge yet. From a organisations perspective, the way activities are executed is the final piece of the puzzle. The central keywords for this final part of the literature are *"Business Model Canvas"*; *"Business Model Innovation"* and *"Business Model AND sustainable"*. A tool called the *Triple Layered Business Model* is discovered during the literature research. Upon the term *"Triple Layered Business Model Canvas"* further research was conducted, leading to a suitable framework in which to visualise existing organisation's operations.

Selection Criteria

The amount of literature being found when using the stated search terms is vast. The selection of search terms is the first step of limiting the scope, but the found articles and sources need narrowing down further, as not all provide useful or trustworthy information. In order to select useful articles, selection criteria need to be used. One of the most important is the date of publication. The topic is young in terms of research, which is shown further on, and this indicates turbulence in results.

It turned out that the majority of the information regarding plastic pollution prevention and recovery technologies is located in internet resources including press-releases and other non-peer reviewed literature. Studies conducted ten to fifteen years ago show results that strongly differ from results of more recent studies. The publication date is therefor an important indicator for relevance, so studies completed in recent years (2017 to 2021) are ranked higher in terms of relevance and validity than earlier studies, as some prove to debunk the earlier work.

A second indicator of quality is the amount of citations per study. The more citations, the more they have been deemed qualitative and accepted within the research community, hence prove worthy of inclusion in this study. Having stated this as rule of thumb, this does apply to the majority of referenced articles, but not all. Some studies were selected on pure tangibility with the information needed for this study. Even then, the more citations, the higher the preference, but in some cases there were just a handful of articles available, not cited widely. In addition to that, geographical location, type of publication and reported outcomes have played a role in the selection.

The keywords that are listed above as well as combinations used to define the literature research. Using these keywords leads to hundreds, sometimes thousands of hits and scientific papers. To limit this amount, an option is redefining keywords or combining them in a different matter. Many times, this leads to irrelevant results or too little difference in amount. The title is analysed for tangibility with the searched for keywords that are deemed most critical like “Riverine Plastic”, “Plastic Recovery" and “ Sustainable Transition” for the best match. The amount of papers is reduced very little by this, but the relevance increases. Following, the amounts of citation come into play. ‘Riverine Plastic Recovery’ on itself is a niche within the theoretical world, but market theory, business model theory, sustainable transitions and waste recovery systems are not. This is the reason for the four sections of the literature research, as the full study aims to combine knowledge. The top 10 of matched papers per category are systematically scanned for actual relevance by reading the abstract. The division of the literature in sections makes the papers easier to dissect in useful theory due to broadness. Forty-eight papers are scanned, of which roughly 40% is deemed irrelevant directly after the scanning. The next step is reading the introductions of the articles. Around twenty papers are found relevant for this study in total, which are read in full. These papers offer something in addition to their own functionality, namely useful references. These references are read when likely to be relevant in a so-called snowballing research method. This leads to another fifteen to twenty articles, reports and papers that are useful and included.

2.3 Riverine plastic

The essence of this research is plastic found in rivers. Essential is to record a set of data to be used to elaborate on upcoming theoretical concepts. As described in the literature-inclusion section, this review is focused on a certain scope. This is due to the shear area of information and knowledge that can be filed under the label 'plastic problem'. In an attempt to briefly envision this, the very first sentence of the introduction of this report should be recalled. The previous century was one of technological and productional development. Systems we take for granted in modern western society, were not dispatched in detail yet, think of a functioning waste management system and infrastructure. Where in the 1960's plastic ingestion news was mainly anecdotal, it took until the 1970's for the first reports on prevalence of plastic in the North Atlantic to be published (Ryan, 2015), sparking serious curiosity for marine litter and pollution as subject for research, shown in figure 2.1, categories included (Ryan, 2015).

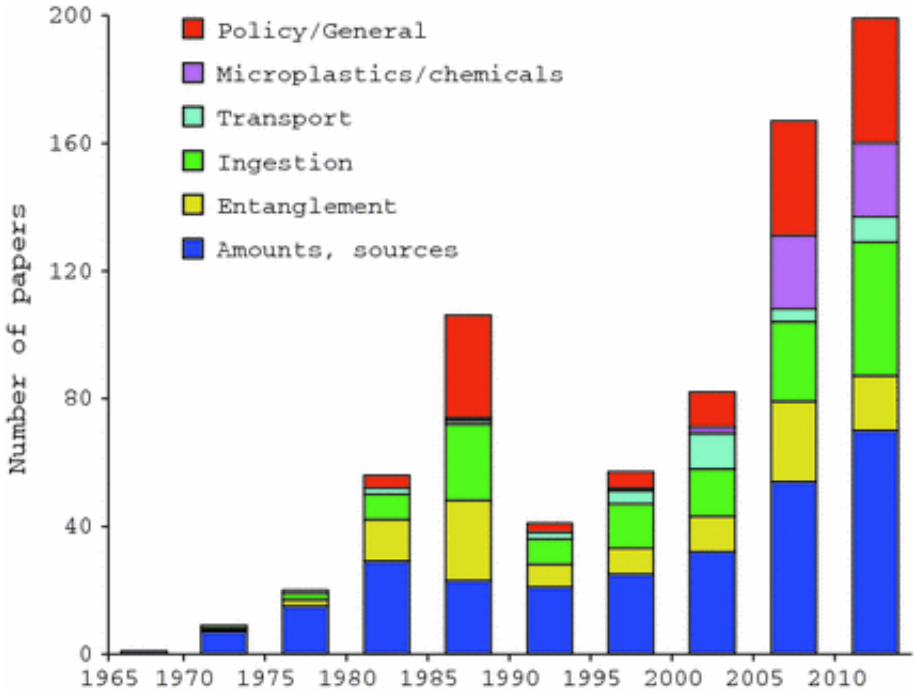

Figure 2.1: Numbers if marine litter papers published (note: the last column covers only 2011-2013)

Parallel the research interest, the plastic production growth and dissemination continued. Within just a few decades after mass production of plastic products started around the 1950s, plastic debris have accumulated in terrestrial environments, in the open ocean, on shorelines of the most remote islands and in the deep sea. The

discovery of the Great Pacific garbage patch, or 'plastic soup', in 1997 can be seen as the instigator of the global acceptance and awareness amongst the greater public of marine litter and plastic pollution. Increasing awareness is a possible gateway to innovation and implementation. This is shown by attempts to clean up this 'plastic soup' in the past decadeDiscovery of this marine pollution and worldwide acknowledgement led to the question of where the marine litter originated from in the first place. This question knows various answers from various authors and researchers. The amounts and percentages used variate over time and have to be specified still, but there is unanimity about involvement of rivers and land-based plastic inputs. Within this area, research is young and thus more limited than studies concerning oceanic pollution without regarding origin, but changing periodically (Blettler et al., 2018)(van Emmerik et al., 2018).

2.3.1 Plastics; global production and processing

The more research is published, the more stable the estimations and approximations become. Areas where researchers instantly agree are at the moment qualitative of nature. An example is the acceptance of land-based sources to be a major input for marine plastics globally (van Emmerik et al., 2018) (Mai et al., 2020) (van Emmerik et al., 2019) (Meijer et al., 2021). So on basic theoretical levels, researchers and studies do agree. On more specific results, the amount of research done thusfar has a large impact on validity of these quantitative results. In the last decade, many assumptions have been made and then soon after revised. The more results are published, the more accurate a range of projections and estimations get, the higher the validation. With this information, the envisioning of the problem gets more realistic. Several research results of the past decade will be presented about riverine plastics, the later the study has been conducted, the more it will be consulted.

When looking into riverine plastics, the production of the material is obviously the starting-point. In essence, plastics represent a positives versus negatives story. The positives revolve around plastic being one of the most versatile materials on earth, having not only changed but possibly defined life as known today. A modern household entirely without plastics would actually be practically impossible to find. It has changed and continues to change the medical world, industry, production processes, storage, preservation, recreation, housing and so on. This is due to numerous interesting properties such as lightweight, low cost, durable, thermal & electrical insulation, possible conduction, corrosion resistance, possible transparency and mould-ability. This is a reason for the high demand of plastics, which is still on the rise (PlasticsEurope, 2020). High demand leads to high production and increase of it. This is shown in figures 2.2 and 2.3, proving as well that the trends coincide, but exact numbers tend to be difficult to define.

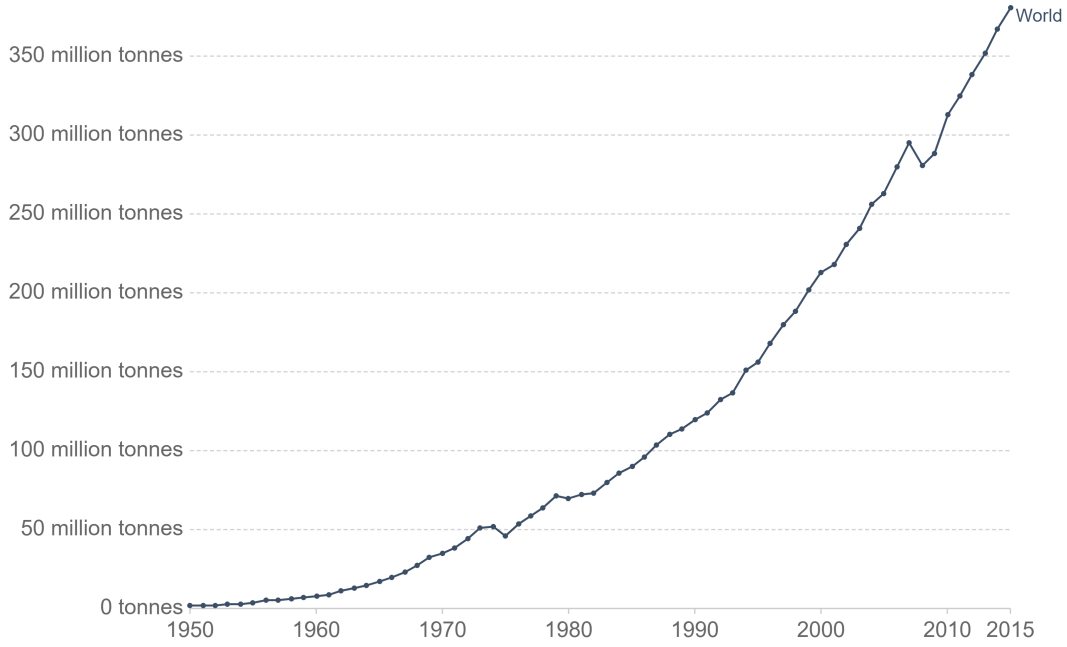

Figure 2.2: Graph of global plastic production untill 2015
(Geyer et al., 2017)

Calculations differ, but estimated is that the global annual production of plastics increased towards 370 Mt in the year 2019 and it must be noted that this steady increase is not yet slowing down. This is due to the varying use of the material, mentioned above, in order to improve life. Many different polymers have been developed to do so, of which six are most important, covering 80% of plastic production: Polyethylene (PE), Polypropylene (PP), Polyvinyl Chloride (PVC), Polystyrene (PS), Polyurethane (PUR) and Polyethylene Terephthalate (PET). The rest of the plastics are labelled 'other'. In addition to this depiction of the current demand, ResearchandMarkets (2021) state in an elaborate market research that the *global* plastic market is projected to grow with an annual compound rate of 3.4% in the coming seven years, with a value of 579 billion USD in 2021 to a prospected value of over 750 billion USD in 2028. This representation of value increase is and indication of a boost in production, with Fuhr and Franklin (2019) forecasting a global production of over 600 Mt in 2030, which results in a *doubling* in only twenty years.PlasticsEurope (2020) have indexed plastic data in the graph on the next page, figure 2.3.

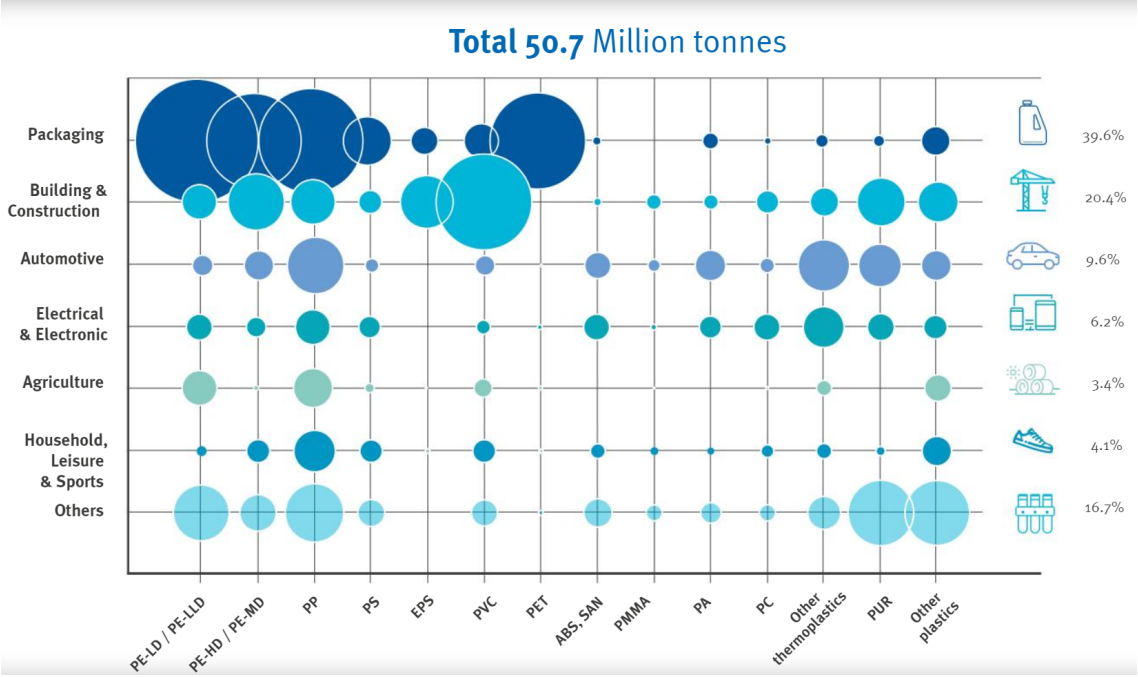

Figure 2.3: Graph of European plastic demand distribution in 2019 (PlasticsEurope, 2020)

2.3.2 From production to waste and litter

Having established a very basic image of plastics, the advantageous and reasons of high and rising demand are clear. So 2.3.1 mainly shows the facts of plastics linked to positives. This does not cover the whole story, as, in recent years, plastic is increasingly linked to negative news (Bernau, 2019). One of the characteristics of polymers that render them very useful, comes with potential environmental drawbacks as well. This is the longevity and durability of plastic, which may not easily degrade in natural environment, if at all susceptible to degradation.

Products in general have a projected life or 'use phase' that sets a pre-estimated amount of time for endurance. After this period of time, the product is at the end of its lifespan and will become waste. This is depending on several factors, for example, functionality, urge-to-buy (Potjer, 2019) and durability. In this case the fact that all products including plastics have an end of their usable life, is of key interest. The world generates between 2000 Mt and 2500 Mt of municipal solid waste annually, of which *at least* 33 percent is not managed in an environmentally friendly way (Kaza et al., 2018). Analysing statistics revolving waste generation shows that in 2010 275 Mt of *plastic* waste was generated globally, accounting for roughly 11-14% of all waste (Ritchie and Roser, 2018). The risk of ending up in the environment is mainly significant for plastic waste that is not properly managed; Ritchie and Roser (2018) stated this to be 32 Mt in 2010.

Waste management thus plays an important role in the product life cycle, especially when regarding plastic ending up in the environment. Geyer et al. (2017) explain the different methods of waste disposal and their usage with respect to time, between 1980-2015, depicted in figure 2.4:

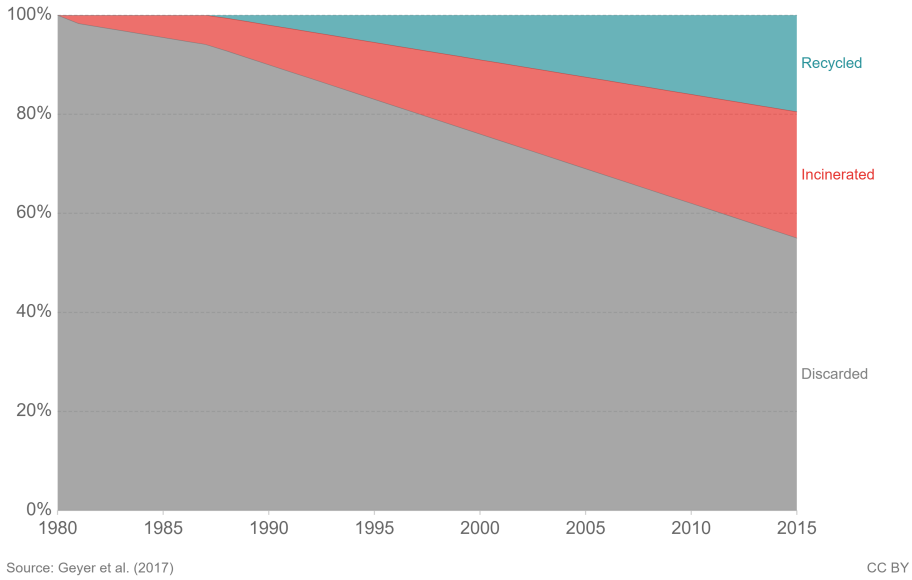

Figure 2.4: Global plastic waste disposal by method, 1980 to 2015 (Geyer et al., 2017)

Seen in the chart are three methods: discarding; incinerating (with and without energy recovery); recycling. Prior to 1980, recycling and incineration was negligible, from there on these rates increased with an average of 0.7% per year. In 2015, estimations show 55% of plastic waste was discarded, 25% percent was incinerated and 20% was recycled. Discarding plastic leads to risk of leakage to the environment, be it in a proper landfill with infrastructure or just directly dumping it randomly.

2.3.3 Types of riverine plastic debris

Plastic comes in all different sizes due to its multitude of uses, making plastic waste of all different sizes as well. In addition to that, plastic does not naturally degrade, but it does get fragmented into smaller pieces as result of natural wear and tear. Plastic waste pollution comprises of the complete range of large pieces of plastics to the smallest of fragments with a size of 1-100 nm (Revel et al., 2018), called nano-plastics. This study focuses on macro-, meso-, and micro-plastics. Nano-plastics **are not** part of this report, as that would revolve around filtration and is not (yet) possible to recover via the ways this study will analyse.

meso- & macro-plastics

Meso- and macro-plastics differ in size, but are practically in the same category, still being obvious (parts of) objects. Macro-plastic usually cover particles with a diameter above 20 mm and meso-plastics refer to particles with a diameter between 5 and 20 mm. Envision this as a bottle cap being meso- and the bottle itself being macro-plastic category. These types are the most researched as of yet, as they form the easily identifiable objects that anybody could directly observe. Most pollution starts with the mismanagement of macro-plastic litter. In short, the main environmental impacts of these plastics are (Gregory, 2009):

- Injury and death of species by entanglement or ingestion
- Alteration of natural habitats by physical interaction
- Transport of floating debris and persistent pollutants to clean environments
- Transport of alien species to new territories, along with the debris
- Seabed suffocation by sinking plastic debris, disturbing the ecosystem

Inherent to this category of plastic debris is rising media attention and regulatory changes. Think of plastic bag banning or tax-charging in over fifteen countries on the continent of Africa, single-use plastic reputation weakening and so on. Most found macro-plastics examples are packaging, sanitary waste and other single use plastics.

micro-plastics

Micro-plastics are categorised by having a diameter smaller than ($<$) 5 mm. Data from monitoring studies show that the size of marine and riverine plastic debris is progressively decreasing, with a higher rate of micro-plastics found in pollution samples over the years. Due to their small size, yet large surface area-to-volume ratio, these fragments might impose a greater threat to environment and human health than larger plastic debris (Chang et al., 2020). The fragments are, as opposed to larger plastics, almost literally found everywhere, in soil, air, seas, freshwater, animals, food and so on. They can be ingested into plants, animals or human beings due to their size. In short, the main concerns involving micro-plastics are (Galloway, 2015)(Chang et al., 2020):

- Transport of chemicals to clean environments
- Contamination of the food chain following ingestion by plants or animals
- Possible physical interaction with tissue or cells, once inside a living organism
- Exposure to toxic chemicals after inhalation or ingestion, possibly altering important biological processes

Micro-plastics are usually defined into five main categories:

- *Pellets*: industrial material used for plastic production process
- *Fragments*: pieces, flakes, beads used in scrubbers, etc.
- *Foam*: polystyrene beads, fragments of insulation foam, etc.

- *Films*: thin, foldable, semi-transparent sheets
- *Filaments*: fibres from clothes, pieces of rope or line, etc.

in addition to this categorisation, there is an important difference in origin of micro-plastics, where a split is often made between *primary* and *secondary* micro-plastics (Auta et al., 2017). Categorised as primary are micro-plastics which are intentionally manufactured for direct use or as precursor material for plastic production. Secondary micro-plastics come from the fragmentation of larger plastics already in the environment, through actions such as weathering or animal activity.

2.3.4 Riverine transport

This study focuses on the *prevention* of plastic litter reaching the ocean, as prevention is preferred to a cure. Cleaning the seas, although probably a necessity, is as putting plaster on a wooden leg if the sources are not tackled. In addition to this, responsibility is easily denied in international waters, whereas rivers are territorial and thus under the responsibility of specific countries. This section briefly identifies the pathways of plastic to the seas.

Waste management significance

A distinction in plastic waste is made, that is between post-consumer plastic waste (produced by end users) and post-industry plastic waste (produced by manufacturers). Post-industry waste is relatively pure, available in high volumes and often supplied a limited number of sources, resulting high recycling potential. Post-consumer plastic is claiming the largest share of the total plastic waste and estimates show that in Germany it was roughly 80% (PlasticsEurope, 2016). This material is less often less pure due to the lack of proper waste separation or complex polymer combinations, has a multitude of possible sources (e.g. individuals) and are available in very small amount. This make the post-consumer waste harder to collect and recycle.

Although collection and recycling rates have increased over time, approximately 79% of all plastics ever made have ended up into landfills or leaked into the natural environment (Geyer et al., 2017). The use of landfills is higher in countries with low waste management. So, nations with effective waste management systems emit less plastics into nature. PlasticsEurope (2020) have produced a graph that shows the difference in plastic management *in Europe*, where the richest countries have found possibilities to almost eliminate landfills, but when looking at less wealthy nations, the landfill rates get increasingly significant. Figure 2.5 shows the differences in waste management in Europe and also suggests a higher landfill and dump rates in developing countries.

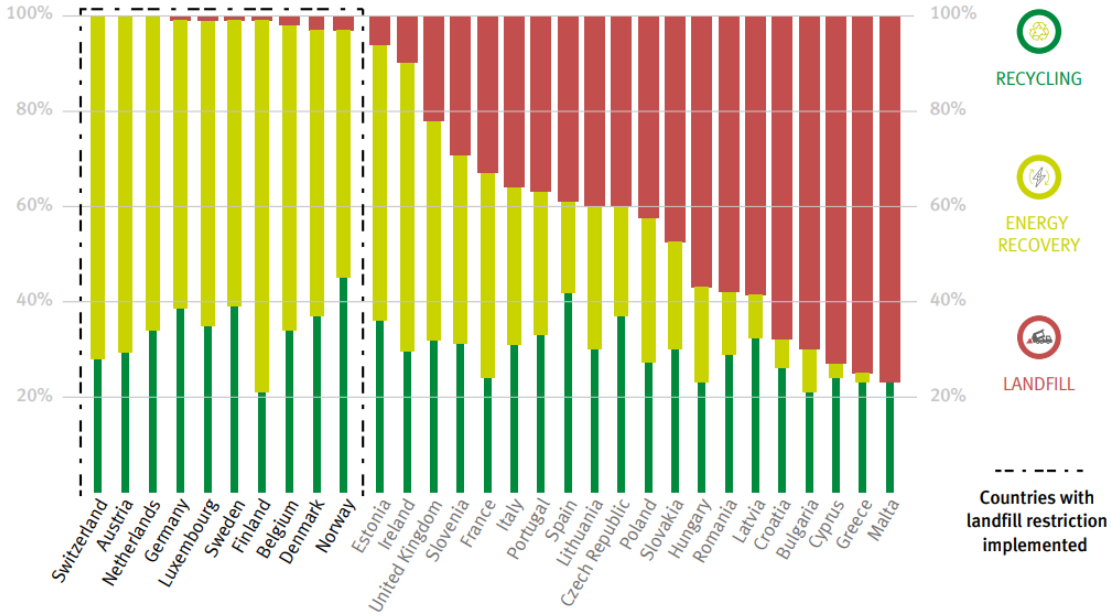

Figure 2.5: European landfill rates (PlasticsEurope, 2020)

Assuming plastic waste makes up for roughly 80% of all marine debris (Carroll et al., 2014) and that 70% to 80% of marine plastic waste originated on land (Ritchie, 2021), land-based plastic waste forms roughly 55% to 65% of all marine debris. Land-based plastic waste finds its way to sea via rivers, and its way to rivers via wind, rain, direct dumping and so on. This information emphasizes to the significant share of rivers in marine plastic pollution.

Critical area's

As shown in figure 2.1, research on riverine plastics is on the rise, with critical rivers a subsection on the subject. Developing research is dynamic, involving possible catastrophic hypotheses to be put to the test. The turbulence is shown in the case of plastic hot-spot identification and studies that relate to possible heavily polluted rivers. Within four years perception of heavily polluted (and thus *polluting*) rivers has changed drastically. In 2017 Schmidt et al. (2017) suggested that out of all rivers worldwide, just five were responsible of 80% of plastic input to seas. This estimation was debunked and adjusted by Lebreton et al. (2017) in the same year, proposing that 162 rivers were responsible for this percentage of the input. The most up-to-date research being found is one of Meijer et al. (2021), where the number of rivers has grown to over a *thousand*. This four year turbulence is depicted in figure 2.6.

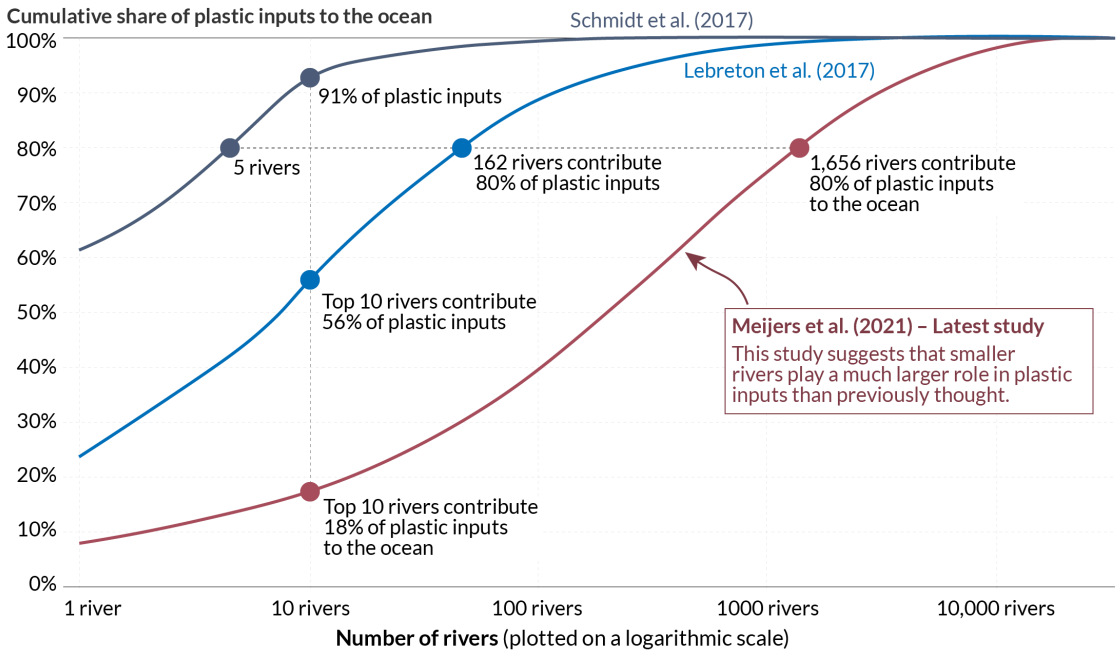

Figure 2.6: Change in research result of critical rivers, 2017 - 2021 (Ritchie, 2021)

The first two studies can be seen as decisive because, although they have been debunked in some way, they have triggered further research, leading to the more holistic and elaborate model Meijer et al. (2021) have presented. This study updates knowledge of plastic distribution in rivers and found that in 2015 *one-third* of all 100.000 rivers contributed to the emission of 0.8 to a 2.7 million tonnes into seas. In addition to this, Meijer et al. (2021) claim that smaller rivers play a much larger role than previously thought. Previously, a top-ten of rivers was considered to contribute to up to 90% of the plastic emission, whereas current research reduces this to only 18%. It must be noted that although figures may not be exact representatives, they are the closest available to date, based on calculations. Results are based on calculating models using high-resolution data, before calibration of the models at 66 rivers in 14 different countries.

When specifying further, it is possible to pin-point the rivers being responsible for the highest emission rates and thus the related (and responsible) countries. Firstly, the premise that plastic pollution is dominant in areas where local waste management practices are poor is strengthened. Where management lacks, there is simply more plastic waste to eventually end up in rivers to begin with. Secondly, cities tend to be located near the most polluting rivers. Cities have more inhabitants than rural areas and include more paved surfaces where water and waste can drain into sewers and rivers. Thirdly, strong polluting rivers do not only have cities nearby, but appear also close to coastlines, indicating the importance of distance (Ritchie, 2021).

Considering continents, it is stated that Asia accounts **81%** of global plastic inputs into seas (Meijer et al., 2021), an estimate that is comparable with studies from 2017 Lebreton et al. (2017). Following Asia at a polite distance are Africa with 8%, South America with 5.5%, North America with 4.5% and Europe and Oceania with less than 1% combined. Even when taking into account Asia's 60% share of the world's total population (i.e. in 2021), the actual and absolute contribution of 81% to global plastic marine pollution is far more that proportional, resulting in opportunities to improve the situation in Asia.

The largest difference in studies over the years, is the change in defining the highest polluting rivers. Previous studies indicated that the highest pollution came from the (geographically) largest rivers in Asia, mainly being in China and India. Meijer et al. (2021) elaborates on this and corrects it with models based on higher resolution data from monitoring and state that the most polluted river is the Pasig River in the Philippines, solely accounting for 6.4% of the global input. Furthermore, seven of the top ten critical rivers are found in the Philippines, two in India and one in Malaysia.

2.4 Existing efforts and innovation

Research may be in it's early stages (Blettler et al., 2018), but development takes place on all fronts, meaning that not only researchers are actively looking for answers, but also organisations and individuals are empirically attempting to exploit what they see as opportunities to better the world. In addition to that, waste collection is not something new, it has been around for decades, if not centuries. Looking for marine pollution solutions, more specifically addressed to riverine plastic, is what adds novelty.

This year Winterstetter et al. (2021) conducted a study to assess availability of techno-commercial solutions to the marine litter problem. Out of 75 submitted solutions, a selection is made of 51 along the complete plastic pollution and value chain, including detection and capture. Most of these solutions are at an advanced level of commercialisation. However, none have achieved sufficient scale to make significant impact on marine plastic pollution. Promising is that a some of the solutions have already been tested *and* are operating in targeted countries. Solutions for developing countries tend to combine technology with people-oriented practices, require low amounts of energy, connect throughout the plastic value chain with valorisation plans and create jobs. Many suggested projects combine policy circumstances with innovations on the fronts of product design, processes and business models, in order to impact the value chain of plastics.

Another study by Schmaltz et al. (2020) attempts to clarify the scattered information of emerging technologies to prevent and collect marine plastic pollution by creating an inventory. This is done by systemically searching and reviewing resources that identify the technologies. The inventory organizes the technologies by type and target plastics (i.e. macro- and/or micro-plastics) The study identifies 52 technologies that fall into categories of prevention or collection, of which 78% are focusing on collection of plastics already in the environment and 59% specifically focus on macro-plastics. Schmaltz et al. (2020) say that whilst efforts deserve praise, current capacity and widespread implementation are limited compared to the potential of the technologies. At this moment, many of the existing initiatives are scattered around the world, missing a national and international linkage of regulation and cooperation to create and sustain significance (The Benioff Ocean Initiative, 2019). The technologies alone cannot tackle the plastic pollution problem. Many challenges like scale, target plastic, associated cost with technological or social implementation, deployment location and so on highlight the need for collaborative efforts across multiple fields (Cordier and Uehara, 2019).

This section will shed light on technical methods that are designed to be deployed in order to attack riverine plastic pollution and ways to process and potentially give value to the plastic caught. The goal is to be generic in description, hence organizations and their influence will not yet be analysed and stated, as that limits

objectivity of the literature review. Furthermore, the scope of this section and of the report as a whole is limited to solutions for *riverine plastics and its collection.*

This section is based on several findings, which sources are not always academic of nature. It must be stated that not everything is academically published as method for riverine plastic recovery specifically. When, for instance, considering a submerged net it can be conclude that this could have a multitude of uses. This section is based on conceptual ideas and practised concepts found on- and offline. For supplementary information, Appendix A establishes a list of all the technologies, in combination with the organisations that use them. The main source for overviews of technology is non-academic related internet articles and websites. Technologies are confirmed to exist or having a change of development in case of multiple reporting on different websites.

2.4.1 Riverine Recovery Landscape

Plastic recovery or collection innovation is a very broad concept, with technologies varying from household wastewater filters and laundry balls to large-scale boats and traps(Winterstetter et al., 2021). When searching and researching these innovations, it is kept in mind that the scope of this specific report concerns the possibilities of riverine plastic recovery systems, hence household filters and oceanic collection systems have not been taken into further account than a formal scan, and won't be included into this section. The same holds for sewage filters, as these are for *prevention* and not collection. The aim of this paragraph is to give an overview of the available systems or concepts taken into consideration for riverine plastic collection in the most generic way, as a survey of different classifications. Connections to specific organisations, for example, are not yet investigated in detail, though the databases from said groups are potential sources for information on categories (The Benioff Ocean Initiative, 2019).

When narrowing the scope to riverine plastic recovery systems, variation is still significant, creating a need to classify. There are many different examples of systems(Lebreton et al., 2017)(Schmaltz et al., 2020), some distinctly unique, some extensions of previous concepts. To create a useful overview, several layers are applied and the most direct one being *within the scope this study* the distinction between *active* and *passive* systems. This is easily explained, but key in understanding analysis of this report. An active system is defined as a system that is actively catching plastic and thus in need of continuous human control or input when in operation (Winterstetter et al., 2021). Many features that active systems often possess involve moving parts, dynamic tools and (high) external energy use, but these do not specifically define whether a system is active. This is because several of the identified systems did not require continuous human control, but still could possess at least one of these dynamic features. *Passive systems* then do not

require continuous human control or input and when set in place can collect plastic debris with minimal human interference (Winterstetter et al., 2021), as same will only be required e.g. on moments of maintenance or emptying. The Benioff Ocean Initiative (2019) provided specific categories, to which they address the lion's share of the riverine plastic catchers. Schmaltz et al. (2020) did something similar, creating classifications for collection and prevention techniques. These categories have been assessed and reorganised in this report, explained below. Firstly, those classified as 'active', followed by those classified as 'passive'. Active systems play a smaller role in this report than the passive ones, but clarification is necessary for the complete picture.

ACTIVE SOLUTIONS

Manual collection

Manual collection is the most intuitive method of recovery, requiring little to no innovation or technology. On the other hand, manual collection does require a high level of organisation and depends heavily on willingness of the people involved (Science and Technology Inc., 2015). There are many different types of manual collection, varying strongly in scale. In 2018, around twelve thousand (12.000) people volunteered to clean Britain's public places like streets, beaches, parks and riverbanks (Nations, 2018). On the other side of the globe, seven thousand military personnel have been deployed to clean up Citarum River in Indonesia (Hasibuan, 2018). Smaller-scale clean-up activities are organised all over the world, where a handful of volunteers gather at a predetermined location, e.g. a beach, to clean up litter. When consulting regular search engines on the internet, a broad range of activities and events can be found when using search terms as "plastic picking", "volunteer plastic clean up" and comparable. These do not pass requirements for official literature resources but do give an indication of the vastness of projects. Social media (think of *Youtube*, *Facebook* and the likes) show videos with millions of views. What has been researched, is the impact and consequences of litter picking. Some critics do compare manual litter picking with an overflowing sink: " there is no point in mopping the floor until the tap is closed" (Nations, 2018). Other studies however, review this stand-point as incomplete, as manual labour can contribute to more than one factor. For example, van Giezen and Wiegmans (2020) state that volunteer beach clean-up groups work to branch out and scale up impacts by combining several plastic pollution facets, bringing together members of society, collaborating with socially more varied groups than usual and contributing significantly to social awareness and acceptance of plastic pollution reaching global scale. One study even finds manual collection is probably the most effective and efficient cleanup solution for a specific location in both amount of litter removed from the river as well as cost per weight of litter removed (Science and Technology Inc., 2015).

Operated Vehicles

One step further in using technology and innovation in riverine plastic recovery, is the use of manned vehicles. This is considered a form of active collection as well, as the vehicles discussed are manned at times of operation. There are a multitude of small scale projects, using boats and other vehicles to collect plastic from waterways, think of governmental of municipal cleanup projects. Commonly, litter recovery vehicles are referred to as *"trash skimmers"* and various examples are found when roaming web search engines (4ocean, 2019) (Infra, 2009) and they are widely available on purchasing websites like *Alibaba*. They mainly operate as skimmers in combination with conveyor belts and have on-board storage for a certain amount of debris. Scale of the boats is, naturally, variable, so they are available for any size of waterway and have been deployed in countries like the U.S.A. (The Benioff Ocean Initiative, 2019) as well as India (Infra, 2009). Other examples are available in Appendix A.

PASSIVE SOLUTIONS AND PARTS

River-booms

Schmaltz et al. (2020) define several different types of booms and barriers, which are collected in this report as one, as the differentiation on rivers is limited, where Schmaltz et al. (2020) also reviews oceanic barriers. Booms and barriers are self-explanatory in designation. In terms of technological complexity, booms and barriers are relatively uncomplicated. A boom is a floating structure that generally - but not necessarily - stretches across the width of a waterway, allowing water to pass but preventing floating surface debris to do so (Gasperi et al., 2014). Originally, booms are designed to contain oil spills on surface waters, during this process it turned out they functioned as well as plastic barrier. A multitude of these structures, ranging from large barriers that sit in coastal waters collecting plastic as it flows out of river mouths to smaller ones that redirect plastic waste into cages or dumpster-like baskets, have been successfully deployed in rivers (Elastec, nd). A lot of collection methods make use of booms and through their simplicity they form a useful addition to other innovations. Booms are often made primarily out of polymers, where caution of damage is important for environmental risk management. Often, these booms and collection devices can be tailored to account for river size and site- or season-specific weather events, like storms, that result in large fluxes of water and thus plastic pollution (The Benioff Ocean Initiative, 2019). Booms can be installed independently functioning both as guidance as well as container, in need of emptying, inspection and maintenance once every specified period. Booms can also be deployed in combination with receptacles, which to be elaborated on in the next bit. Booms are the most conventional types of barriers used in marine debris guidance and collection.

Receptacles

While booms divert and aggregate plastic pollution, the debris is still in need of removal from riverine environment. Although, as stated above, booms can function independently, their main characteristic is debris guidance (Gasperi et al., 2014). Storage of large amounts of waste are necessary in order to increase capacity, therefor receptacles have been introduced. A receptacle is defined as a hollow object or container used for storage containment. The most basic form of receptacle is that of a cage, semi-submerged into a waterway, through which water can flow as unrestricted as possible, without letting predetermined sizes of debris pass. These receptacles come in many sizes and other forms of containers and are all designed to catch and *store* riverine debris. They vary in complexity in the same way as booms and barriers.

Combinations and innovations

The described passive systems can be regarded as independently deployable both as well as parts of a combined system. These basic components have been described to allow visualisation, yet the creativity is mainly reflected in combinations of components and innovative additions. A myriad of these combinations and innovations have been introduced to the global plastic cleanup landscape (The Benioff Ocean Initiative, 2019). As stated above, booms are the most conventional of barriers available, but certainly not the only ones. There is a multitude of innovative methods used to form barriers, varying from nets (Systems, 2020) to floating rotating devices that guide debris without limiting waterway traffic passage (RiverCleaning, 2021) to air induced curtains creating not only flow direction but forcing submerged plastics to the surface, guiding those to a specified destination (Spaargaren, 2018). Not only barriers are subject to innovative alteration, different receptacles have been considered over the past years as well. These cover large cages (Allseas Engineering, 2021), durable litter traps (Clearrivers, 2021) and submerged bins that circulate and filter water (Langford, 2017). Barriers are often combined with receptacles of all sizes. This is not where extension and innovations end, though. Most concepts include innovative methods of emptying the storage and dealing with the collected debris, attempt to send messages and improve societal environment. The best known of the innovative riverine plastic collection systems is the *Interceptor #*, created by 'Stichting The Ocean Cleanup' (The Ocean Cleanup, 2021a), but a pioneer can trigger others to follow, shown by various other creative methods (Snow, 2021)(McLaughlin, 2021). The search for available concepts points out that there are many launched and developing ideas, all varying on different levels of collecting, storing and emptying. A myriad of projects and ideas have been initiated in the past decade (Schmaltz et al., 2020), waiting to either reach success or fail, nonetheless supplying valuable data along the way.

2.4.2 Processing the catch

Creative concepts involving collecting, storing and transporting plastics out of the rivers, meet one question in order to reach a full cycle: 'What to do with the catch?'. The catch consists of trash, rubbish, debris, in essence materials and objects deemed useless and being discarded of. The need to do something with the waste is something that all concepts share. In the process of valorisation, this waste is alongside clean water part of the end product, which ideally should be involved in the valorisation (Dijkstra et al., 2021). Assumed is that direct sale of trash will not be feasible or attractive, so the scope of this section is recycling and repurposing. In brief, only a small section of plastics get recycled - 9% in the U.S. and 15% in Europe (Pool, 2020).

For recycling and reprocessing of plastic litter, there are three main techniques: mechanical reprocessing (primary and secondary), thermal recuperation, and chemical depolymerization. It is actually difficult to recycle plastic technically and economically due to the poor waste separation, high cost of energy, lack of fiscal incentives, contamination by several other materials, and unstable market outlook (Hahladakis et al., 2018)(Inamuddin et al., 2021). This is important information, suggesting a challenge. The coming years will tell whether a real change can be achieved in plastic recycling. In this context, chemical recycling can play an important role as plastic use can only be decreased to a limited extent and better package design, that is by avoiding composite and multilayer materials, can only facilitate recycling, while not eliminating the plastic waste problem (Vollmer et al., 2020). The techniques will be shortly addressed below.

Mechanical recycling

Mechanical recycling is the processing of plastic waste into secondary raw materials or products, where the chemical compounds of the plastics are not reorganised or broken down. The three important steps involved are processing, granulating, and cutting. The homogeneous plastic wastes are used to produce the products with almost similar or slightly lower in terms of durability and mechanical strength, than the original product (Inamuddin et al., 2021). The waste is mechanically shredded, washed and molten by an extruder. Then, in the same process, plastic granules or fibers are produced from it again (Ragaert et al., 2017). This form of recycling is particularly suitable for waste streams of one type of clean plastic. In principle, all (clean) thermoplastics can be mechanically recycled with little or even no loss of quality. However, plastic waste is often a contaminated mix of materials, hence the mechanically recycled plastic can contain contaminants and the quality of the end product eventually decreases. For this reason, strict rules also apply to the use of recycled granulate in products like food packaging. In addition, mismanaged waste consists of a high percentage of contaminants that comprehend mechanical recycling. For *industrial-scale* production of recycled and

managed plastic, the thermoplastic waste is recycled through a mechanical recycling process. Here, it gives reliable quality control, and consistent source of feed stocks, due to large amounts of clean waste plastics, sometimes with efficiencies nearing 100% (Inamuddin et al., 2021). These efficiencies are nigh impossible to reach with recovered household plastic waste due to higher levels of contamination. Mechanical recycling is the current industrially ubiquitous technique for the recovery of waste polymers and different technological aspects of sorting and reprocessing do exist. The challenges of mechanical recycling are associated with contamination or mixing of various types of plastic in waste, lowering purity and quality of the recycled product (Ragaert et al., 2017).

Chemical Recycling

A step further stands chemical recycling, also known as 'feedstock recovery', which can treat mixed or contaminated plastic waste that cannot be recycled via standard mechanical recycling (Pool, 2020). With chemical recycling technologies, the recycling industry has developed complementary solutions to existing mechanical recycling to recycle mixed or contaminated plastic waste that otherwise would be incinerated or sent to landfill (PlasticsEurope, 2020). However, it has to be stressed that chemically recycled polymers are more expensive than the virgin material because of the raw material cost, capital investment, and scale of operation (Ragaert et al., 2017). The most important difference between chemical and mechanical recycling is that in mechanical recycling, material is not broken down to its essences or building blocks, but shredded into smaller pieces of the same material. With feedstock recycling on the other hand, the plastic is deconstructed down to it's building blocks in the form of monomers via depolymerisation, polymers via dissolution or feedstock (oils and fuels) via conversion (Ragaert et al., 2017). Chemical recycling is often linked to a circular use of plastics, where end-of-life treatments aim to re-use the plastic as a resource again (Vollmer et al., 2020). Figure 2.7 visualises the different pathways of recycling plastics mechanically or chemically. The figure also involves the additionally needed resources for most chemical recycling processes.

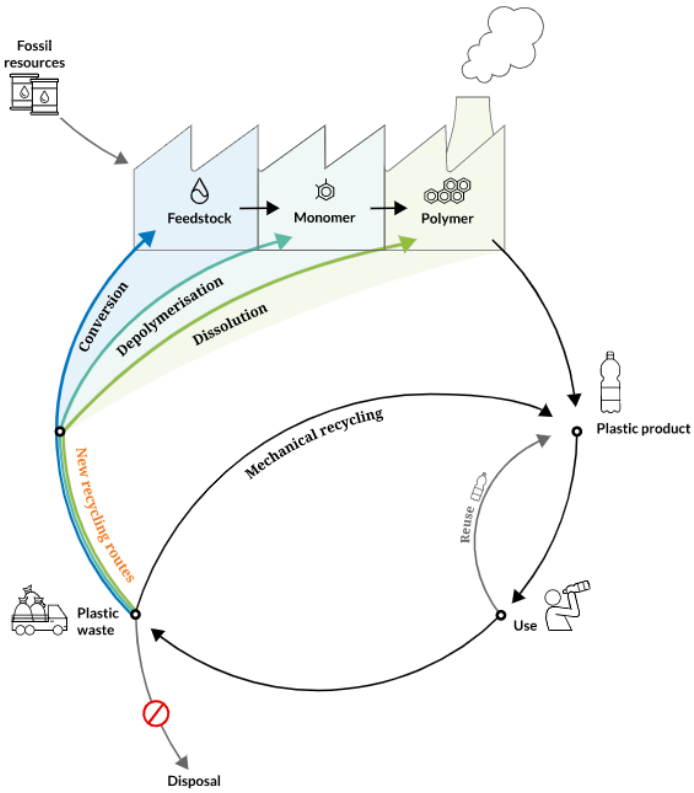

Figure 2.7: Mechanical or chemical recycling paths for plastics (Pool, 2020)

Waste-to-energy

The third main method of recycling plastics is better expressed as repurposing plastics, as it uses plastic waste to generate electrical energy (Moustakas et al., 2020). Energy recovery from waste means the conversion of waste into usable heat, electricity, or fuel through a variety of processes, including combustion, gasification, anaerobic digestion, and landfill gas recovery. The most common thermal treatment is incineration, where plastic waste is incinerated and the heat is used to power electrical generators. Less common is the so-called advanced thermal treatment (ATT) implying technologies such as gasification or pyrolysis (European Bioplastics e.V., 2015), both to be classified as chemical recycling. Several waste-to-energy (WtE) technologies have been developed and successfully used at industrial scale to recover energy and products in different countries (Moustakas et al., 2020). The European Union monitors and publishes its post-consumer waste treatments, where in 2018 42.6% of plastic waste has been used in energy recovery processes, 32.5% of it is recycled in other ways and 24.9% reached a destination in landfills (PlasticsEurope, 2020)

2.5 An Industry and Market

In previous sections the current knowledge about riverine plastics and the landscape of plastic innovation have been discussed. The surrounding facts of the environment form the basis, market analysis theory can form the bridge to deployment. In the modern age, many ideas have been formed with good intention, or ideas that were technically astonishing, that did not take off due to the lack of market analysis. The market analysis aspect can ensure success or failure, depending on how structured it will be executed (Lucas Jr and Goh, 2009). This report starts with the definition of a market in the most simplified form: "A market is an arrangement between buyers and sellers to exchange goods or services for money" (Robinson, 2017). Markets are the fundamental means by which scarce resources are priced, and are essential to the operation of the price mechanism. This broad and rudimentary perspective is later on assisted by a focus on the framework called the *Multi-level Perspective* (MLP), which is widely used to study the emergence and growth of the new technological fields and industries (Markard et al., 2015).

2.5.1 Market formation

Markets and industries can only be established when certain conditions are present, without which nothing will take off. Not yet specifically focusing on the *Technology Innovation System* or *Multi-level Perspective*, the most important conditions are as follows (Markard et al., 2015)(Himmelweit et al., 2001)(Porter, 1980):

- **Buyers** - Without demand, no chance on sales
- **Purchasing power** - Consumer resources need to allow purchase
- **Sellers** - At least one entity needs to offer the demanded
- **Knowledge balance** - To prevent one party of exploiting advantage
- **Means of communication** - Dynamic exchange of information
- **Medium of exchange** - Unit that provides exchanges and transactions

These factors fulfil a necessary role in the structure of a healthy market, forming the basis for products and services to be bought and sold.

2.5.2 Market life cycle

In the previous chapters it has been stressed that research on riverine plastic is in its infancy, which could be a link to an important aspect in the market analysis, namely the life cycle stage of the market or industry. Figure 2.8 shows the standard stages of an industry and similarly of a product within that industry.

The stages are assumed self-explanatory. During the development stage, an idea is invented and a possible market presents itself, for that single product. The growth

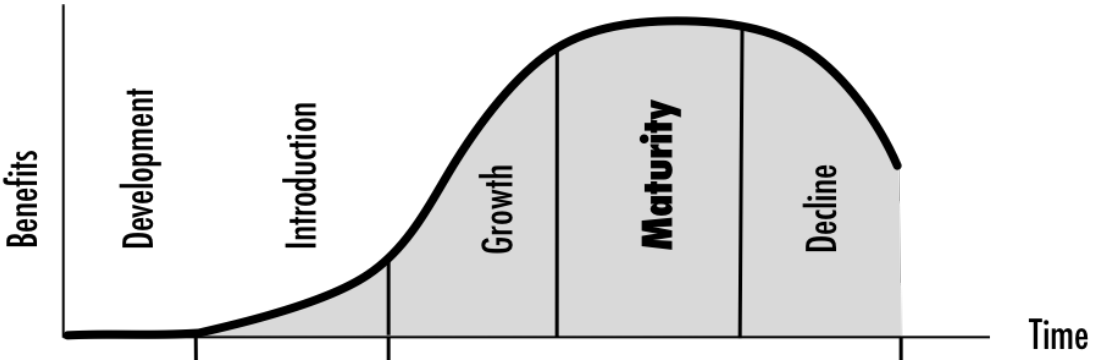

Figure 2.8: Industry life-cycle stages

stage indicates the acceptance of an innovation, standardisation of production develops and competitors have shown up, creating dynamic development parallel to sales. A market is mature when this development noticeably slows without decline in sales revenues, competition has stabilised with only a few late entry competitors. The time span varies per industry, but the decline stage has proven to be almost inevitable, where pace with replacement or competition is lost, leading to an industry become antiquated (Editorial, 2021) (Klepper, 1996) (Audretsch and Feldman, 1996). Ortt et al. (2010) address a similar approach, with different designations of the phases: a pre-diffusion phase, consisting of an Innovation Stage and an Adaptation Stage, followed by the Market Stabilisation phase. This offers a comparable dimension, where diffusion is a key element determined by innovating and perfecting up until the moment of maturity.

2.5.3 Sustainable Transition Perspective

There are different frameworks and perspectives used to execute and review these standard market analyses in greater detail and within a technological field. This report has found the so-called *Multi-Level Perspective* to be the favorable tool to use in assessing the world of plastic recovery systems.

Transitions and the Multi-level Perspective (MLP)

Technological change never occurs overnight, it is part of a certain non-linear shift in standards, hence technological change is inseparably connected with transitions (Loorbach et al., 2017). Increasingly, sustainability has become a key topic of the 21^{st} century, serving the amount of research done in the field of sustainable transition theory and technological transition theory. The 'Energy-Transition' is one of the best examples of gradual transitions. It is best described as an unpredictable nonlinear process without drastic changes over night. At least since the 1970's, parts of the public have called upon policy makers to find renewable alternatives to fossil fuels and create more energy efficient ways of living (Loorbach et al., 2017). Yet,

noticeable actions have been implemented mostly in the past fifteen years and in rich and developed countries. The energy environment is turbulent, with technological innovations disrupting markets, fossil fuel companies put under pressure resulting in efforts to survive, and strong changes in popularity and thus use of energy resources (Grubler, 2012). This example is influenced by public opinion and newcomers in the field, ranging from big-tech companies like Google and Amazon, to automotive conglomerates, to furniture stores changing product energy consumption. This shows that transitions are not just technical of nature, but are supported by an important societal aspect too (Geels, 2019).

It is important to understand these transitional paths towards sustainability. This report has simplified the terms of conditions regarding socio-technological transitions and systems, in order to produce clear a subsection. The focus is on the ways it could be beneficially used in the plastic pollution environment. Studies on the field of transitions have been around for over a hundred years (Loorbach et al., 2017), showing the core concept of viewing a target area as a multi-layer system. This report has used several ways of identifying the plastic pollution and its 'surroundings', which can be addressed more effectively in this multi-layer overview, called the ***"Multi-Level Perspective"*** (MLP). This perspective pictures the world as build up of socio-technical systems, consisting of people and the way they use technology. Within these systems, it designates three different levels within which the transitional process takes place, which are called *'Niche'* (micro), *'Regime'* (meso), *'Landscape'* (macro), visualised in figure 2.9.

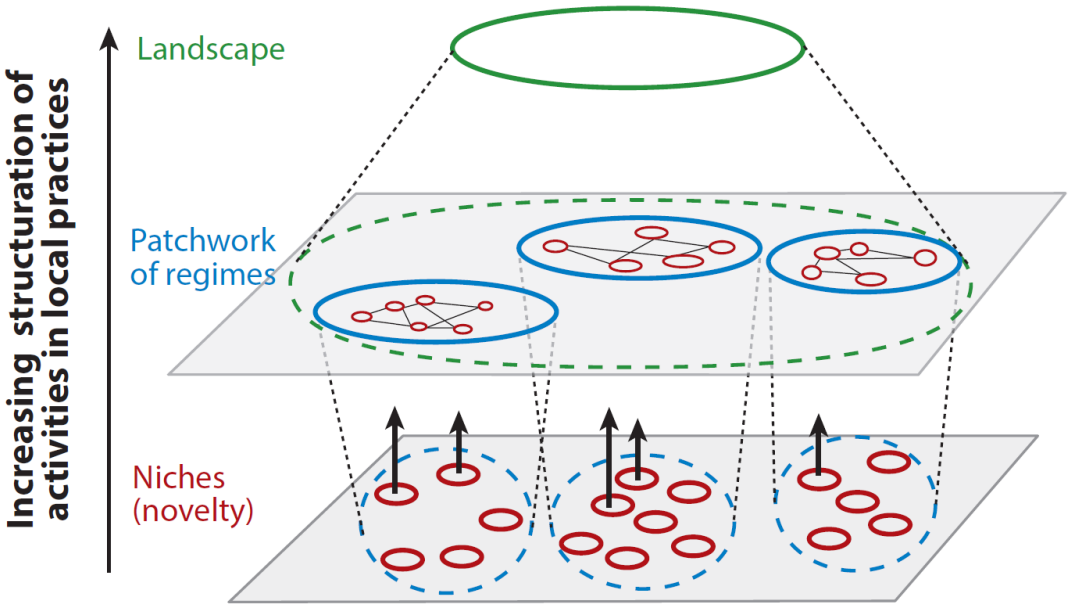

Figure 2.9: The three level of the MLP
(Loorbach et al., 2017)

Within this perspective it should be stated that these levels are not describing tangible every day events. The levels are formed as methods to aid understanding socio-technical transitions (Geels, 2019). In short, the world consists of *socio-technical systems*. A system consists of social norms and technical structures that form the mainstream activities performed in the system, called the *regime*. This structure is influenced by trends and strongly differs locally and globally. These external influences affecting change (scarcity, price fluctuation, overpopulation, awareness, etc) form another level referred to as the *landscape*. Within the landscape and regime, there are 'spaces' that are perceptive yet protected from the societal influence where people with ideas can group together and start developing their concepts into products (e.g. R&D departments, universities etc). In these places 'out of the box' thinking is practiced, thus developing ideas that reside outside the mainstream regime, called *niche* developments. When one of these new ideas catches a handful of consumers within a regime to start using it, it might take on and, influenced by forces from the landscape, become a new force to change the standards, i.e. alter the regime (Geels, 2002)(Geels, 2019). This alteration embodies a nonlinear and time-consuming transition, which can be envisioned by consulting figure 2.10.

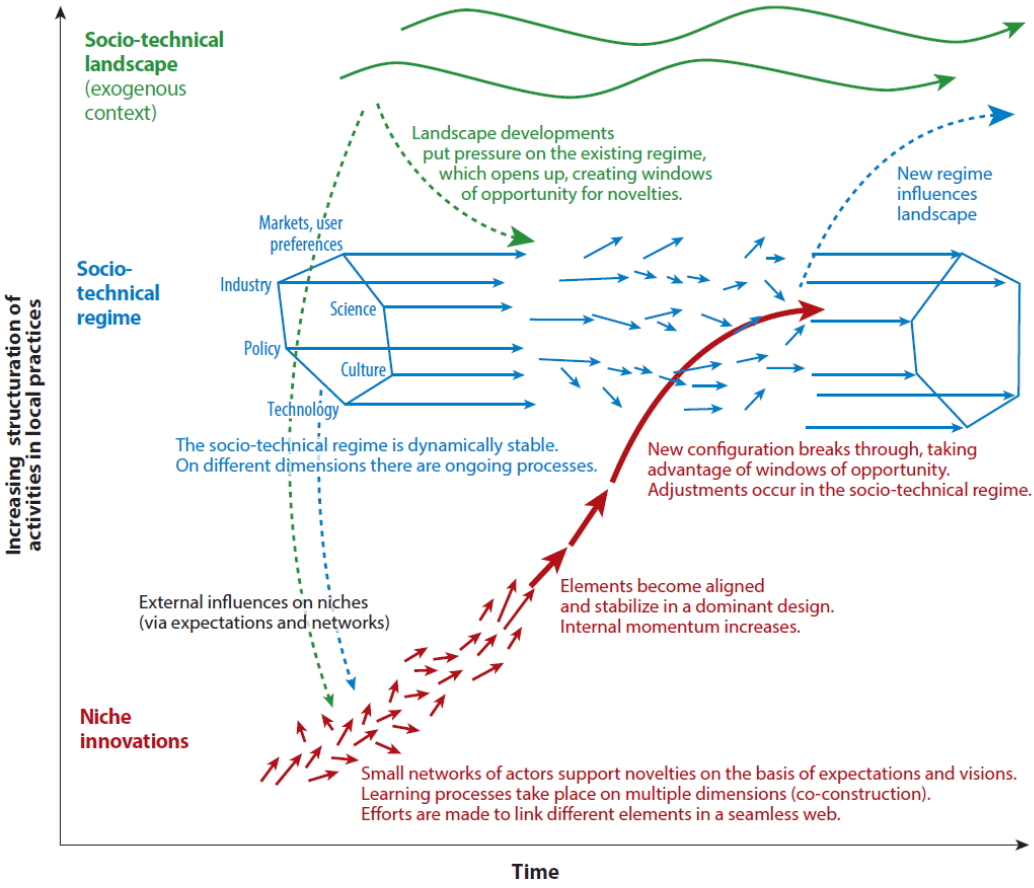

Figure 2.10: Transition using the Multi level Perspective (Loorbach et al., 2017)

2.6 The Business Model, Innovation and Sustainability

The road to balancing information for the scope of this report has defined the surrounding information and theory deemed relevant. Yet, encompassing details only partially provide the resources needed for realising a strategy. Information about a company as an entity and data from within this company are essential reaching the goal. This section elaborates on theories that have been proven to assist business from within, complementing outside information a business has gathered. In the process of '*doing*' business, there is an abundance of different tools that offer direction and instruction of which this report has made a selection. A specification of a standard business model forms the basis, the 'Business Model Canvas' of Osterwalder and Pigneur (2010) extend on this and further details follow when 'Sustainable Business Models' are amplified.

2.6.1 A Business model and Osterwalder's Canvas

A primal part of business activity is knowing how to do business and defining which business to be focused on. There are many ways of elaborating on what business to propagate, for which equally many terms of use exist, think of 'strategy', 'business concept', 'business model', 'revenue model' and so on (DaSilva and Trkman, 2014), used unintentionally intertwined. The term '*Business Model*' is one of the most used and one of the most recognised of these terms, though often misinterpreted (DaSilva and Trkman, 2014).To avoid misuse, this report will initially use a literature based standard definition of a business model, which then is followed by explanation. The term 'Business Model' consists of two separate terms that are in need of clarification individually, in order to deliver a complete overview. Firstly, Osterwalder et al. (2005) define the term 'business' and respectively the term 'model' as follows:

"the activity of providing goods and services involving financial, commercial and industrial aspects."

"a simplified description and representation of a complex entity or process."

Osterwalder et al. (2005) proceed to combine these descriptions into a proposed academic definition for the term 'Business Model' (BM), that is as follows

"A business model is a conceptual tool containing a set of objects, concepts and their relationships with the objective to express the business logic of a specific firm. Therefore, it must be considered which concepts and relationships allow a simplified

description and representations of what value is provided to customers, how this is done and with which financial consequences."

Having written down a definition for a business model, it will be referred to as ***BM*** from now on. As there have been many varying definitions through the years (DaSilva and Trkman, 2014), Osterwalder et al. (2005) kept their proposition sufficiently wide in order to be able to take most of previous definitions into account as well. In short and layman's terms, it revolves around specified proposition, creation & delivery and capturing of a predetermined value (Chesbrough, 2007), hence it is essentially an elaborate description or a blueprint of how a firm converts its resources and competence into financial value, taking into account all elements involved. Osterwalder and Pigneur (2010) devised a clear tool, called the *'Business Model Canvas'* (BMC) that represents these core factors and classifies them in nine building blocks stated and visualised in figure 2.11:

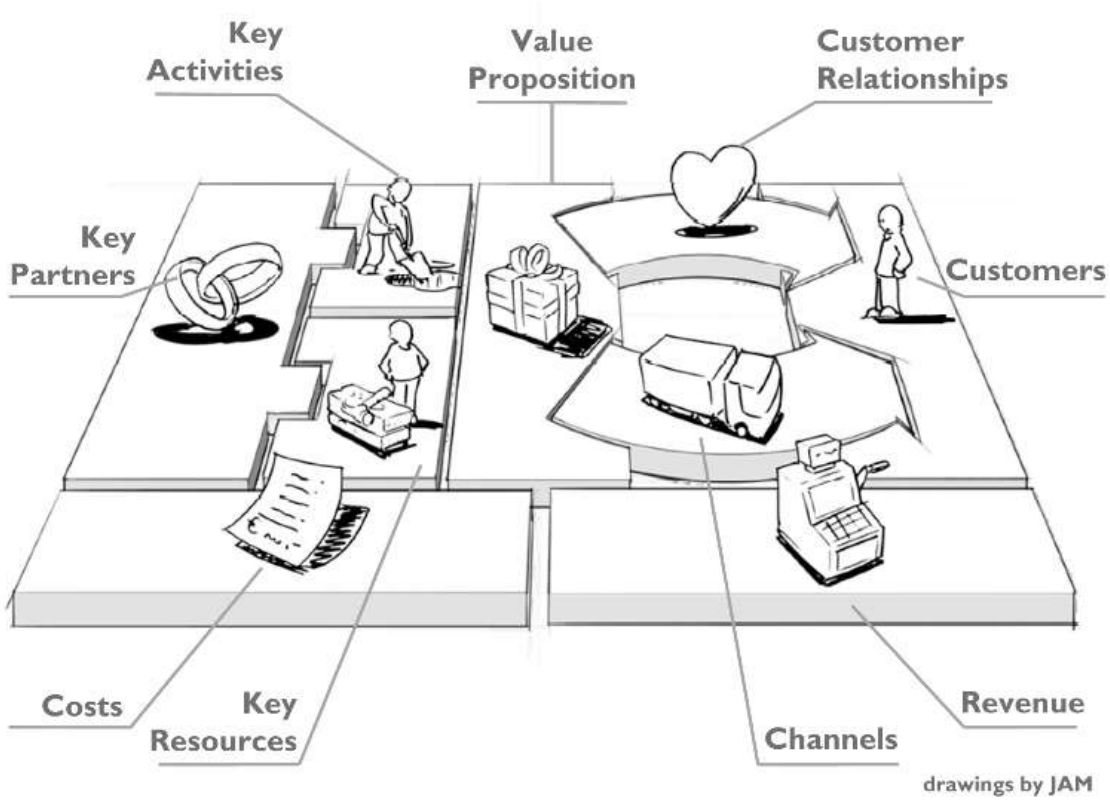

Figure 2.11: Business Model Canvas
(Osterwalder and Pigneur, 2010)

These building blocks are the essence of a BM and differ per firm or company, therefor this canvas earns its name. The blocks can be seen as sections of a report, where the structure is known but the detailed information has to be filled in by the entity.

2.6.2 Business Model Innovation and Sustainability

Having stated the definition for a BM, it's broadness stands out. The concept was first used on academic level in the year 1957 (Osterwalder et al., 2005), indicating a certain grade of dynamic ability, as the BM's of today differ strongly. Through the decades, different trends and demands passed in review that affected or enforced change in the way business was managed. This is an articulation of innovation as enterprises nurture new BM's in order to improve, as to be a step ahead. No BM, despite the rate of success, is everlasting (Chesbrough, 2007). Chesbrough (2007) constructed a framework for ranking BM quality, encouraging development, which is one of various inducers of 'Business Model Innovation', where the meaning of a (well performing) BM is thoroughly emphasized. It is progressively identified as a pivotal factor to delivering higher sustainability impact, in communal and environmental fields, by initiating change in the industrial system (Bocken et al., 2014), but a unanimous consensus on the embedding and direction of this BM innovation seems unlikely.

As mentioned before, one external influence or trend that affects business in the 21^{st} century is *sustainability*, resulting in specific adaptations of BM's aiming to following on that trend. Innovation in Sustainable Business Models demands creating preferable customer and company value by pin-pointing societal and environmental needs (Boons and Lüdeke-Freund, 2013). Many studies have proposed specific perspectives on the subject; Bocken et al. (2014) propose a well known example that lays a foundation for Joyce and Paquin (2016), who propose an extension on Osterwalder's Canvas used in this research. The extension is implemented to specifically accentuate the sustainable input into doing business and using business models. According to Joyce and Paquin (2016), the standard Osterwalder's Canvas, although leaving room for sustainable input, does not encourage adding sustainability aspects, as it mainly considers making profit or creating economic value. Joyce and Paquin (2016) devised an expansion of the standard canvas, by adding two layers, resulting in the *'Triple Layer Business Model Canvas'* (TLBMC). The already accepted standard form of the Osterwalder canvas turned into a layer of economic value, whereas they added a layer for environmental aspects and societal aspects to end up with three layers. These extra layers are both constructed with similar building blocks as the default canvas, but the nine sections are slightly tilted towards the main theme of the layer as shown in the figures 2.12 and 2.13.

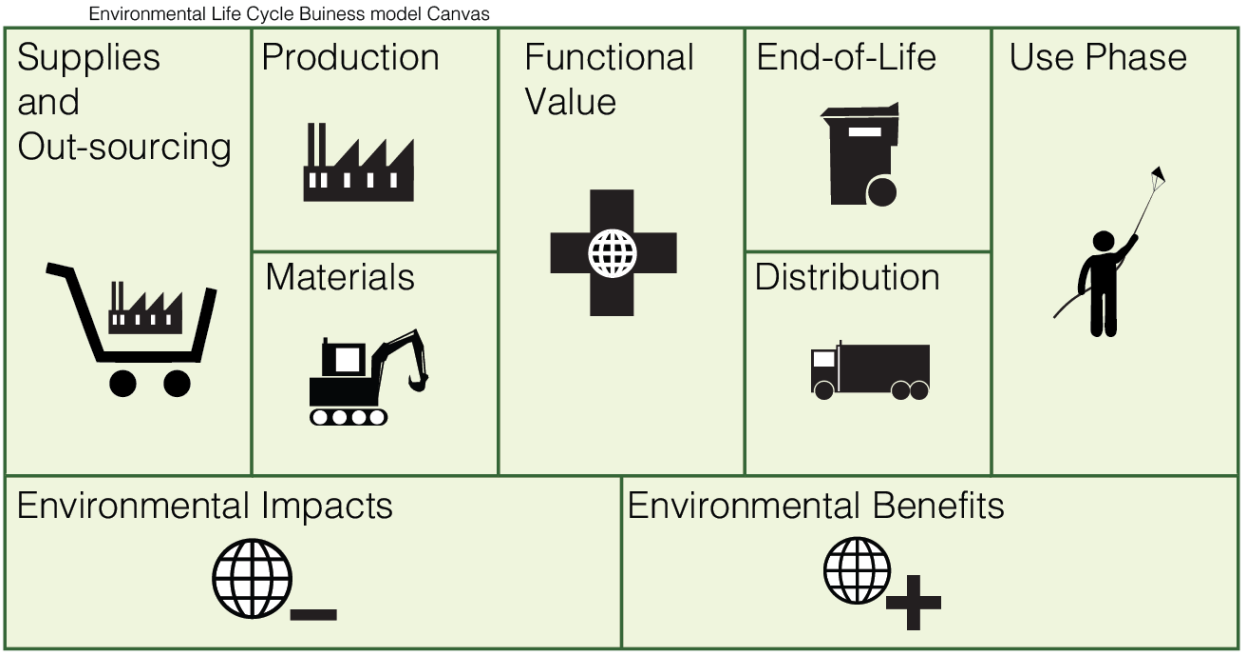

Figure 2.12: TLBMC environmental layer
(Joyce and Paquin, 2016)

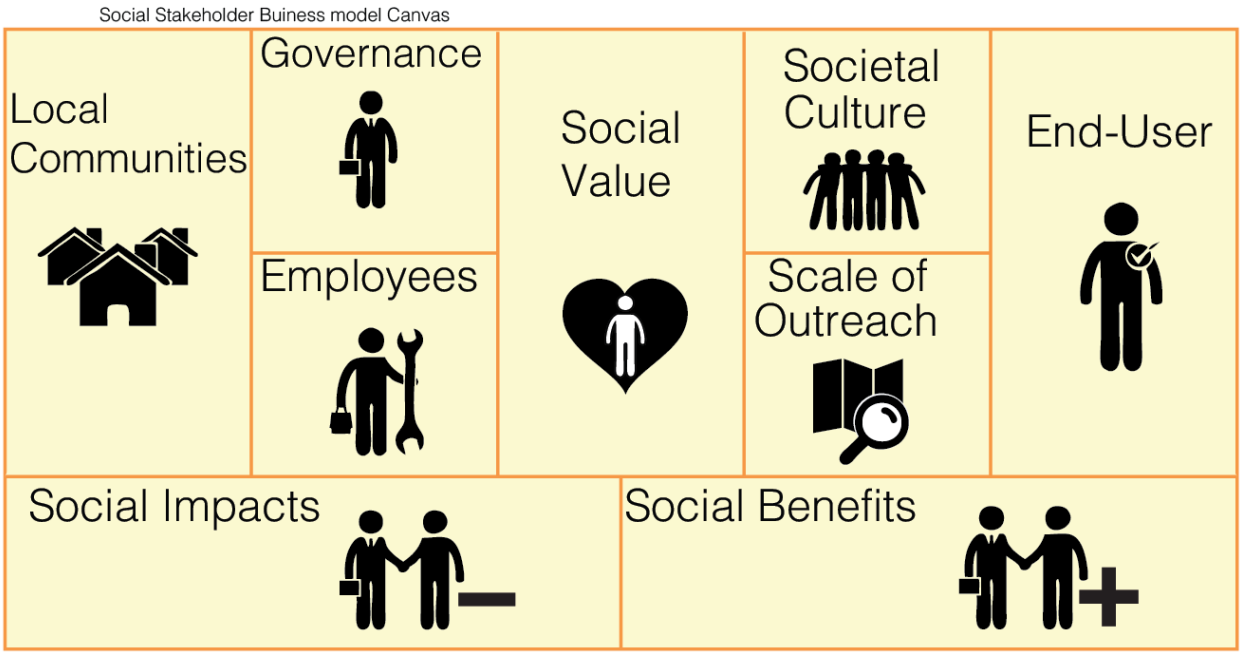

Figure 2.13: TLBMC societal layer
(Joyce and Paquin, 2016)

2.6.3 Plastic business development

At the closing part of this literature review a final piece of literature has to be mentioned. Discussed are riverine plastics and their recovery systems, as well as the market environment, different perspectives and the utility of BM's, sustainability and innovation in general. The missing link can be identified as research into BM application and innovation within the landscape of plastic pollution. Although emerging only recently, all research exercised should be considered in order to avoid unnecessary and unwanted duplication.

Both Dijkstra et al. (2020), Dijkstra et al. (2021) and Winterstetter et al. (2021) have written studies in recent years which are deemed important for this research of a global deployment framework. Central themes consider the review of an available BM that take plastic pollution in any form into account, including its recovery from waterways. Dijkstra et al. (2020) state that the knowledge of sustainable BM's on academic level could support implementing the superior technologies and services, which can attribute to conquer possible barriers more easily. A literature assessment devoted to implementation of innovation that seeks to diminish harm to the environment by plastic contamination is conducted to BM's. BM's revolving around plastic pollution are categorised in different types, recovery being one of them. These categories are then ranked according to financial opportunities and environmental externalities in the so-called *waste hierarchy*, depicted in figure 2.14 (Dijkstra et al., 2020)

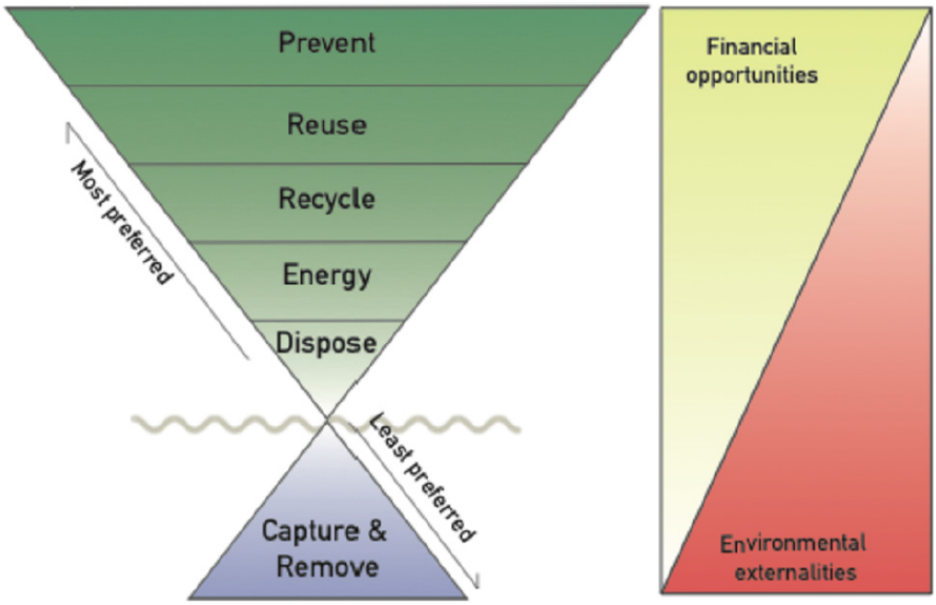

Figure 2.14: Plastic waste hierarchy
(Dijkstra et al., 2020)

This hierarchy states that capturing and removing plastic that already contaminated an environment, is least preferable. This can be attributed to the facts that this is only possible when pollution has already damaged nature, plastics are degraded and prevention is often not included in capturing operations. However, it is also stated that neglecting the plastics already dumped in the environment can lead to serious environmental and societal problems (Revel et al., 2018), resulting in a *necessity* of removal. In addition, Winterstetter et al. (2021) conclude that innovations which attack land-based inputs of plastics in the environment are more worthwhile than oceanic collection, hence should be the preferred option when attempting recovery.

Although required, plastic recovery and collection from the riverine or oceanic environment is seen as a **short-term** approach in the transition towards global sustainable plastic management (SPM) (Dijkstra et al., 2021). Plastic pollution is not demanding just a single solution, but for structural societal change, which only to be achieved gradually. Studies indicate that the industry of sustainable and marine plastic management is growing (Dijkstra et al., 2021) and prove that the majority of companies and start-ups involved, focus on the removal and collection of plastics. This is not necessarily in line with the waste hierarchy expectations. When singling out some companies' and start-up's BM's, this is explained by a combination of capturing plastic with creating awareness of the dangers. Visualising heavily polluted the consequences shows to be a tangible way of addressing the plastic problem. This visualisation results in and increase in demand for a more sustainable way of living. This creates an opportunities to climb the ladder of the waste hierarchy on the long-term, when combining several aspects.

Finally, Helinski et al. (2021) have developed a selection framework from the customer's perspective of recovery system selection. This framework is coherent with most of the previously found literature on aspects of important variables of plastic recovery systems. It provides additional simplicity in the selection process of a suitable system and indirectly addresses an upcoming industry by being written and published. This paper is the closest thing found to a business related article revolving recovery systems, identifying important variables of devices, yet not to economic and practical implementation of those devices. It is written from the standpoint of a customer, be it in any form of entity. This leaves a knowledge gap between the customer and the developer, as the developer is not represented in a similar matter with a framework providing guidance towards helpful decisions. In addition to this, the paper does not specifically focus on problematic area's, which are showing up mainly in developing countries, and actually do not take *location* into account as important variable.

2.7 Literature Review Takeaways

The literature review has been divided into four main categories concerning riverine plastic in general, existing efforts into catching it, a basic understanding of how to look at an industry and finally business activity in the field of plastic pollution. The search for available information has led to a vast landscape of information, every element being either of interest for or applicable to riverine plastics issues. For reasons of nuance, a selection needed to be made. Hence, the literature study consists of a summary of information deemed necessary by the author. These pieces of the puzzle have led to several insights and defined the theoretical base for this thesis. This section describes the main takeaways from the literature and theory.

First of all, plastic is a versatile, multi-functional material with important traits as durability and longevity, making it extremely useful in modern every-day life. On the other hand however, it is capable of inducing serious harm to human health and the environment (Wright and Kelly, 2017) (Revel et al., 2018) (Chang et al., 2020). Annual production of plastics is estimated to grow even further in the coming decades, resulting in a projected 600 million tonnes in 2030. Overall, over 9 *billion* tonnes of plastics have been produced to date and the lack of natural degradation leads to the majority of these plastics still existing in some form on the planet. Rough estimates suggest that around 75% has ended up in either landfills or in the environment. Of all oceanic debris, 80% is thought to come from land-based sources. This plastic reaches the ocean mainly via *rivers* and the annual amount that does reach the seas is set on 8 million tonnes. The main driver behind plastic pollution is mismanagement of plastic waste. To illustrate this, Europe and Oceania have a well designed waste management system and emit a combined total of less then 1% of all plastic emitted into seas. In contrast, Asia combines a high rate of development with a low level of waste management, leading to the emission of 81% of global plastic emission. Large pieces of plastic, called Macro-plastic, do not degrade naturally but they are fractionalised into smaller and smaller pieces called micro- (<5mm) and nano- ($< 100\ \mu$m) plastics. Plastic awareness has been peaking in the developed world, with advancing research on micro plastic recovery, whereas macro-plastics remain the pressing issue in the developing world. In short, 'the plastic problem' is not easy to fix. It is a wicked problem with many challenging aspects to be fixed.

Challenges usually attract enthusiasm. When awareness grew on oceanic plastic pollution, attempts were made to free the oceans of plastic debris. Although possibly a necessity, to date it proves not to be effective or efficient. A step up on the ladder toward actual prevention might increase potency. This has been leading to several parties experimenting on the field of riverine cleaning. As of this day, we see many different ideas trying to tackle riverine plastic pollution, some of which having been already physically tested or deployed. A distinction is made between manned systems (active) and unmanned systems (passive). The focus of this review

lies on passive systems, the main categories being receptacles, booms or combining innovations. An availability overview has been made. When recovering plastics, the final aim is to avoid enging up with a batch of useless waste. Separating, cleaning and recycling are the main options. Mechanical recycling is the traditional way of recycling, where contamination highly affects result as large pieces of one type of plastic are mechanically shredded to smaller pieces, molten down and used again in a production process. Chemical recycling involves the chemical fractionating process of plastics, bringing product at the end of their lives back to their chemical building blocks, in order to be used again. Incineration is considered as a form of recycling as well, when the heat is captured and used for energy production. Downside however is, that this system produces a high level of carbon dioxide.

Indication of carious interesting knowledge gaps has been leading to the next sequence A general understanding of industry structures and transition theory. An industry is in need of several key ingredients: 'buyers', 'purchasing power', 'sellers', 'knowledge balance', 'means of communication', 'medium of exchange'. These ingredients need to be established or confirmed before there can be any trade. Furthermore, the market life-cycle stage needs to be identified. In order to determine the window of opportunity for emerging technologies, the Multi-Level Perspective has been proven to be effective in assessing the external influences, standards and disruptive opportunities.

The literature review has led to a series of assumption that will be verified during the research and on which the results will be based. The six assumptions that are essential to the research will be evaluated later on and are as follows:

- *"When maximising income, the organisations and individuals from developed nations are the best targeted customer segment"*
- *"Smart, technological complex solutions pose better marketing than simple systems"*
- *"Deploying expensive and complex systems rather causes public aversion than affinity, due to lack of tangibility"*
- *"Involvement of local communities poses the best long term trajectory"*
- *"Local people in Indonesia dislike large Western branding"*
- *"When reverting to the basics, there are two ways of providing viability to a riverine plastic recovery project in Indonesia, an economic approach and a communal approach"*

An industry assessment alone is not the aim of this research. So in order to create a model to put the novel plastic catcher to the test and to devise steps in the process of deployment, the manner of devising a plan needs to be looked into. Every well performing business is backed by a properly considered BM. The literal definition of a BM varies broadly in words but the goal is always the same: proposing a certain value, identifying a way of creating and delivering it and finally capturing is with a maximum efficiency. A canvas has been devised by Osterwalder (2004), which proposes a template on which to build a BM. Yet, this model focuses mainly on economical value creation, something that is not always desirable in sustainable innovation. A sustainable extension of the standard BMC, called the Triple Layered Business Model Canvas (TLBMC), adds two extra layers that cover environmental and societal value proposition, creation and capture. This framework is expected to prove very useful in devising a strategy for novel plastic catchers in particular.

The next step is to combine the results of the literature review into a framework to come up with useful result. The information addressed knowledge gaps regarding effectiveness, difficulty, local desirability and operationality of riverine plastic catchers. The MLP and TLBMC provide insight in moments of opportunity and the ingredients needed to grasp these moments. This literature review is followed by the methodology where the further research design will be introduced as basis for finding answers to the research questions. Further scoping will be implemented as well.

Chapter 3

Methodology and frameworks

Mode of research, its methods and frameworks used are central in this section. An overview of the overall approach and theoretical and practical steps taken, is important for the transparency and validation of the upcoming results, in order to try to come to satisfactory answers to the research questions. To link the knowledge gap to useful theory of business models and experience, several methods of approach have been used. For starters, the literature review forms the bedrock of the report that led to the scope of the research, where available information was analysed, selected and summarised in order to use it and select a main theoretical framework. A case study has been conducted in order to verify assumptions and suspicions, serving as verification of the connection between theoretical information found and the practical knowledge it could be fitted to. This desk research led to the first version of a concept framework. This model formed the base for the following expert interviews, functioning as verification and assessment of the case study results, addressing errors and successes on which experts could shed some light on.

This chapter deals with the theoretical framework selection and it's evaluation, the arrangement of the steps and events during the research process and the processing of the gathered information. As stated above, two research methods have been used, respectively a case study complemented by expert interviews. These methods, the way they have been used and the reasons for selection, are explained. Finally, the mode of data generation and processing is evaluated.

As research relating to relatively unexplored business processes is as a rule not expressed in numbers, this research is of a qualitative nature. According to generally accepted standards, appropriate research methods have been selected in order to generate the correct data and generate it in the correct way.

3.1 Structure of the Research

In order to create a clear view of the process, the chart displayed in figure 3.1 was put together, where all the steps in the process are pointed out.

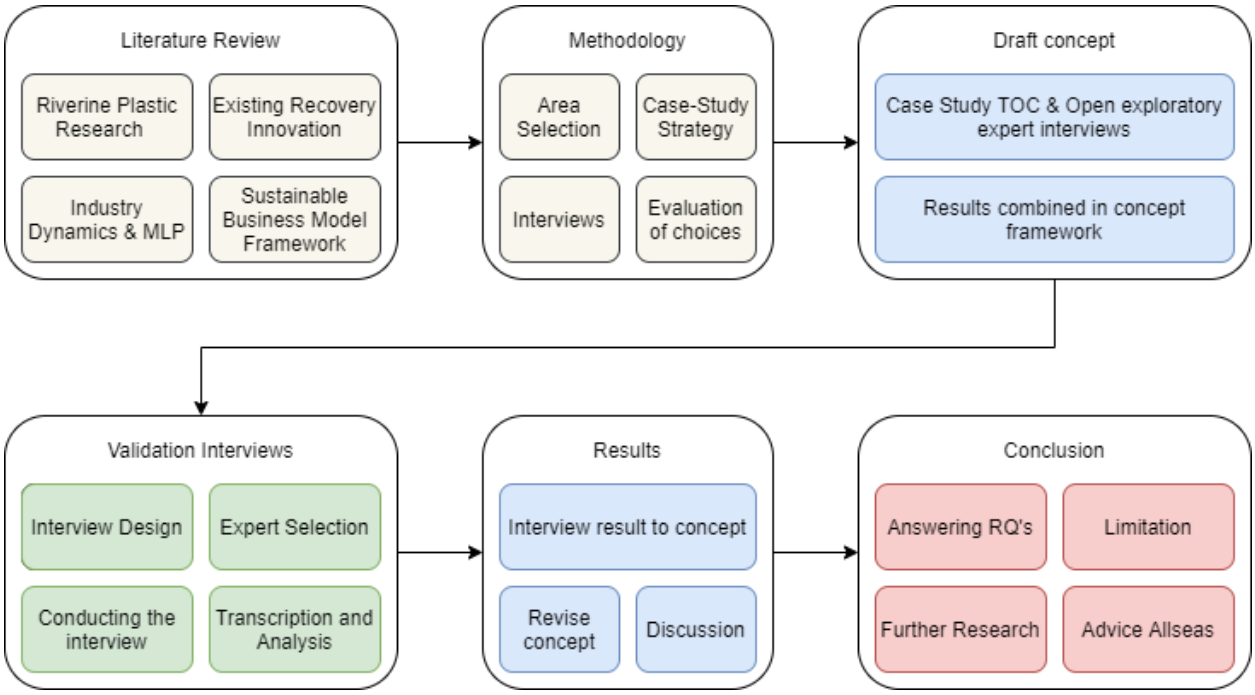

Figure 3.1: Research structure and components

Firstly, the literature review provided the information best suited to the chosen research methods. This subject has already been covered in the aforementioned chapters. Secondly, the research area had to be specified in more detail in order to properly apply the chosen research methods. This will be the subject below.

3.2 Framework Conditions

3.2.1 Area Selection

Conform the literature, the research area had to be located in Asia as this continent theoretically offered the most opportunities on the plastic recovery field as the world's largest riverine plastic emitter. This led to a selection process of several countries, where the following criteria played a key role:

- Riverine plastic presence based on most recent calculations (Meijer et al., 2021)
- Present landscape factors on plastics, be it public opinion, regulatory or else
- Present organisations working on plastic pollution suitable for a case study
- Possibilities for the author to connect with the right people for interviews

Naturally, the area selection process was fundamentally based on presence of plastic waste on land and in rivers. Literature pointed out that Asia is the most significant polluter when it comes to plastic emission into the seas, so the the research area had found its first boundaries. Meijer et al. (2021) pointed out the correlation between urban rivers and plastic emission and build a model in cooperation with the Ocean Clean-Up, that served as a visualisation of the most polluted rivers (The Ocean Cleanup, 2021b). Asia, though, encompassed many nations labeled as developing countries. These countries had vastly different norms, values and cultures, hence Asia was still too extensive as area of research. Further specification was required for a valid use of the frameworks, so the next step was to examine online channels for presence of plastic awareness of any form, which indicates landscape factors that could influence an industry. Examples were found in online articles among others written by Shahab (2021) Atika (2020) Lee (2021). In combination with these factors, areas where organisations were actively recovering plastics were sought for (The Ocean Cleanup, 2021a) (Clearrivers, 2021). These requirements had been leading to the selection of two possible areas of research, namely *Malaysia* and *Indonesia*. These two countries ticked the boxes, labeled as developing countries yet relatively progressive for developing country standards, which could lead to a changing landscape and high possibilities. Moreover, the nations are modeled with a high emission rate of plastics via rivers by the most accurate calculations to date. The final decision was made based on the fact that Indonesia is the second largest contributor to global emissions of plastic pollution in the ocean (Vriend et al., 2021), which made the matter more pressing. In consultation with Allseas Engineering B.V., the author selected ***Indonesia*** as area of research, in view of their more extensive market penetration and network for interviews compared to Malaysia.

3.2.2 Framework selection

A distinction had to be made after consultation of the literature, one between available information and statistics and potentially suitable theories. Specifically, the riverine plastic overview and available solutions involved an overview of available information, where a summary of all that was deemed to be of any importance to the research was written down. This was followed up by theories that were expected to help finding answers to the research questions when combined with the

riverine plastic information. On an academic level, there was an abundance of theory that covered themes as industry overview, market dynamics, entry barriers or business models. To create sufficient order, it was decided to focus on one specific perspective to map the area and industry and one framework that formed was to be used as assessment tool of viability, enabling a visualisation. These theoretical tools were respectively the *Multi-Level Perspective* and the *Triple Layered Business Model Canvas*. One of the main drivers for the selection of frameworks was the tendency towards *sustainable* innovation, e.g. in the field of technology- or business process innovation.

Multi-Level Perspective

The Multi-Level Perspective was, as explained, a tool to analyse certain influencing dynamics on a specific industry. Industries are location dependent, so the area selection was a determining factor for the functionality and use of the MLP. Another important aspect of the MLP was that it is focusing on the interaction between a socio-technical system and a transition, in this case towards sustainability. The developed world is in another segment of the transition towards sustainability than developing nations, which led to the assumption that sustainable innovations and products that could catch on in the developed world would not necessarily do so in the developing world due to a significantly different economical and social environment. This essentially measured that the landscape factors and regimes in different areas differed strongly and needed to be mapped accordingly. Niche innovation might have been part of the same category of functionality, i.e. recovery of riverine plastic, but the actualisation was depending on these identified differences. The niche innovations needed to uphold to different standards than would be the case in the developed world. The MLP analysis confirmed the assumption of the window of opportunity for plastic recovery systems.

Sustainable Business Model

In order to effectively respond to a window of opportunity in any industry, a detailed plan had to be devised so to reduce expected risk as much as possible. Osterwalder (2004) devised a very useful tool for a detailed display of intentions, value and costs of an idea and more, called the Business Model Canvas, which essentially is a template for a business model for any service or product. The main goal of this tool is to capture *economic* value. In the case of plastic waste recovery economic value creation was not the main driver, in this case it was sustainability. Bocken et al. (2014) were coming to similar views and devised eight archetypes that might define *Sustainable BM innovation*, not only proposing economic value, but adding on the environmental and societal scale as well. These archetypes proposed the foundation of something useful, but were not concrete enough for this specific report. In 2016, Joyce and Paquin (2016) used these archetypes to create a new canvas that elaborated on the one Osterwalder designed, called the *Triple Layered Business Model Canvas*, which did indeed suit this study. This model encompassed three

forms of value, respectively 'economic'; 'environmental' and 'societal', which were represented in the form of three layers each composed of nine building blocks. The economic layer was similar to the Osterwalder BMC, the societal and environmental had a comparable structure but a focus revolving around their own accompanying theme. This formed a suitable basis for the analysis on how to utilise the window of opportunity. Furthermore, it provided the theory needed to enable a framework that would be able to assess the readiness of riverine plastic recovery systems.

Consistency with research questions

During the process of selecting perspective and framework it was important to maintain an iterative point of view. In the literature, a range of subjects was analysed to which even more models could easily have been applied, but the main aim of this report was to get a clear cut answer to the proposed research questions. The questions have been key to the decisions taken during the selection. The MLP and TLBMC combined possessed the right ingredients to answer the sub-questions, offer a concept and eventually lead to a conclusion for the main research question. Stakeholders, important variables, barriers and business models were (in)directly intertwined in the MLP and TLBMC.

Application and first draft

After selection of the frameworks, detailed analysis followed. In order to construct a useful and new framework specifically for riverine plastic recovery systems, the MLP and TLBMC were applied and filled out with the help of a real-life example (case study). The MLP analysis led to landscape factors and existing niche innovations in Indonesia that influenced standards and incumbents. These could possibly change the current regime, or better said, create new standards. This categorised the window of opportunity as existing but currently in it's early stages. The next step was estimating value of the TLBMC to riverine plastic recovery systems specifically, provisionary filling out the building blocks to create an overview. Not all blocks might have turned out equally important. Importance of a building block was estimated, partly based on present information and knowledge within AllSeas Engineering B.V., partly on theory and partly on the case study example. The case study led to the first draft of a concept framework, which was validated with the results of the expert interviews. After expert insight, a conclusion and final draft were made.

3.2.3 Concept design

All mentioned above has been done in order to achieve an addition to the academic collection of knowledge in the form of a useful development framework for riverine plastic recovery systems and provide the system created by Allseas Engineering B.V. with useful recommendations. The design of the concept framework in relation to the important elements of the TLBMC concentrated on the industry of riverine plastic recovery. By evaluation of these elements via the interviews the elements could be ranked in order of vital importance. The final checklist framework has 5 elements per pathway that were deemed as minimal requirements for a system to be deployed in Indonesia. These are current demands for an organisations plan to viably deploy a recovery program in Indonesia. This framework of variables and requirement aimed to serve as a flexible model that could be used on ideas and concepts of recovery systems before deployment, so that an assessment of readiness could be formulated and areas of improvement could be singled out.

The following research, specifically chapters 4, 5 and 6, were not written down as they in happened chronologically, but in logical research order. It was a fluid process of development, where the case study, interviews and concept creation were continuous processes happening parallel to each other.

3.3 Research Methods

In order to create validity to the concept, a case study and expert interviews had been selected as most useful research methods. Both research methods are known for supplementing one another well. Technology transition, business model and deployment research was of qualitative nature, hence these methods had been selected. The case study strategy and interview protocol will be described below.

3.3.1 Case study

As extension to the gathered literature information, desk research was continued by a case study, a useful method for analysing specific objects or phenomena of interest in the real world (Sekaran and Bougie, 2019). Different strategies exist for execution of a case study, where this report had chosen for an in-depth single-case approach. A case study was designed to provide answers to the 'how' and 'why' questions that could not be proven by theoretical speculation, as it analysed a real-life phenomenon. Within descriptive research a multiple-case study is preferred, as variables can be compared in a cross-case analysis. This report however, reflected on a study that was *exploratory* aimed and structured. Here, a single case gave initial insight in a certain phenomenon and got into greater detail, compared to a multi-case. A single

case study provided useful information to base concepts on and thus added guidance towards more concrete questions to submit to interview candidates.

For a case study to be effective, the correct cases should be selected and analysed. Organisations were quite picky about what information they release into the world, which could have led to a biased view of the case study compared to the real world results (Sekaran and Bougie, 2019). This was a key part in the selection process. The aim of the case study was to create a conceptual framework not only based on literature and theory, but on an active organisational example and the processing of the study's results.

Case selection

The importance of choosing the correct case had been noted, the selection process followed. Literature has illustrated the overall novelty of research into the subject of riverine plastic, let alone its recovery. From different categories of cases to analyse, the most fitting had to be selected. Consequently, a list of criteria has been setup.

For the first part the use of a single-case approach was deemed the most suitable. It concerned the broadness of the concept model and the lack of available eligible cases with the needed transparency for an in-depth analysis. This is due to the still limited application of riverine plastic recovery systems. Moreover, a single case study offered full commitment to the details of one case, necessary when creating a detailed framework. Hence, a single case was selected for further analysis. Besides *riverine plastics*, the main case criteria were as follows:

Criterion	Details
Case-type	Triple Layered Business Model Analysis
Location	Indonesia
Company type	Active Riverine Plastic Recovery project
Information	Company reports and expert interviews
Technology	Publicly available description
Business Model	Identifiable building blocks and priorities

Table 3.1: case criteria

These criteria aimed to singling-out the most suitable case to analyse. Because the research was not so much plastic, but mainly business related, it was decided that the most effective focal point in terms of useful data acquisition would be the organisation itself. If it was solely a process of acquiring quantitative data of riverine plastic in Indonesia, a point of view from a specific river might have sufficed, but this lacked the business side of the story needed in this respect. The location was clear, Indonesia was the ticket. Important for the case analysis was the availability

of information, be it scientific, organisational, news related or any other form. Not all articles published by a company regarding its own product were objective and valid, so cross-article comparisons were used to prove whether a statement was correct. The technology actually used was to be clearly defined and should have had a sole purpose intercepting and collecting riverine plastic. Finally, it had to be presumed being that the organisation of choice shared such a level of information that the their business model priorities were easily identifiable as building blocks of a standard BMC or a TLBMC.

These criteria led to selecting ***The Ocean Cleanup*** as organisation of choice. The Ocean Cleanup (from now on **TOC**) is an organisation that is aiming establishment of practical recovery of oceanic plastic debris and recently started a riverine prevention project The Ocean Cleanup (2021a). TOC had already deployed a riverine plastic recovery system in four different countries whilst this report was written, Indonesia being one of them. A key aspect of the beliefs of TOC was transparency, where official company documents such as annual reports are published widely. These sixty-page reports were proposing not only successes, but failures as well. This allegedly was done in honor of the company's mission to above all reduce marine plastic debris, even if that entails sharing sensitive information with competitors. TOC preached they intend to be the spark to a new industry, where they aim to be an inspiration to others to see potential in plastic waste reduction.

Case study strategy

Having selected the subject of the case, the next step was then to define what the elements would be in need to be unraveled. In order to make this goal clear, a main case study question was drawn up, directing the essence of the research questions to the case of TOC, tending as follows:

What are the essential aspects enabling viability in the business model behind The Ocean Cleanup

This question was supported by the theory and tools selected, the MLP and TLBMC. The manner of answering the question was intended only to be desk research, but the interviews proved key to fill the gaps that were too hard to answer soundly. The question pondered on the MLP and TLBMC, whilst attempting to fill out the Triple Layered Business Model Canvas for TOC as completely as possible to identify strengths and weaknesses, drivers and risks. The same held for the Multi-Level Perspective for the Indonesian environment. Issues in the 21^{st} century tend to have a high pace of development, so time was of the essence. Research had proven to develop on the course of only several years. Therefore, the more recent the articles and pieces of information were the more relevance addressed to them. The most relevant knowledge had been selected for use in the literature review. This held for the case study as well; The River cleanup project was relatively young to begin with, but the years actually taken into account in the case study were 2017 to 2021.

Quality Criteria

That left the quality criteria as concluding part. Each study has a certain amount of rigor. Four constructs that provide said rigor are listed and and linked to the case study below.

1. **Construct Validity** Includes identifying correct operational measurements. Possibly a slight challenge with a case study, as qualitative research seldom results in measurements. In order to improve this, notable discoveries form the case study were discussed in the open interviews with experts.
2. **Internal Validity** seeks to establish a causal relationship between two or multiple variables, which was not of importance for this case study
3. **External Validity** however, was interesting in this case. Indonesia was chosen as research area, where the end goal was making developing countries as a whole reachable. Generalisability, which is key to external validity, was a reoccurring theme in this case
4. **Reliability** describes the extent to which the same results would be produced when the research would have been repeated in the same conditions. By asking comparable questions testing findings of the case, this was improved

3.3.2 Expert interviews

Expert interviews are a key part of qualitative research, as experts can share experience and knowledge directly with the researcher. Flick (2018) stated that expert interviews could function as essential groundwork for complementary research methods. This advise was taken to heart in this report, as interview insight would support the case study findings and later on provided validation of the concept framework created. The experience and knowledge that interviewees had gained during their journey towards expertise allowed them to give a more complete perspective, adding soundness to this distant desk research. Two types of interviews would be conducted. The first few interviews were of exploratory nature and focused on completing the case study on TOC. These interviews were unstructured. The second type of interview was a semi-structured setup, that aimed to validate the conceptual framework. The objectives of the interviews were as follows:

- Complement case-study exploratory desk research with first hand experiences
- Validation of the conceptual framework and extension or contraction when deemed necessary
- Validation practical potential in addition to theoretical potential
- Sparking discussion in order to gain additional insights

Design and set-up

Interviews have been conducted in several fields tangible to Indonesian riverine plastic pollution, ranging from experts with experience on doing business in Indonesia or recycling company expert, to Indonesian society experts, riverine plastic researchers and incumbent partners. As mentioned, the chosen approach of interview setup was split in two. The first set-up was free in its direction, the latter was a more systematic and comprehensive approach where cornerstone subjects were ensured, but unexpected additional information could still be unraveled Flick (2018).

The *open* interviews were designed to suit the interview participants, which were selected via networks of the author and of Allseas Engineering. This was achieved by performing a background-check of the participants, uncovering functions and expertise within the field. The primary reason to conduct these interviews was strengthening the construct validity of the case study. The open questions were assembled to match the expertise as much as possible to maximise effectiveness. These questions, much like the case study, aimed for the 'why' and 'how', rather than the 'yes' or 'no'. The *semi-structured* interviews required a bit more strictness and in addition needed to facilitate comparison. The method most suitable for this was a semi-structured interview, achieved by creating a list op predetermined but open-ended questions to submit to the candidates. The questions were formulated as not be as simple as 'yes' or 'no' questions and yet, motivating enough to converse and asses the correctness of assumptions. In Appendix B, the structure and specific questions asked have been provided.

The challenges using interviews as data collection method in general were to determine the correct candidate and to set up the correct questions to ask all of the candidates. This held for both interview set-ups. Extra difficulty experienced in the validation process was the need to be able to compare, yet ask questions to which all candidates could properly give an answer.

Interview Participants

The selection of candidates was a selective or *purposive* sample method of the non-probability sampling kind (Sekaran and Bougie, 2019). For expert interviews a probability sampling method is of no use because of the need of certain level of experience and knowledge an interviewee must possess (Flick, 2018). The knowledge required was derived from the literature and the developed framework, with some of the building blocks of the TLBMC at the centre of interest. The targeted candidates were chosen based upon tangibility with these constructs, yet from varying fields of expertise, as to create sufficient diversity. Not only business experts were interviewed, consultant companies, recycling experts and people with societal insights of Indonesia were included. This ensured that the interviews could shed light on multiple aspects of the proposed framework. Tables 3.2 and 3.3, show an overview of all interviewed experts. The names of the candidates were left out for privacy reasons, but background, function and relevance will be described.

3.4 Data collection summary

3.4.1 desk-research

The case study was initiated by exploring the foundations of the selected company. This was acquired by analysing several different sources of information varying from publications, website, news-based articles and media coverage, presentations, videos and documentaries and interviews. These databases were profoundly accessed online and many of the sources were free to access, some of them required access by institution identification provided by the Delft university of Technology. First of all, a general background of the company needed to be profiled, including company start, history, size, product and goal. The central themes of necessary information had been defined in the case study strategy and revolved mainly about a combination between business, strategy and riverine plastic recovery. In combination with the theory provided in the literature review, a business model canvas was drawn up for the company, identifying key features. In addition to that, lack of possible important features has been addressed.

Assumptions

The lack of these important variables raised questions related to the effectiveness of the project on different fields, risks and possible alternatives. The main assumption was the distinction between two different entry levels; the 'fields' as in the aforementioned sections on prevention.

In short, whilst tracing several alternative riverine recovery systems in Indonesia, a clear demarcation line appeared between larger companies tied to pollution prevention organisations and smaller, local operations. On the one side, a large organisation attempted to maximise revenue and income, mainly generated in the *developed* world, in order to install systems, leading to the priority of creating awareness (predominantly in the developed world) over effective pollution prevention of their product. On the other side, mainly smaller local projects reduced costs as much as possible in combination with the highest efficiency of plastic recovery and communal cooperation. These assumption were essential to the fundament of the framework and have been firmly evaluated in the research. In Chapter 5 is shown whether an assumption was deemed correct or incorrect.

3.4.2 Interviews

The interviews with experts had two different purposes: the first to evaluate new information found during the case study, *the second* was to validate assumptions made during the process and the concept framework created.

A research physically done from the Netherlands obviously faced limitations in relation to accuracy in estimating the specific situation in a certain area. By conducting interviews with people with actual experience in Indonesia, the information and knowledge derived from the internet and from hard copy publications could be verified or be debunked. In addition, unforeseen information considered important surfaced during these discussions. Moreover, companies are usually selective on what to share, thus creating a probable one-sided perspective. Discussing the other side of the story, the complete image tended to appear. During these conversations, missing pieces of knowledge were addressed and falsified information was corrected. The interviews were set to different duration, dependent of convenient times according to the candidate. The duration varied between 30 and 60 minutes. The first four interviews were unstructured and open-ended. A brief summary of the research was sent to the participants, but due to the lack of structured questions, preparation material for the interviewee could be limited. This led to elaborate and broad answers, not always straightforward. It must be noted that this was indeed fully in line with what had been aimed for by the exploring interviews.

3.4.3 Results and Validation

The results of the case study were in and appeared to be quite distinct. The results induced a draft concept framework aiming to improve the decision making process for companies when attempting to make a difference in developing countries. It provided an opportunity to create a framework for riverine plastic recovery systems in general, specified to characteristics of Indonesia. This framework was based on data gathered via the literature study. This combination had to be validated in order to create rigor. This was done by a *second* set of interviews, this time structured differently. The setup of the discussions was semi-structured. The questions and the concept framework were sent to the candidates beforehand, to enable them to generally prepare. The results of the case study and the validation were compared with the research questions of this study to formulate conclusions.

Interview Experts		
Candidate name and reference	Background & Expertise	Reason & Relevance
Expert 1	A civil engineer currently working as project manager at *DHM Infra*	Worked on a riverine plastic project in Indonesia in collaboration with the DUT, looking for the best technical system for riverine recovery in Indonesia
Expert 2	This expert is a Hydraulic and Environmental engineer that has ties to the DUT. Currently, a Coastal/River Engineer at *CDR International B.V.*	Before CDR International, expert was an active team member of *The Ocean Cleanup* as local environmental researcher and engineer in Indonesia. Performed several research experiments for technology development and has a clear understanding of riverine plastic and Indonesia
Expert 3	This expert is Project Manager Water Indonesia at *Royal HaskoningDHV*	Royal HaskoningDHV Indonesia is the local partner of The Ocean Cleanup River Project in Indonesia, fully taking care of operation and maintenance. Participates at World Cleanup Day and knows the plastic pollution and consequences for the communities first hand.
Expert 4	Teacher in the Indonesian language and culture, editor, writer	Native Indonesian turned Dutch, this expert specialises in the factors of culture and society. Is from Jakarta and knows the ins and outs of business and the balance. Is editor for The Erasmus Magazine and writes articles for several Indonesian media

Table 3.2: Overview candidates interviews

Interview Experts; follow-up		
Candidate name and reference	Background & Expertise	Reason & Relevance
Expert 5	Circular Economy consultant at Rebel Group, situated in Indonesia, the epicenter for waste management issues	Expert 5 has an engineering background turned consultant, showing different sides of experience. At the moment, E5's focus is on emerging markets, mainly in South-East Asia, specifically addressing the plastic waste problem
Expert 6	Engineer at Engineering Bureau of the Amsterdam municipality	Was involved in a potable water project in Indonesia in 2017. When working on clean and drinkable water, plastic plays a large part. Cooperated with a local NGO that contacted governments
Expert 7	Waste management and resources advisor in the Netherlands	Lived in Jakarta in a highly polluted area, making waste management and processing central in life and personal interest. Attempted to increase awareness levels in Indonesia x
Expert 8	Sustainable Insights expert and developer at IKEA	Has direct Indonesian roots (parents) and personal and professional interest in Indonesian culture and protocol. Involved in bilateral agreements between the Netherlands and Indonesia. Board member at Indonesië-Nederland society.

Table 3.3: Overview candidates interviews

Chapter 4

The Case Study

This Case Study is supposed to process the previously acquired theoretical knowledge and combine it with real-world examples into the first stage of a new concept. The subject of the case study is the *River Cleanup* project of The Ocean Cleanup in *Indonesia*. Main themes are *economic factors*, *stakeholders* and *environmental impact*. These themes are established in order to work towards answering the research questions of this study. This chapter aims to define the basis for a framework for assessing novel riverine plastic recovery systems or concepts as straight forward as possible. In this specific case, a thorough analysis of The Ocean Cleanup's riverine recovery project provides an insight in the manners of action of a viable organisation. The literature in chapter 2 explains riverine plastics and increase in relevant research, also in various requirements for recovery systems, existing efforts and business related aspects of catching plastic. the overall information derived from these elements enables the author to utilise the selected *'triple layer business model canvas'* theory and create a generic beginning to a new framework.

A case study in general opens the road to multiple sources of knowledge and information and encourages research methods to be combined. The foundation of the case study lies in the information made public by The Ocean Cleanup itself in the form of annual reports, news-articles and so on. In addition, internet and opinion articles involving riverine plastic catching in Indonesia are consulted. A research from afar unfortunately has a major disadvantage, being the lack of first hand information acquisition. To add soundness to the findings, as explained in chapter 3, expert interviews considering the themes listed above are added to the desk research to increase detail of case study results.

4.1 The Ocean Cleanup

4.1.1 Company background

Boyan Slat, the founder of The Ocean Cleanup (TOC), is a former student at the Delft University of Technology. He establishes this company in 2013, right after leaving high school. The organisation quickly learned that the idea to just "clean up plastic debris" was not as simple as initially imagined. The plastic problem posed many if's, and's and but's and was established to be a complex issue.

Initially, TOC set catching ocean plastics using energy of natural currents as main target. More than 270 scale tests were executed before the first system was launched in 2018. The system however, did not function in a way that met expectations and suffered from various structural errors, leading to a recall. Not long after, system 001/B was launched, which was an an adjusted version of the first system where errors were theoretically remedied and other improvements, such as modularity, were included. This system did catch and retain certain amounts of ocean plastics, show some effect of improvements. Meanwhile, it has been pulled out of service as the functionality and operations were deemed to not be ideal. The organisation is not giving up its initial plan to drop out cleaning up the oceans and thus is in the development phase of system 002.

One very distinctive feature of TOC is the research done parallel to the practical activities. The organisation relies heavily on said research, therefore decided to contribute to public knowledge as an organisation. During oceanic plastic recovery, the research branch of the company is looking for causal relationships. One of the main results is a model identifying heavily polluted rivers and the main source of marine plastic: *land*. Hence, they set up a riverine plastic recovery project, with the first system was launched in 2020. in the meantime, four systems have been deployed, results of the catch and system operations are processed and the goal is to devise a new generation of systems to be mass produced near the site of deployment, without the errors as shown by the first generation of operative systems.

TOC is in several ways attempting to deviate from the norm of traditional organisations. This is shown by another key characteristic of the company which is committed to the public by spreading awareness. At the moment of publication of this report, this public consists mainly of citizens of developed and rich nations and societies. The main reasons behind this twofold. One, the large funds that are required are easier racked up in these parts of the world and two, sustainability is mainly an issue that is acted on in the developed parts of the world. TOC relies heavily on funding and donations by individuals and other organisations and uses (social) media platforms to acquire these (crowd) funds. In may 2017, the company had raised roughly $31.5M in donations (TOC, 2017). Although *profit* is not the aim, *financial resources* are vital, especially for the strategy of TOC.

The portrait of TOC is completed by the proclamation to be as transparent as possible, changing public opinion with rapid dominance of (social) media (Costoo, 2020). This is accomplished by a team of 91 full time employees and 16 part time team members (The Ocean Cleanup, 2021a), with the organisation planning to add 10 more full time employees in 2021, showing growth is still happening.

4.2 Current state Indonesia

For a company to set its mind to a specific location, it must have something to offer. Separate from the reasoning done by TOC, an assessment of the situation revolving plastic waste reduction has to be done. An organisation should be aware of the situation in the desired location. The selected tool for that job is the *Multi-Level Perspective*, described in the literature. Indonesia is exposed through the view of the MLP, by analysing multiple internet articles, social media and also conversations with experts with first hand data, via interviews.

Niches

Let's first look for niche innovations aiming to rattle the regime. " Are there any?", " Are they effective/popular?", "Are they influencing local public opinion?". The first of these questions is quite simply researched from afar as it concerns actual objects, events and activities. This produces an affirmative answer. There are many different innovations or initiatives to clean up plastic pollution in Indonesia. The experts are asked to verify and confirm this, which all experts do. The rate of influence is harder to judge, so whether they are actually shaking the regime is harder to tell. This is asked in the interviews, to which experts respond that the niches are closer to rattling the regime than to just emerging. With this in mind it can be concluded that the systems are effective, having impact on the public opinion. The regime is not yet destabilised, but is not out of reach either.

Landscape Factors

At this point, specific measuring results becomes a challenge. Landscape factors, trends and exogenous factors that affect sustainable transitions, are slightly abstract factors and often overlooked in researching and assessing possible rising markets. Cultural values, (inter)national rules in economics and trade, macro-political developments and new global standards are all landscape factors that can influence a current regime. Cultural aspects are important for the acceptance of change, so it is possible to match Indonesian culture be matched with transitioning to plastic pollution prevention? An important factor in selecting Indonesia is the fact that desk-research points out that the nation is progressive (Ratnawati et al., 2020)(of Environment & Forestry, 2020)(Shahab, 2021). Consulting experts leads to agreement and elaboration. Awareness levels, though trailing the developed world significantly,

are on the rise. Indonesian individuals are grouping to spread the message of the possible dangers of plastics. Universities are setting up departments of research, municipalities and NGO's are organising cleanup activities There are big steps to be made, as single use plastics are essential in day-to-day life in Indonesia , but regulatory changes are implemented in the form of banning plastic bags in Jakarta in 2020 (Ang, 2020). This indicates governing changes and presence on the agenda on municipal and governmental level.

Regimes

The regime is the center part of the socio-technical system, i.e. the standard and the phenomenon to alter. It is described by the norms of every day life. These norms are a combination of social & cultural constructs with a level of technology development of a society. The regime is influenced by the niche innovations and the landscape factors and is changeable, if challenged sufficiently. As of this moment, the socio-technical regime in Indonesia connected to plastic pollution relates waste management. It has been established, that Indonesia has very poor waste management infrastructure, technology and public contribution. Piled up waste in public places or neighbours incinerating their waste on a balcony are normal sights in Indonesia. Although this is the norm right now and the majority of people is not yet actually concerned with plastic pollution, some demographic divisions are visible, where a younger generation appears to be much more open towards the subject of sustainability. Moreover, this generation is growing in numbers, where the older generation is beyond its peak. This shows a transition where a younger generation sets off to take better care of their own waste. In the first phases, this group is vastly outnumbered, but where the older generations slowly decrease, the younger only win ground, possibly changing the standards.

MLP conclusion

The window of opportunity needed for a structural change in socio-technical regimes, the functioning part of a transition, is not a tangible or exact concept. It is depending on various factors and can be interpreted subjectively. What the MLP does, is providing an indication for the fundamental decision whether to act or not. As said, In the case of Indonesia there are many aspects pointing in the direction of an opening window of opportunity, as becomes clear reading the above. Public awareness levels are rising, initiatives originate locally and renewing legislation is passed. This said, it has to be stated that the importance of the social and cognitive lock-in of the older generation is not to be underestimated. A window of opportunity is to be handled with care, where the MLP is a way of improving background information on what has to be taken into account and what not. The perspective does show that in Indonesia there are influential exogenous landscape factors that have influence and an increase in niche innovations.

4.3 Business Model Analysis

Every year, TOC publishes annual reports with elaborate financial statements. Financial balance in this case is what viability means, so according to the annual reports of 2017; 2018; 2019; and 2020, TOC manages to make their operations viable. In 2017 the company recorded 1.9M USD more expenses then income, but in the three years that followed an income surplus was recorded of respectively 3.3M; 12.8M and 3.6M USD (The Ocean Cleanup, 2021a) (The Ocean Cleanup, 2020) (The Ocean Cleanup, 2019) (The Ocean Cleanup, 2018).

Due to a analyses of the annual reports, on social media and other internet sources, that TOC is showing high activity during the drawing up of this report is drawn up, meaning they have indeed found a viable way to perform their activities since 2013, when the company was founded. The case study aims to deepen this observation of performance. 'What are the most essential aspects enabling viability in the business model behind TOC?' ensures a 'how' and 'why' enabling the established performance. In order to do so, an extensive desk research is conducted by the author to identify the approach of TOC. Moreover, several experts are consulted in interviews to fill gaps in the desk research as completely as possible. The first step of the process was to devise important factors to fill out in Osterwalder's*Business Model Canvas*, identifying the most important features according to TOC. This led to the canvas as shown below, explained on the following pages:

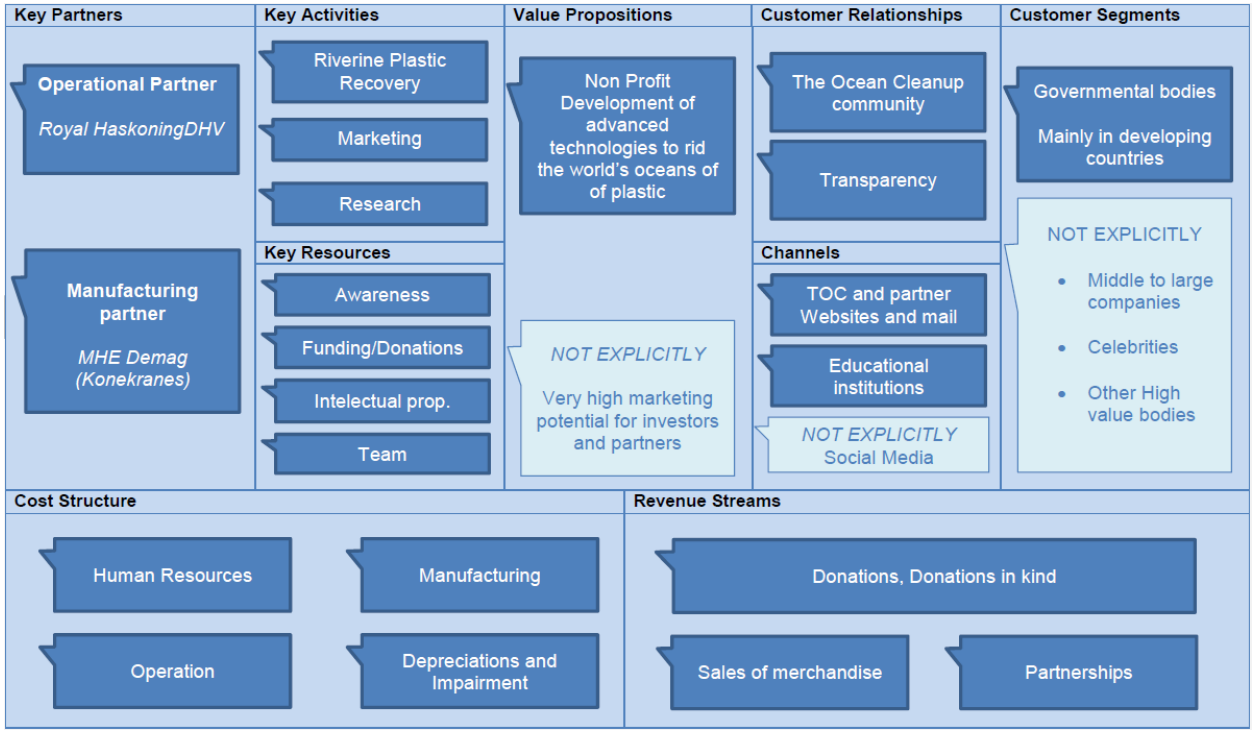

Figure 4.1: Standard Business Model Canvas of TOC

Value Proposition

The value proposition of TOC is an interesting building block to begin with, as it represents their values and deliverables. In this case, this is two-fold as well, where one clear deliverable is defined by the company itself, but this study identifies another form of value creation that is not explicitly mentioned. To start with the first one, TOC offers to "rid the oceans of plastics by using advanced technologies" as a non-profit organisation. Riverine plastic recovery has become a large part of this deliverable as it prevents further accumulation. The company researches and devises the technology in-house.

The value of TOC that is *not explicitly mentioned* relates to value creation for partners and associated entities. As sustainable issues and aspects are rising in popularity, it changes customer behaviour leading to a shift in customer demand. Consumers (i.e. within the developed world of trade) expect of products and services increasingly that the process behind it takes sustainability into account. Being associated with TOC expresses a concern for sustainability, which can be used in marketing core activities of the associated entity. The expert involved in TOC points out several companies that already do so, but state this process reduces local affinity as well.

Customer Segments

In order to deliver any form of value, customers are to be identified. In the case of TOC, the target customer is the party buying the (explicitly) mentioned deliverable, a recovery system. The customer would be a party that buys TOC's technology directly. These customers generally are entities responsible for a certain location, such as governments, municipalities or large organisations that aim to recover plastic from a specific river as a part of their contribution to sustainability, ideally in the developing world.

This poses a challenge, as the Interceptor is a high value machine, starting at a CAPEX around 1M USD and additionally over 100.000 USD annual operational cost. This is where the implicit value lies, as companies like Coca-Cola form a partnership with TOC (Aziz, 2021). TOC's main income is mainly generated via donations of any kind, not via sales or joint-venture profit (The Ocean Cleanup, 2021a). The partnerships combine the technology and knowledge of TOC with the network and financial capabilities of large organisations. In return, these partners can heavily market their contribution to sustainability on a large scale, making it worth-while to invest. Theoretically, these companies could be regarded customers as well. The implicitly buy a service, be it other than the core activity of plastic recovery. In the conversations the replies to this suggest that selecting and contracting these companies is an amorphous procedure. But, when selecting the customer segments, governments are currently targeted unsuccessfully, hence TOC reverts to creative solutions by implicitly selling marketing services to conglomerates. Governments of developing countries pose as bottlenecks for this high-cost project.

Channels

To reach the target customer, for now those are entities that want to implement an Interceptor, the main channel is one-to-one appointments where possibilities are discussed. Secondary channels are digital contact and long distance conversations, mainly aiming to establish visits and live physical contact.

To reach the implicit customer sections (the "donors"), other channels are used. TOC has invested heavily in media coverage and social media activity. In juni 2020, TOC had nearly 1.5 million followers, combined on different social media platforms, an increase of 367% in a period of nine months (Costoo, 2020). TOC's marketing and PR have become a prime factor and one of the most important channels to distribute their message.

Customer Relationships

Visits to official customers is key in TOC strategy for customer relationship (The Ocean Cleanup, 2021a), to which a personal reply can than be provided. Extraordinary situations, such as a global pandemic, pose risk to this form of communication, but when possible to execute it can form a very strong relationship. Another way of customer engagement is TOC Community, which is mainly maintained via press and social media. For example, individuals can ask questions which will be answered in a personal manner by employees, or get priority when new events are planned or merchandise is released.

Key Activities

Focusing on the riverine recovery division of TOC, The key activity is riverine plastic recovery. This is only possible through funding and partnerships. For riverine plastic recovery a system is designed, produced, implemented, operated and maintained. Although aiming to do same locally on the longer term, design and production are for the time being located in the Netherlands.

Because of the need for funds, maintaining relevance and relationships are an addition to the key activities of TOC. Attracting and receiving donations, partners and so on, costs time and effort. Ensuring good visibility and press covering is key.

Doing research is another characteristic activity for the organisation. In 2020 alone, the company contributed to eight (8) peer-reviewed scientific publications, of which the majority covered *riverine plastic*. Interviewees emphasise the value of research to TOC.

Key Resources

Although materials and construction sites are clear resources, they are not considered key resources to the business. What makes TOC stand out is the public support, for which awareness of a problem is essential. So spreading awareness is

something TOC benefits from. Necessary for this are the team, their technological innovations and funding.

Key Partners

For the riverine department, ideally TOC has two types of partners, namely manufacturing partners and operating partners. Because the Indonesian Interceptor can be considered a pilot, not everything develops according to plan. Exemplary is the production of the system in the Netherlands. In this light, the Dutch leading engineering company Royal HaskoningDHV, operating globally within the field of technological consultancy, is operational partner in Indonesia.

Cost Structure

TOC is faced with a stereotype cost structure for companies selling high value and complex physical products: human resources (the team), manufacturing, operating, depreciation. Included in 'the team' are costs from salary, marketing and PR. Specific cost of the production and operation have been collected collected. The approximate production costs of a system as the one in Indonesia are around 1M USD. Maintenance and operation cost 125.000 USD annually, according to Royal HaskoningDHV, operational partner on site.

Revenue Streams

Earlier mentioned, the most important part of TOC revenues are donations of any kind, accounting for up to 99% of all income in the past four years (The Ocean Cleanup, 2018) (The Ocean Cleanup, 2019) (The Ocean Cleanup, 2020) (The Ocean Cleanup, 2021a). The year 2020 heralds a new approach of selling merchandise that is specifically designed and manufactured from the plastic waste that is recovered. |But still, these sales account for roughly only 3% of total income in 2021.

4.4 Triple Layered Business Model analysis

As explained in the literature, in order to specifically contribute sustainable innovation, a business model should cover more than just a small part of sustainability in a typical business model canvas. This is where the TLBMC comes in handy as a visualisation tool. The previously filled out BMC functions as the economic layer, where as extension there are two layers designed specifically for sustainability. When applying this framework to TOC, something interesting happens. The company's business model is quite simply represented within Osterwalder's canvas, but when aligning it to all three layers, some irregularities appear. This section will elaborate on the process. The irregularities raise questions, for which experts provide valuable information to complete the case.

4.4.1 Environmental layer

As TOC is in its core an organisation connected to environmental improvements, the second layer of the canvas is quite straightforward. All blocks are represented in the given information, albeit varying in detail. The quantitative figures of most aspects are know. The layer is depicted in figure 4.2.

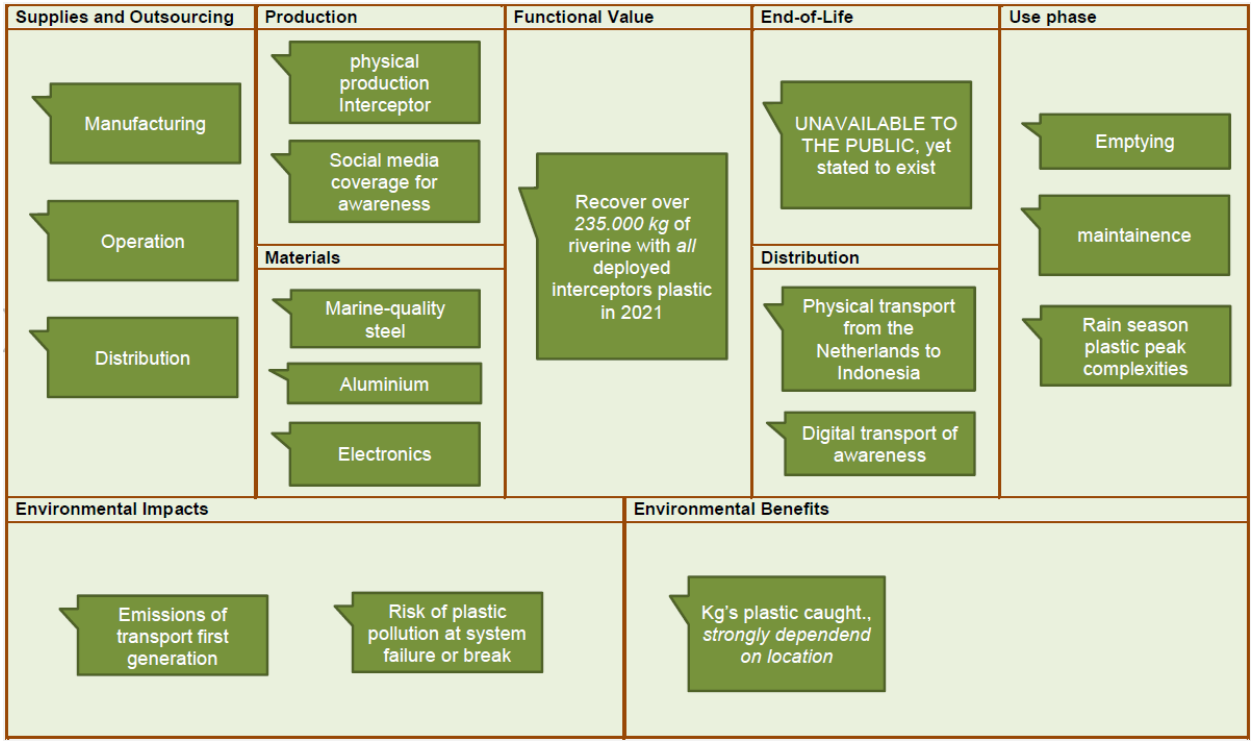

Figure 4.2: Standard Business Model Canvas of TOC

Functional Value

The Interceptor is a system designed to recovery pollution, therefor the functional value being delivered is relatively easily determined. As stated in the annual report of 2020, TOC has collected 235,505 kg of plastic from rivers with the three Interceptors they have deployed, systems 001, 002 & 004. System 001 is located in Jakarta, but details of it's specific catch are not available. When an equal distribution is assumed, System 001 caught about 78,500 kg of plastic in 2020, equal to approximately 215 kg a day.

Materials, Production, Supplies and outsourcing

All Interceptor systems currently active have been produced in the Netherlands. The main materials as used are marine-quality steel for the hulls, aluminium for the equipment and its structure and materials needed to install required electronics. The processes of manufacturing, distributing and operating are outsourced, for which several reputable partners have been contracted.

End-of-life, Distribution and Use Phase

The annual reports of The Ocean Cleanup (2020) and (2019) state that Life Cycle Assessment is a big part of the deployment strategy of the Interceptor systems. However, it just cannot be made public *yet* due to possible conflicting interests Hence it can only be stated that TOC claims to have take this into consideration with no data yet available at this moment. Distribution has been an issue, as system 001 was produced in the Netherlands and then shipped to Indonesia after a series of tests. This endeavor took nearly a year. During its life-cycle, the system will have to be operated, maintained and emptied regularly, for which Royal HaskoningDHv has been contracted. Also, Indonesia faces a rain season every year, where a peak in riverine plastic is measurable. This is one of the use-phase complications, as the system cannot yet handle this and as a consequence is being shut down in these periods, according to one interviewee that was situated in Indonesia for a riverine plastic project.

Environmental Benefits and Impacts

The environmental benefits are clear, as the system is designed to rid the environment of polluting plastics. Impacts can be quantified in mass of the catch per period of time, which in this case would be 215 kg a day, when following own assumptions made. System 001 is designed to aid the environment, but has impacts as well. The first avoidable are obviously the costs and emissions of transport. The second one is the possible pollution, in case of system failure or break down and subsequent sinking.

4.4.2 Social layer

The social layer addresses the stakeholder's side of the story and focuses on local involvement. This is where the study takes a turn, as questions appear when filling out the layer. Till this moment the results are quite clear. The Osterwalder's BMC has proven it's worth and even the environmental layer of the TLBMC showed an interesting overview of some of TOC's important traits. In the context of the social layer, visualisation is getting complex; the layer that induces questions that help shape the results of this thesis. The social canvas is shown in figure 4.3, where two segments stand out, the two that cannot be addressed.

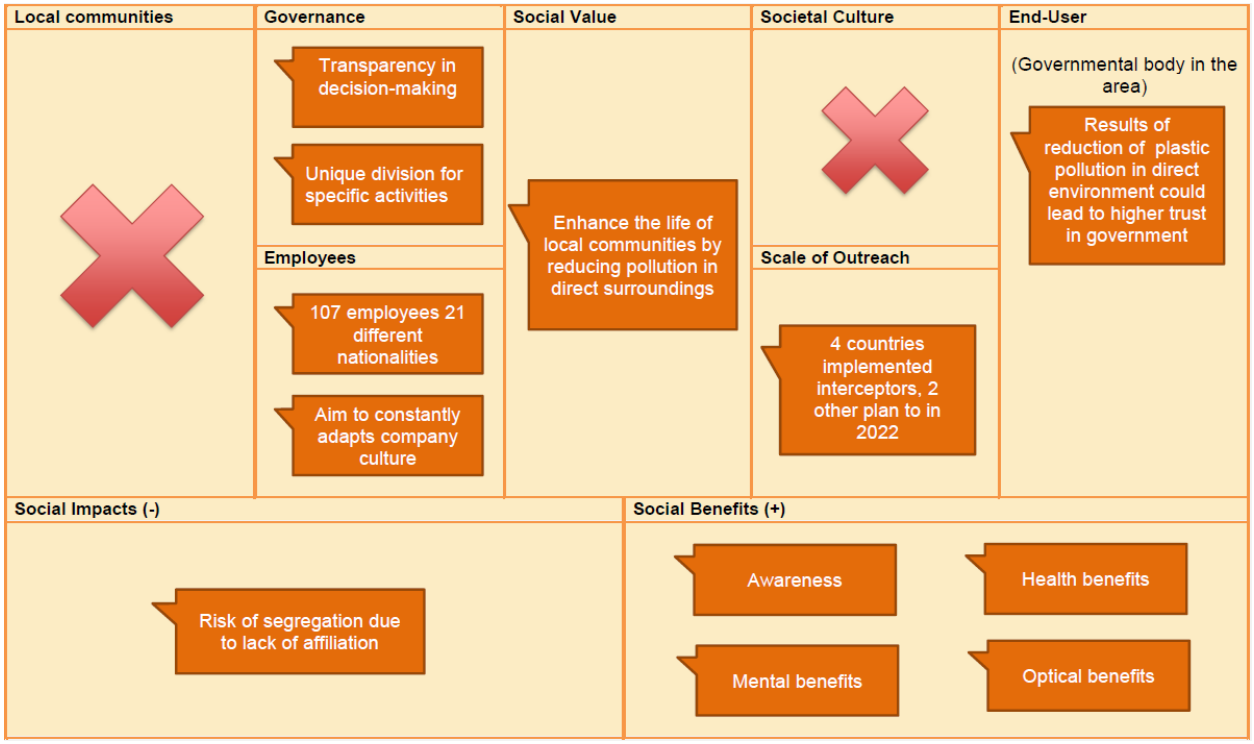

Figure 4.3: Standard BMC of TOC

Social value

The social value that Interceptor 001 delivers to Indonesia is very direct, because pollution can affect both the physical and mental health of people (Wright and Kelly, 2017). By decreasing the amount of pollution, the risk of health issues can be decreased as well. In addition to this, an awareness multiplication could be a result, getting the ball rolling.

Governance and Employees

An important part of the mantra of TOC is the pursuit of transparency in their decision-making process. They suggest that transparency is maximised, where only some articles cannot be published due to conflicting interests in the business area. In

addition to this, they show unique divisions within the organisation each specified to a field of operation; interception; technologies; projects and so on. Over a hundred of employees are spread out in these divisions, representing 21 ethnicities. Across the organisation the ambiance is key to motivation. People are motivated by the contribution to sustainability and spreading that message.

End User and Scale of Outreach

The end-user is one of the more complex building blocks in this case. Ideally, the end-user is a governmental body that buys an Interceptor system and thereby the ability to provide cleaner areas for its civilians,in turn making the civilians the one that experience the effect of the system the most. The effect, however, is unmistakably the improvement of environment and surrounding, with several benefits at hand.

Social Benefits and Impact

These effects can have several results, as communities can profit from healthy environments and prosper in the right circumstances. This is hard to quantify, which makes the social layer of TLBMC for TOC stand out. The effects that are created by the system can lead to benefits with different grasp. The environment in the area improves, leading to optical benefits, and possibly f.e. long-term tourism improvements. On a civilian scale, less pollution can lead to health benefits and mental state improvement. The experts reveal that local people are actually seriously affected by the measurable pollution accumulation.

The Lack of local communities and societal culture

So, a lot can indeed be said about the stakeholder involvement of the activities of TOC, but it is complex to quantify it or give it concrete labels. This is evident due to the fact that two building blocks of the social value creation cannot be filled out with the current activities of TOC. These had to be crossed away due to the fact that two experts confirmed out of first hand information that there were no local communities directly involved with TOC, as e.g. corruption affected governmental engagement on some level. Moreover, leading Western companies have been selected as partners, as the systems prove to be too complex for local manufacturers. This leaves local communities out of direct involvement, affecting the societal culture the system can generate within a community. As a result, people do not feel involved or responsible in whatever way.

4.4.3 Conclusion and follow-up

The previous section offers in-depth insight in the activities of TOC and the feasibility of those activities. Yet, besides insight and answers, also several issues were addressed during this process.

In conclusion, the Multi-Level Perspective has shown that Indonesia has the potential to offer a window of opportunity when it comes to sustainable related niche innovations, specifically linked to the plastic problem. This explains the presence of companies such as TOC and might justify these decisions.

TOC's core activity is concerning environmental improvement. The global recovery of plastics from ocean and river, is a complex process in all possible ways for which an industry is not genuinely developed or defined yet. This asks for creative business decisions in order to reach feasibility. The selected model for analysis is the Triple Layered Business Model Canvas. When isolating the economic layer of the model, which represents the standard Osterwalder Business Model Canvas, the approach of TOC reaches high tangibility. In the annual reports most numbers and the reasoning behind them are present, leading to a completed layer. More questions are raised when looking deeper into the reports and consulting the experts, finding out that the systems TOC develops are not explicitly the product that they sell, nor a form of service. Technically, TOC thrives on donations of any kind, but they have also partnered with large multinationals as Coca-Cola to realise further development. The financial commitment of these partnerships are donations on paper, but reviewing them practically, the donors get something very valuable in return: marketing potential.

Moving on to the second layer of the TLBMC, the environmental layer, the fill out remains relatively smooth with the help of the annual reports, news articles and with the help of people known to the organisation. TOC's main mission is cleaning the oceans' plastics, an action that is designed to improve the environment, so their activities and environmental value created is tangible.

When arriving at the last layer, the social value layer, things turn out increasingly complex. In spite of the fact that TOC does state to aim for maximising local involvement and social improvements, in practice this proves a challenge to realise. Their business model revolves around a maximisation of income in order to cover the costs of their technological innovations, which leads to a gap in social involvement with the communities in countries that are on another financial level, like Indonesia. The system is to costly, complex and distant from Indonesian point of view, that there is little affection. For the government, this is not just another project to invest in, but a large project that involves many different parties, which hampers quick actions.

All in all, with the strategy of TOC explained, a manner of providing viability has emerged, albeit still complex and tied to TOC specifically. The main theme is

maximising income in order to provide financial backing for sophisticated innovation. Bluntly spoken, this can be reached by investments and donations *mainly* from the developed world, very few to none local. Although the motivation indicates the intention can be labeled as 'good', in practices there is a lack of tangibility with the communal and cultural factors of the developing country of deployment. This, in combination with the knowledge of presence of several smaller scale solutions, raises the suspicion of one or more other basic forms of realising viability.

Awareness is an important driver for TOC and acting on the creation of awareness is a structural enabler for their financial achievements. This is something not directly to be derived from their business model, but implicitly it is a core factor. When assessing TOC with the standard BMC, a proper breakdown is indeed possible. When applying TLBMC, it is noticeable that the economic and environmental layer could theoretically go hand in hand, but by doing so, the local stakeholders are losing ground as the social layer recedes to the background.

Chapter 5

Expert Interviews and Case follow up

The case study of TOC not only offers answers and new insight but poses some questions and a basis for discussion as well. During the case study, several experts have been consulted focusing mainly on TOC, but during these interviews there was room for conversation after some set questions. This proved to be key for building up to the full context, as it turned out that other initiatives are actually up and running in Indonesia, and have been so for considerable time. Obviously, these systems are not without their own challenges and uncertainties, but they point into a different direction of viability. This chapter offers insight in the information shared by nine different experts on fields that are connected with Indonesian riverine plastic recovery and waste management.

The chapter sets off with identifying other ways of riverine plastic recovery, followed by addressing the gaps found in the case of TOC, according to the experts. These gaps can be seen as flaws, but pose opportunities as well. According to the TLBMC, there are several important factors required to establish a certain connection with the local community, which in turn is necessary for long term embedding and triple layer coherence. The experts provide their thoughts on these aspects and their view on improvement for Indonesia.

5.1 The Results

Nine in-depth interviews form the basis for this chapter. Roughly half of these interviews open and unstructured and the other half are semi-structured and designed with a specific set of questions. The interviews have been designed to take between 30 and 45 minutes, but depending on the interviewee the possibility arises to prolong this and go deeper into detail. This leads to an abundance of information to process for building up the picture of the context and analysis. The significant parts are included in this section. In an independent Appendix, available upon request, all the interviews are transcribed and included to provide as much transparency as possible. This section appoints five main themes the interviews reveal. The questions asked during the semi-structured interviews can be found in appendix B.

5.1.1 Case Supplements

Let it be stated again that interviews are part of the case study in Chapter 4 to begin with. The case study aims to assess the viability of TOC and its riverine plastic recovery project. The interviews complement the desk research with available information. The respondents have been free to answer in the way they prefer. Listed below are most important supplements to the case and the so-called 'economic approach'.

Required Performance Period

TOC as a whole is a young organisation, that started in 2013. Since then, the company has been able to act independently due to the many subsidies and donations they achieved to generate. These are noble causes, but money is never given completely without demand in return. In other words, the donations are based on certain expectations in relation to performance. It is of essence to be able to report performance of any kind within a predetermined period of time and compare it to preset expectations. This is why TOC in their annual reports highlights the performance of their systems including all their activities. TOC is the first company within the plastic recovery industry that acts on such a scale and and as such setting a benchmark rather than trying to reach a certain standard, nevertheless they are obliged to their donors to report performance and require to convince these financial resources to keep up the support on the long term. This holds for any company that runs on donations of any kind and always poses significant risk.

Local affiliation

The economic approach to riverine plastic recovery, introduced to the world by TOC, has several advantages and disadvantages. In an attempt to maintain objectivity, this report has opted for the TLBMC as the reference model for sustainable implementation or adaptation of innovation. The aim of using this model is to dynamically connect the three layers revolving 'economic value', 'environmental value' and 'social value'. The case study poses that in the case of riverine plastic recovery this is still a challenge to realise and when assessing feasibility this has not yet been reached in full. This might be due to the difference of technologies provided by the developed world and the financial options of the developing world, where a large difference is found. This is one of the most important take-aways from the interviews. The majority of interviewees stated that although the aim of TOC is to operate locally, in reality the organisation experiences issues on such a level, that implementing *their* technology in true connection with local communities is not possible because of factors as high costs and high education levels required for operation being too much of a restriction. This, of course, generally depends on the technology and service that an organisation proposes to use.

Technological Complexity

The example of TOC poses a solution with a high complexity rate when it comes to technological development. In short, the Interceptor is a custom made floating structure that runs on solar power. Within the Interceptor, several subsystems regulate the waste entrance and distribution, where sensors measure occupation levels of storage. This all is driven by digital software, which provides the user an interface for operation on board (TOC, 2021) These are levels of complexity very well embedded in developed society, where it is designed in this case, but every interviewee thinks it's questionable whether this is the right mix of ingredients for a locally operational recovery system, as local knowledge might be inferior to the required knowledge. That being said, in practice, the majority of the interviewees do agree with the fact that new and smart solutions are more attractive to invest in. In the case of TOC, nearly 100% of financial assets can be traced back to high value entities located in the developed world, who are backingthe company because it is attractive for them to do so. This is partly due to the *smart* solution that TOC offers.

5.1.2 Indonesian Plastic Activity

Stated before is the fact that TOC is not the only organisation battling plastic in Indonesia. There are many ways to do so, but the focus of this research is on riverine recovery systems, so only organisations that are active in this specific field of the plastic battle have been focused upon.

Rising Awareness

Still, internet articles, news articles and word-to-mouth information that reached the author, suggested a multitude of different organisations or individuals that implemented different ways of riverine recovery systems. This observation is presented to the participants during the interviews. Each expert shares the opinion that awareness on sustainability, more specifically on the field of plastics, is on the rise. This enforces the window of opportunity that was suggested with the use of the Multi-Level Perspective, but it also indicates impact of the (small) initiatives which already are active. With all the participants agreeing with an increasing level of of awareness, each of them post their own individual elaboration. The full transcripts show everything in detail, but there are some important pointers.

One of those is that there are several governmental regulations that show a changing landscape. There is a well known ban on plastic bags in Bali. Moreover, a national report called the *National Plastic Waste Reduction Strategic Actions for Indonesia* is published, where a plan of action is described and goals for 2025 are set (Ratnawati et al., 2020). When discussing this comprehensively with some of the interviewees, it is pointed out that verbal plans versus practical actions are separate worlds in Indonesia. Governments are fare from efficient and exposed to higher risks of corruption, making bureaucratic decision-making processes tedious. Verbal plans pose impulses for popularity rating, so politicians verbally commit to them, but not backing words with actions later on.

Another one is the presence of local activities that are *not* organised or controlled by the government, where small scale factories offer a viable way of recycling or re-purposing several materials, including plastics. Although this should be a governmental task, it *does* address a certain value to plastic waste even in its current form of small scale operation. This leads to different constructions nationwide, the 'Bank Sampah' being a good example. Because of the lack of a waste management system, inspired people open something, called the Bank Sampah, that can best be described as waste-bank, where you can hand in plastic waste and receive a reward (in various forms, depending on location) as citizen. This waste is then sorted and brought to the right people able to process it.

Alternatives characteristics

This induces small scale action as plastic is, in a way, monetised, which is not only essential to get something done in Indonesia. Experts agree it is the *only* way of

getting locals involved in Indonesia. This leads to some locals deciding to contribute to the waste management system and collect plastic, as it offers them something in return. One way of doing so, is recovering it from rivers. This initiated creation of some local riverine plastic recovery systems, quite different compared to the system of TOC. These systems are located in smaller rivers near villages. The aim is to collect enough plastic to survive financially whilst improving the local situation. These systems are designed fitting the bare minimum needed to function in order to minimize cost (Dijkstra et al., 2020). The procedures used when doing so, are not actually depending on *technology*, as the tech used consists mainly of nets, booms, simple surface waste guidance and sometimes simple receptacles (Helinski et al., 2021).

In appendix A a list of all different solutions globally is described, where only the most basic of those qualify as viable options in Indonesia. The risk of micro plastic is inadmissible in Indonesia, as macro plastics are in such high absolute amounts present, that small mesh size micro plastic catchers would clog instantly. Because of this, micro plastic recovery is not considered a priority.

Derived from the interviews, there are in fact ***two basic categories*** of riverine plastic recovery in combination with a feasible project in Indonesia. Both options are located on the far ends of the spectrum. The first one is described by the case study of TOC, where as much financial backing is sought to realise technological solutions that ideally include all steps of recovery, storage and selection. The second one was discovered during desk research and confirmed during the interviews. It focuses on a long term approach *by maximising local involvement*, the reasoning behind this is that '*it should at least partly be the intention of the local community themselves to do something about plastic*' for a long term project to stick. These projects rely on vastly different aspects compared to a project such as The Interceptor. Examples of these differences are aspects as local connections & experience, absolute minimisation of costs and keeping the system as simple as possible without diminishing functionality.

5.1.3 Communal approach

The interviews, discussions and desk research paved the way for identifying the *second approach* on realising viability within the field of riverine plastic recovery in Indonesia. There is an abundance of factors to take into account when operating locally. This has been discussed in the interviews and can be found in the transcripts. The most frequently returning factors addressed by the interviewees weigh more significantly than the ones fewer mentioned. As stated before, current riverine recovery activities can only be categorised in two different segments, when reverting to the basics. The second category of low tech and cheap recovery systems applied in small communities, forms the basis for the ***"communal approach"***.

Cost are one of the most important possible inhibitors of a communal approach. Helinski et al. (2021) classify three basic cost categories for riverine recovery systems; *low* ($\leq$\$ 10.000), *medium* ($>$ \$10.000 and $\leq$ \$ 100.000) and *high* ($>$ \$ 100.000). System cost are highly dependable on location and vary all around the world. When focusing on Indonesia, it is clear that TOC aims to maximise income and financial backing, but in interviews *cost minimisation* surfaces as a second option to reach viability with the main goal of involving local communities, as money is everything to the local survival culture and as little should be spent on things such as a recovery system, in order to reach local involvement. All interviewee's agree that, when looking at this cost scale, communal approaches should aim for system cost within the *low* range.

So, this second approach aims for something else than maximisation of financial resources, which is maximising local commitment and motivation to partake. All interviewees agree on the assumption that embedding riverine plastic recovery into the local society on *a long term* must involve local commitment and motivation, so an organisation is advised to act on that involvement if the prospects are set for a long term (Hunsberger et al., 2005). This differs from the economic approach, where in a predetermined period, performance must surface in order to keep organisations satisfied with their investments and prolong same. Some arguments suggest good reason to aim for long term project performance as, for example, it is stated to be sustainable, both in terms of environment and durability. Another important thing is supervision and company involvement. The more the local communities are involved, the more responsibility can be transitioned to those communities. When a system is just located somewhere and supervised by external parties, when in a situation they decide to leave, the project collapses immediately. Opposed to this is social embedding, where communities should get the feeling that it is partly *their* idea to clean up plastic waste because it is in *their* own best interest as well. This prolongs the project's expected lifetime.

Because the aim of this report is the creation of a framework that can assist *any company* with the will to get involved in riverine plastic recovery, another important factor has been addressed in the interviews: *local experience*. The developed, or Western, world is a very safe and structured business environment, where international trade has developed certain norms and cultural differences are, although still present, relatively easy to bridge. When setting of to different parts of the world, cultural aspects differ more than often taken into account. Interviewees stress that attempting to do business similarly as an organisation would in its own environment is very undesirable. Indonesian culture is heavily embedded in its business and political environment and experts have been emphasizing this difference repeatedly. Social connection is, for example, a serious requirement when aiming to realise any deal or project. In the developed world, contracts, approval, negotiations and signatures are the standard when making a deal. Only this doesn't regularly get people in Indonesia on board, as both parties are expected to socially connect before there

can be any form of trust, requiring more time and effort.

But this involvement offers something in return. Local involvement is important on the long term, because projects have a higher chance of continuation when supervision leaves. Absolute effectiveness per system might be lower compared to systems of high technological rate, but systems are functional and easily scalable. How to involve the locals, according to the interviewees?

5.1.4 Motivators

So, experience with cultural aspects intertwined in business activities in Indonesia is a must, as well as getting local communities on board when initiating a project. It is established that local habits are a very important factor for either success or failure and that the social environment in Indonesia differs strongly from that in developed countries. Hence, organisations need to understand what is important to people within the local communities they are supposed to be operating in.

Since this report has Indonesia as main interest, the participant for the interviews *all* have ties to Indonesia of some sorts; from being born in Indonesia to having worked on a professional project in Indonesia. When discussing Indonesian business style in combination with involving communities in sustainability projects, one theme surfaces at every interview: the importance of money.

In Indonesia, every day life is on a different level than it is in what we call the developed world. Survival is something people in richer parts of the world often hear, but they might not fully store the meaning of this message. In Indonesia, a significant part of society lives from day to day, actually trying to survive. To them, money is the most important gateway to survival, as it represents food, electricity, clothing and possibly even shelter. This means that there is little room in an average person's everyday life for thoughts on sustainability or plastic waste management. This is different to the environment of many Western companies, where sustainability is becoming an necessity in company activity and promotion. So, when aiming for local involvement, an organisation should create attraction for local involvement. This essentially means an initiator for people to start thinking more seriously about plastic waste and find it in their own interest to participate in pollution prevention. Scientists and researchers may hold a number of today's fashionable topics in high regard. The locals in Indonesia, however, would probably not even think of them. Practically, mainly money and value make sense to the Indonesian public, as it provides tools for survival, so plastic pollution becomes a part of this cycle when it monetised.

Now, there are various ways in order to make progress in this field. An identification of the options can be useful for the sake of converging towards predominant concepts. The multitude of these attempts are backed by promising ideas and theories,

but stumble upon one and the same fact when put in practice: " *Virgin plastic is cheaper and of better quality than recycled plastic"* (PlasticsEurope, 2020). During the interviews, experts point out that recycling does happen and is viable in some parts of Indonesia, but only on a small scale, because of the lack of regulations. But as there is an abundance of plastic waste in the landscape, there are potentially many of viable resources as long as being addressed as valuable.

When discussing ways to do so, tangibility is of essence. People in Indonesia are not necessarily impressed by sophistication and ethics, hence any possible way of valuating plastics should be tangible for them. The only option found being tangible to both government and public, might be *tourism.* It is discussed with participants and plastic pollution definitely affects tourism as beaches and forests overflown with plastics are not an attractive way of selling a tourist destination. The more pollution, the fewer tourist. Many parts of Indonesia are dependent on tourism and less tourists leads to lower revenue in this sector. When people need every Rupiah to survive, any decrease in work would not be a good thing. Tourism offers an opportunity to make pollution prevention and its improvement of local community's situation tangible, hence enhancing their involvement.

5.1.5 Assumptions and verification

This chapter summarises the contents of nine detailed interviews. The interviews are transcribed in full detail in approximately 50 pages and are available upon request. For the purpose of this report, however, we will focus on a restricted number of factors and assumptions, which give at least sufficient ground to verify or falsify. The questions are designed following the parameters of the desk research, as described in hte aforementioned. This desk research points in a certain direction that justifies assumptions. The design of the questions is aimed at avoiding biases and not pointing participants in a certain direction, yet still enabling approval or disapproval on a specific assumption. Whenever an assumption was confirmed or contradicted, space was given to the interviewee to elaborate on this view and give context. The six most pressing assumptions are listed below:

- *"When maximising income, the organisations and individuals from developed nations are the best targeted customer segment"*
  confirmed
- *"Smart, technological complex solutions pose better marketing than simple systems"*
  confirmed
- *"Deploying expensive and complex systems rather causes public aversion than affinity, due to lack of tangibility"*
  confirmed
- *"Involvement of local communities poses the best long term trajectory"*

confirmed

- *"Local people in Indonesia dislike large Western branding"*
  contradicted
- *"When reverting to the basics, there are two ways of providing viability to a riverine plastic recovery project in Indonesia, an economic approach and a communal approach"*
  confirmed after elaboration

5.1.6 TLBMC reflection

This research finds Indonesia as serious contributor to total riverine plastic emissions into the ocean. The tool used to assess this viability in a case study is the " *Trible Layered Business Model Canvas*". This canvas helps to describe and display the procedures which TOC has followed to implement a recovery system in Jakarta, Indonesia. This tool also singles out deficiencies in the approach used by TOC. These flaws utter in the second part of the research and the most important function of the interviews. To complete the cycle of this research and make comparison possible, the TLBMC is compared with these results and subsequently discussed with the interview participants. The goal of the TLBMC is uniting economic value, environmental value and social value within a single business model to maximise sustainability. In order to properly reach this, Joyce and Paquin (2016) state that coherence between the different building-blocks, called horizontal coherence. Not only horizontal coherence is required, but also coherence between all three layers needs to be established, called vertical coherence. This is visualised in figure 5.1.

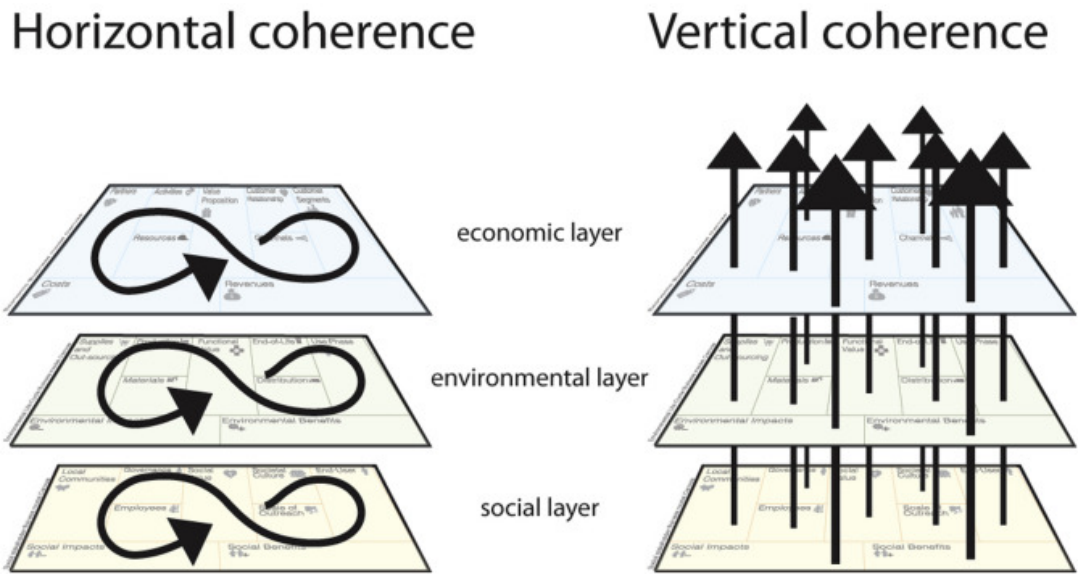

Figure 5.1: Coherence visualised (Joyce and Paquin, 2016)

Horizontal coherence can be seen as a logical step naturally occing when a layer is properly filled out. But as seen in chapter 4, the organisation that is best know within the current industry cannot tie up all loose ends together in practice.

The goal of this study is to assess the possible methods of realising viability for riverine recovery systems in Indonesia in practice in order to motivate entities of any sort to contribute. Ideally, a way of connecting all three layers in a framework is found for which expert believe opportunities will arise in the near future. But, at the moment, when looking at the realistic opportunities within today's regulations and social habits, it does not seem possible to unite the three layers of the TLBMC in order to create complete coherence. The Interceptor project theoretically aims to do so, but in practice and by focusing on the economics of the project, the organisation has to compromise on crucial aspects of the social impacts and values. On the other side of the spectrum, it is suggested by the experts that including local communities and delivering secure social value in turn results in an inevitable cut-down on the economic opportunities for the organisation.

5.1.7 Conclusion

TOC has shown one way of creating value while recovering plastics, by actually spreading awareness and implicitly selling high value marketing opportunities. They have been successful in doing so, mainly thanks to individuals and organisations in developed countries, driven by a strong public opinion. This opinion though, differs significantly from the public opinion in the locations where TOC actually operates and recovers riverine plastics.

In the interviews, the public's view on TOC and an economic approach are discussed. This results in examining alternatives and conversing about local needs, local possibilities, the local technology readiness and the ways to include the local needs into a business model similar to that of TOC. There is a reason that no organisation has yet been able to do this to date, as there is a large gap between the maximisation of income & financial reserves and the involvement of local communities scaled on a whole other financial level. Viability is not yet reached when looking at both economic and social gains in conbination with the environmental benefits, but it could well be reached as yet by choosing wisely between an economic or a social angle of attack. This would break ground on the two roads to follow. During the interviews, a lot has been said about the "what's, where's, why's and how's" of bot approaches.

Chapter 6

The Framework

This chapter will focus upon the creation and validation of a framework aiming to ease the decision making process on whether an organisation should indeed act or not. Where the previous chapters are set up to answer the research questions, this chapter is using that theory and information to create a practical framework. Prior research on riverine plastic recovery has been qualitative of nature and there is now a need to create a framework with tangible, quantitative aspects. A go-to-market strategy is a qualitative concept as such, but viability is measurable to a certain point. Some key characteristics of a strategy can form the basis of success or failure, which in turn can make those aspects quantifiable requirements to present to organisations. Again, the aim is to make some sort of check-list, a quantitative method, that enables to derive whether or not viability is realistic for an organisation.

The concept framework is devised parallel to the case study of TOC. The first concept is created upon basic knowledge of the theoretical literature in combination with the knowledge from TOC. Subsequently, this concept has been proposed to experts in interviews, in order to enable them to make their remarks. This provides for further refining the concept not only based on literature but on expert opinion. First, the approach that TOC poses is dissected and assessed. Then, the alternatives are analysed. This leads to a framework that is based on the two approaches, as discussed in the previous chapter.

These two approaches are the **core** of this research, but it is found that these two alone cannot create a complete framework, so a *third* option is added and a difference is made between active and passive participation. This chapter elaborates on the concept of the framework, its revision and its validation.

6.1 The First Concept

The goal of this report is to design a framework and it is seen as an ongoing process. Not all versions or adaptations are shown, only the predominant two. The first being the draft as presented to the interviewees and the second being the final version as amended following their discussions and opinions. The first version of the framework directly connects to the assumptions made after the literature studyw had been completed. These assumptions are mentioned in Chapter 2 for the first time. This is shown below:

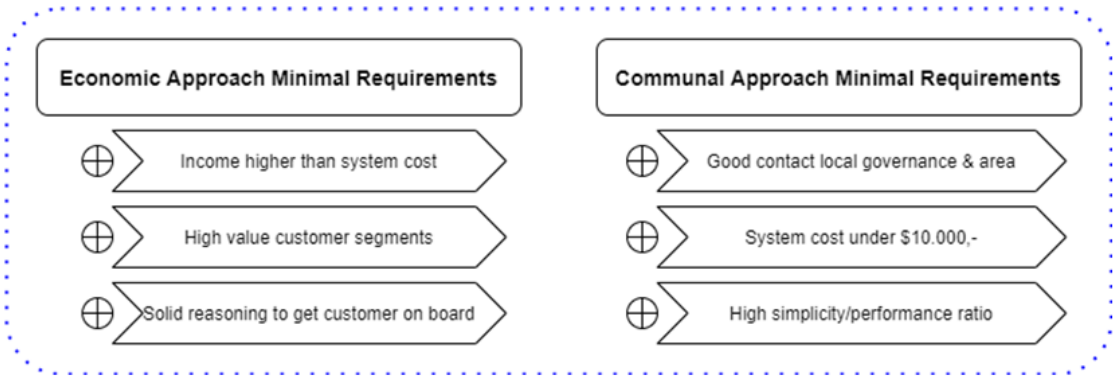

Figure 6.1: First draft of pathway requirement

This image shows two approaches and the first selection of minimal requirements to qualify for either one of the approaches. This report works towards a complete framework, its essence being two approaches towards viability. These are based on essential knowledge from the literature, for example the plastic hierarchy embedding in plastic business (Dijkstra et al., 2020) (Dijkstra et al., 2021), as well as impressions from the interviews.

6.1.1 Economic Approach

As stated in chapters 4 and 5, the first discovered approach for viability is labeled 'Economic Approach', as its main theme is purely monetary. The aim is to generate as much income as possible, in order to increase freedom in activity and return on investment. This can be useful in many different manners, think of unforeseen issues like the lack of local cooperation. The Ocean Cleanup for example, aimed for a financial construction where the local authorities and the organisations would share costs fifty-fifty, yet this turned out to be unrealistic. In order to continue implementation, TOC finally took full responsibility for the financial aspect, which is only possible when a cash flow or reserve allows so.

Creating a quantitative checklist for this approach is complex. Many variables, such as location and technology complexity level, influence the minimally required

amount of income, so it has to be defined within a ratio in order to realise some form of generalisability. This leads to the first demand of 'income higher than system cost'. Whatever the planned cost of implementation, the generated income will have to be in excess of these costs. In Indonesia it is shown that high amounts of financial backing for sustainability projects are rare. The Economic Approach relies on company creativity, creating value other than the plastic recovery system itself, as governments or local parties often can or will not pay substantial amounts. These amounts have to be sought by seeking out high value entities to approach as partners or customers, hence the 'high value customer segment'. The Ocean Cleanup does so by channeling their message to several large, Western companies and celebrities, even individuals. The way this is done, again in order to generalise, is part of a follow-up plan. The only thing of importance is the ability to approach high value entities and in order to do so, an organisation should have attractive arguments and 'sound reasoning to get these entities on board'. This can be achieved, f.e. by being a pioneer on technological fields of plastic recovery, by having a vast network, by confronting companies with waste produced by them and so on. Reasoning behind should always be sound and bulletproof enough to support the organisation's belief.

6.1.2 Communal Approach

The communal approach suggest stark contrast to the economic approach, maximising the combination of social and environmental value created, with less focus on economic value and technological complexity. In Indonesia, multiple examples exist where a barrier is deployed in a communal river to stop plastic from escaping. Experts confirm same and elaborate on the societal and cultural structures of Indonesia. The focus of this approach is involvement of local communities, as effective long-term solutions require an active contribution of local people (Hunsberger et al., 2005) An important part of this involvement is assessing what drives the local communities to undertake something and how to structure their organisations. Experts confirm that recycling of waste materials, including plastics, and the consecutive collection, are locally organised endeavors in Indonesia, as it currently stands. National governance and regulation is virtually absent, making mainly decentralised, small scale projects viable.

A project aiming for long-term impact possibly sounds attractive for companies that want to contribute to solving the plastic issues. This approach too, demands some minimal requirements from an organisation, when looking at the basics. Because this approach can be described as a stripped down approach to viability, quantifying the demands is less complex. There are several assessments of local habits and needs in Indonesia, as well as recovery system classifications (Dijkstra et al., 2020) (Helinski et al., 2021). One of the most important factors is to know how the social and organisational landscapes in developing countries including Indonesia are structured

in this respect. This creates the first requirement: 'Good contact local governance & area'. With this local experience comes knowledge of financial difference in parts of the world. Budgets are varying strongly, influencing public involvement. Systems are categorised as low-, middle- or high cost. Implementation in Indonesia with the aim of local involvement requires low cost, hence 'System cost under $10.000,-'. Finally, operation and maintenance should be within the range of local knowledge and skill sets, but the system should not lose its functionality. The 'Simplicity over performance ratio' should be considered, where simplicity should not endanger some kind of minimal performance level.

6.2 Input and Adjustment

The concept as shown above, finds it's fundament in literature, additional internet searches, assumptions and the first conversation with an expert. This concept has subsequently been sent to all other experts before an interview takes place. During the discussions it became clear that, although heading in the right direction, there was a clear need for further refinement. The assumptions had to be firmly confirmed in order to be of use. The experts were asked about their opinion on these assumptions, followed by the checklist and the framework. Discussions about correct assumptions followed, after which was discussed what they liked about the framework or which aspects they thought were missing. Experts might have been thinking that there were too many (or few) requirements, have not been understanding the demands or have been thinking they lacked grit. Following the interviews, the checklist changed continuously, resulting in a final list as shown in figure 6.2. All requirements are shortly explained on the following page.

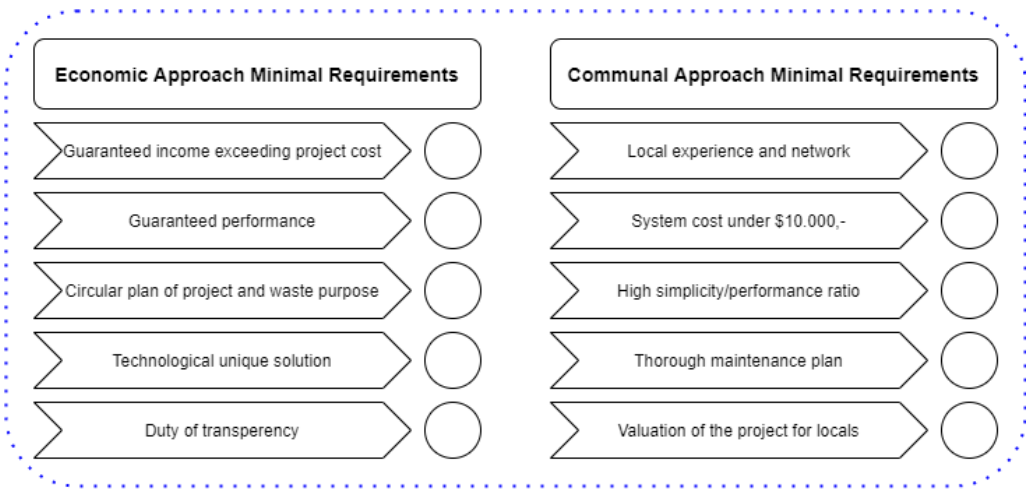

Figure 6.2: Consulted and improved framework checklist

6.2.1 Adjustments Economic Approach

Due to its broadness the economic approach is not easily quantified. In essence, the following enablers have been identified and discussed with experts to display them most accurately.

Guaranteed income

When embarking on an economic plastic recovery and business trip, it is clear that maximisation of income is key. To maximise income, a detailed plan with cost estimates of system CAP-EX, operation cost, salary and so on, is required in order to establish the actually required income. Preferably, the income should exceed the cost structurally, as implementation of a western project in a developing country most likely entails unforeseen cost, for which the developer will be responsible.

Guaranteed High Performance

When relying on partners, donations or marketing opportunities, performance is at the heart of the continuity of the project. Initially, theoretical ideas and tests might reel in investments, but during the project, performance has to be realised to keep entities on board.

Circular Plan of Action and Waste Purpose

There are several requirements when tapping into Western subsidies, donations or partnerships. One of them is the necessity of providing a picture of a complete solution. Only catching plastics in rivers will not be enough, the full cycle needs to be embedded in the project, from recovery to recycling, re-usage, redistribution to end-of-life planning.

Unique Technological Solution

Another part of generating these funds is originality. Copycat behaviour does not sit well with legislation, i.e. subsidies, or any other investor or customer for that matter. Distinguishing from others by specific outstanding technological characteristics is important.

Duty of transparency

Finally, in order to meet the demands, an organisation should be as transparent as possible about its actions, intentions and most importantly, the reality of their project. This can go by means of annual reports and regular media updates, not only on progress, but as well on failure.

6.2.2 Adjustments Communal Approach

The communal approach delivers a checklist more quantifiable than the economic approach, due to its well defined limits of low budget and high involvement. During the interviews, changes and additions are made, explained below.

Local Experience and network

Not only Indonesia, but developing countries in general, provide for a significantly different business environment than the more developed parts of the world. To travel there for plastic recovery business, a business new to many organisations, without a local network or experience in any local business activities poses high risks of failure.

System cost under $10.000

Aiming for long term, decentralised and simple solutions, small to mid-size rivers in communal areas pose the best options for recovery. Systems that are to be deployed should have a low budget in order to facilitate ease of involvement. A system classified as *low cost* is desirable.

High simplicity / performance ratio

Low cost imply simple systems, which as such can even be an advantageous when the specific goal is social embedding. Locals should understand the technologies, as they are supposed to be involved in operations and maintenance. The simplicity should, however, not too significantly degrade performance.

Thorough maintenance plan

Climate in Indonesia is different to the general situation in most developed parts of the world. Tropical climate induces more wear and tear to systems, taking f.e. into account that serious floods are fairly common. In addition to this, maintenance is not embedded in Indonesian culture. After installation, functioning without interference is generally expected. A thorough maintenance plan would be required to ensure long term implementation.

Valuation of the project for locals

In order to actually involve the Indonesian people in projects, impacts have to be valuated and monetised. Money is the most tangible necessity of life in Indonesia, especially when compared to environmental and sustainable values. Locals should be able to assess a project by its value *for them*, which should then result in increased motivation of participation.

6.3 Additional Approach

As described in the aforementioned, assessing the manners in which viability can be realised in Indonesia for a riverine plastic recovery project as of today is the essence of this report. The approaches, however, do not add up to a usable framework. The purpose of a checklist is one of examination, of ticking boxes. When compared to a specific project or system, this can lead to approval or disapproval of one, the other or both approaches. In order to provide this study with a complete and usable framework, a third approach is now added to create a division between active and passive involvement.

This study converges to two predominant concepts. One is seeking *involvement* in solving plastic waste issues, the other involves *active* riverine plastic recovery systems and projects. These two are linked, but not intertwined. If a company aims to contribute to solving the plastic problem, this doesn't directly imply an active project of their own. Although the actively setup projects are the essence of this report, the framework must be also accessible for organisations that are not set to actively partake but do want to contribute in another way. When concentrating on an active project, the designed checklist will provide the first assessment of the project. When not in the position to set up an active project, there should be another option to get involved to some degree. A 'passive involvement' approach shows the provisional options. It has to be emphasized that these options are set up to deliver a practical framework and are reviewed by the experts as valuation, but are not part of the in depth research. The passive approach poses interesting opportunity for further research on the framework. Its addition is shown in the following sections in figure 6.3.

6.4 Final framework

Now, the framework can be created by combining all the information, discoveries and knowledge described in the prior chapters. The initial conceptual checklist is adjusted and improved and can now be implemented at the center of the framework, where the additional approach is added subsequently. As the research question formulates, the framework is aimed to set a standard for a accurate go-to-market strategy, which is the step before forming a specific business case or model. The combination of theoretical knowledge from literature and practical knowledge from experts is combined with care. The framework can be seen in figure 6.3 on the following page and elaborated in short.

The first step to any project is an idea. An organisation has the urge to make a difference in the field of sustainability, specifically solving plastic pollution issues in Indonesia. The level of involvement in the search for a solution poses the first

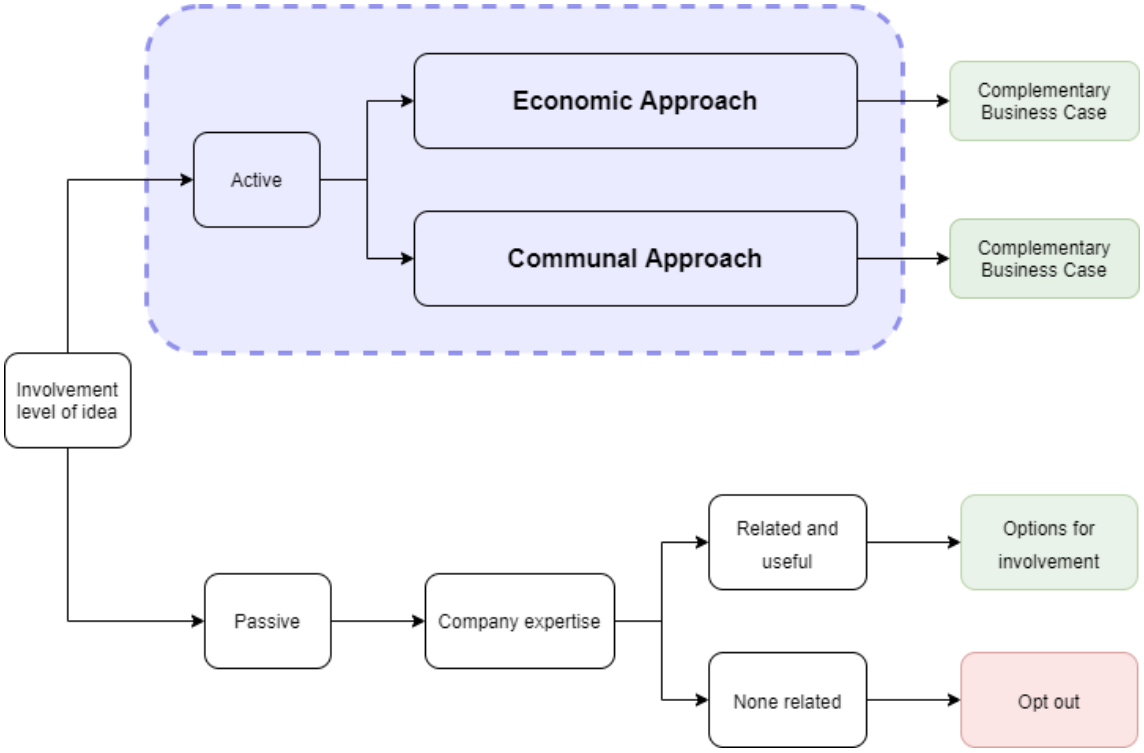

Figure 6.3: Decision Framework for Riverine Plastic Recovery in Indonesia

important decision. If a company has plans to set up it's own plastic pollution and prevention department, or anything similar, this is deemed as *active*. The company will have to organise the riverine recovery during all stages of the project. When the goal is active involvement, it is assumed that a number of companies have already developed a certain plan to back up the urge and have at least worked out some ideas already. This is when the go-to-market strategy *checklist* finds its function as an assessment tool for these ideas. When there is a foundation for a certain idea, it has to be checked for chances on viability, in most stripped down form and for which it has to meet the demands, displayed in the checklist.

When everything checks out for one of the approaches, the foundation of the project can be seen as a good start and a direction for the project is determined. When some requirements are not yet met, the organisation should know where their idea needs improvement. In some cases, when few requirements are met, an organisation can simply decide not to get actively involved.

This is one of the situations where a company can decide to explore passive involvement in riverine plastic recovery in Indonesia. This approach poses opportunities for further research, as it might help companies decide to join forces with already active recovery organisations and offer backing in any form.

6.5 Unexpected insights

This section supports the framework, more specifically the decisions it is based on. The validation is done during the interviews, where experts could evaluate the version of the framework that was sent to them and their comments and remarks were discussed. This resulted in an iterative process where the checklist and surrounding framework were refined after each interview, absorbing the latest information.

Initially 5 interviews were planned. From these first interviews, however, the author derived that there seemed to be more ground to cover than initially anticipated. The first four interviews produced a clear independent consensus among the interviewees on the distinction between two approaches. The author deemed it desirable to establish more expert opinion on the details of both of the approaches. A second round of interviews was scheduled, inviting people who had already been interviewed as well as new candidates. A new set of questions was formulated around the theme-question '*why is there expert unity in agreement with local involvement improving sustainable innovation, but is it hard to actually realise?*'. These questions focus on a more in-depth view of the previously gathered data and present the interviewees with a concept framework to evaluate (see Appendix C).

The new set of questions was sent to the candidates accompanied by a summary of the research done so far. The interviewees received the same questions, in order to enable comparison. In total, a selection of 13 candidates was approached, of which initially 10 replied and agreed to be interviewed. Eventually, this resulted in 9 actual interviews. Of these interviews, 8 were conducted digitally and 1 was done in person. The interviews were designated to last approximately 45 minutes. In reality most took longer to conclude, with one of them costing 80 minutes in total. The interviews done digitally have all been recorded in consent with the interviewee.

The various insights were identified and each conversation led to a deeper understanding of the Indonesian situation. There was a generic consensus when comparing independent answers. For example, the possibility to economically approach the riverine recovery market in Indonesia concerning the first mover advantage of TOC was highlighted. In addition, the experts were asked whether they considered this possibility useful or that a local approach should be the preferred approach. During all interviews, the experts had more relevant information to share than expected, leading to extension of the first meeting or the planning of a follow-up.

In summary, the interviews in general had actually more relevant information to share than initially anticipated. This additional info triggered either extension of the first interview, resulted in planning a follow-up session or scheduling a completely new interview.

6.6 Reflection

The framework presented in the aforementioned boils down an abundance of information into its most basic form. In summary, this section reflects on the connection to the literature, different theoretical frameworks used and the distillation process leading up to the results.

The literature poses, besides an overview of highly polluted area's and available technologies, two theoretical tools that have been used in this research to process information in an attempt to revert to the basic needed for a go-to-market strategy. These tools are respectively the *Multi-Level Perspective* (MLP) and the *Triple Layer Business Model Canvass* (TLBMC). The framework that is established in this report, however, does not follow suit either of these tools structurally. The framework produced does not resemble a BM as such. What is does, is transforming the information collected via the tools that are used into something novel. The MLP and TLBMC are essential building blocks to the framework, as shown below.

Firstly, the research area is based on the use of the MLP. The location is depending heavily on topicality of plastic pollution. This study focuses on an assumed niche of areas where overlap occurs between developed and developing countries. This indicates the seriousness of pollution issues in combination with a certain form of awareness of sustainability. Indonesia fits the bill. The framework is designed with these parameters in mind, a topic to be returned on in the discussion.

Secondly, the use TLBMC suggests the application of this canvas on RPRS's or a form of restructuring of the building blocks. In a sense, this is exactly what has been done, only the blocks have been put back together differently. The framework proposed by this study identifies basic needs for a go-to-market strategy for RPRS's in Indonesia, done by using the TLBMC. The most essential blocks, strengths and weaknesses of one real life example are processed. These essentials have been discussed with experts. The literature on TLBMC in combination with these discussions have led to the identification of *two basics strategies* for riverine plastic recovery projects in Indonesia. These strategies are renamed as 'Pathways' within the created framework, each with designated minimum requirements based on the literature and validated by the expert interviews.

The framework is a novel tool created to provide organisations that are new to the game, so to speak, a first set of guidelines. These guidelines are presented in two primal 'approaches', upon which complete (TL)BMC's can be created and without which market entry is complex.

Chapter 7

Discussion

7.1 Main Findings

This thesis is initiated to contribute to the transition towards improved global plastic waste management. There is a lot of information to be found in relation to a range of themes in the plastic waste world. Motivation is on the rise, but not all elements are connected correctly yet for a plastic recovery industry to actually take off. This report aims to bring the available information together and bridge the knowledge gaps for actual deployment riverine recovery systems in Indonesia, finally categorising the essence in a framework to be used by organisations willing to setup a plastic project. In this section the main findings shall be discussed and the results of the analysis and framework creation evaluated by linking the research questions to the findings.

7.1.1 Indonesia and The Ocean Cleanup

The first practical part of the research is the case study, looking for *essential aspects enabling viability in the business model behind The Ocean Cleanup*. The case study addresses some answers to the first *three* sub-questions. The first analysis, using the MLP, is mainly to confirm the location *Indonesia* as suitable for riverine recovery systems, independently of TOC's judgements. This has been leading to the identification of a window of opportunity, i.e. approval of Indonesia as a potential fruitful area for plastic pollution prevention.

The main analysis of the case study is supported by TLBMC, a visualisation tool for enablers and inhibitors in a business model. The goal of the TLBMC analysis is to find and identify the activities being unique TOC's approach and look for options to dissect those activities down to the basics for generalisation. By doing so, several risks and complex situations are unraveled, accompanied by unanswered questions.

The case study is breaking down an exemplary organisation brick by brick, uncovering the basic pieces of the puzzle aiming to reuse them. When using the TLBMC, a 3 theme analysis is used: *'economic value'*; *'environmental value'*; *'social value'*. These values are to be considered when innovating sustainably, where only economic value does not suffice. It turns out that TOC has the ambition of incorporating all three themes within their projects and BM's, but practical problems tend to prevent their realisation. The company does operate viably as income exceeds expenses, at least up until now. Essential to their operation is the combination of *economic* and *environmental value*. TOC generates multi million dollar amounts annually to invest in research and recovery activities. Over 90% of these amounts are *donations*. This money is collected mainly from Western individuals and organisations. Key aspects for collection and maximisation of this income for riverine plastic pollution projects are for instance *heavy marketing campaigns*; *addressing circularity*; *technological uniqueness*; *waste process solutions*; *performance log* and *transparency* . Practically seen, TOC's sales of awareness are more important than sales of their Interceptor system, because when sufficient funds are raised, a system can be deployed no matter what. By approaching recovery system deployment accordingly, it turns out that *'social value'* is not effectively Incorporated in TOC activities. Local stakeholders are not involved as much as aimed for, because the activities are way out of scope of local standards. However, for long-term sustainable innovation, local involvement is of high importance. When setting off to act on plastic pollution, *'environmental value'* is always a deliverable, amount not necessarily specified. TOC chooses to combine this with *'economic value'* as a means to guarantee operation.

7.1.2 Expert Interviews

To create an overview as complete as possible, expert interviews are initiated during the case study where the unanswered inquiries are discussed, as well as afterwards for validation. One of the biggest issues in organisational deployment of riverine recovery systems is the lack of comprehensive overview of information on the matter. This information is essential to a complete picture, as the case study poses risks to TOC's and consequently their approach's viability. This leads to the question whether there could be an alternative modus operandae, involving *social value* and thus other manners to create viability. Preceded and based on desk research revolving plastic recovery activity in Indonesia, the interviews propose questions concerning the *economic approach*, providing the expert's assessment of this approach as useful, yet as process it is deemed complicated and not locally embedded. Then, follow-up questions focus on lack of local involvement and how to initiate and incorporate it as yet. There are other, smaller projects recovering plastics in Indonesia, but there is apparently a world of difference between TOC's approach and that of smaller incentives. Discussing alternatives, the demographics of Indonesia and the influences affecting local businesses have been addressed, together with mo-

tivators, technological adaptation and governance. The interviews disclose a second way of viably initiating a riverine plastic recovery project, combining *environmental value* with *social value*, i.e. maximising local stakeholder involvement. The chances here lie mostly within small, simple solutions that relate to the local communities, making plastic tangible. Indonesia is organised in a different way from Western society, so business and involvement function by different ground rules. Key elements for maximising local involvement are found to be, for example, *technological simplicity*; *cultural side of business*; *local motivators*; *local waste management*; *cost minimisation* and *system requirements Indonesian climate*. All experts believe that local involvement is a necessity for sustainable innovation on the long-term, as local communities must feel the need and motivation to act independently, act without supervision. In order to do so, drivers are important. Plastic is more heavily embedded in every-day-life in Indonesia than it is in developed nations and people are more focused on surviving a certain period of time than on providing sustainable ways of living. For local involvement, plastic pollution has to be valued in a tangible hence monetary way. The best way to quickly do so is to visualise the number of jobs lost as a result of plastic pollution against jobs that could potentially be created by acting on plastic pollution.

7.1.3 Two Approaches and a Framework

This information might be valuable but not yet practical or easy to use. A willing company or an organisation is looking for a tool or an easy manner of guidance. For this reason, the results are processed and incorporated in a framework. The essence of this research resides in the *two approaches*, i.e. the two approaches to viably deploying riverine plastic recovery systems in Indonesia. The essence of a viable go-to-market strategy is its basics, its foundation, which was not refined and described before. This research has uncovered those basic standards for viability and created a **checklist** for guidance involving those minimal requirements. It is a checklist where respectively the *Economic Approach* and the *Communal Approach* are assigned *five minimal requirements* for an idea to qualify for a potential alternative approach. These requirements are summarized in an easy-to-use checklist. This tool can assist an organisation in assessing the viability of any specific idea for a project. The checklist alone, however, does not provide for a complete framework. To complete the framework, another approach is added and the distinction is made between *active* and *passive* project involvement, where a company can decide to set up a project of its own or join an already existing initiative with financial backing or knowledge and experience.

7.2 Implications

The research aims to be objective, whereas the subject is influenced strongly by subjective factors as demand and awareness. This poses some implications along the way worth noting.

Local problem, global consequences

Plastic pollution poses a problem with potential impact on human life, welfare and health on a global scale. Once plastics hit the oceans they move freely and are hard to catch. Since sustainability is an increasingly important item on the political agenda of the developed world, these nations and their citizens are looking for change. Contradicting, the developed nations are geographically providing for the smallest contribution to plastic pollution. This poses an implication, because the parties that are the most motivated to act, have to do so in another countries jurisdiction to realise real impact. There are geographical subjective differences that pose implications in deployment. The proposed framework can limit impact of this limitation when it opts for local involvement. When local involvement is established correctly, this can decrease the differences in geographical public opinion.

Political implications

Plastic is stated to be the problem, where it is only a material and the situation is complex. The way nations, organisations and individuals deal with the disposal of plastics is an essential part of the problem. The same holds for regulations set on production. Both these aspects are complex political issues that influence business operations and are intertwined with geographical issues. Governments are theoretically responsible for providing healthy and clean surroundings for their citizens to live in, but in practice often neglect this in parts of the developed world or are not able to act thoroughly as other matters are more pressing, i.e. starvation, war, pandemic. Governments are also responsible for production regulations within their country. This is intertwined with the geographical issues. A nation might loose out when it regulates firmly, as companies can transfer their activities to other nations where legislation is more lenient. This development is frustrating drastic legislative changes.

Practical implications

This study provides for a framework that is realistic and easy in use. Realistic means admitting errors or less-than-ideal situations, as is the case in Indonesia. The use of the TLBMC strives for complete coherence within the layers. Today, this is not deemed realistic by the case study and the interviews, yet is the intention of sustainable innovation. This poses practical implications when incorporating the use of a TLBMC into a marketing strategy.

An ideal situation is well regulated waste management across the world where the gap between developed and developing countries is bridged. Riverine plastic recovery should be unnecessary in this future situation, but could be a very important part of the transition towards it. This might affect interest of companies, as it influences a long-term trajectory of a project. This is something companies should take into account. The goal of plastic recovery systems is to aim for these systems to become redundant within a predetermined period. Parallel to riverine recovery, waste management should improve. What riverine recovery can do is create awareness and broad support of the problem, by making it tangible.

7.3 Limitations

This report follows certain research methods and other theory in attempt to maximise the value and trustworthiness of the results. Although, this research is facing its limitations, it does not impact the relevance of the results found and conclusions drawn. Acknowledging the limitations will specify the use of the results and introduces topics for further research.

Scope and Relevance

This report is focusing on a section of a global plastic problem. The definition of a relevant scope within this complex problem is a critical limitation to this report. The plastic pollution issue is a widespread issue and difficult, if not impossible to cover within a single master's thesis. So a precise scope is essential for concrete results. Scoping is also a sensitive process, where important information might be unintentionally excluded from research. There is an abundance on riverine plastic literature and sustainable business model literature. The selection of the literature has been done early on in the research. One discovery was the turbulence within the relevance of riverine plastic research. This provided a limitation to the relevance of this report. Combined with the selection of literature and case, actual appliance of the framework can be affected in the years after publication. The interviewing process and candidate selection has been done in order to confine this limitation as much as possible. Examples of scoping limitations are the choice of macro- and micro-plastics as subject of choosing the TLBMC as only analysis tool.

Available information

Whilst defining the scope, TOC was selected as actual case study. TOC is one of few organisations that qualified for in-depth analysis via a case study. The company publishes annual reports, posts updates online and is covered in news-articles regularly. Organisations within the field of riverine plastic recovery posing credible amounts of publicly available information are hard to find. As a result, a multi-case study appeared to be practically out of reach, making a cross-case comparison impossible.

Information on small scale projects, i.e. communal oriented projects, proved to be difficult to collect. The research was done exclusively from the Netherlands, more specifically form Delft and Rotterdam. First hand Indonesian information could for obvious (pandemic related) reasons not be collected. The interviews compensate for a considerable part of this limitation, but *official* evaluation reports on specific small scale Indonesia organisations were not available.

Academic generalisability and robustness

Indonesia is obviously not the only nation facing plastic pollution issues. The original direction of the research was assessment of minimal requirements in *developing countries*, but a specific research area was needed to come up with practical results. A comprehensive comparison with developing countries is too large to cover in this research. This makes the use of the framework, for now at least, specific to the area of Indonesia. That does limit the academic possibilities to generalise this framework without further research. On the other hand, it has to be noted that during the study, news and social media channels have been continuously followed. Empirically, the author has categorised initiatives emerging within these channels, from varying countries, by the use of the framework. From a funding agreement in Netherlands and Belgium to clean the river 'Maas', to a fisherman in Vietnam recovering plastic during fishing trips. By empirically comparing the efforts, the prospect of generalisation is broadened. Officially, academic research should provide this robustness, but empirically, the framework shows a tendency to hold on the majority of project worldwide.

Actuality

Striking while the iron is hot increases effectiveness. In this case, the iron resembles momentum, determined by topicality. As long as plastic pollution gains ground within research and public view, the momentum will keep increasing. Actuality is an important driver behind this study, but at the same time it is a limitation as momentum is not within the actual scope.

Legislation and regulation

Official legislation and regulation in Indonesia is predominantly excluded from this report. It is established that projects are active and possible by means of the case study and interviews, but the actual laws in Indonesia fell out of the scope of this report.

Manual coding

Coding for the study has been done manually. Manual coding does not affect the quality of the coding and the results in particular, but it presents difficulties when repeating or improving the research. It is not digitally noted what the best codes are and how they are categorised. When further research is initiated, this may affect a time schedule.

7.4 Further Research

Plastic pollution is a widespread problem that can potentially harm human health and welfare globally. This thesis involves riverine plastic pollution, an essential part to this plastic problem. Focusing on riverine plastic, this thesis proposes a specific set of subjects interesting to research more in-depth.

To ensure a functioning framework an additional approach is added to the initially defined ones, differentiating between active and passive involvement. This is an extension to the essence of this study. The framework presents two options for further research, being not independent subjects but specific improvements. The first is enhancing firmness of the results. This can be done by conducting more interviews based on the same questions. The framework can then be assessed by a larger number of experts, improving validation of the framework as it is. The second option is to deeply investigate the option of *passive* involvement. This part of the framework is realised by discussing the author's idea for an extension with three experts and within Allseas Engineering B.V., but has not been researched in depth as it is constructed to complete the framework and enhance functionality. It is a first step towards generalising the framework and thus offering opportunity for further research. The same holds for generalising results and applying the framework to projects that are not aimed for Indonesia but other developing countries.

This research identifies two ways of realising a viable go-to-market strategy for riverine plastic recovery projects in Indonesia. The first combines economic value with environmental value, the second combines social value with environmental value. These evaluations are based on the TLBMC. In the best situation, the three layers of the tool are equally represented within a sustainable project. In Indonesian riverine plastic recovery, this is as of today not yet the case, but experts said that opportunities arise. The identification and definition of what provides viability in a go-to-market strategy is what this study does. A follow-up research can investigate the possibilities of realising complete coherence between economic, environment and social values created.

Lastly, in order to involve local communities it is important that the problem is quantifiable for these communities. This research came to the conclusion that the best way forward is putting a price tag on plastic pollution in every day life for locals to comprehend. A suggestion to do so is the use of tourism, as polluted areas attract less tourists, which leads to less jobs and money. This is probably not the only way to do so. Further research can identify other ways to put a price on pollution locally. When there is a broader spectrum of ways to price pollution there will be more support among the communities, as not only people involved in tourism will understand the motivation.

Chapter 8

Conclusion

The objective of this research is to facilitate a framework to assist organisations willing to deploy a riverine plastic recovery project in Indonesia. The prospects and barriers of the implementation in Indonesia are mapped in detail and processed in an easy-to-use framework. The literature review provided a theoretical basis for the research and the case study connected the theory to a real life example. This enabled the creation of a framework. The expert interview provided extension on the case study and validation of the framework, leading to amendments and additions. The framework was then applied on an active plastic recovery program under control of a Dutch offshore firm, leading to recommendations and a first impression of the framework's use. The main findings and possible following academic and practical steps were elaborated on in the discussion. this section focuses on the results and concludes the report. The answers to the research questions are stated, followed by a summary of the recommendations and contributions of the report.

8.1 Research Questions

This section looks back on the research questions the study set out to answer. One by one, the process of answering the questions will be reviewed. The answers provide the basis for the results.

1. What is the current state of research on deployment of riverine recovery systems in developing countries?
The current state of research on riverine plastic recovery is split up in several sections. The first section included in this is based on identification of amounts and global hot-spots. Research is developing quickly and range is increasing, making this section more stable compared to 2017. The second section included is an overview of technologies on which research is developing, but is well established as well, think of basic collection systems for objects. The third and final section relates to man-

agerial aspects and implementation of riverine recovery systems. The last section of research is underdeveloped and simultaneously the focus of this report, increasing its relevance.

2. What are the main parameters that influence market potential for riverine plastic recovery systems in Indonesia?
The literature provides the essential understanding of riverine plastic recovery systems in general with two main categories being identified, differentiating between *passive* and *active* systems. This report covers passive systems, which have three basic sub-categories: *booms*, *receptacles* and *buoyant structures*. Combinations are possible. This provides an overview of what makes up a catcher technically. Specification to Indonesia follows in the case study, where an acknowledged plastic recovery cooperation and its river project are inspected in depth, uncovering the characteristics of the Interceptor. Following the assumption that this was not the only defining standard for plastic catchers, discussions are initiated in expert interviews where alternatives to this system are described. Examples of influential characteristics are 'technological complexity', 'cost', 'river size' and 'capacity are examples'. The predominant characteristics for *implementation* are categorised in the framework, divided per pathway

3. Who are the stakeholders linked to the riverine plastic recovery in Indonesia and what is their significance?
The TLBMC identified gaps in the approach of TOC regarding limited social value created. The inspection points out that the organisation does not offer a complete and locally integrated solution, reducing opportunities of long-term continuation. This underlines the importance of *local* stakeholders, such as villagers with municipal or practical functions, to riverine plastic recovery. Conversations with experts specify the most important *local* stakeholders, emphasizing the decentralised organisational structure of Indonesia itself and its plastic waste management bodies.

4. Which business strategies do organisations have at their disposal for riverine plastic recovery in Indonesia today? The case study shows annual reports of TOC for the years 2017 through to 2020. These annual reports include financial statements defining and clarifying income and expenses and showing maximisation of income as one manner of strategy. It is assumed that this is not the only viable strategy for riverine recovery in Indonesia, as it is purely based on Western financing. The interviews address this assumption, resulting in an in-depth discussion with the experts. When looking for local finance, it is emphasized that minimising cost is key to this quest. Sustainability is not predominantly incorporated in the financial balance of Indonesia. A second strategy is identified, being maximising local involvement. *5. Which other factors could be decisive for market entry in Indonesia specifically?*
This question assumes a different business environment in Indonesia compared to that of most developed nations. Sustainability is an embedded issue in the developed world, resulting in mainly Western firms focusing on increasing sustainability. Developing countries, however, are area's with higher potential for increasing contri-

bution to sustainability. This leads to many organisations from the developed world aiming to act in developing countries. Western norms and values differ strongly from the standards in Indonesia and implementation is not always desirable. For example, culture is more heavily embedded in doing business in Indonesia, making the whole process to be treated carefully and socially. Examples of Western companies that underestimated the assessment of this business environment resulting in underperformance have been discussed with experts, emphasizing this importance.

MAIN. What makes a go-to-market strategy viable for deployment of novel river plastic recovery systems in Indonesia?
The sub-questions provide the missing pieces of the puzzle that is the main research question. The full scope of the research provides the answer, from chapter 1 to chapter 6. There are ***two essential approaches to finding viability in Indonesia*** on the riverine plastic recovery field. The case study identifies one way of providing viability, the experts show another. These two approaches are broken down into minimum requirements for a project to qualify. These minimum requirements are categorised in a framework. This framework is to be used by organisations that do not focus primarily on riverine plastic recovery but do have the urge or a developed plan to contribute to solving the plastic problem.

8.2 Recommendations

With the results of the study, i.e. the answers to the research questions, a framework has been devised and proposed, presented in figure 6.2. With the help this framework, practical and academic recommendations have been constructed.

Based on the trend of an increase in sustainability demand, managers and practitioners are well advised to take into consideration the probable transition towards sustainability that is at hand. Plastic pollution prevention is an impact part of sustainability issues and, besides contributing to a less polluted world, could prove fruitful for partaking organisations. An increasing rate of public support for sustainability has been recorded. This is can trigger actual demand for riverine plastic recovery systems in the near future. Already, the trend results in multinationals adjusting company strategies towards sustainability. However, contributing to plastic pollution proves a difficult endeavor to embark on. The framework presented, poses a tool that can assist decision making in organisations willing to accept the challenge of plastic pollution prevention. Based on the results, practitioners, managers and organisations should consider using the framework to create a clear overview of the level of development of their plastic project aimed for Indonesia.

Academically, further research recommendations have been discussed in the discussion. In short, it is advised to look deeper into the passive pathway of the framework. Moreover, the framework is created to suit Indonesia best as possible. Research into

the generalisability of this study is suggested, as more nation face plastic pollution issues that require assistance.

Specifically, the framework has been applied to a plastic project launched by a leading Dutch offshore company, Allseas. The organisation was exemplary for appliance of the framework, as its core business does not connect to plastic pollution prevention, yet they are motivated to get actively involved in riverine plastic recovery. Applying the created checklist results in a clear overview. The project of the company in its current form does not meet all the requirements to either one of the *active* pathways, but the strenghts and weaknesses of the project are categorised as expected. The company now has to decide the required improvements are desired or another option, i.e. *passive* involvement, is preferred.

8.2.1 Market Acceptance

The findings of this study mark the importance of market acceptance of a project. The framework is constructed on the requirements for *minimum market acceptance*, where either one of the approaches propose a set of requirements to viably deploy a riverine recovery project in such a way that the target market is willing to get involved. The target market differs strongly with each approach, making the stakeholders within each approach essential. An economic approach focuses on the demands for sustainability solutions in the developed world, whereas a local approach relies on relevance in local areas with a lower demand for sustainability issues. The framework addresses requirements for the initial *go-to-market strategy*, after which a detailed BM will be required. The difference in stakeholders for each approach has been identified by the use of the building blocks of the TLBMC. When an organisation would decide to continue the project it is hence advised to involve the TLBMC when developing a unique BM. This model incorporates the stakeholders in a sufficiently elaborated manner.

8.3 Contributions

8.3.1 Academic

This decision-making framework for riverine plastic recovery projects is the main theoretical contribution of this thesis towards the field of research. The literature pointed out that there is research available on (riverine) plastic recovery systems. However, this available research is mainly from a technical point of view or from a 'customer's' point of view, as is shown in a number of cases. In none of the cases, assistance is offered to organisations and companies that are motivated or forced increasingly to contribute to sustainability in a way and choose plastics as issue to attack. Whenever organisations are in such a position, chances exist that in the process these parties only reinvent the wheel, being undesirable. This study sets off to close this gap and ease the basics in the decision-making process for organisations. The theoretical contribution is split in segments.

The TLBMC analysis posed parts of the contribution, as it is the first of its kind to dissect the activities of this sustainability driven organisation. According to Joyce and Paquin (2016), sustainable innovation and implementation follows the triple layers of their canvas, the three values driving long-term sustainability. The intentions of TOC are in line with this but not yet practically realised. The case study provided important knowledge for sustainable action in developing countries, especially with support from companies from the developed world. The 'why' and 'how' of viability of riverine plastic recovery projects in Indonesia are discussed with experts providing added knowledge leading to the creation of the framework. The framework poses as the first tool of its kind in the academic world, one that can function as motivation for organisations of any kind to join a transition towards sustainability. This can be beneficial to organisations as the demand for sustainability contributions is rising. Moreover, within the realm of (TL)BMC research, this study shows way of use of the canvasses other than traditional. The (TL)BMS's can be used for an analysis and a diagnose of what is well designed and what not. The results of this analysis form the essentials of a business strategy in their most basic form. This way of use is the other way around, compared to the normal use of these canvasses.

Where business meets riverine plastic recovery, the study shows the basics of business opportunities for companies. The framework itself is designed to assist companies with *other* core activities that plastic recovery, but suits any type of company when empirically applied. The most important theoretical contribution is the seemingly inseparable connection between sustainable innovation in Indonesia (and possibly other developing countries) and firm stakeholder involvement. This is also identified by using the TLMBC. Until now, this has been mainly presumed but seldom academically emphasized.

Finally, this study elaborates on current literature by uniting two fields that have

been separated until now: technological and managerial research on riverine plastic recovery. The literature study provides an overview of available literature on both sides. The empirical research done for this study unites the theory found by proposing a framework that integrates both aspects, which is the essence of *Management of Technology*.

8.3.2 Practical

The main practical contribution of this thesis is the useability of the framework. It is aiming at managers and organisers at companies in general. In the introduction it is stated that the demand for sustainability and specifically plastic pollution prevention in Western business operations is on the rise, but practical action cannot yet match this demand. This is because the practical cause for sustainability is still in its initial phase. A framework or a tool presented to and aimed at general business operators can induce participation, accelerating a transition and benefiting the organisation. And the framework created in this study is kept as generic as possible in order to meet these demands. The use of the framework may vary between businesses as the level of plan development can vary strongly, but the basic requirements for a riverine recovery project in Indonesia are comparable for any company. The framework is to be used as a checklist for these requirements whether a project qualifies for implementation or not. It addresses strengths and weaknesses. The decision to abort or to improve is still kept within the organisation itself. These decisions are depending on resources and ambition, both variables that are not universal amongst the respective companies. The framework does boost *the ability to decide* whether deployment of a riverine recovery project is worthwhile. The practical use of the framework is available upon request, the framework is applied to the riverine recovery project of Allseas and contains confidential information.

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Appendix A

Existing Riverine Plastic Recovery Technologies

A.1 Overview of existing technologies

This part of the appendices gives an overview of available idea's concepts and existing technology at the time of publication of this report. It does ***not*** cover all available idea's concepts and existing technology, but aims at showing the variety in inventiveness and use of technology at the moment. During the research, it becomes clear that many different parties are coming up with ideas to improve plastic prevention. Many ideas are tangible and realistic, some of those are in use. Other idea's are vast and very imaginative, still might function as inspiration. Each item will be shown within a subsection, where it will be visualised and explained shortly. Also, the web addresses will be added.

Marine Drone

A drone that cruises through the water column to collect debris and plastics. Similar to the idea of a robotic vacuum cleaner or lawn mower. Operates in shifts, relatively small, when capacity is reached it returns to 'the mothership', floating central container and charger.

Concept Phase

https://www.core77.com/posts/22902/flotsam-spotting-elie-ahovis-marine-drone-like-a-roomba-for-ocean-garbage-22902

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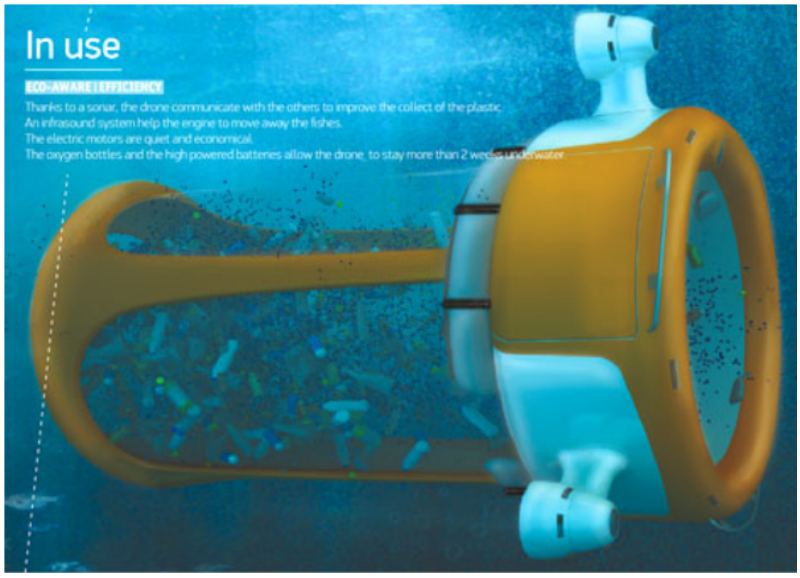


Figure A.1: Core77 Marine Drone

Mobile Eco-Robot

A floating structure, size comparable to a drilling platform. It is powered by solar panels and designed to suck up plastics from the water column. It is said to be connected to satellites for monitoring and operating efforts.

Concept phase

https://ecofriend.com/eco-oceans-eco-mobile-robot-cleans-up-the-world-s-oceans-on-a-grand-scale.html

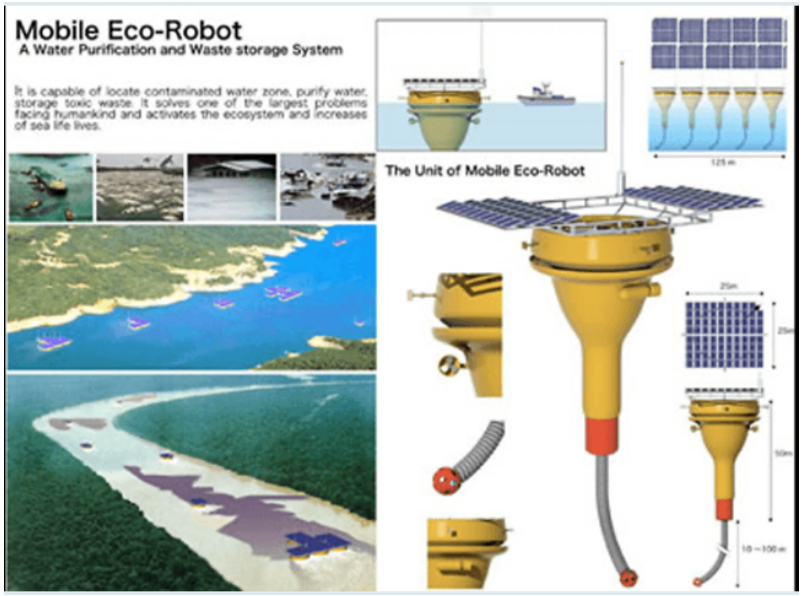


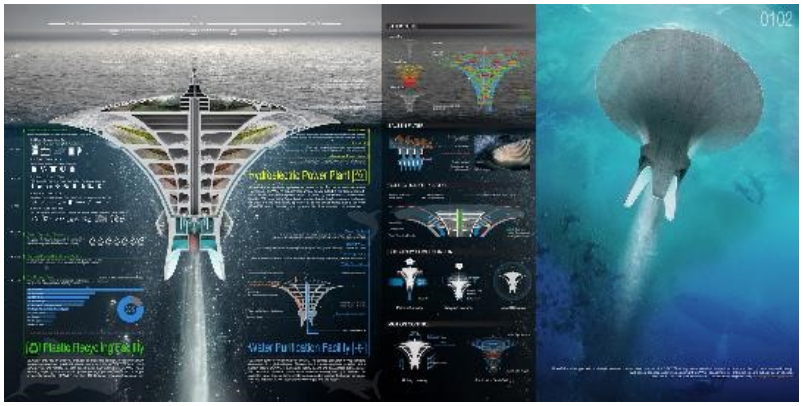
Figure A.2: E

Seawer

A garbage so-called 'sea-scraper'. A very large floating structure, 500 meters in diameter and 300 meter draught. High dollar investment, estimated to be over 3 billion USD. Designed to filter the seas via sieves and separate the waste which is to be stored.

Concept phase, no development

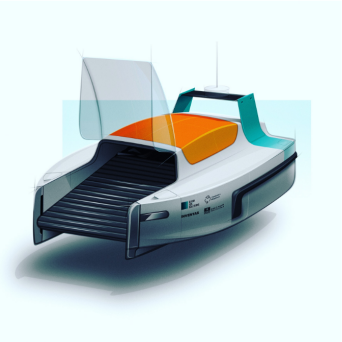
http://www.evolo.us/seawer-the-garbage-seascraper/



flexipod and robot cleaner

Concept, developers are working together with Oslo. It consists of autonomous robots that sail around and collect trash, they return this trash to the docking stations. It uses computer vision and remote sensing to find trash. It uses internal collection pools with waterfalls to split the plastic.

Concept Phase

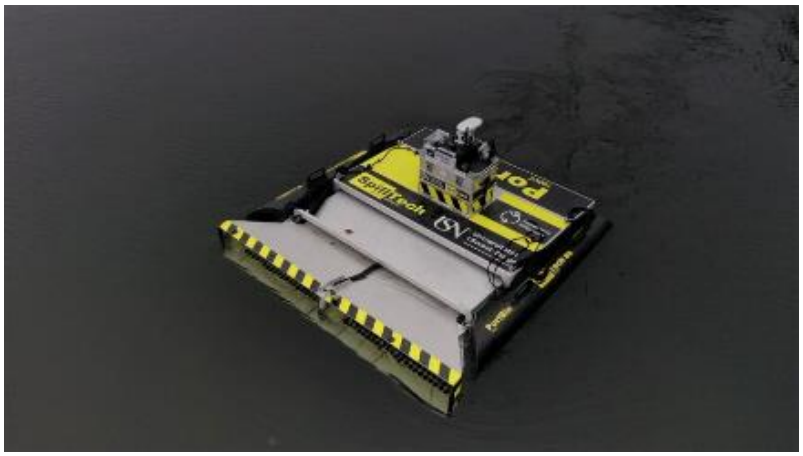


Portobin Robot

The technology that is used is based on oil spil response systems. SpillTech is developing the PortBin robot, a surface drone traveling around small to mid-size water bodies, particularly hoovering floating waste. It needs an operater, so is an active system.

Pilot Phase

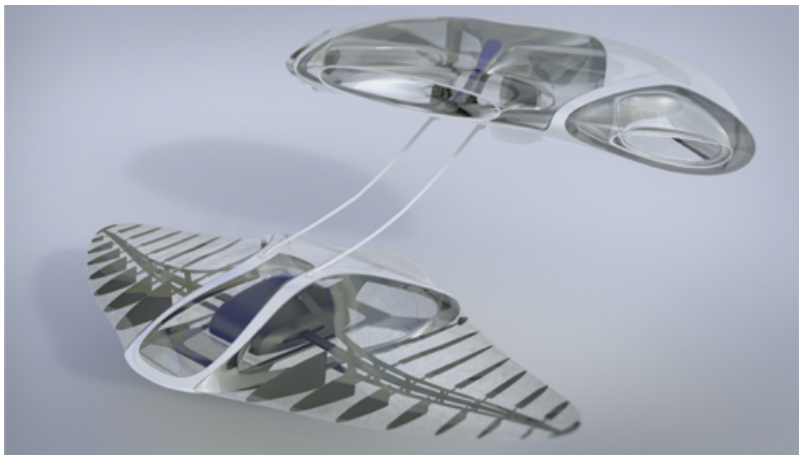
https://www.theexplorer.no/solutions/small-and-mobile-surface-drone-for-collecting-plastic-waste/



Ocean Robotic Cleaning system

An idea combining a mother-ship and a suction satellite in one. Is to be designed for cleaning the pacific ocean, specifically the Great Pacific Garbage patch. The idea looks like it involves high investment, no exact figures are found.

Concept Phase



Sargaboat

An active system, where a boom and recovery vessel are combined. It is designed to block passing seawead, where it is found functional as plastic barrier as well. The idea is to deploy several barriers that will protect beaches and then sail by with a vessel to scoop up all the debris that is cumulated at these barriers. *In Use*

https://theoceancleaner.com/services/

Cleantec Infra

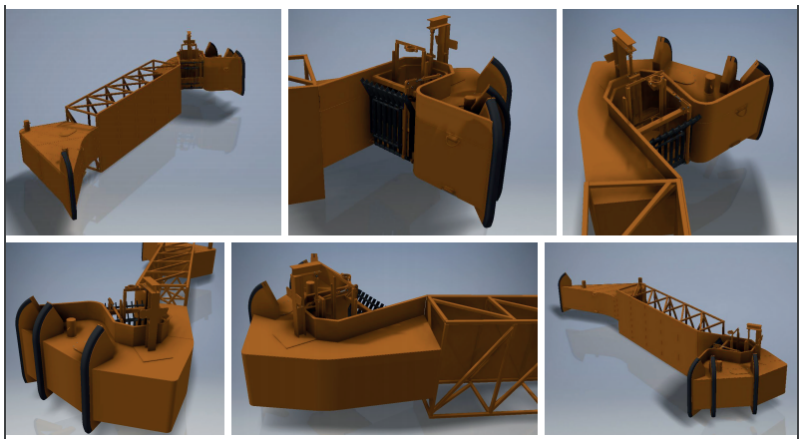
Working system, Manufactured by Aquarius Systems in the USA. A vessel with a "mouth" and a transport belt that scoops up floating debris. It is currently deployed in India on the Ganges river where they remove the floating waste such as: Aquatic Hyacinth, algae, religious materials, plastics, bottles, garbage, etc. This floating waste is collected in the boat that has a storage capacity of 10-20 cubic meters. It seems like this solution is very suited for India with high amounts of waste and very cheap labour.

https://www.cleantecinfra.com/trash-skimming

Veegarm MRD

The concept intends an arm attached to a boat. This vessel will sail through patches of plastic or other garbage, the garbage will then collect at the end I think. It seems that these arms are also used for oil spills and other environmental spills, and that there are a few in use.

In Use



Ocean Phoenix

Concept, this idea is practically unrealistic, as there is a very slim chance it will ever be crated due to complication and prce tag of over 3 billion USD. The idea behind it, however, is to combine a large ocean bound vessel with the equipment to filter, recover, sort and process floating debris.

Oceanic Cleanin System

A pod that can be released into the ocean. Separate units will scavenge around for plastic and collect it, to then move back in a cuttlefish like manner, meaning that it is to be propelled by fin-like structures.

Concept Phase

https://www.yankodesign.com/2011/08/12/cleaning-cuttlefish-style/

Orca

A proven concept that uses a vortex to create suction, originally intended to collect oil after an oil spill but it can also be repurposed to collect plastic. It is an active system and is to be deployed from a seavessel.

In Use

https://www.orcaclean.com/

Waste Free Oceans

Another proven concept, two vessels dragging a net with two booms. Very practical, not very technologically innovative. WFO focuses on the complete chain, products with recycled materials, awareness campaigns, etc. It seems that they are not so much working on the reduction of plastic in the ocean with technological means but more focused on awareness campaigns and initiatives to ensure that children are aware of all these problems.

In Use

The Ocean Cleanup Interceptor Procject

Elaborately described within this report.

In Use

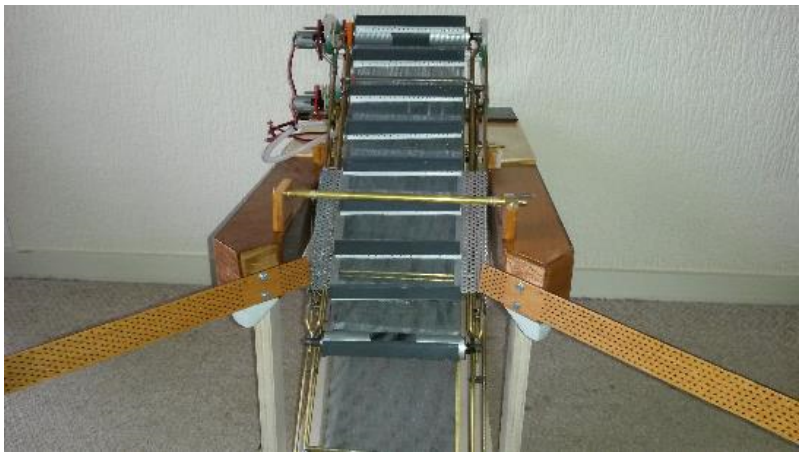
https://theoceancleanup.com/rivers/

Saraswater transporter

Concept, idea likely not in use anymore, no new updates since 2015. Uses transport belt to scoop up plastic from the ocean or rivers.

Concept, not to be developed

http://www.saraswater.nl/



Shoreliner

Deployed in Rotterdam, in the Wilhelmina haven. Riverine recovery system that where a boom leads to a container, which stores the waste. The bin is not removable.

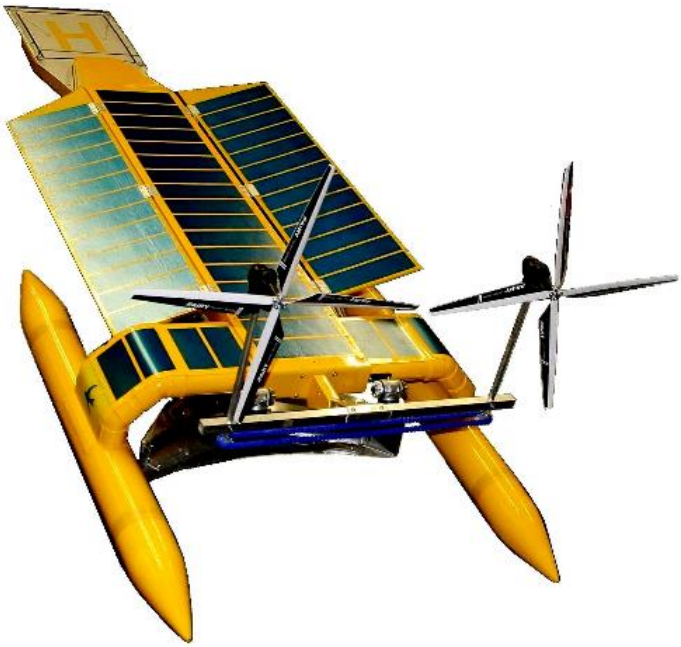
In Use

https://www.tauw.nl/op-welk-gebied/duurzaamheid/shoreliner.html?sqr=shoreliner&

Seavax

A large vessel that is set to skim the surface of water bodies and collect surface plastics. It is to be powered both by wind and by solar power.

Concept Phase



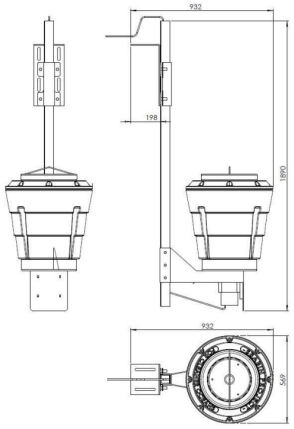
Seabin

A semi-passive, small-scale system that is in use in ports, filtering the water and catching debris. It is, as the name suggests, similar to a normal bin. In addition, it uses a small pump to create a vortex that sucks down plastic, where it is caught in the container.

In Use

https://seabinproject.com/the-seabin-v5/

- Power: 110V / 220V Consumption 2.5 amps 500 watts
- Pump: 25,000 LPH
- Sturdy HDPE construction
- 316 Marine grade stainless steel bracket
- Capture micro plastics > 2mm
- Catch bag: holds 20kg
- Weight with bracket: 55 kg
- Electrical cable: 6 meters
- Seabin dimensions: 500 x 500 mm X 1800 mm
- Reusable catch bags
- 2 Year warranty
- Recyclable components
- Removes an estimated 1.5 tons per year



1. The V5 Seabin units are installed on floating pontoons only
2. There are staff to maintain the Seabin on a daily basis
3. Maximum distance to an electric energy supply point is 6 meters (more with an extension cable, not provided)
4. Voltage provided 110V/220V
5. Freeboard range between 460mm minimum and 820mm maximum
6. Maximum water current speed range equal or below 4 knots
7. There is a minimum 1.2 meters of water depth at the lowest astronomical tide

Floating Horizon

The concept is to use an open half circle to collect plastic, it will be pulled by a manta ray like machine that floats below surface.

Concept Phase, no indication of development

http://www.floatinghorizon.org/the-concept.html

Noria

In a waterway near Alphen aan de Rijn, this initiative is operational. It is built on a small scale with aim to upscale quickly. Simple and passive system. A storage capacity of about 100 litre at the moment. A wheel scoops up the plastic against the flow, the aim is to be water powered, but at the moment it uses an electrical motor that powers the wheel.

Pilot Phase

https://www.noria.earth/

Trash Booms

Simple but practical, the idea of these trashbooms is that they are placed near streams that are river inlets, so trash that is brought to larger rivers can be caught before it reaches a them. These booms need to be emptied regularly and do not have a central collection point or cage.

In Use https://plasticfischer.com/trashbooms

Bolina Booms

These booms are used to stop almost all types of floating waste. The system was built to stop tree stems at dams, so the systems are built to resist high strains. The barriers are anchored to spud piles, and they use a lot of stainless steel fences and links to ensure that the system does not collapse, with the goal to deflect waste, but not really to catch it.

In Use https://www.bolinabooms.com/nl/

Sea Defence Solutions

A prototype has been installed in Italy. It is designed as waste guidance in rivers, done by deploying two barriers and forcing the debris contamination to one side of the river where they then can collect it later, or place a litter trap.

Pilot phase

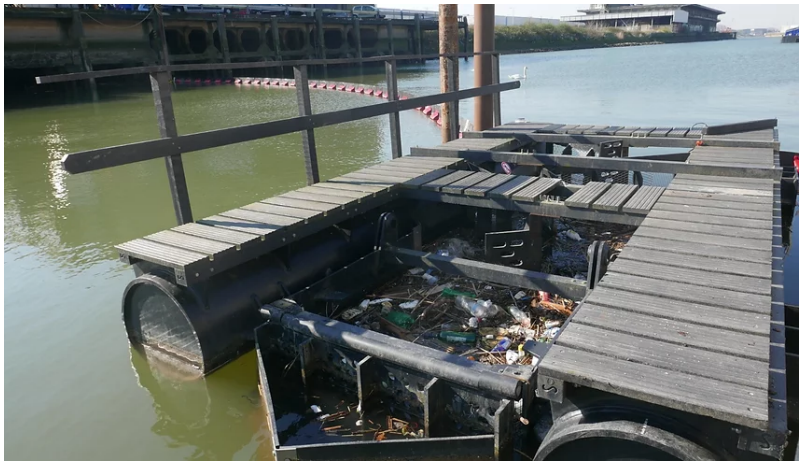
https://www.seadefencesolutions.com/

Clear Rivers

Installed in Brussels, Rotterdam and Ambon. No radical or innovative design, but largely focused on education and awareness. They have got a thought-out plan for the waste they gather, recycling it into furniture and floating plastic honey-comb like structure on which they make benches and floating gardens/parks.

In Use

https://www.clearrivers.eu/litter-traps



StormX

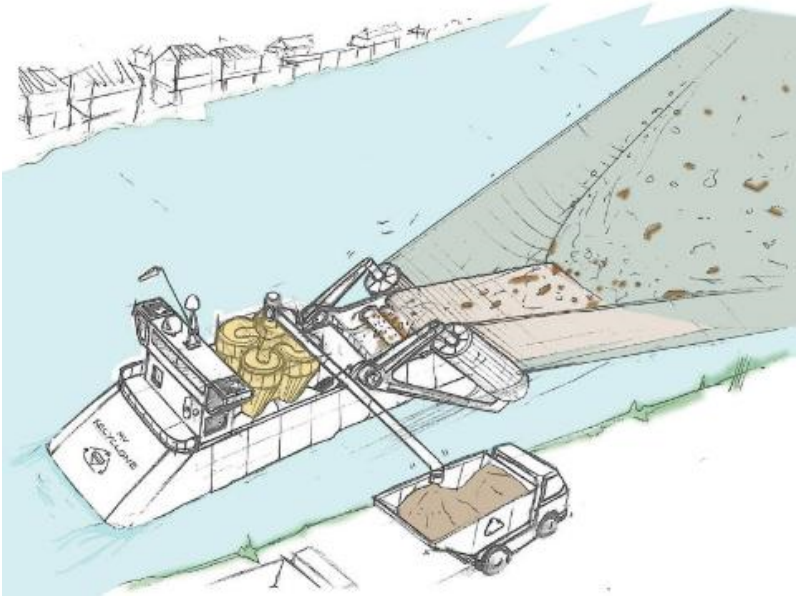
Operational systems, several of these products installed in the US. Largely focused on technical solutions, not so much on the waste streams that follow. Customer base seems to be companies that want to deal with waste themselves or governments that want to make rivers cleaner. The system is basically a net that is temporarily attached to sewage and/or drainage systems.

In Use

MV Recyclpone Barge

A very distinctive design, relevant because it is designed by a multinational, Dyson. It consists of a vacuum cleaner on the water that uses nets to pull the plastic towards the barge of a vessel. There a cyclone separates the plastic from the water.

Concept Phase



Ran Marine

A so-called 'Waste Shark', an autonomous robot, hunts the water for plastic debris.. It is designed to sail autonomously for up to ten hours before it has to sail back to a docking station to be charged. It should be able to recover 50 kg a day. It already patrols several ports in Europe.

In Use

https://www.wasteshark.com/

The Great Bubble Barrier

The great bubble barrier performs by pumping air through a perforated hose. This hose is laid on the bottom of a waterway, diagonal on the flow direction of the waterway. The bubbles force the plastic to the surface of the waterway, where it is pushed towards the shoreline by the diagonal force of the flow, in order to be collected. It is operational in Amsterdam, further testing has been done in the Wervershoof.

In Use https://thegreatbubblebarrier.com/en/

CTU System

This system was in use in 2012, as an active system. The system has two guiding arms that guide the litter into the collection mouth, this mouth has a transport belt that will move the litter to the shredders where the plastic can also be sorted and shredded. SK international is a trash handling company, operating the system.

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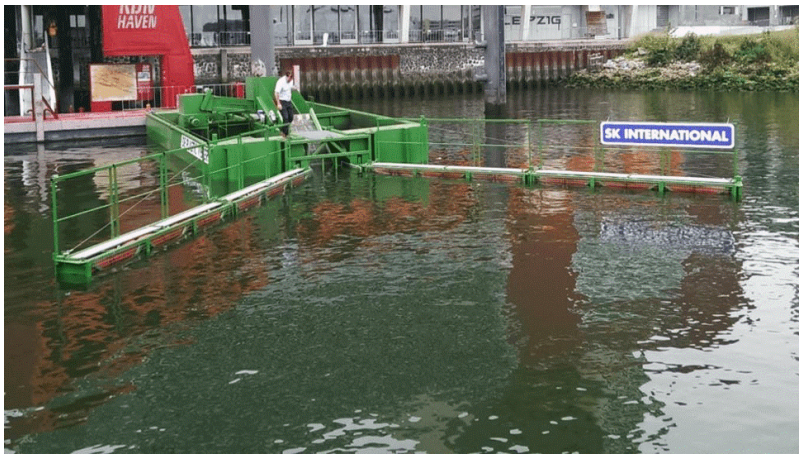
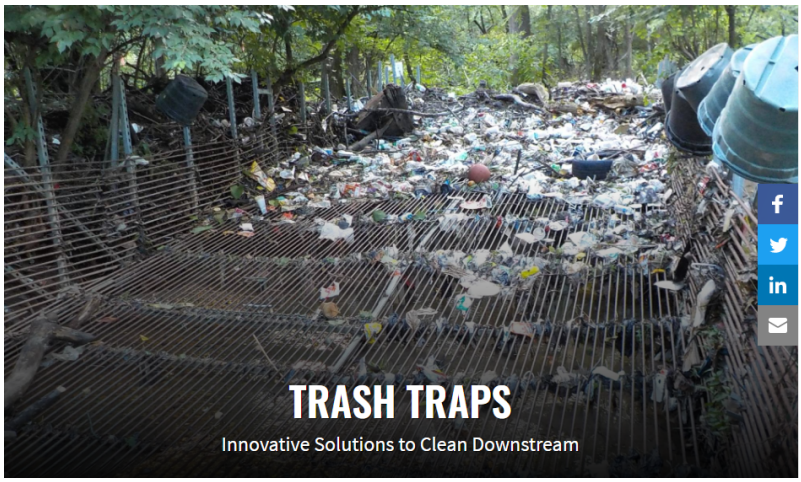


Nash Run Trash Trap

The litter is collected between the steel bars positioned at a five degree angle. The litter is sorted and measured, the data is then used for advocacy goals. The system is placed in the United States in the DC area. This solution is not able to catch smaller plastics due to the large opening between the steel bars.

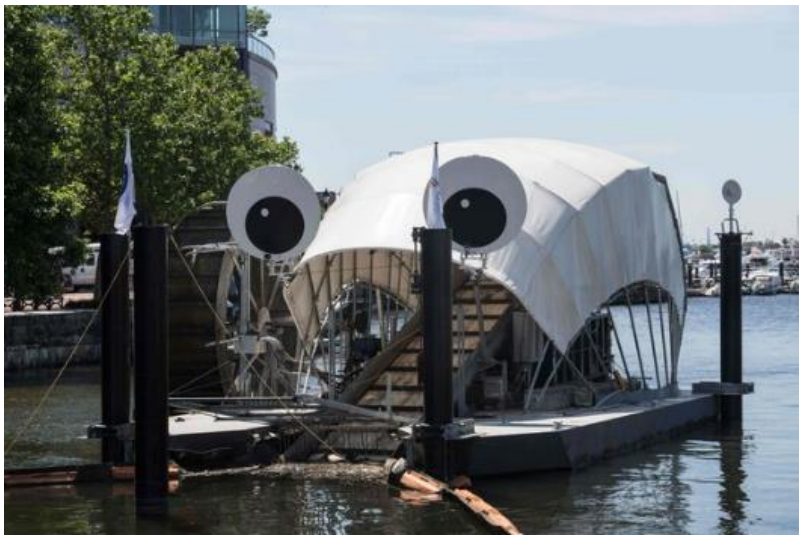
In Use



Mr. Trash Wheel

Similar to the Interceptor of the Ocean Cleanup and thus aiming for a smart, inclusive solution. Instead of only being powered by energy from the sun, a wheel is attached to integrate water energy. Consists of a barrier and a trash collection belt that is water powered. The trash is moved into a container at the end of the transport belt.

In Use https://www.mrtrashwheel.com/



Bandalong Litter Trap

A system designed for operation in small creeks and waterways, seemingly to be operational across a few continents; Africa, Australia, North America. Uses high strength booms to guide debris towards a receptacle.

In Use

https://stormwatersystems.com/bandalong-litter-trap/

Appendix B

Interview Document

B.1 Semi-structured interview questions

Interview Questions

A list of questions to help find the answer to the research question of the report:

"What makes a go-to-market strategy for deployment of novel riverine plastic recovery systems *viable* in Indonesia

General Questions Regarding Your Engagement to the Subject

1. What is your name and what is your professional engagement towards Indonesia?
2. What is your experience with plastic pollution and why is it(/has it been) important to you?
3. Are you still involved in plastic pollution prevention of any kind today?
4. Why (not anymore?)

Current state Indonesia in respect to plastic pollution in rivers and oceans

1. How would you describe 'waste management' in Indonesia at the moment?
2. What is the level of public awareness on plastic pollution in Indonesia, and is there public urge or movement for change?
3. What is the level of governmental awareness on plastic pollution, and willingness to act?
4. What percentage of rivers in villages and cities do you estimate to be polluted with plastics?

Brief introduction to the study-specific questions

The model that is being devised in this study is shown in the accompanying document. A short explanation is as follows:

"During the study, I have assumed and verified two possible pathways that can make a go-to-market strategy viable as of today, considering riverine plastic recovery systems in Indonesia.

The first one is one of ***maximising income****, focusing on big money by targeting large multinationals or high value entities to pledge to a partnership, leading to innovative and smart ways systems that can recovery plastics from the rivers, starting directly.*

The second one revolves around ***maximising local involvement****, by focusing on minimising cost, providing technologically and operationally simple systems, implemented in cooperation with local communities with the aim of long-term structural change.*

The study aims to develop an assessment tool, where minimal requirements for realisation are presented for ***each pathway****, in order to use it as a checklist that identifies if a plan is suited for either one. In order to draw up these minimal requirements, I would like to ask you the next set of questions."*

Questions on minimal requirements to successfully enrol plastic cathing business

1. When maximising income, would you agree that western companies are the most fruitful target?
2. Do new technological innovations provide a positive impulse for a marketing strategy?
3. Are innovative and smart systems a good solution to attack riverine plastic pollution (on the long term)?
4. Do people in Indonesia feel affiliated with large company marketing?
5. Which aspects are important in Indonesia when trying to maximise income via donations or partnering?
6. Are you familiar with the Ocean Cleanup (and their river cleanup project)?
7. Do you think their strategy is a onetime success, or could it be repeatable? (If explanation needed for this question, let me know in the interview)
8. Would you say that multinationals qualify to generate donations of any sorts and on any level (individual or organisational)?
9. Does an NGO or other non-profit structure improve public willingness of getting involved?
10. . What is the amount of an average subsidy granted for a sustainability project by an Indonesian governmental body?
11. . Can tourism be used as a motivator for the local community to increase motivation for pollution prevention?

Framework related questions

1. What are your thoughts on the framework attached in the email that was sent?
2. Which aspects are you missing in the framework?
3. Why are you missing those aspects?
4. Do you consider the plastic catching 'industry/market' as unique?
5. Does the framework represent this uniqueness?
6. Is there anything else you'd like to add?