Faculdade de Design, Tecnologia e Comunicação
Universidade Europeia

2022

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REPURPOSING MARINE WASTE: A CIRCULAR APPROACH

DOCUMENTO FINAL

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Projeto apresentado ao IADE - Faculdade de Design, Tecnologia e Comunicação da Universidade Europeia, para cumprimento dos requisitos necessários à obtenção do grau de Mestre em Design Management realizada sob a orientação científica da Doutora Isabel Maria Bernardo Pereira Farinha, Professora Auxiliar do IADE-Universidade Europeia e da Doutora Sara Patrícia Martins Gancho, Professora Auxiliar do IADE-Universidade Europeia.

Dedico este trabalho à minha mãe, que é a pessoa que mais me deu nesta vida e por quem tenho o maior respeito pela sua dedicação, ética de trabalho e obstinação na luta pelos seus objectivos. Sem ela nada disto seria possível, obrigado mãe.

agradecimentos

Quero primeiramente agradecer à Doutora Isabel Maria Bernardo Pereira Farinha não só pela assistência e apoio enquanto supervisora e orientadora, como pelo seu profissionalismo e paixão pelo projecto Blue Circular Post Branding, pelo oceano, pela economia circular e pela Ericeira.

Gostaria também de agradecer à Doutora Sara Gancho pela sua constante disponibilidade, pela sua paixão pelo ensino, pelo seu profissionalismo nas suas funções e pela motivação que me deu quando precisei.

Por fim, o maior agradecimento vai para a minha mãe que me apoiou nos momentos mais difíceis e ajudou a superar as muitas dificuldades que surgiram em paralelo com a pesquisa ao longo destes meses.

palavras-chave economia circular, design thinking, poluição marinha, plásticos marinhos, redes de pesca

resumo

Este trabalho final de Mestrado examina a possibilidade de aplicar estratégias de design circular aos plásticos marítimos, com o objectivo de melhorar a saúde marítima e costeira dos portos da capitania de Cascais.
Através da incorporação de dados fundados em revisões literárias, análise de documentos, casos de estudo, entrevistas e metodologias de observação a nossa análise demonstrou a existência de uma oportunidade para a aplicação do design circular no campo dos plásticos marítimos, e em concreto das redes de pesca com pertinência para ser replicada avançando para o futuro que reúne benefícios ambientais, sociais e financeiros ao planeta, oceano e comunidades nas imediações.

Concluímos que será necessária investigação futura no que toca ao redesign de equipamento de pesca. Adicionalmente, documentamos detalhadamente e diagramamos a evolução do projecto BCpb, de forma a criar um potencial modelo reprodutível para a aplicação de estratégias de design circular para lidar com o lixo marinho, entre eles as redes de pesca descartadas.

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Keywords Circular economy, design thinking, ocean pollution, marine plastics, fishing nets, Cascais capitancy

abstract

This Master's Thesis examines the possibility of applying circular design strategies to marine plastics in order to better the coastal and ocean health of the ports of the Cascais captaincy.

Through the incorporation of evidence from literature reviews, analysis of documents, case studies, interviews and observation methodologies our analysis shows that there is a circular design opportunity in marine plastics that is worthy of being reproduced heading into the future that brings environmental, social and financial benefits to the planet, ocean and communities in the proximity.

We concluded that further research is needed pertaining to the redesign of fishing gear. Additionally, we created a diagram and documented the evolution of the BCpb project, so as to create a potential template for the application of circular design strategies in dealing with marine plastics.

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INTRODUCTION

The present Master's Thesis is unique in that in order to ensure the project's success, Design Management methodologies were used as the thought structure for this research, which we believe will help the project stand out and avoid redundancy.

We hope that this research will help better our planet in a small but convincing way.

Research context

According to the Central Intelligence Agency (CIA, 2022), Portugal's coastline is 1793 kilometers long – 60% of the country's total borders – far exceeding the country's land borders of 1224 kilometers, which means that the success of a small and local ocean-related environmental change project has the potential to become an asset for scalable application across the entire coast.

Ericeira, a Portuguese city in Mafra municipality is considered to be the surfing capital of Europe for its exceptional coastline characteristics. Up to the publication of this document, it's the first and only European surf location to be protected by the World Surf Reserves, and second worldwide only to Malibu USA in a very restricted list of only 11 locations (World Surfing Reserves, 2020).

The Blue Circular project (bluecircular.org) is a project born in Ericeira – later extended to Cascais – under the Captaincy of the Port of Cascais, a local organ of the Maritime Authority General-Directorate which regulates maritime spaces under its jurisdiction that extends from Foz do Rio Sizandro (Torres Vedras) up until Forte de S. Julião da Barra (Cascais). The project incentivizes the local fishermen to recover marine plastics and fishing artifacts caught in their nets and to deposit them in the organization's marine ecopoints rather than dumping them back into the sea. After that, Blue Circular's challenge is to reintroduce these materials into the economy using a circular strategy, either by repurposing or recycling them. At that point, research is key to form ideas and design clean processes of reintegration, but it's also pivotal to

communicate clearly in order to nurture the necessary partnerships to develop the value chain of the circular model, which focuses on recycling as a strategy and local industrial synergies.

Motivations

Plastic debris is a material of high societal concern, as it has been declared an unnatural stressor to a wide range of organisms and ecosystems, an eyesore and an unethical addition to nature. The cleaning of contaminated areas requires effort and funds, which have implications for the economy. Plastic debris can also be seen with the naked eye, which partially explains the concern of the public (Koelmans et al., 2017).

One of the strong motivations for this study is making the world a better place; in this case by leveraging creativity, design and a transdisciplinary holistic approach that includes social factors in order to address marine pollution.

In any given context, understanding every small system in place and their complex interconnections is not a simple task in the *Wicked World* (Epstein, 2020) – a term explained in the two paragraphs below – but as long as we draw knowledge from a variety of disciplines (using a holistic approach) it is certainly possible.

As David Epstein describes in his book *Range* (2020) – a strong influence in this study's approach, where the advantages and disadvantages of people considered specialists and generalists are explored – what specialists are truly suited for is excelling at kind learning environments, which are defined by having a static set of rules such as a chessmaster studying and practicing chess; patterns repeat over and over, and feedback is extremely accurate and usually very rapid. He calls this learning domain the *Kind World*.

On the other hand we have the generalists or late specializers, who sample a variety of disciplines before truly committing to one (if ever), who excel at problem-solving in what Epstein calls the Wicked World – a term he uses to describe our rapidly changing reality which requires conceptual reasoning skills that can connect new ideas and work across contexts, and for which you'd need the ability to apply knowledge broadly – requiring broad training (Epstein,

2020), a stance that SAPEA (Science Advice for Policy by European Academies) seems to agree with:

> "Close interdisciplinary collaboration between the natural, social and behavioral and regulatory sciences is the way forward for addressing the complex issue of plastic waste and pollution. The absence of concrete evidence of microplastic risks at present does not allow us to conclude with sufficient certainty either that risk is present or that it is absent in nature. It will thus take some time before more reliable conclusions on risks become available for the various environmental compartments and for public health assessment." (SAPEA, 2019, p. 12)

This paraphrase not only serves to provide a cross-reference on the interdisciplinary approach that Epstein establishes as good practice, but also to highlight the concern that there is already damage done that we cannot fully grasp the consequences of, and thus we should also work hard at predicting specific outcomes of these environmental changes if we want to reach a high degree of competency.

The problem

In spite of plastic's very important role in our economy and crucial role in many industry sectors due to its low cost and high functionality, the growing of these materials in short-term applications is a very inefficient way of using resources.

According to a 2014 study, it was measured that over 250,000 tons of plastics were afloat at the sea (Eriksen et al., 2014) – and there is no reason to believe that this number hasn't massively outdone itself by now, the year of 2022.

According to Moir (2022), the European Court of Auditors (2021) and our own observation during the course of this investigation, there are three main challenges in reusing plastics recovered from the ocean:

1. Cost/ Availability: Throughout the course of this investigation, we found that most of the industries that have the recycling capabilities for these plastics are already allotted to recycling domestic waste and have little room for expansion, or, have no financial

incentive in opting to recycle national plastics which is more expensive in comparison to the alternative plastics from international seas that get purchased much cheaper..

2. Greenwashing: The alternatives available to these transformation industries include buying new plastics for a much cheaper cost than that of the whole recycling process or, in case their product's marketing speech is environmentally aligned, importing the already separated washed and extruded plastics from Asian countries such as Singapore, which further pollutes the planet but gives them the ability to market their products as recycled ocean plastics. In the present, most of the financial incentive to get companies on board with circular economy ideas comes from the ability they have to associate their brand with these initiatives, boosting their bottom lines as a result of being seen as more green – effectively exploiting this loophole is what we call greenwashing. Thus we can say that greenwashing is the act of making false or misleading claims about the environmental benefits of products or services (Moir, 2022).
3. Enforcement of Legislations: With the Asian plastics loophole being so commonly exploited, another course of action would be to create and enforce legislations that prevent greenwashing from happening and further incentivize the recycling of products even at a theoretical financial loss. Unfortunately this represents yet another challenge, as even though there exist regulations already in place for this purpose, they don't seem to be properly adjusted and/or enforced. In 2021 the European Court of Auditors published a Special Report titled "The Polluter Pays Principle: Inconsistent application across EU environmental policies and actions" outlining the flaws of application of these environmental policies (ECA, 2021).

With that being said, the evidence suggests that the focus should be on circular economy approaches and away from linear processes and end-of-life cleanup (SAPEA, 2019). In this study our intention is to pursue our research goals while working under the assumption raised by SAPEA that the answer lies within a societal/ design-shift; away from linear economy processes.

Objectives of the study

The general objective of this study is to determine whether there is a circular way to reuse the recovered discarded fishing nets mainly composed of Polyamide 6 (PA 6) nationally, and if so to design a model representing the operation that is circular, functional and hopefully easily copied and implemented in similar contexts.

The specific objectives for this study are:

1. Involvement of the community in the virtual supply chain through the design of a circular strategy that exchanges some kind of reward for their cooperation.
2. Growth of ocean pollution awareness within the fishermen community.
3. Research of other attempts at tackling the environmental problem of ocean pollution and determining their usefulness as an example.
4. Determining by order of proximity which of the industries from the plastics transformation sector have interest in forming meaningful partnerships with the objective of bettering coastal hygiene.

Research question

Is it possible for the marine litter recovered by the Blue Circular project to be transformed and reintroduced in the economy through the use of a circular strategy considering the recycling limitations of the recovered plastics, and the availability of transforming industries in Portugal?

This central question then raises 4 specific questions which align with the specific objectives of the research:

1. Is it possible to use the help of the community in order to reintroduce recovered marine litter in the economy using a circular strategy?

2. Will the community's involvement in this strategy raise their level of awareness toward ocean pollution?
3. What are some projects that successfully reverse environmental damage through circular economy strategies and can they be useful as an example or source of inspiration?
4. Can industries in the plastics transformation sector and otherwise be recruited to the effort of bettering coastal hygiene?

Research design

> *"The function of a research design is to ensure that the evidence obtained enables us to answer the initial question as unambiguously as possible." (...) when designing research we need to ask: given this research question, what type of evidence is needed to answer the question in a convincing way?"* (USC, 2015, General Structure and Writing Style, para. 1).

To obtain relevant evidence which accurately answers our research question, we came up with a research diagram (Fig.1) which helps us organize and picture what our research steps will look like.

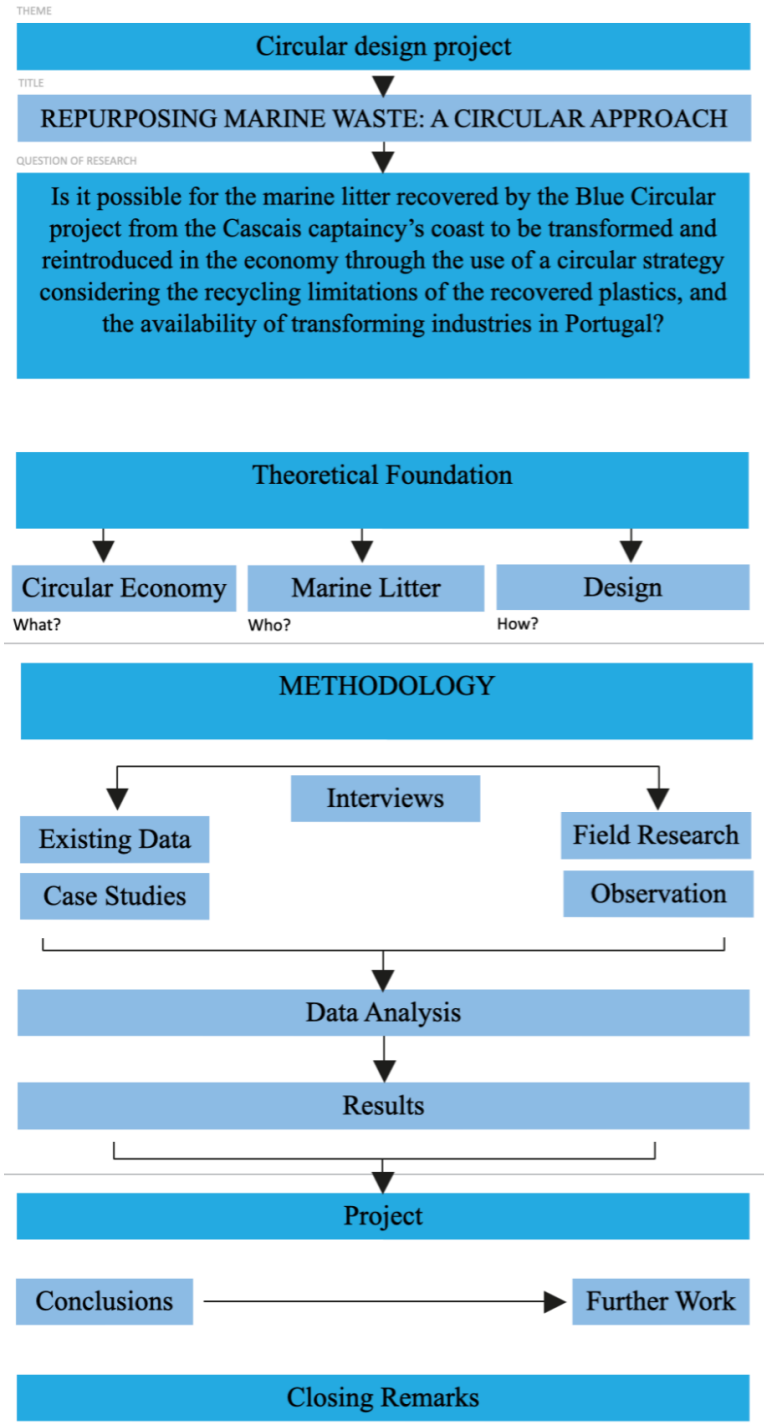

Figure 1: Research diagram

The thesis is organized in four distinct chapters and a final part for the output in the form of a project.

Chapter one provides a brief state of the art analysis that relates to circular and blue economies that serves as an exploration of concepts and ideas that we hope to utilize as the theoretical foundation for this research. It starts by touching on the definitions of the two terms and finishes by contextualizing them in the marine activities (fishing).

Chapter two serves as a introduction to design management and design thinking and their applications within a business environment while also providing a self-critical analysis of its own success. Sustainability and plastics are introduced and it's a continuation of the theoretical foundation for this research.

Chapter three describes our methodological approach to the research question, citing relevant sources that describe the tools used in the empirical research, namely document analysis, case studies, interviews and observations.

Chapter four provides the outputs for our methodological approach, the results are presented and discussed individualy per section and reflect the questions raised in the previous chapter. The knowledge generated in this section is what will provide the basis for our actual project and intervention in Part III.

In Part III we go through 4 different phases to generate our research output, a diagram representative of the circular process we managed to create, that we give a detailed explanation for. After that we present the closing remarks for our research and the limitations we noticed during it and finally we leave pointers for future researchers in the field.

PART I: THEORETICAL FOUNDATION

In the following two chapters and its sub-chapters within part I a literary review will be made in such a way that it establishes with clarity the current understanding of what we think are the two key concepts involved in creating a solution for our research question – Blue circular economy and Design management.

Chapter 1 - BLUE AND CIRCULAR ECONOMY

The Blue and Circular Economy are two concepts that refer to the economic systems of the ocean and of circularity of resources, respectively. These two concepts will be precisely defined and reflected upon through a literary review in the upcoming topics inside of this chapter: “Circular economy: The plausible evolution of consumption” and “Blue economy: Wealth in the ocean”.

The two concepts inspired the name and aim of the project Blue Circular Post Branding Project – a local circular economy project based in Ericeira and Cascais, Portugal – which brought forth the need to research the repurposing and recycling of marine plastics for this specific set of circumstances[1]. These two concepts together also name – but shouldn’t be confused with – the Blue Circular Economy (bluecirculareconomy.eu) initiative, which is a transnational project co-funded by the EU Interreg Northern Periphery and Arctic Programme, that is backed by the European Regional Development Fund. Its aim is to support the development of the fishing net waste industry in regions across Europe’s Northern Edge and to help small and medium-sized enterprises (SMEs) offering products and services within fishing

[1] The BCpb project is an initiative advanced by the research unit UNIDCOM/IADE, managed by Universidade Europeia. The project has the code MAR-04.03.01-FEAMP-0294, approved in the scope of the MAR2020 Program, on behalf of European ID - Association for Research in Design, Marketing and Communication and managed to get the extension of its deadline, until December 2022. The founders of this project are Prof. Carlos Duarte (PhD in Production Engineering / University of Beira Interior) and Prof. Isabel Farinha (PhD in Sociology/ ISCTE-IUL). Prof. Rui Miguel takes part in the project since the beginning as a senior researcher (PhD in Textile Engineering /University of Beira Interior).

gear recycling solutions in the NPA region to attain a greater market reach (Blue Circular Economy, 2020).

Circular economy: the plausible evolution of consumption

As we delve deeper into the realizations of the consequences of our exploitation of the planet's resources and as we begin to suffer from them in the form of accurately foreseeable environmental disasters such as climate change, pollution, and biodiversity loss, it becomes clear that we, as humans, can no longer maintain the exploitation/production pace that only seemed to increase tens of times over every year up until this point.

After this realization, there was a need to rethink the ways used up to then, in order to pave a brighter road for the future, otherwise the consequences would be unbearable and would likely result in our eventual demise as a species living on this planet Earth.

A Circular Economy is "a model of production and consumption, which involves sharing, leasing, reusing, repairing, refurbishing and recycling existing materials and products as long as possible" (Circular Economy: Definition, Importance and Benefits | News | European Parliament, 2015, What is Circular Economy, para. 1).

This idea of a Circular Economy started being improved on and looking more and more like the solution we would likely rely on to fix the several problems we had negligently created. It had many strong points in its favor; consider the image below:

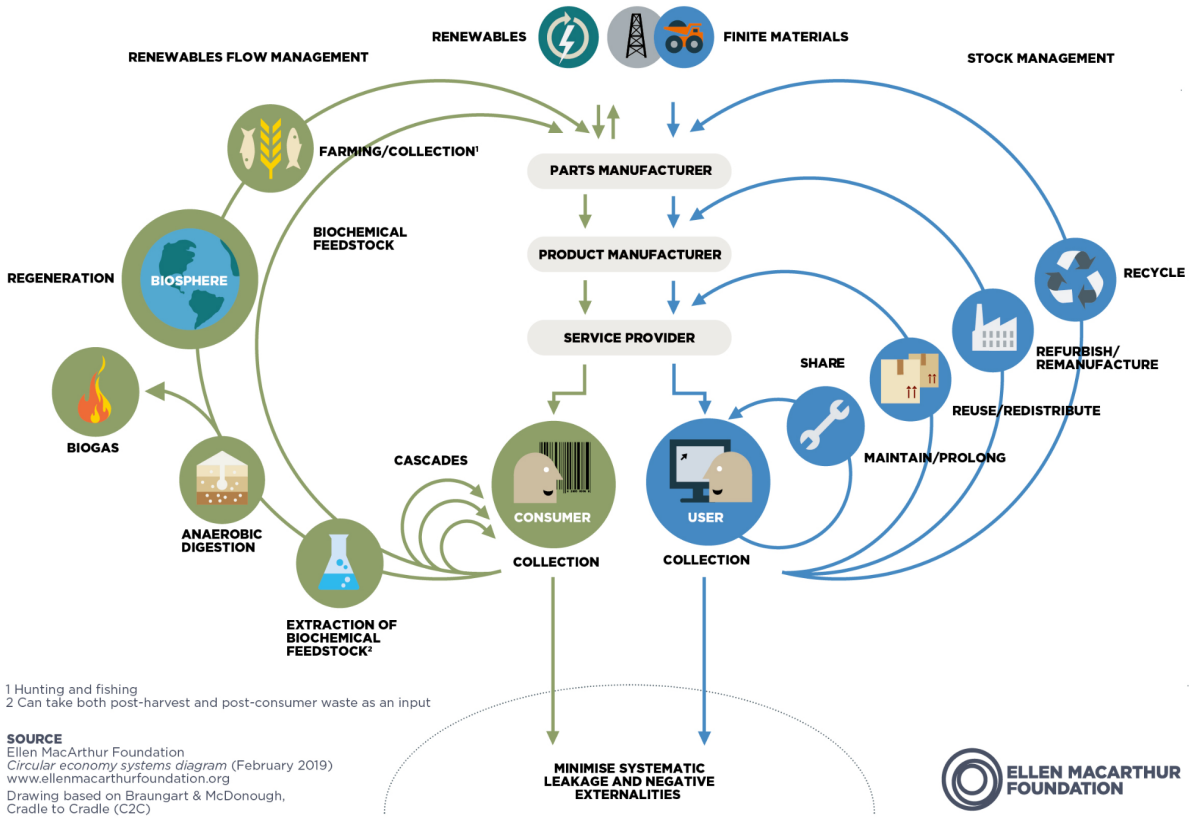

Figure 2: Circular economy diagram (Ellen MacArthur Foundation, 2019)

In a simplified way, figure 2 outlines the inner workings of an updated and improved economic model.

In this cleverly illustrated proposal by the Ellen Macarthur Foundation we can first see that it's split into two different colors: the green on the left side, and the blue on the right side. By doing that, two possible routes are presented when it comes to expanding on the value of the materials at the end of their usable lifespan: the renewables route and the finite materials route, each making use of a slightly different way of getting reintroduced into our economy, but in the end adding an enormous amount of net value per object through the reduction and sometimes even full avoidance of waste production (Ellen Macarthur Foundation, 2019).

A circular economy employs reuse, sharing, repair, refurbishment, remanufacturing and recycling to create a closed-loop system, minimizing the use of resource inputs and the creation

of waste, pollution and carbon emissions (Geissdoerfer et al., 2017) – contrary to the previously and currently used linear economic model which can be better summarized by "take, make, waste" (Brydges, 2021)

Unfortunately, over the last 150 years, the industrial evolution has been dominated by this linear model of production and consumption. The industrial revolution has brought unprecedented prosperity to our society, but this growth spurt couldn't happen without cost: The linear model (Fig. 3) is built on two very wrong assumptions: the first is that Earth has infinite resources, and the second one that it has infinite regenerative capacity (Wautelet, 2018, p. 18).

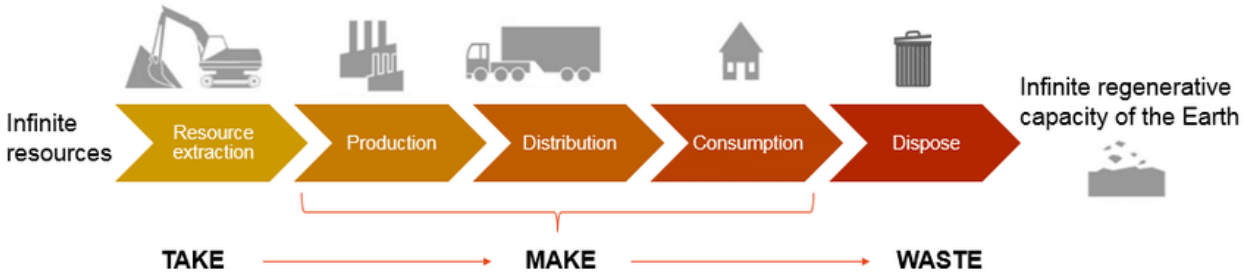

Figure 3: Linear economy: The 'take, make and waste' approach of production (Wautelet, 2018)

The mentioned circular economy model, although well thought out as a solution to limit resource usage and waste production will undoubtedly be met hard to fully implement, mainly due to powerful industry lobbies favoring short term gains and disregarding environmental concerns, but also because it's being such a drastic paradigm shift in terms of the consumer perspective – for example with the switch from product ownership to product leasing.

Regarding resistance to novelty implementation, the concept isn't exactly new and can be analyzed from a different perspective in the "Diffusion of Innovation Theory" first described by Everett Rogers in 1962 (Fig. 4). We can verify that not every user is adopting innovations at the same point in time; in fact the rate of adoption is so different that it resembles a bell curve and adopters can further be segmented into differently named groups in regards to their willingness to adopt an innovation.

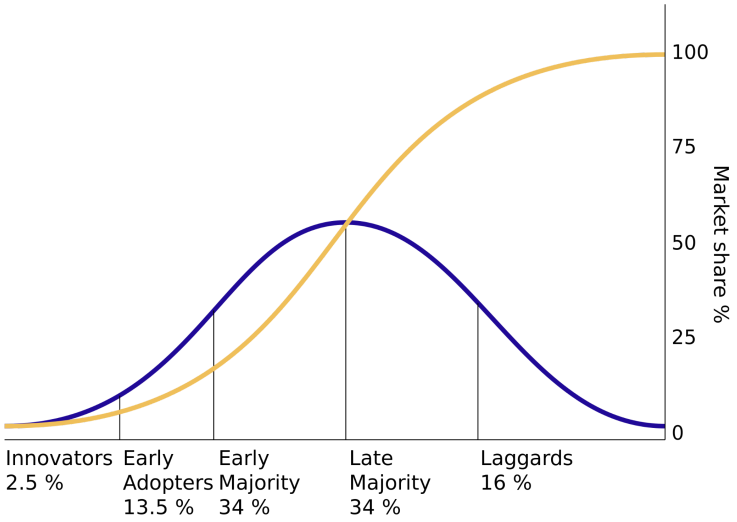

Figure 4: The diffusion of innovations (Rogers, 1983, p. 247)

Although the initial theory pertains to innovation adoption, this same theory has been further extended successfully into Policy Adoption (Stone, 2012) and Tech Adoption (Moore & Simon, 1999), which indicates there might be some similarity in adoption rates in different kinds of adoption, and that of course would include the Circular Economy and it's total adoption.

As of right now, we seem to be at the stage where we cross *the chasm* (Moore, 2002) which is a critical point in the adoption life cycle of a product that according to Moore is the most difficult step in making the transition between the early adopters and the pragmatists. Only a small percentage of projects will make it through this crossroad, while most will fail to be adopted and fade into nothingness, hence the term *the chasm*.

It's hard to tell precisely, but there are some hints that we might have already crossed this hurdle, such as the approval of laws which force limitations on single-use plastics and the prohibition of rejecting recovered materials for profit reasons (Presidência do Conselho de Ministros, 2021), which often happened since buying new from China was always cheaper for the manufacturer rather than spending resources on recycling; and with Mediterranean countries calling for "No Plastics in Nature by 2030" (World Wildlife Fund, 2015) we can at least be a bit

hopeful. Full transition into this model is a slow and incremental process but is undoubtedly a strong bet for the future.

That being said, the CE model is not without its challenges, and a 100% circular economy is practically and physically impossible. We won't be going into detail into the flaws in the idealistic closed loops system since the word ideal already implies perfection and that is unlikely to happen and we consider that besides the point of this research; nonetheless, know that in his paper "Circular Business Model Innovation: A process framework and a tool for business model innovation in a circular economy" Mentink (2014) goes into detail on those limitations.

So, this variable is important to be carefully considered when evaluating compromise moving forward into the future.

Marine assets in a circular context

Similar to the circular economy, the blue economy focuses on exploiting, preserving and regenerating marine assets instead of consuming them until the point where they can no longer provide a viable stream of goods.

There isn't really an agreed upon definition of what Blue Economy is; World Wildlife Fund (WWF) begins its Principles for a Sustainable blue economy report by clarifying "For some, blue economy means the use of the sea and its resources for sustainable economic development. For others, it simply refers to any economic activity in the maritime sector, whether sustainable or not (WWF, 2015) but in a general context it's often used as an economics term to describe economic sectors related to the ocean and its sustainability, and this is the interpretation of the term we decided to move forward with.

According to The Global Environment Facility, the ocean is already a significant generator of wealth. One of their recent reports estimated that the value of key ocean assets is US$24 trillion, with an annual value of goods and services at US$2.5 trillion – which accounts for about 5% of global GDP and the 7th largest economy. Approximately 5.4 million people are

employed in the fishing, aquaculture, navigation, tourism and energy production sectors, generating 500 billion euros every year (GEF, 2018).

With the blue economy expected growth, a 'business as usual' trajectory for the oceans forecasts a catastrophic economic and environmental outlook with lasting impact to people and the planet. Increasing demand for marine resources, technological advances in the exploration of ocean resources, overfishing, climate change, ocean acidification, pollution, biodiversity and habitat loss, along with inadequate stewardship and law enforcement are conflating to produce irreversible damage to the health of the oceans (GEF, 2018).

The Blue Economy concept bases itself on sound science to inform policy formation, which will help shift the multiple sectors involved in coastal and marine based economic activities away from practices that are leading to environmental degradation.

> "A sustainable Blue Economy combines governance, strategic priority and policy setting and investment needs while simultaneously identifying the socioeconomic opportunities provided by the coastal and ocean resources" (GEF, 2018, p. 2).

The Blue Economy thus is a vision of an ocean and coastal areas that foster economic growth and sustainable livelihoods (GEF, 2018) – and that is something that is of great interest to Portugal, the biggest coastal state of the EU (Ministério dos Negócios Estrangeiros, 2017).

Microplastics in nature and society

In the ocean, asides from wealth there is also plastics; of which microplastics are particularly alarming. According to The National Geographic's resource library, "Microplastics are tiny plastic particles that result from both commercial product development and the breakdown of larger plastics" that can represent harm to the environment and animal health. The issue with microplastics is that because they are plastic, they do not readily break down into harmless molecules – and can take hundreds or thousands of years to decompose. On beaches they can be seen as tiny multicolored plastic bits in sand – while in the oceans,they are often consumed by marine animals. (Liitschwager, 2019)

In January 2019, SAPEA's research (Science Advice for Policy by European Academies) concluded a few things regarding microplastics in nature and society:

1. Microplastics are already present across air, soil and sediment, freshwaters, seas and oceans, plants and animals, and in several components of the human diet
2. They come from a variety of sources, including plastic products, textiles, fisheries, agriculture, industry and general waste
3. In controlled experiments, high concentrations of these particles have been shown to cause physical harm to the environment and living creatures, including the inducing of inflammation and stress
4. Though there are limitations in the measurement methods currently available, the concentration levels measured in many real-world locations are well below this threshold
5. Because of these limitations there is no reliable evidence about the levels or effects of these particles, especially nanoplastics, which are very difficult to measure and evaluate

Although in 2019 researchers couldn't conclude specific consequences of ocean pollution (Galgani et al., 2019), they left the topic on a high-alert tone, with attention to the ocean exploration growing at an unprecedented pace (SAPEA, 2019).

Now in 2022, a study from the current year shows that microplastic pollution has been detected in human blood in almost 80% of the studied population and raises concerns that they can travel around the body, cause damage to human cells and may lodge in organs and cause millions of early deaths a year (Carrington, 2022). This confirms that microplastics have infiltrated the food chain, which is a major source of concern not only as an immediate danger to us humans but to the whole ecosystem.

As previously mentioned, Circular Economy policy setting and law making is very likely the route we ought to take in order to take the leap onto the new economic paradigm, and there have been some steps taken in that direction globally and locally (Ministério dos Negócios Estrangeiros, 2017) that are somewhat reassuring in that we are at least moving towards it.

The most ambitious goal in this aspect that has been set so far is the Paris Agreement (IPCC, 2015). The Paris Agreement is a legally-binding international treaty on global change in which 192 Parties at the COP 21 Paris agreed on limiting global warming to well below 2, preferably to 1.5 degrees Celsius, compared to pre-industrial levels by 2030. (United Nations Climate Change, 2018, para. 1).

Unfortunately, according to several specialists such as Johan Rockstrom from Potsdam Institute (2022), the reality is that from a pure natural science perspective it is still possible but only under the conditions that we can keep the resilience in our living biosphere intact on land and in the ocean, and that we can decarbonize according to what he calls the carbon law; which means to cut emission by half every decade and reach a 0 point in 30 years time. The issue here is that this scenario doesn't look probable at all given the political situation in the world; "we're not bending the curves fast enough", said Rockstrom when interviewed by the Ellen McArthur Foundation in February of this year 2022. On a recent article of The Atlantic on the 6th of April of this year 2022, Peter Erickson – the Climate Policy Program Director at Stockholm Environment Institute – says that the even the window for technical feasibility is rapidly shrinking, and here we would be talking about things like shutting down coal, oil, and natural-gas global usage (Meyer, 2022). The European Maritime & Fisheries Fund agrees and concludes that despite EU funding support to involve the fishing industry in the reduction of marine litter drastically increasing, the indicators aren't displaying progress. (EMFF, 2020)

So while we can say the window is still open from a pure scientific perspective, there are no signs of the global leadership taking us to that safe landing zone, which further shapes the notion that the goal will not be met.

Maritime activities and sources of marine litter

Even though in this research we are mainly focusing on lost and abandoned fishing gear, there are many ways that plastics get into the ocean which are important to keep in mind in order to grasp the entirety of the problem and even draw close comparisons. Plastics in the ocean can

either be sea-based or land-based (Tab. 1) but what is important is to define an outcome we intend to achieve (eg. pollution mitigation) and carefully design the mechanism of action that will take us to the desired outcome (eg. introduction of new regulations). Judging from the information described in Table 1, we can immediately see that education is, unsurprisingly, the most flexible and 'low-hanging' mechanism for both prevention and mitigations outcomes across the board – and while it might not be the one with the strongest impact on this list, it's strength lies in its flexible, straightforward, cross-board effect

New fishing regulations seem to favor finetuning of Extended Producer Resposibility (EPR) schemes and as for product innovation, the most promissing line of thought is to find smart ways of designing products such as ropes and nets from scratch with their specific recycling purpose in mind right from the get go (European Commission, 2020)

Table 1: Scope of the Plastics Treaty (Tessnow, 2019, 48)

Source	Category	Mechanism	Outcome
SEA-BASED	(Mainly) Lost & abandoned fishing gear	Fishing Industry Regulations	Pollution Mitigation
		Product Design Innovation	Pollution Prevention
		Education	Pollution Mitigation/ Prevention
LAND-BASED	Hard Plastics + Soft Plastics	Improvement of Collection and Recycling Systems	Leakage Prevention
		Circular Economy	Pollution Mitigation/ Prevention
		Product Design Innovations	Pollution Mitigation/ Prevention
		Bans	Pollution Prevention
		Economic Mechanisms	Pollution Mitigation/ Prevention
		Education	Pollution Mitigation/ Prevention
	Microplastics	Bans	Pollution Prevention
		Product Design Innovation	Pollution Mitigation/ Prevention
		Technology Development	Pollution Prevention
		Education	Pollution Mitigation/ Prevention

Now that we've established that not all plastics come to ocean through the same means, and some common mechanisms to deal with that, let's focus our attention in Portugal:

Biannual microlitter surveys on 10 beaches in Portugal (Antunes et al., 2013), revealed that the most common items are primary microplastics, of which 57% are plastic pellets, 8% are plastic macrolitter – the most common being cotton bud sticks (38%) and fishing ropes and net pieces (35%) – and 11% was Styrofoam pieces of various sizes represented, which can be related to fishing activities but also originate from consumer packaging (Antunes et al., in preparation). Different surveys of litter caught in fishing trawls along the Portuguese continental shelf (Neves et al., 2015), revealed that plastic was the dominant fraction (76%) and was present in all trawls. Approximately 40% of the collected litter was attributed to fishing activities, while it is also interesting to highlight that the highest density of litter was found near the mouth of Tejo river, probably related to the high population density in the Lisbon metropolitan area. (European Commission, 2016)

Chapter 2 - DESIGN MANAGEMENT & DESIGN THINKING

In this chapter, we will define and talk about the design tools that were utilized to attempt to answer our research question; In order to understand how Design Management can be a useful tool let us first define what the term encompasses in its meaning:

According to the Design Management Institute (DMI) design management is the business side of design.

> "Design management encompasses the ongoing processes, business decisions, and strategies that enable innovation and create effectively-designed products, services, communications, environments, and brands that enhance our quality of life and provide organizational success." (DMI, 2020, para. 1)

Similarly, Kathryn Best (2019) quickly sums up design management as "the management side of design". In order to fully understand what this over-simplification encompasses, let' us expand a bit on this definition with a few references and citations:

> "Design management is rooted in the shift from a hierarchical model of management to a flat and flexible organizational model, which encourages individual initiative, independence and risk taking. Designers feel at ease with the new, more informal model of management. The new model is based on concepts like customer-driven management, project.based management, and total quality management, which all deal with design" (Borja de Mozota, 2003, as cited in Best, 2019, p. 16).

Best begins her book *Design Management: Managing Design Strategy, Process, and Implementation* (2019) by defining design as both the process of making things (designing) and the product of this process (a design), and then asks the question: Can design be used to add more value to businesses, society, and politics? The answer is of course, yes, because analytical skills are necessary but insufficient for developing innovative products and services.

When Carl Sagan in Cosmos (1980) explains what the 4th dimension would be like – even though we as 3 dimensional beings aren't able to fully comprehend its meaning – we can understand some of it; and that is only possible through the masterful use of analogy – which is a powerful creative tool highly regarded in any innovation field, as proven by the key figure in 17th century scientific revolution J. Kepler when undoing "Aristotle's clockwork universe" by using analogies such as *the wilderness guide in uncharted territory* (Epstein, 2020). Furthermore

it was later concluded by Kevin Dunbar, a psychologist who in the 1990's started investigating how productive lab works worked, that there was a high relatability between diversity in backgrounds and successful analogy utilization: "The labs in which scientists had more diverse professional backgrounds were the ones where more and more varied analogies were offered, and where breakthroughs were more reliably produced when the unexpected arose. Those labs were Keplers by committee" (Epstein, 2020, p. 108).

The powerful access to creative methods and analogy making when combined with the analytical skills of the management side of design management, provides for a great tool in dealing with the problematic at hand.

Katheryn further divides the design management discipline into 3 parts:

Part One: Managing the Design Strategy - Ensuring the establishment of a long-term growth strategy - not just immediate and short-term gains.

Part Two: Managing the Design Process - Creative team management, developing a culture of collaboration, skillful presentation of thoughts and ideas - this stage is about leading

Part Three: Managing the Design Implementation - Understanding the differences between the management and leadership agendas, design materials, working relationships and ethical responsibilities.

> "In the area of design management a wide variety of perspectives exist that reflect the rich array of individuals, professions and contexts involved, such as academia, the public or private sectors, business and industry, the design profession, public services and governmental bodies. Indeed, the lack of consensus on both the scope and substance of the design management discipline has ensured ongoing, rich debate about its continual evolution" (Best, 2019, p. 11).

Just like Best (2019) and Epstein (2020) suggest, it seems like an holistic approach to things is the most fruitful way of ensuring success when dealing with high complexity problems, since "design is inextricably linked to the way in which society, the environment and businesses interact" (Best, 2019) - and Design Management just so happens to be a discipline which brings together people with a very wide variety of backgrounds

A Design manager is someone who holds the role of managing design, or managing *through* design; the role itself will highly vary from organization to organization and the person fulfilling this role might be called a “brand manager”, a “project manager”, an “account director”, a “ design consultant”, or an “advertising planner”. Irrespective of the job title, the job description is related to the understanding of strategic goals in the context of its organization and how to effectively apply Design tools to accomplish goals and reach successful outcomes with passion and enthusiasm (Best, 2019).

The growing awareness of the advantages and flexibility brought by design are many, such as acting as an enabler for innovation and collaboration; and the increasing desire to use these advantages to further improve a product or a service through specific design processes such as Design Thinking, is making it increasingly common to find this position filled in company projects or teams.

Furthermore, design can operate at 3 different levels of complexity in any organization (Fig. 5), where the deepest level includes the making of policies which is extremely relevant for the topic at hand. Organizations like SAPEA (Science Advice for Policy by European Academies) exist to provide unbiased guidelines for policy making, which will then need to be put to good use through ethical and responsible means.

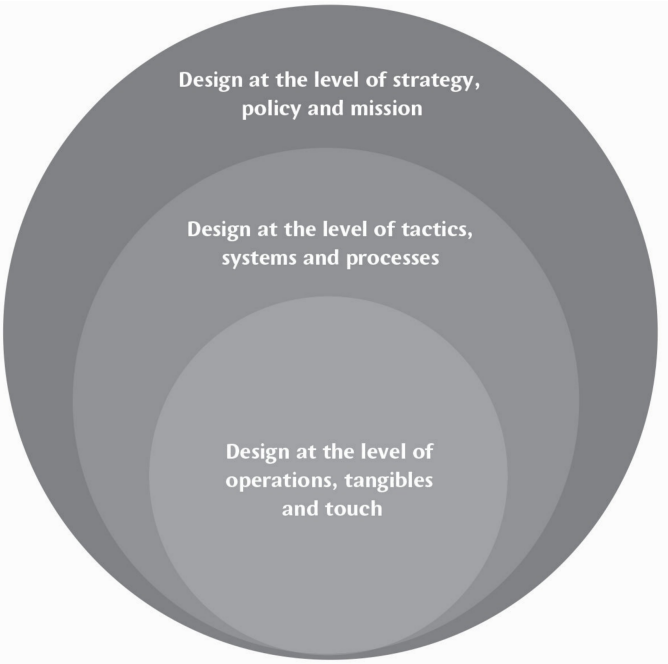

Figure 5: Levels of Design operations, adapted from Sean Blair (2019)

This excerpt from Design Thinking: Business Innovation is particularly concise in abstracting the challenges of design into a single point:

> "Designers look upon any experience that is harmful (whether emotionally, cognitively, or aesthetically), or otherwise disruptive of people's well being is a problem (considering all aspects of life, such as work, leisure, relationships, culture, etc.). And so their main task is to identify problems and generate solutions for them" (Vianna et al., 2012, p. 13).

So what about Design Thinking?

After a certain point in time, global market competition caught up and ensured that innovation was not only a success differentiator, but the actual means of survival in its harsh competitive environment - Design Thinking formed as a byproduct of the search for new innovation pathways.

Essentially, Design Thinking is a semi-structured step by step methodology with tons of room for flexibility, creativity and convergence of ideas that according to the book Design Thinking: Business Innovation (Vianna, 2012) consists of these three stages:

The first stage – called the Immersion Stage – is broken down into two parts: the Preliminary Immersion and the In-Depth Immersion. As their names imply, first you should try to grasp the problem in a superficial way, and reframe the problem if there's a need for it; then proceed to In-Depth Immersion where you take note of the opportunities and challenges that arise from deeply experiencing the problem and relating to players, focusing on the human dimension with the objective of determining 4 different types of information:

1. What do people say?
2. How do they act?
3. What do they think?
4. What do they feel?

Usually there is a huge influx of information at this stage, moreso if you are working as a team which is ideally how you would maximize the amount of creative inputs and therefore generate a better solution to a more well defined problem; because of that and from now on it is often a good idea to use synthesis at the end of this and every following stage, as not only it allows for a better simplification, but also can often generate a segway into the next stage.

The second stage – Ideation – is the stage where ideas are generated, preferably through a group effort, and then selected based on their feasibility and quality. Sometimes the ideas generated will have such a high degree of adequacy that all that remains for them is to be validated on the next stage, Prototyping; when needed it is also adequate to synthesize your ideas provenient from this stage to better transition into the prototyping stage.

The third stage – Prototyping – provides a peek into real world applications through interactions with the model and serves as a validation tool, reducing uncertainty in a simplified fashion and thus increasing the chances for success. Although it's presented here as the final stage of Design Thinking, this step can be used throughout the previous stages and be run in parallel with them; it's important that the structure remains flexible enough to fit the creative needs of the project, players and participants.

After running several prototypes, all that's left to do is to select the most successful model or make a combination of the most successful models and take notes made during the Immersion stage into account in order to create the best solution possible.

Success measures of design

But how reliable is design in maximizing business processes? Naturally, answering this question is of the utmost importance when pondering the usage of design as a tool, and for that reason research has already been conducted in order to flesh out performance metrics in to properly answer this question; a few examples of that are:

The Design Management Institute (DMI) and Microsoft joined hands to create "The DMI Design Value Scorecard: A Design Measurement and Management Model", which assesses what role design plays in the organization, where design is adding value, how well design is executing and what role design could play in the future (DMI, 2018).

Iker Legarda's article "A Model for Measuring and Managing the Impact of Design on the Organization: Insights from Four Companies" (Legarda et al., 2021) presents a model for measuring and managing the impact of design on the organization by assessing the four levels of design impact in the literature: results, perception, processes, and design culture, with promising preliminary results.

Joseph J. Paul's article "Performance Metrics to Measure the Value of Design" (Paul, 2010) defines an approach to predict the link between design and purchase behavior.

Yuanyuan Yin's article "Development of a design performance measurement matrix for improving collaborative design during a design process" (Yin et al., 2011) develops a design performance measurement (DPM) through the use of the 5 indicators efficiency, effectiveness, collaboration, management skill, and innovation.

These studies strongly suggest that design performance is measurable through a variety of metrics and that its impact is very positive in the contexts explored in these papers. Additionally,

we found out that Jon Fukuda from Limina.co put together a well summarized list of additional research that had been conducted to demonstrate the business impact and value of design:

McKinsey's recent "The Business Value of Design" report, which described a 10% revenue growth and 20% shareholder return advantage for businesses in the top quartile of design-centric maturity.

Invision's "The New Design Frontier," a 40-page research report analyzed the state of design maturity across 24 industries, 77 countries, and 2,200 companies. The results of this 2019 study found that design propels substantial business impact. Companies with high design maturity are more likely to see cost savings, revenue gains, productivity gains, speed to market, and brand and market position improvements through their design efforts.

The Design Management Institute's 2016 study that quantifies what design professionals suspected for years: over a ten year period design-driven companies outperformed the Standard & Poor's 500 by 211%.

The Danish Design Center's 2001 "Design Ladder" describes the ways businesses incorporated design. By 2003, they used the model to establish that companies with the highest integration of design increased their financial performance by 20% compared to businesses where design integration remained static or declined (Fukuda, 2020).

It seems safe to assume, at least for now and in the current paradigm, that the research points toward design as a reliable tool for pursuing problem solving and innovation, mainly due to its flexibility in approaching problems at any level of complexity through its creative toolset.

The role of sustainability in the design practice

Design sits prominently at the heart of the circular economy model (Ellen McArthur Foundation, 2021) which as previously defined on the first subchapter of chapter 1 "Circular economy: The plausible evolution of consumption" is an economic model committed to abandoning the linear economic paradigm of "create, use, throw away" – which most things

today are still designed for (Ellen McArthur Foundation, 2022) – in favor of going full circle through the reutilization and reintroduction of the materials in the economy or through creative and technological means that can otherwise improve and extend the product's usage life, thus reducing the amount of waste created. We will see a few examples of this in Fig. 7.

Because decisions made early in the manufacturing process crucially impact how products are used and later, handled at end of life, it can be said that previously design has typically been part of the problem (Moreno et al., 2016). However, the design practice has evolved tremendously in recent years, and has increasingly shifted its concerns to sustainability, thus it can be said that design has the potential to be part of the solution (Ceschin & Gaziulusoy, 2016). Multiple concepts have emerged regarding the place of sustainability in the design process: "green design", "eco design", "sustainable design"... confusion over the goals of circular design may shape different understandings of the concept (Wastling et al., 2018), yet we can say these approaches ultimately aim to decrease damage to the environment (Moreno et al., 2016) – in order to avoid the pitfall of confusion, we will be referring to these approaches by "circular design".

Where problems in the linear design process may be based on simple relations, circular design is rooted in complex problem solving and it is based on a systems thinking approach (Wastling et al., 2018). Each set of elements and patterns is unique; this complexity makes identifying a starting point for action challenging.

The Circular Product Design Framework (Fig. 6) proposes a strategies list for creating technical products that last – These are clustered into four groups: design for reuse, refurbishment, remanufacture and recyclability based on the 5R Framework – These strategies can be plugged into a comprehensive circular product strategy applicable to different industries and at different scales (Circle Economy, 2020).

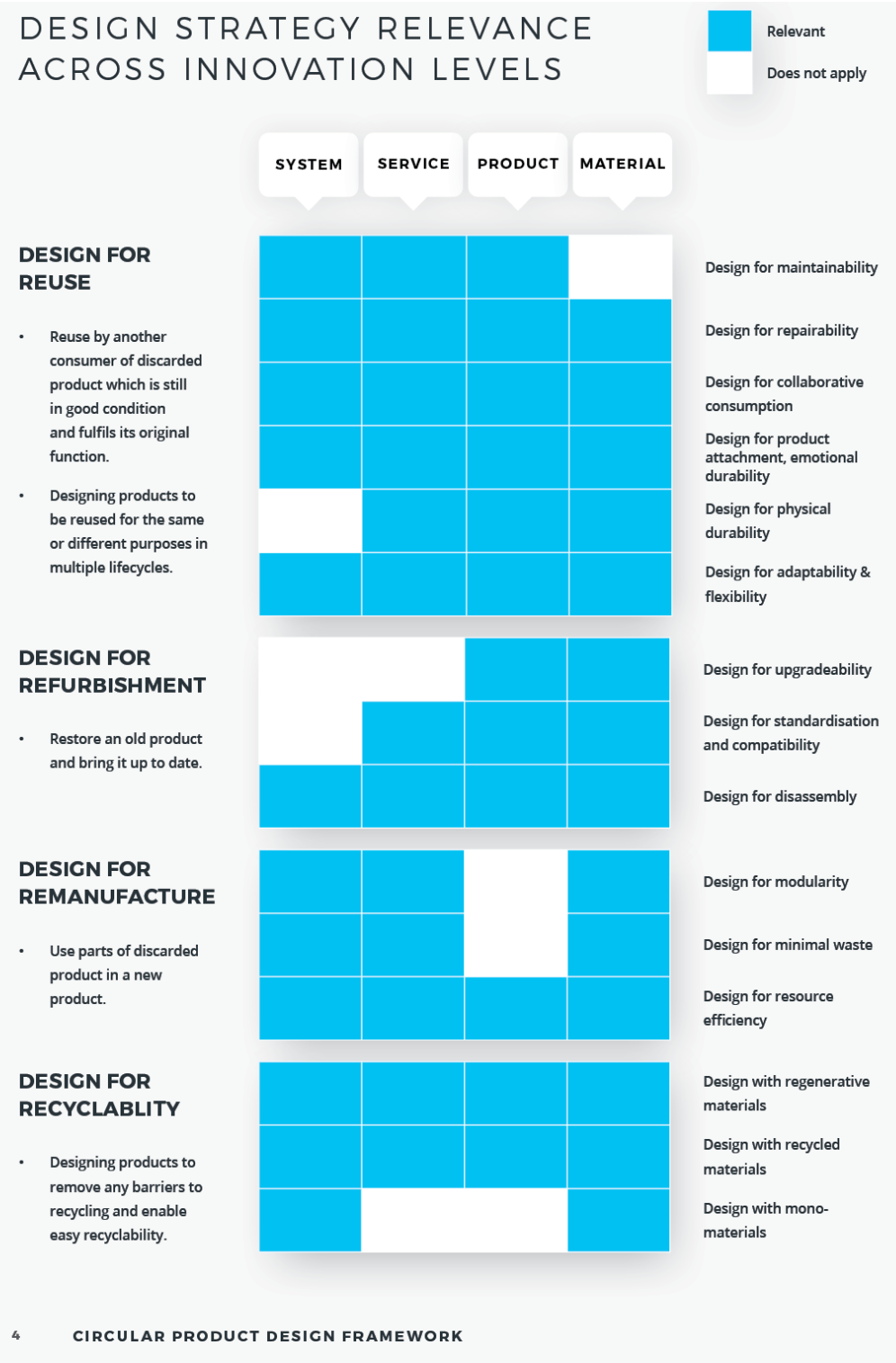

Figure 6: Circular product design framework (Circle Economy, 2020)

As previously mentioned, the main focus of circular design is the creation of products that fit the circular economy model, which ultimately means protecting the environment and reducing waste by design – redesigning.

In the context of marine litter reduction, the concept of good practices is defined as those arrangements that have proven to be effective in delivering a contribution to marine litter reduction and that demonstrate social, technological and/or institutional innovation in a specific category of the waste hierarchy (CleanSea Project, 2015). We can think of good practices as guidelines; the specifics will vary from case to case, discipline to discipline – for example in circular design they could be that: A circular product remains useful for a long time, it can be repaired, updated, is produced from renewable or recyclable materials, uses as little energy as possible over its entire lifespan, can be transported efficiently, can be used by many and considers those who manufacture, maintain and recycle it (Diez Office, 2021).

Here are a few circular design good practices examples (Fig. 7.) taken from Circular Design Guide's case study list that were put together by the lead figures in circular design innovation Ellen McArthur Foundation & IDEO:

Figure 7: Examples of Circular Design good practices

Ecovative: growing alternatives to petroleum-based packaging – this innovative biomaterials company creates a mushroom-based protective packaging they call myco-foam to replace plastic foams like styrofoam. Coincidentally, as mentioned in the 'Maritime activities and sources of marine litter', styrofoam pieces represent 11% of all plastic pollution in the 10 Portuguese beaches surveyed in the study.

FAIRPHONE: a better phone is a phone made better – Fairphone has turned a traditionally linear product, a mobile phone, on its head with the world's first repairable, modular smartphone that is made up of responsibly sourced materials.

MUD Jeans: pioneering jeans for life – Mud Jeans provides organic cotton jeans to customers through a leasing model. The company repairs them when needed or recycles the material to create new jeans

VIGGA: Children's clothes subscription service – Vigga offers a clothing service for children that does not require ownership. When your child outgrows their clothes, you simply send them back to receive the next parcel of neatly folded clothes, in the correct size.

CATERPILLAR: Fix it before it fails – rather than fixing equipment when it fails, Caterpillar's technology monitors and receives feedback from equipment while it's being used to anticipate repair needs and address them before they get to break, which according to their own research vastly prolongs the machine's life.

Materiom: Atlas of the future – Materiom is an open-source online platform that offers "recipes" for designing with locally abundant biological materials.

In all of these examples we can observe that there is a big focus on designing and using the service part of the product – through leasing, subscription services, reparations, modular upgrading – as a means to change pollution outcomes, raw material starting points, premature discarding and waste in general, highlighting also the very beneficial value of early repair strategies, as opposed to repairing after breakage.

Fishing nets and marine plastics as a circular resource

In November 2019, Greenpeace published a report called "Ghost gear: the abandoned fishing nets haunting our oceans", which lead to the following key findings:

- An estimated 640,000 tonnes of ghost gear enters the ocean every year, equivalent in weight to more than 50 thousand double decker buses.
- Ghost gear is estimated to make up 10% of the plastic waste in our oceans, but represents a much higher proportion of large plastics found floating at the surface. Associated rubbish from fisheries, such as packing containers, tape and buoys also contribute to ocean plastic pollution.

- In some specific ocean areas, fishing gear makes up the vast majority of plastic rubbish, including over 85% of the rubbish on the seafloor on seamounts and ocean ridges, and in the Great Pacific Gyre.
- Around 300 sea turtles were discovered dead in a single incident in 2018, entangled in a ghost fishing net in Mexican waters.
- 'Ghost fishing' effectively competes against fishers for their catch. Ghost gear is also a hazard to ship navigation and safety at sea.

Old netting has to be disposed of somewhere, usually it ends up incinerated or in a landfill; either option is a less than ideal environmental solution, although they certainly beat ocean dumping.

The possibility of developing a virtuous supply chain – starting from recovery and selection of materials, to their thoughtful recycling or repurposing – seems to not only be the most environmentally sound solution on the table but could also be an incredible business opportunity.

Many businesses, organizations and individuals are already venturing into the future economic paradigm in order to take advantage of the opportunity of being among the pioneers of the new system, contributing to the health of the planet while reaping the rewards of the closed loop system; from these, two case studies in particular are worth mentioning:

An example of this is English company Waterhaul (Fig. 8), who recovers the ropes and nets from Corwall's coastline, separates them by polymer type and then recycles them through a mechanical process of shredding, washing and agglomeration; then they inject the recycled plastic into a mold and turn it into serviceable products such as eyewear and other equipment.

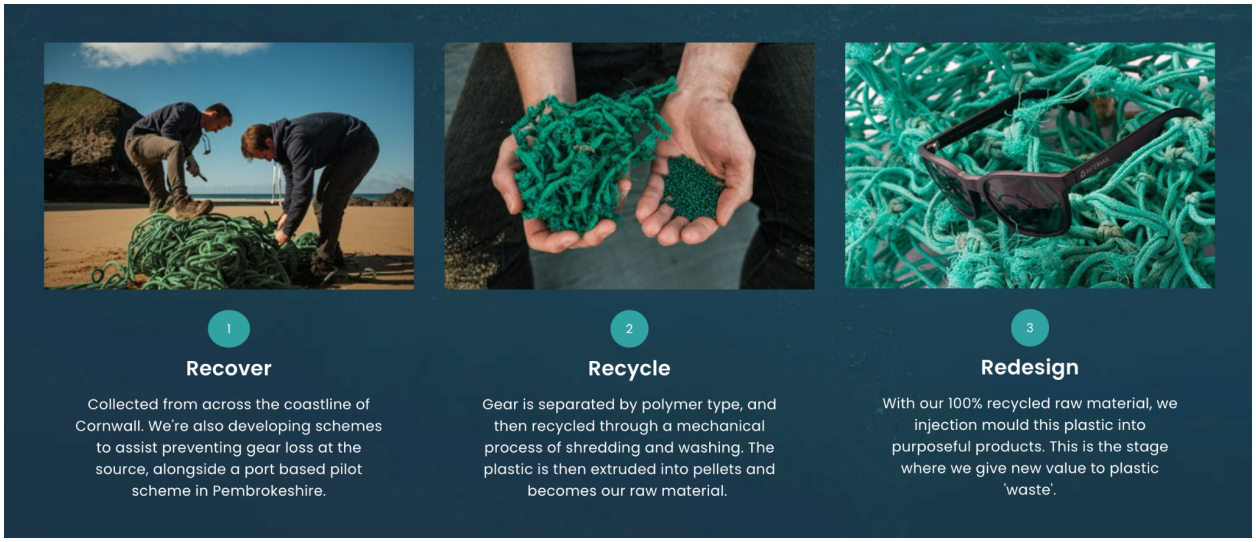

Figure 8: Waterhaul's ocean plastic transformation process (Waterhaul, 2019)

Recovered ocean plastics such as fishing nets and ropes are made of Polyamide (Nylon); Polyamide – interchangeably used with Nylon – is a synthetic plastic fiber fabric made from petroleum. In the 1930's, it was the first invented lab made fabric and it represented a new age in fabric manufacture – the age of synthetics. Polyamide has lots of attractive characteristics as a fabric : It's strong yet lightweight, it's durable, holds dye well, dries quickly and it's extremely practical and cheap to manufacture. In the short term it's an incredibly beneficial material, but since Polyamide is made of petroleum it has a major disadvantage: it won't easily decompose. (Encyclopedia Britannica, 2015)

Fishing nets for instance are entirely made of Polyamide and very often get ripped, lost or discarded in the ocean when they reach their durability limit. That's because the alternative – paying for its proper disposal (landfills, incineration) – is more expensive. We and the Blue Circular Postbranding project looked at this as an opportunity to tackle the problem of ocean pollution in our coastline; by getting closer to these fishermen, informing them, relating to their issues and providing them a free means to dispose of their trash while simultaneously rewarding their effort, we hope that this can become a successful angle of approach for the Cascais captaincy coastal hygiene.

Giving a new life to the retrieved plastics is a great challenge in itself, since Nylon is very cheap to make – but not nearly as cheap to reuse or recycle, which is the main way to extract maximum value from the material before it becomes completely unusable.

The UE launched the BCE (Blue Circular Economy) project which lasted from October 2018 and ended in September 2021, whose mission was to *"generate sustainable business opportunities focussed on polymer based fishing gear solutions through informed, innovative and collaborative efforts, for the benefit of enterprises, local economies, and the environment"* (Charter et al., 2020, p. 2) by which they aimed to address the waste problem associated with fishing gear disposal. To do that, they provided free webinars, conferences, workshops and 1:1 mentoring to those in the fishing industry who were interested in turning the waste into business opportunities. They also examined existing research and gained a few key insights related to fishing gear:

- Fishing operators work to very tight margins and do not want their fishing gear to fail.
- Fishing gear is expensive; with some individual fishing gear costing up to 200k €
- There are a range of scientific working groups that work on technical requirements for the development of fishing gear.
- A new gear design has a development phase that can require flume tank trials, and the construction of model fishing nets built to scale to take account of vessel size, engine types, fish behavior and gear interaction.
- Product design and development processes for fishing gear often appear to be based on key people's knowledge and experience in the company rather than following a structured product design and development process e.g. stage-gate process.
- Fishing gear is often assembled in Europe with components procured from suppliers in India, China and South Korea.
- Fishing gear is generally made to order; therefore, there is often a lot of dialogue between the fishing operators, and fishing gear manufacturers and/or assemblers.
- Customisation of fishing gear is common, with adaptation based on individual experience of fishing operators, leading to a variety of co-design of fishing gear.

- Fishing gear is typically repaired and modified by the fishing operators and/or sometimes by the fishing gear suppliers as part of contracts with fishing operators.

The EC introduced the SUP Directive (Single-use plastics) which aims to completely ban the 10 single-use plastic items most commonly found on Europe's beaches, none of which are fishing gear, prompting sustainable alternatives where they are easily available and affordable (European Commission, 2019). The plan to limit the use of other plastic items involves raising awareness, introducing design requirements such as connecting caps to bottles, label requirements that inform the consumer about their proper disposal, but most importantly introducing waste management and clean-up obligations for producers, called Extended Producer Responsibility (EPR) scheme, a policy under which producers are given a financial and/or physical responsibility for the treatment or disposal of post-consumer products (OECD, 2013). The EPR scheme targets the increase in collection rate of waste fishing gear, thus reducing disposal at sea or by landfilling and incineration.

Both the SUP Directive and the EPR scheme fall under the "polluter pays" principle, which is to say that the actors or the activity causing the pollution should pay to right the wrong. For example, some activities known to release pollutants into the atmosphere had to install expensive filters to reduce their emissions. (Wunderlich, 2020) Unfortunately in terms of fishing gear waste it's hard to pinpoint who's responsible, since fishermen fall under small-scale producers and thus are exempt from these directives and principles, and the industries producing the fishing gear claim small margins (Charter et al., 2020).

From this we can conclude that there are several legislative proposals being pursued, none of which either directly or immediately solve the problem. Nonetheless, the path of legislation is undoubtedly the most important key factor in continuing to guide the necessary economic and societal changes to make a definite change – while also promoting and financing research that explores big and small scale solutions and projects like Waterhaul.

PART II: EMPIRICAL RESEARCH

Research can have either a quantitative or a qualitative approach, the chosen approach depends on whichever has the stronger connection with the research problem and seems more appropriate to answer the objective of the research.

Quantitative research is often used by researchers who follow the scientific paradigm (Haq, 2014) and functions by deriving results from quantified data. Qualitative research on the other hand functions by focusing on a few carefully chosen respondents to derive a very detailed description of the researcher's observation, which is better suited for research areas such as design, because of its high subjectivity and heavy contextualization nature – it's hard to quantify the context of social relationships, for example (Haq, 2014).

In this case we opted for the qualitative method. To further clarify the subjective characteristics of design and why it'd be less useful to work with hard quantified data as the means of research, here is a useful side by side comparison of Design research and Market research (Fig. 9) we found in Vianna's book Design Thinking: Business Innovation (2011) which points towards this immersive, qualitative characteristic of Design as opposed to Market research which relies on the use of statistic samples towards predictive models:

	Design Research	Market Research
Focus	People.	People.
Objective	Seeks to understand cultures, experiences, emotions, thoughts and behavior to provide inspiration for the project.	Seeks to understand behavior through what people do, or say they do, in order to predict how they would behave in a new situation, while coming up with solutions based on their answers.
Data Collecting	Primarily through semi-structured conversations between the researcher and the interviewed.	Primarily through questionnaires and structured interviews.
Sampling	Represents samples qualitatively and seeks profiles of extreme users, because unusual and obscure observations may lead to new and interesting ideas.	Statistically represents the sample, with the intention of understanding answers of the masses, commonly ignoring points off the curve. Data analysis requires an objective point of view that is critical and unbiased.
Type of information collected	Behavior, objects and words people use to express the way they interact with things and processes around them.	People's opinions and behavior regarding current situations or expectations of future contexts.

Figure 9: Design Research versus Market Research Methodology (Vianna et al., 2012)

Here's a paragraph from the same book by Mauricio Vianna which summarizes the importance that design confers to context specific variables:

> "The designer understands that problems affecting people's well being are of many kinds, which makes it necessary to survey the individual's culture, context, personal experience and life

processes in order to attain a broader view, so as to better identify obstacles and create alternatives. By taking the trouble to conduct a thorough survey, the designer can pinpoint the causes and consequences of difficulties and be more assertive in seeking solutions" (Vianna et al., 2012, p. 13).

Inside the qualitative research methodology exists a subtype called ethnography; ethnography in particular is a flexible research method that involves immersing yourself in a community or organization in order to gain a deep understanding of a group's shared culture, conventions and social dynamics through up close observation. The main advantage of this method is that it grants you access to more authentic and spontaneous information that you wouldn't gain access to if you'd simply asked (Caulfield, 2020) and helps you profile extreme users, whose unusual and obscure behaviors may lead to new and interesting ideas (Vianna et al., 2012).

The qualitative research strategy (Fig. 10) starts off by defining what is the research question (I), followed by a literature review (II). After that, the research question will demand certain data points for which the methods for obtaining them are defined (III) and the results analyzed (IV) after which the conclusions are drawn from the results (V). These conclusions answer the research question either by confirming it or denying it, thus completing the cicle.

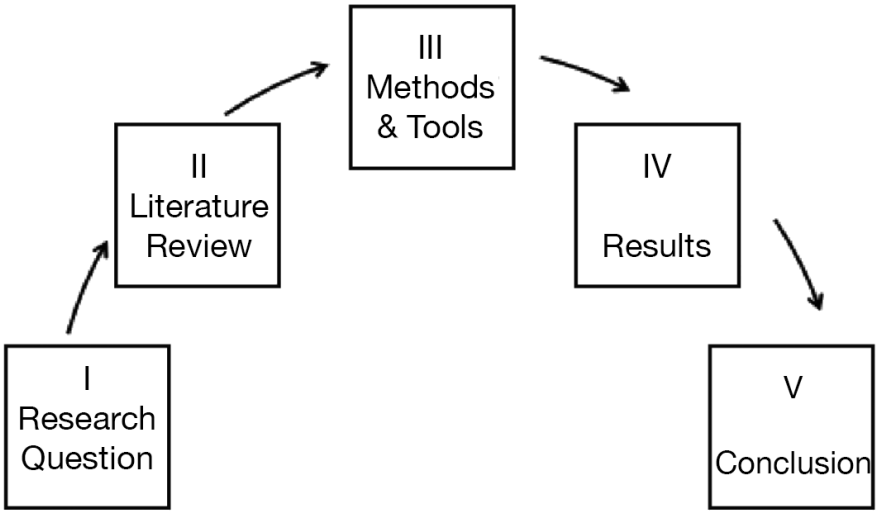

Figure 10: Qualitative Research (adapted from Instituto Universitário Militar, 2019)

Chapter 3 - APPROACHES, METHODS AND TOOLS

When we do research, we must carefully gather information from a variety of sources; It's very important these sources are classified into primary sources or secondary sources, as the credibility, fidelity and authenticity of the information can vary wildly based on the type of sourcing they have. Primary sources are those that haven't been the target of interpretation or summarization by other critics or researchers. On the other hand the sources that have already been interpreted or summarized and facilitate the access to primary sources of information are the ones we call secondary sources (Instituto Universitário Militar, 2019).

In other words, primary sources give us access to raw information and first-hand evidence, while secondary sources give us access to second-hand information and facilitate access to primary sources through the commentary of other researchers.

The secondary sources in Table 2 helped us gain a better understanding of the topic and how other researchers have approached it, while also providing convenient and summarized access to other sources without the hassle of collecting all the data by ourselves; while the primary sources mentioned on the same table provide us with direct evidence that we can use to make new discoveries.

Table 2: Primary and secondary sources of information

INFORMATION SOURCES	
PRIMARY	SECONDARY
Results of interviews	**Literature review**
Oral testimonies	**Case studies**
Observation	Journal articles, dissertations, books
Document analysis	Encyclopedia entries
Government documents	Newspaper articles

In order to collect the information we need, we must define the approach we will be using along with the methods and tools, but first let's define what exactly is the information we are looking for. We must find out:

- The composition of the collected marine litter
- The recycling limitations of the collected marine litter and the percentage of plastic materials in it.
- Successful case studies of similar projects
- The availability of the Portuguese transformation industries
- Analysis of potential partners within said industries
- Some strategies we can utilize in order to reintroduce the marine litter in the economy through the partners to be selected
- The perception and stance of the community towards the issue
- The stance of the UN towards the issue

The needed data for this research will be collected through:

A thorough literature review, which helped us establish in Part I the theoretical foundation of the key concepts involved in this project – such as the circular and blue economies, design thinking and management and the ocean pollution and its related health concerns for the human population – while also helping us contextualize the research and creating a broad perspective of the problem and define what is state of the art in research and projects with similar goals.

1. **Document analysis** of listings of national industries from the plastics sector which might or might not be available to partner up. The conversion rate is expected to be extremely low.
2. **Case studies** of similar projects and observations about the Blue Circular Postbranding project.

3. **Semi-structured interviews** using a focus group methodology which will aid us in conversing with Ericeira's fishermen population – a vital link for the success of this project and its circular economy model.
4. **Observation**, the field work of this research, will allow us to gauge the interest and general stance of the fishermen community and also to relate, inform and motivate change, evaluate the composition of the collected marine litter, and better understand the United Nations sense of urgency and stance regarding ocean pollution.

In the following subchapters these methods will be individually described according to what the literature says and a link will be made between the knowledge from the literature and our specific needs for this particular application.

Document Analysis

Document analysis is a systematic procedure for reviewing or evaluating documents. Like other analytical methods in qualitative research document analysis, like other qualitative research methods, prompts the examination and interpretation of data in order to elicit meaning, gain understanding, and develop empirical knowledge. (Corbin et al., 2008). The analytic procedure entails finding, selecting, appraising (making sense of), and syn-thesising data contained in documents. Document analysis generates data in the form of excerpts, quotations, or entire passages, which are then organized into major themes, categories, and case examples through content analysis (Labuschagne, 2003).

A list of the national companies working in the plastics extrusion sector was pursued and created by the colleagues at the BCpb project and later partly contributed to by us. This list totals the 26 companies from the plastic recycling sector in Portugal that could be tracked. Later, an attempt at contacting them through official channels was made with the objective of forming partnerships that added value to the value chain of the BCpb project.

The results of these contacts are quantified and reflected upon in the respective results section.

Case Studies

A case study is a detailed and intensive analysis of a specific subject, such as a community or organization, similar or identical to the object of research (Muratovski, 2016, p. 49).

Case studies are commonly used in social, educational, clinical, and business research and often favor qualitative methods (Bryman, 2012). They are great instruments for gaining concrete, contextual, in-depth knowledge about a specific real-world subject and are often a good choice in a thesis or dissertation,since they help keep the project focused and manageable when you don't have the means to conduct extensive research. a single subject can be explored in its full depth and complexity, or multiple case studies can be conducted in order to compare and illuminate different aspects of the research problem (McCombes, 2021).

In this case we opted for a small number of cases with a proportional amount of study depth. In order to guide our analysis and gain a complete understanding of the case studies and their contextes a literature review was conducted of the sources related to the research problem: ocean pollution, circular economy, blue economy and design management.

The criteria for the selection of these case studies was that:

1. They must provide a working example of circularity in action.
2. Their study must answer questions relevant to the investigation

Table 3: Questions to be answered by case studies

QUESTION	CASE STUDY
How are the circular economy and the Nylon industry affecting each other?	Aquafil
What are some steps to take in the future?	Aquafil
What are some other recycling options for this type of end-of-life plastic?	PlastiX

In addition to these criteria, another deciding factor in selecting was that according to Waste Free Oceans and as reported by the EMFF (2020) PlastiX and Aquafil together have the capacity to recycle all Europe's fishing gear, netting and ropes.

Interviews

In qualitative research interviews are one of the primary means of sourcing information. These can be:

1. Unstructured, where the questions and order they are asked aren't set, the interviewer makes an effort to listen a lot more than he intervenes, limiting himself his interventions to incentivize the subjects to keep talking and making an effort to not lead on to a particular answer as this could invalidate the research. This type of interview is best suited for exploratory studies and topics of psychological nature.
2. Semi-structured, where the topic and maybe also the questions in the interview are set in advance. Opens the possibility of using a focus group methodology.
3. Structured, where the questions and the order they are asked are set and structured. (Instituto Universitário Militar, 2019)

Structured interviews are used for quantitative research, while unstructured and semi-structured interviews are used for qualitative research. In both cases, these last two offer an interview process with emphasis on flexibility (Bryman, 2012).

In this circumstance, semi-structured interviews are not only in line with the qualitative character of the research, but also offer the best of both worlds: by combining the elements of structured and unstructured interviews we get comparable, reliable data and the flexibility to ask follow-up questions. Not only that, the ability to set up a thematic framework beforehand encourages two-way communication while avoiding distractions while introducing the element of detail and richness provided by its open-ended nature (George, T., 2022).

In a semi-structured interview the researcher has a list of questions or fairly specific topics to be covered referred to as an interview guide, but the interviewee has a great deal of

leeway in how to reply. Questions may not follow on exactly in the way outlined on the schedule. Questions that are not included in the guide may be asked as the interviewer picks up on things said by interviewees. But, by and large, all the questions will be asked and a similar wording will be used from interviewee to interviewee. (Bryman, 2012, p. 471).

The focus group interview methodology we selected is a research method designed to extract observations from the group's dynamic and shed light on a topic of interest through the allowance of a group debate moderated by the interviewer and are often used in social science and user research disciplines. A focus group may be a good choice when the researcher is interested in real-time, unfiltered responses on a given topic or in the dynamics of a discussion between participants, you're confident that a relatively small number of responses will answer your question or you are seeking directional information that will help you uncover new questions or future research ideas (George, 2021).

During the awareness intervention in the morning of the 11th of May of 2022 we had the chance to ask a lot of questions the fishermen at the dock, but since it happened in an unstructured way and was more of a conversation than a quantifiable interview we decided to select a sample of subjects to interview at a later date. The selection of these subjects based on schedule convenience, in this case that means all those present and available to answer during their morning work hours on the randomly selected dates of 9th of August, 19th of August and 20th of August, between 09:00 and 12:00 AM which overlaps with their work hours; also to note that we made an effort to not select subject who had previously been interviewed in the informal way mentioned earlier.

To further understand the range of challenges and solutions to the development of a circular design process involving the community stakeholder, a categorization table (Tab. 4) and detailed interview plan (Appendix 4) were developed. The objectives of this interview were to:

- Understand the cooperation dynamics involved with the fishermen community
- Understand the impact of the awareness intervention in the Cascais capitancy docks.

- Determine how aware are the fishermen about ocean pollution and their activity's impact in it.
- Understand how the fishermen perceive themselves and determine how we (BCpb) are perceived.

Table 4: Categorization table for interviews

CATEGORIZATION TABLE		
OBJECTIVE	CATEGORY	QUESTIONS
Understand the cooperation dynamics involved with the fishermen community	Circular cooperation	Does gathering the fishing nets give you extra work?
		Are the waste big bags being picked up by the municipal retrieval services in a timely fashion?
Understand the impact of the awareness intervention in the Cascais capitancy docks.	Social action	Do you use the bags for their intended purpose?
		What kind of waste do you find most often in the sea?
Determine how aware are the fishermen about ocean pollution and their activity's impact in it.	Environmental impact	Have you realized that by preventing ocean pollution you are directly removing a big competitor from your activity?
		From all the sources of ocean plastic pollution, where do you think plastics provenient from fishing sit at?
Understand how the fishermen perceive themselves and determine how we are perceived.	Community engagement	What do you think people think of the fisherman profession?
		What do you think of the idea behind the net exchange (BC:PB)?
		Do you feel good about what you are doing for the younger generations?

The questions were asked to a small group of people – seven in Cascais and six in Ericeira – which we decided to use as our focus group.

The focus group is a research method designed to extract observations from the group's dynamic and shed light on a topic of interest through the allowance of a group debate moderated by the interviewer and are often used in social science and user research disciplines. A focus group may be a good choice when the researcher is interested in real-time, unfiltered responses on a given topic or in the dynamics of a discussion between participants, you're confident that a relatively small number of responses will answer your question or you are seeking directional information that will help you uncover new questions or future research ideas (George, T., 2021).

Observation

Observation approaches can be qualified into two categories:

1. Participative observation, where the investigator immerses himself in the environment he is closely observing, in order to better understand the subjective perspectives of the people he interacts with
2. Non-participative observation, where the investigator is an external actor who observes the phenomena from the outside perspective without making the special effort of interacting with the community. (Instituto Universitário Militar, 2019)

Due to the ethnographic nature of our involvement, we will be opting for the participative observation category which is the one that best suits our approach – as the research was conducted on site (Cascais capitancy ports, Cascais and Ericeira), working closely with the community, the project members.

To better understand the range of challenges and solutions to the development of a circular design process involving the port authority, community, location, logistics, maintenance and operators an observation table was developed (Tab. 5) – which will set the structure as we branch out to use the observation method at the chosen locations:

Table 5: Observation table

OBSERVATION TABLE	
CATEGORY	QUESTION
Logistics	What do we observe about the boats?
	What do we observe regarding the containers
Fishing nets	What does the maintenance process of the fishing nets look like?
	What do we observe about fishing nets?
Fishermen	What tasks are the ones staying at the dock doing?
	What do we observe about the fishermen?
Location	How is the cleanliness of the immediate surroundings?
	What else is there to say about the area?

Chapter 4 - DATA ANALYSIS AND RESULTS

In this chapter we will explain how we are going to analyze the results of our data gathering process and explore some perspectives of the observed behaviors.

Document Analysis

In this section we will present the results of the selected document for analysis, which provides us with information about the number of existing industries in Portugal related to plastic recycling and/or extrusion, their location and whether they are available to cooperate with a new project with the specific details of the BCpb.

For ethical reasons concerning the right to privacy of every company and individual involved, the names of the companies will be omitted in both the visual representation of the results (Fig. 11) and the table which contains the original data (Appendix 1), in which case they will be referred to by "company #" and so on.

In the table present in Appendix 1, which holds the analyzed document, the "Reachable" column quantifies whether or not it was possible to contact said company through their public means of communication. The column "Interest in cooperating" broadly quantifies whether or not there is interest in cooperating with Blue Circular: Post Branding project. For data presentation effects it's simplified through a Yes or No field, but it is worth noting that this answer could be due to a variety of reasons including lack of equipment to recycle the specific plastics needed, physical and logistical limitations, already engaged with different projects requiring similar equipment, lack of interest in abiding by ecologic regulations, lack of financial interest, etc. As for the "Location" column it's simply a note on their physical location, which is illustrated in figure 11 as a means of visualizing this data point.

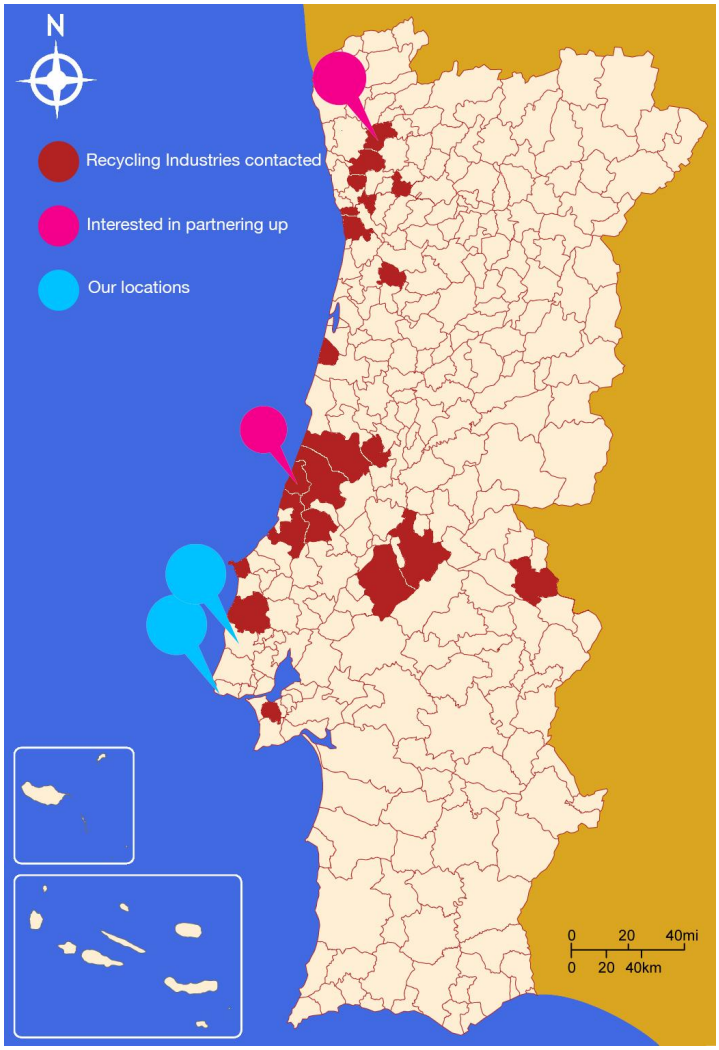

Figure 11: Visualization of results from attempting contact with local industries

Out of the 26 companies that had any connection with plastic extrusion activities, 2 replied positively while 24 were excluded for reasons such as the ones mentioned in the "Interest in Cooperating" column description. As expected, the results show that the conversion rate was extremely low – but that doesn't mean the results weren't meaningful. Company 13 and 26, represented in Figure 11 by the pink pin, replied positively, and that indeed meant a new partnership. Unfortunately that does not mean we were ultimately able to create a synergistic relationship.

Case Studies

In this section we will present the results of our case studies finding, whose selection as stated in the previous chapter (Ch. 3) was based on whether they could provide a working example of circularity in action and if their study answered questions relevant to the investigation, which we confirmed through the contents of Table 3: Questions to be answered by case studies.

Aquafil

Founded in 1965 in Italy, Aquafil is a leading company in the manufacturing of synthetic fibers focusing primarily on Polyamide 6. Currently they operate from Europe, the US and Asia. Today, they remain a leader in the research of new production systems for sustainable development. Perhaps because they've been around for so long and showing responsible growth, it's not surprising that on their website they show to be extremely compliant with every kind of EU regulation such as the chemicals management policy, the 17 Sustainable Development Goals (SDG) outlined in UN's 2030 Sustainable Development Agenda (United Nations, 2020) and a bunch of other relevant third party certifications, showing compliance with 60 different regulations in total, which we won't be referring to individually (https://www.aquafil.com/certifications/).

Their flagship product, ECONYL® nylon, revolutionizes the world of synthetic fibers through a closed-loop model. Nylon waste such as abandoned fishing nets or textile production scraps are recovered and converted into new yarn, replacing the traditional caprolactam (the main component to produce Nylon 6, derived from oil) in the manufacturing process – effectively eliminating Oil extraction, transformation and Caprolactam production which according to figure 12 account for 90% of pollution – and maintaining the same qualitative characteristics as traditional nylon while being able to be infinitely recycled into new fibers.

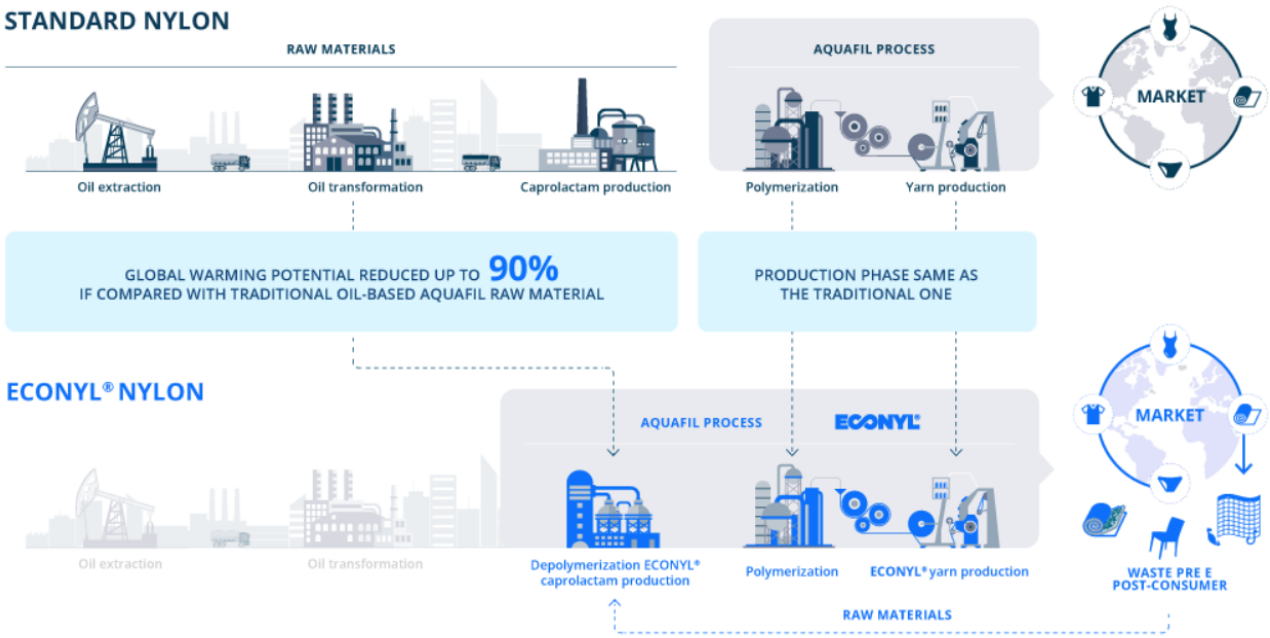

Figure 12: Production of standard Nylon vs. ECONYL (Aquafil, n.d.)

Another great thing that Aquafil accomplishes with ECONYL is completing the value chain for lots of ambitious smaller scale projects focused on plastics retrieval such as:

- The Blue Circular Postbranding project (highlight on the importance of the discovery of Aquafil's recycling solution for the completion of their closed-loop system)[2]
- Teko, a Scottish company that designs socks and footwear [3]
- Nofir, a Norwegian company that collects discarded fishing gear for recycling [4]
- Valentina Vasilatou, a Greek company that designs swimwear [5]

Sadly, the only other companies we could find evidence of operating in the same manner as Aquafil with their ECONYL fabric production only amounted to two – Fishy Filaments and Bureo – but we would like to note that perhaps this is what the future should look like – with

[2] https://bluecircular.org/
[3] https://www.tekoforlife.co.uk/
[4] https://www.nofir.no/
[5] https://valentinavasilatou.com/

more companies aiming to ace the environmental regulations and reproducing the success of Aquafil, while keeping the sector fresh with competition, new exciting research and innovation.

PlastiX Global

Plastix Global is a Danish company, whose mission is to mechanically recycle post-use maritime fibers into high-quality raw plastic materials. They specialize in fiber conversion focusing primarily on the conversion of used fishing nets, ropes and trawls into high-quality raw plastic materials such as plastic pellets which are used to manufacture what they call "Green Plastics". Their quality focused process (Fig. 13) starts with sourcing the fiber polymers from the aforementioned used plastics – which are globally sourced via ports, fishing net producers, and plastics collectors – and then sorted into the different types of polymers and colors.

Figure 13: Plastix's ocean plastic transformation process (PlastiX, 2020)

The sorting can be quite labor-intensive, but is definitely an indispensable part of the process of making it possible to recycle these plastics into useful raw-material; a consideration which is often overlooked (Blue Circular Economy, 2022). After sorting the polymers are shredded, washed, separated, and dried. Finally, the materials are compounded and extruded into recycled pellets, turned into "Green Plastics" and then sold to manufacturers who transform them into a variety of market products such as shoes, skateboards, clothes, bottles and bags.

Much like Aquafil, they comply with certain EU regulations like the UN's SDG's and a few other third party ones.

Plastix Global's on-site laboratory analyses, registers and assesses the recyclability of all input waste streams. Currently 800 different types of nets, ropes and trawls are registered in PG's database (Blue Circular Economy, 2022)

We found one more company that is turning the same disused end-of-life fishing gear into raw pellets but focusing in particular on the PA6 fibers for this (European Union, 2021): french company Fil&Fab (https://www.fil-et-fab.fr/)

What we can learn from cases like PlastiX and Fil&Fab is that among all the recycling methods available to us for plastics in general, not all of them are of equal usefulness or possibility of application when dealing with plastics provenient from end-of-life fishing equipment. Through the addition of a careful sorting process they have added a means of plastic pellet production to the ocean plastics recycling repertoire, broadening the applications of end-products related with circular economy projects involving ocean plastics.

Interview Content Analysis

Before exhibiting the results of the recorded interviews, we feel it's important to reaffirm that the remarks made within this chapter result from the recorded interviews – whose Content Analysis Table (see Appendix 5) and audio files (see Appendix 6) can be examined in the

appendix in its original language: Portuguese. These interviews in turn reflect the themes and questions inherited from the interviews's Categorization Table (Tab. 4) in Chapter 3 and the results and discussion summarized through different bullet points in their respective location sections.

Cascais

The interviewees in the port of Cascais were happy to talk about their profession and comment on a few questions regarding the fishing nets while they were performing work tasks at the port. Given their eagerness to discuss certain aspects of their profession, work conditions and tools such as the fishing nets, the interview quickly developed beyond the pre-defined questions and became a very rich source of information on the community, which fortunately was in line with what we looked for and the semi-structured format we prepared.

The takeaways from the seven interviews conducted in Cascais port were:

- Bringing the broken nets to the shore is, contrary to our initial expectation, standard procedure – and that is due to the price of new nets (~50€) being superior to sending them to a reparations professional in a different port to fully repair (~20€). Because of the price of purchasing new nets, fishermen are reluctant to throw them away, and when they do it's after thoroughly confirming they can no longer be repaired which happens in land – making the containers placed in the port for the recovery of the fishing nets highly convenient in terms of location and usefulness, which results in the containers being used very often.
- Apart from very few older aged outliers, fishermen themselves don't repair their own nets in the port of Cascais, and instead employ someone to do them for them in a different port. Reparation of own nets seems to be a fading trend as the younger generation no longer learns it.
- The fishermen community of Cascais are not happy with the way the municipality puts their interests in second place, forcing them to work in subpar conditions. The interviewees reported that often local kids and tourists will jump from the dock onto the fishing boats while they are away for lunch, steal bags and damage equipment all while

the coastal police watch without intervening. Moreover, the jumps are made from a crane which used to help fishermen unload their cargo from the boats which has since then been deactivated by the municipality in fear of the interactions between said intruders and the device. Because of that, unloading has to be done by hand – which greatly increases the time and effort of the task and therefore reduces profitability.

- The Docapesca intervention didn't reach the small sample we interviewed and we suspect that even if it did, because Docapesca has ties with the municipality which the fishermen have a very negative impression about, it wouldn't have been much welcome. Citing interviewee #3: "In Ericeira the municipality takes care of the fishermen, but here in Cascais they don't do anything for us. The priority is to make the tourists and the rich people that live here happy." Although the practicality of the recycling plastic bags from the intervention did not reach this small sample of fishermen it does seem that it wasn't totally useless, as the topic of ocean pollution and fishing net disposal seemed to be very fresh on their minds.
- Interestingly, the interviewed sample of fishermen at the port of Cascais were very aware of the impact of fishing on ocean health, two of the eldest even going as far as to say that fishing with resource to nets should be abolished as a practice, since it's the fishing art that kills the most – small fish, big fish, everything – and that it is a "murderous" practice and, that there are other better ways of fishing such as "aparelho", "arrasto" and "covos". The younger fishermen didn't comment and one of them disagreed, arguing that fishing with nets is "an art that requires a certain knowledge and a lot of extra effort in net maintenance that most aren't happy about", attempting with this to justify the elder fishermen's opinions on the subject.
- Although the reported health of the seas and fish that these fishermen work with was reported by them as very poor – "the worst it's ever been" – there was an interesting opinion on why that is so unrelated to pollution, which was that the sea and the seafloor is "stale", there is no natural currents moving the floors and that previously there was more life in the floors, subsequently also more fish and a livelier sea in general because of the fishing art of "arrasto" (trawling) which artificially moved the floors it passed through.

This practice has been banned since January of 2017 as it was considered terrible for the environment and an extreme waste of resources since the violent method damaged about 70% of the total haul, making it unusable for sale and consumption (Iniciativa Gulbenkian Oceanos, 2017).

- The kind of litter they find in the sea and in nets and octopus cages are almost always not provenient from fishing activities, instead the report that disposable hygiene products such as masks and menstrual pads are the most common, along with bottles, plastic and glass alike.
- Although there was a certain hostility toward the municipality, it seems that said hostility doesn't extend to the BCpb project, and its containers are mostly welcome since they provide a comfortable way of disposal for them.
- According to interviewees #1, #3 and #5, their profession nowadays isn't valued by society and most "just eat, but don't even think or know where the fish come from". They did note that among the general public, the older people still value them and their profession as they think it's fair, but this unfortunately stopped being so with the younger generations.
- Interviewee #1, the eldest and most experienced subject (56 years of age, fishing since he was 14 years old) was very verbal when it came to leaving the ocean a better place for tomorrow, to which interviewee #5 the youngest of the bunch at 25 years of age supplemented that he was only like that because it was his generation that ruined the sea the most, arguing there was guilt involved in his sentiments.

Ericeira

Although smaller in number, the interviewees in the port of Ericeira were also happy to offer their opinions and knowledge of the fishing craft and we were fortunate enough that among them happened to be the treasurer of the fishermen association.

The takeaways from the 6 interviews at the port of Cascais were:

- The port of Ericeira sees less fishing than that of Cascais, and that is reflected on the number of active fishermen at the port. 5 out of 6 of the interviewees were retired

veterans (all over 60 y/o) who spent most of their life at sea and still come to the port every single day to perform equipment repairs and preparations for the active fishermen. The remaining 1 is a sport fisherman.

- Similarly to Cascais port, bringing the broken nets to the shore is standard procedure that every fisherman abides by – The fishermen at the port of Ericeira report the same price for nets (~50€) an a slightly lower price for full repairs (15€) making it even more worth for these men to properly maintain their nets. There are very few remaining fishermen that repair their own nets (<2) as most are not willing or can't afford the time cost of doing it themselves (between 2 and 3 full days of work for one net), hence it's not something that is even taught on by the previous generations.
- A particularity of this fishing location is that due to the morphology of the coastline it is not possible to park the boats at sea – this setback is solved through the employment of a tow truck that hauls the boats to and back from the sea. The transport costs the fishermen 25€ and 15 minutes for a single use which further reduces profitability, meaning a 350€ and 3 and a half hours lost over the course of a week – plus costs for extra wear that the boats suffer from this kind of transportation.
- One of the interviewees reported that he and 5 of his friends are upgrading their "old wooden boats" – that on the exterior looked brand new, probably due to the very attentive maintenance jobs done over the years – to new aluminum boats, which are already ordered at the factory; when asked about it, he explained that these barely need maintenance and are more durable to the sea and the hauling back and forth from the port, while the wood boats get maintenance done almost on a daily basis since they tend to leak. According to them, the replacement of wood boats for their fiber, iron and aluminum counterparts is the trend.
- Due to the nature of the interviewees current occupations (5 retired veterans and 1 sport fisherman), it wasn't possible to measure the impact of the Docapesca intervention. What we can say is that according to these seniors and the treasurer of the fishermen association all are in agreement that every single boat is equipped with trash containers that they religiously make use of – "nowadays there is no fisherman that throws garbage

to the sea" – and even without the bags they claim that waste is separated and taken back to the port – which might suggest that the introduction of the recycled plastic bags from the initiative could be redundant. On the other hand, there have been witnesses of rare instances when waste is mismanaged and entrails of fish are placed on the recycling containers, leaving it to rot in the sun and releasing smell. This is thought to have been in the period of adaptation and has since then been corrected.

- All of the fishermen agreed that most of the pollution they find at sea comes from fishing activities, and when exposed to the reality of the situation in Cascais even speculated that the waste found over there has more to do with the Tejo river than coastal pollution in itself.
- At this location, every fishing art is used, and that includes net fishing, "aparelho", hook fishing, and "alcatruz"/"covo" (Fig. 14, 15) fishing. The preference of fishing art mostly has to do with the time of the year, since different fish require different arts, and the only arts that are consistently used year round are the ones pertaining to octopus fishing.
- Most seemed to agree that "alcatruz" fishing (Fig. 16) (a plastic cage used in octopus fishing, alternative to "covos" and favored over them in this location for their durability and price) is terrible for the environment and unnecessarily kills a lot of octopuses and other lifeforms since it will get stuck on rock and won't degrade: – "the thousands of alcatruz abandoned at the bottom of the sea infinitely fish all year round to no one's benefit, it's murderous". Controversially 2 interviewees disagreed, arguing that "alcatruz" don't get stuck at the seafloor since they only get dropped on sand and not on rock. This raises a question which could spark its own research: Is a modern fisherman, equipped with regular technology, devices and knowledge capable of accurately discern whether the seafloor is complete sand or rock and what new methods can be employed to further increase the accuracy of this endeavor?; the same 2 fishermen stated that in their opinion the ocean and the fish are just as healthy and abundant as they were in the past and that there is no need for alarm.
- Regarding the BCpb project, all are in agreement that bringing the nets back is something they do anyway and it's nice to be rewarded for it, while #4 and #5 added that the

fishermen association is a very small entity that survives through tiny helpings from different places, adding the BCpb to those is welcome as it diversifies sources of help. The fishermen association is vital for their profession in ways such as providing the tow truck that takes and brings boats from the sea and instructing and employing the operator.

- Regarding their subjective feeling of how appreciative the community is regarding the fishing professionals, interviewee #1 was alone in thinking that menial workers like them aren't valued, #2 abstained, while the remaining agreed that it's a very tough and hard working job and as such they feel like people value them for it since it's rarer nowadays as "people sit on desks for work all day long".

Figure 14: "Alcatruz" fishing device

Figure 15: "Covo" fishing device

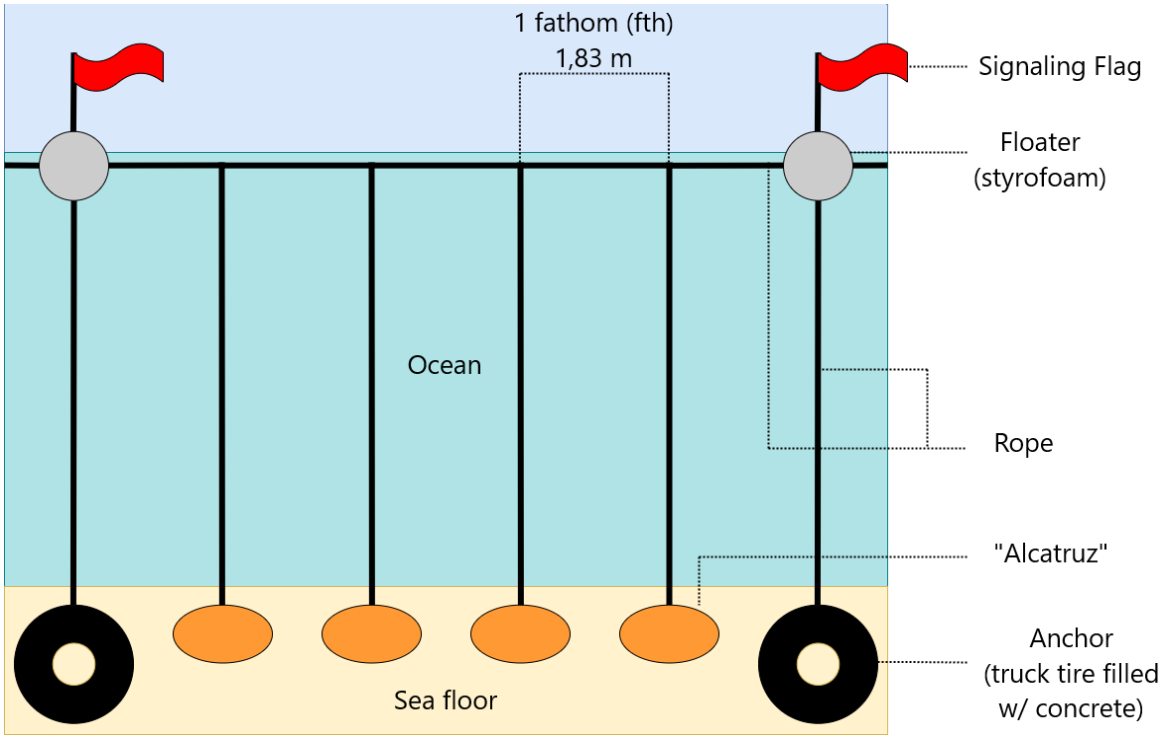

Figure 16: "Alcatruz" octopus fishing diagram

From the conducted interviews, we can make a few conclusions:

The fishing nets retrieval operation is successful and well accepted, mainly due to not giving the fishermen work that they already wouldn't do and satisfying their need of having any container placed in proximity of their work stations so that they can dispose of the nets with ease. Moreover, we got the sense that even though environmental practices aren't the fishermen's first concern they aren't oblivious to them, and seem to take a certain degree of satisfaction about realizing they are contributing to the ocean's health when the subject was brought up.

Although environmental practices are not their first concern, the fishermen crowd are generally very aware of the subject and can report with a degree of specificity what kind of waste they do or do not find while at sea.

Previously "alcatruz" weren't made of plastic but of clay. According to interviewee #4 that changed because during the winter when the sea is the roughest, fishermen would have to

retrieve all the alcatruz and stop using them for the duration of the season, since the sea would break the devices. The replacement of the devices for their plastic versions enables fishermen to fish the highly demanded octopus for the entirety of the year, which represents the majority of their income in comparison to the fishing of other species.

There may be something to be done regarding pollution originating from “alcatruz” fishing in the future; there is a strong possibility that although the damage done is invisible to the naked eye it might be responsible for the endangerment of species in the future due to the rate at which they accumulate at the sea floor without ever having the chance of being removed, infinitely and indiscriminately fishing any species for the entire lifespan of the very durable plastic, which there are no known methods of removal for as of now.

Not to mention the “alcatruz”, the anchors used for the anchoring points of the alcatruz ropes (Fig. 16) are big rubber tires from trucks, stuffed with concrete which although we weren’t able to confirm through the interviews, raised the suspicion that this is yet another object that gets abandoned in the ocean forever.

Lastly, the floaters used to keep the GPS marked signaling flags afloat (Fig. 16) are simply a block of the cheap styrofoam, which constantly gets replaced since it breaks down and floats away to the sea. This left us wondering if there could be a better way of doing this – as it seems like a great opportunity to redesign these fishing devices that have such reliable and time tested efficacy, but through the lens of an environmentally conscious design.

Another perhaps bizarre detail for non fishermen we found in regards to rubbers and plastics being utilized that potentially contribute to the microplastic catastrophe in the ocean is that corvina, a type of fish fished with the “aparelho” (Fig. 17) device which is basically a collection of hooks and lines, is fished not with live bait but with rubber bait (Fig. 18), that is cheap “durable” (in comparison with live fish) and that this particular type of fish will still swallow, allowing them to fish out this specific fish from say a very big school of sardines. We feel that similarly to the rubber tires and styrofoam practices with alcatruz fishing this could perhaps be grouped with those for further investigation.

Figure 17: The "aparelho" fishing device

Figure 18: Rubber bait used in "aparelho"

The type of waste present in the ocean vastly differs between the two locations. We can hypothesize that this is due to the proximity of Cascais to the Tejo river bringing about more urban waste to the sea.

The different locations have different requirements for boat durability, contrary to the port of Cascais, the port of Ericeira's morphology doesn't allow for the parking of boats at sea thus raising the durability requirements of the hull so as to handle transportation from and to the sea.

The expenses of purchasing equipment, repairing said equipment, repairing the boat, transportation to the sea and back to shore, time waste due to poor work conditions quickly add up and interfere with profits. This could in part explain the lack of young fishermen, as it's a highly specialized profession, with

very hard work hours and physical labor that pays the average crewman from 800€ up to 1500€, depending on the amount of fish caught, working 6 days a week, which aren't very

attractive work conditions. In general, the way profits distribution works is, after the cargo is unloaded and sold its value is then split in parts, each crewman taking the equivalent to 1 part, while the boat master takes 2, in order to cover for the aforementioned costs pertaining to equipment and boat ownership. The thin line of profitability that they are forced to thread makes them careful about life extension of equipment, special mention of the fishing nets which get repaired over and over again before getting disposed of.

Observation

A brief synopsis of what we will see in this subchapter:

The observations made in this Chapter were recorded according to the Observation Table (Tab. 5) prepared in Chapter 3, from which they inherited the observation questions and their related category parameters.

The results of the observation are organized in 2 parts, the first one for the Cascais port and the second one for the Ericeira port.

Following a brief introduction in each of these parts, you will find several tables of observation, each exhibiting its different findings, below which you can find our own comments and conjectures about them.

In each of these parts you will first find a table based on data collected by Docapesca from which we can roughly deduce the amount of boats at each port, the number of crew in each boat and the approximate size of each boat – that's Table 6 for Cascais and Table 11 for Ericeira.

After the first tables there are 4 additional tables in each part, each showing a different inherited parameter from the observation Table in Chapter 3 (Tab. 5) – That's Tables 7,8,9,10 for Cascais and 12,13,14,15 for Ericeira.

As stated, for the sake of partitioning the information, our own conclusions will be drawn out throughout the subchapter, accompanying their respective tables.

Cascais

During the Docapesca: fishing for a sea without litter intervention, the following information was recorded:

- Number of boats at the port
- Name of the boats, registration and plate number
- Name of the crew master
- Number of crewmen of each boat
- Size of recycled bags attributed (directly related to size)

For the port of Cascais the recording of information had 4 different incidences: 14/07/2020, 15/07/2020, 13/11/2020 and 17/06/2021. Table 6 provides a simplified visualization of the complete table available in the appendix (see Appendix 2):

Table 6: Results of Cascais fishing vessel and crew size

CASCAIS: FISHING CREW SIZE								
Crew size	1	2	3	4	5	6	?	Total
Nº of vessels	2	14	10	3	5	1	3	38
CASCAIS: FISHING VESSEL SIZE								
Small (30L bags)	1	6	10	1	0	0	3	21
Medium (80L bags)	1	8	0	2	5	1	0	17

Although the size of the vessel does not correlate with the number of crew members – big boats will sometimes have a small amount of crewmen and small boats a bigger amount – the size of bags attributed (30L vs. 80L) does have a direct correlation to the vessel size therefore allowing us to deduce that there are 8 small boats, 13 medium sized boats and 17 big boats, which means size distribution at this location is uneven and trending towards bigger sized vessels.

On the 9th of August of 2022, we took our previously designed observation parameters inherited from Observation Table (Tab. 5) in chapter 3 – which in turn is deeply rooted in the objectives of this research – to the location of interest (Cascais) in paper form in order to fill out and register what we observed. The following are the resulting filled out tables:

Table 7: Cascais: Observation of Logistics

LOGISTICS	
BOATS	
Departure	00:00/00:30 AM
Arrival	Highly dependant on vessel size/ type of fishing; Up to 16:00 PM (very rare)
Duration of Leave	10~12 hours avg; can go up to 16 hours
Duration of transport from coast to sea VV.	None (boats are parked at sea in this port)
Material	Iron, aluminum, fiber
Dimensions	Medium/big
FISHING NET CONTAINERS	
Usage frequency	Frequently used
Maintenance	Great; there is someone personally responsible for calling the retrieval services when containers are close to full capacity
Contents:	Very close to full
Placement:	Excellent; close to fishermen work stations

Since boat size at this location trends towards the bigger size, fishing sessions tend to be of much longer duration than its Ericeira counterpart, which as we will observe in the next section has in general smaller boats thus shorter fishing session duration. This deductive observation coincides with the information provided by the fishermen during the interviews.

The distribution of boat construction material we observed trended towards iron with a few more expensive aluminum exceptions and a few cheaper fiber solutions. We can deduce that the usage of the heavier iron boats is preferred since boats are parked at sea and need no transportation to reach the water.

The containers placed by the BCpb are working excellently and provide a comfortable efficient means of disposal at an excellent location and also a great opportunity for the collection of recycling materials. The containers are frequently used and there is a person responsible for calling the retrieval services when they are close to being full.

Table 8: Cascais: Observation of fishing nets

FISHING NETS	
Maintenance	No one doing net maintenance (it's not a practice at this port)
Placement	Correct
Others	Other fishing arts are more popular throughout the whole year

Fishing nets are carefully looked after by the fishermen, who extract the most value they can from each net. The times when fishermen would repair their own nets are over though, and no one at this port repairs their own nets instead commissioning a net repair professional at the Costa da Caparica port 40,3 km away – where they also sell their fish at the lota (this is mandatory according to food safety regulations). This fact is very important and coincides with every observation and interview done during this investigation as it implies a degree of concern towards the nets that makes them less likely to be treated as use and forget disposable tools.

Although fishing nets do have their place, they might be only a part of the problem; there are other fishing arts that perhaps currently surpass the pollution and life harming potential of nets, such as octopus cages ("covos") which are not associated with seasonal fishing but instead used throughout the entirety of the year.

Table 9: Cascais: Observation of fishermen

FISHERMEN	
What tasks they do at dock	➢ Reparation of fishing devices ➢ Making of new devices (observed "Covos") ➢ Maintenance of floaters, cables, boats ➢ Unloading and cleaning of fish
Gender	All male
Age group	~ 35-50

The fishermen keep busy at the dock and perform activities supportive of their fishing activities; these have mostly to do with maintenance but also involve making new fishing devices from scratch and unloading and cleaning of fish. The fishermen observed were all of the male gender in the 35-50 age group.

Table 10: Cascais: Observation of location

LOCATION	
Cleanliness	➢ Work tables are washed with hose ➢ Waste is in the proper containers ➢ No smell
Others	➢ Organized in units of space per boat ➢ Big vessels "costeiras" of >3 crew get 2 units ➢ Small vessels "locais" (8-9 meters) of <3 crew get 1 unit ➢ Within proximity of the mouth of the Tejo river

In regards to the location itself, the most relevant things that can be said are that boats are parked at sea as opposed to being parked in land, and the port of Cascais is within very close geographical location of the mouth of the river Tejo which appears to be related to the increase in

domestic waste observed at sea. The fishermen's work location is not ideal but it's clean and organized and there is no smell.

Ericeira

During the Docapesca: fishing for a sea without litter intervention, the following information was recorded:

- Number of boats at the port
- Name of the boats, registration and plate number
- Name of the crew master
- Number of crewmen of each boat
- Size of recycled bags attributed (directly related to size)

For the port of Ericeira the recording of information had 2 different incidences: 11/05/2022 and 13/05/2022. Table 11 provides a simplified visualization of the complete table available in the appendix (see Appendix 3):

Table 11: Results of Ericeira fishing vessel and crew size

ERICEIRA: FISHING CREW SIZE								
Crew size	1	2	3	4	5	6	?	Total
Nº of vessels	1	1	9	3	0	0	0	42
ERICEIRA: FISHING VESSEL SIZE								
Small (30L bags)	1	1	9	3	0	0	0	14
Medium (80L bags)	0	0	0	0	0	0	0	0

On the 19th and 20th of August of 2022, we took our previously designed observation parameters inherited from Observation Table (Table 5) in chapter 3 – which in turn is deeply rooted in the objectives of this research – to the location of interest (Ericeira) in paper form in order to register what we observed.. These are the resulting filled out tables:

Table 12: Ericeira: Observation of logistics

LOGISTICS	
BOATS	
Departure	05:00 AM
Arrival	11:00/13:00
Duration of Leave	6~8 hours
Duration of transport from coast to sea VV.	15 min. each way (30 total)
Material	Fiber
Dimensions	Small
FISHING NET CONTAINERS	
Usage frequency	Frequently used
Maintenance	Great; Once a week or on call
Contents:	Just emptied
Placement:	Excellent; close to fishermen work stations

Boat size at this location trends towards the smaller size hence fishing sessions tend to be of much shorter duration, averaging 3 hours less at sea in comparison to its Cascais counterpart, and in the extremities at most 10 hours less. This observation also coincides with the information provided by the fishermen during the interviews.

The distribution of boat construction material we observed trended towards fiber with a few older wood boats, which we heard from interviewing fishermen in the port are being replaced as soon as they possibly can for fiber or the rarer aluminum. We can deduce that the usage of the lighter and cheaper to maintain fiber boats is preferred since boats are parked at land

which in turn causes extra wear to the boats, making manutention of the vessels a more highlighted concern for the population at this location.

Similarly to the port of Cascais, the containers placed by the BC:Pb are working excellently and provide a comfortable efficient means of disposal at an excellent location and also a great opportunity for the collection of recycling materials. The containers are frequently used and there is a person responsible for calling the retrieval services when they are close to being full. During the period of observation (formal and informal) there wasn't an instance where we observed failure of the containers emptying.

Table 13: Ericeira: Observation of fishing nets

FISHING NETS	
Maintenance	Observed cleaning and washing of nets; repairs are done at a different location and are commissioned (Peniche)
Placement	Correct

The same care is given to the fishing nets by the fishermen in both ports, except here they are even more zealous about it. In 2 separate instances fishermen were observed caring and maintaining their nets, removing organic material that got stuck in them and washing them. For actual reparation though they operate identically to the fishermen of the Cascais port by hiring a repair service that comes out cheaper than what it would cost them to get new nets, the only difference being that the service they employ is in Peniche which is closer to their location at 115km distance albeit a bit out of they way; this may explain the extra care observed at the port. The cost factor seems to be important in creating a degree of concern towards the nets, which in turn makes them less likely to be treated as use and forget disposable tools.

The fish here gets sold at the local lota, which is an improvement over the fish over at Cascais that has to travel 40km to the nearest lota. (the mandatory place for selling the fish according to food safety regulations).

Although fishing nets do have their place, they might be only a part of the problem; there are other fishing arts that perhaps currently surpass the pollution and life harming potential of nets, such as the preferred type of octopus cages at this port "alcatruz" (as shown in Fig. 14) which are not associated with seasonal fishing but instead used all year around.

Table 14: Ericeira: Observation of fishermen

FISHERMEN	
What tasks they do at dock	➢ Cleaning and washing of nets ➢ Washing and repairs of boats ➢ Reparation of fishing devices ➢ Making of new devices (observed "Covos") ➢ Maintenance of floaters, cables, boats ➢ Unloading and cleaning of fish
Gender	All male
Age group	~ 40-70

Similarly to what happens in the port of Cascais, the fishermen keep busy at the dock performing activities supportive of their fishing activities; these have mostly to do with maintenance but also involve making new fishing devices from scratch and unloading and cleaning of fish, the exception being that although it was reported during interviews that "covos" and other fishing devices are sometimes crafted at this location, it wasn't possible to observe this in any of the 2 formal and several other informal observation sessions. We suspect that this has to do with the prefered art of octopus fishing, as according to our observation there was a strong bias towards "alcatruz" – which get cheaply bought already made since they consist of a single piece of molded plastic – over "covos" – which do require some craftsmanship and seemed to be preferred at the Cascais port. The fishermen observed were on average aged between 40-70 – much older than at the Cascais port – and also all belonging to the male gender.

Table 15: Ericeira: Observation of location

LOCATION	
Cleanliness	Work tables are washed with hose Waste is in the proper containers Some smell
Others	Organized in units of space per boat Boats parked on land Sand is dredged year round to forcefully maintain the shape of the port and beach Because of the limited space and dredging, port and beach are forced on top of eachother

The location of the Ericeira port is a clear downgrade from Cascais; The port is smelly, the boats are forced to park on land due to the geography of the coastline and sea currents, the beach is filled with beach goers to the brink which almost “spill over” to the fishermen’s space (Fig. 19) and the sand is constantly being dredged year round in order to not get the area taken over by the sea and to a lesser degree keep smells away.

Figure 19: Beach (left side of the wall) spilling over to the fisherman's quarters (right side of the wall)

PART III: DESIGNING THE CIRCULAR DIAGRAM

Through the research conducted in the previous chapters and the evolution that happened at the internal level in the BCpb during the course of this research we decided that the best contribution we can make for the improvement of ocean health and future research is to come up with a diagram that shows the current circular process of the BCpb that we tuned and developed in parallel with our research and based its findings using the Design methodologies discussed in Part I, which as we mentioned seems to be a promising field of research that is still in its infancy and we hope to contribute to by providing a solid case study for future research to come. Figure 20 shows the conceptual starting point for the BCpb prior to this research.

Figure 20: BCpb starting point

The diagrams that we will present at the end of this chapter is the result of our empirical research and is based on the article Structuring Circular Objectives and Design Strategies for the Circular Economy: A Multi-Hierarchical Theoretical Framework published on the journal of sustainability (Franconi et al., 2022), on the article A review of Double-Loop Design Management Model published on the Convergências journal (Gomes et al., 2018) and on the tools provided by the Circular Design Guide initiative by the Ellen MacArthur Foundation and IDEO such as the Circular Design Business Model and Product Journey Mapping worksheets.

Within this next section you will find an observation of the circular objectives defined by Franconi in the article mentioned in the paragraph above in an attempt to processualize circular model generation; you will also find a walkthrough of how the BCpb was put into action, a list of partners who were key in making it happen, how we came in contact with them and how we managed to coexist symbiotically in the partnerships.

Phase 1: Defining the product

First we must define our circular "product"; although when the BCpb started it was still unclear what type of circular strategy, the first thing we realized is that our tools, connections and efforts would be put to better use by focusing on a recycling strategy for fishing nets.

Let us consider five different circular objectives brought up by Franconi, examine, and use our empirical data to make observations on each of them: longevity/maintenance, reuse, refurbishment, remanufacture and/or recycling (Tab. 16). These observations will help in guiding our next steps, as the circular opportunity takes shape.

Table 16: Circular objectives and observations

Circular Objective	**Description**	**Observations**
Longevity/ maintenance	Design for maintenance/longevity is an approach for extending the life of a product by incorporating maintenance considerations. Frequently, this circular objective is associated with the product–service system. Design for maintenance/longevity is close in meaning to design for slowing resource loops, design for long-lasting products, design for obsolescence resilience, design for durable products, design for extending life cycle, or design for product-life extension.	Fishing nets are already cared for in order to ensure they reach their full durability potential. There is nothing to be done in this aspect since it's not realistic within the scope of this research to come up with an infinite lifespan type of fishing net.
Reuse	Design for reuse implies creating the conditions for value to be reused in a new product life cycle as-is, with minimal rework. As with the other circular objectives, planning for reuse should begin prior to the beginning of the product lifetime. While EU directives emphasize the importance of reuse [31], the design for reuse method has received less attention compared with other circular objectives. Design for reuse is	Fishing nets are not a 1-use device, and since they are made of a single type of plastic (PA6) and thus are already at their maximum purity level for recyclability, at first glance there doesn't seem to be much else that can be done in the manufacturing process to affect reusability.

	different to design for creative upcycling and design for repurposing.	
Refurbishing	Design for refurbishing is defined as extending the product's lifetime by restoring its full functionality and/or aesthetics by reworking only what is compromised. Only portions of the product that have failed or are badly worn can be disassembled and rebuilt with old and/or new components. Consumer acceptability of refurbished products has recently become a study focus. Design for refurbishing is close in meaning to design for reconditioning.	When fishing nets reach the "soft" limit of their repairability, the harder structures within the nets get used as the base for "new" refurbished nets. From our empirical research we found this practice to be widespread, thus we consider this objective is already put into practice.
Remanufacturing	Design for remanufacturing extends product lifetime by restoring used products to like-new or better-than-new condition. To clean, restore, and replace components during remanufacturing, total disassembly is required. What sets remanufactured products apart from refurbishes is their condition, performance and warranty. Some scholars consider remanufacturing to be the most promising circular objective in the CE.	Remanufacturing is possible and indeed very promising, but since in the specific case of fishing nets that would always require them to be extruded first, it seems logical to first analyze the recycling logistics.
Recycling	When there are no other options to extend the product lifetime except recapturing the value of materials, recycling can be considered as the main circular objective. Design for recycling ensures proper material selection, separation, and reprocessing for new material flow. Design for recycling is close in meaning to design for upcycling	PA6 wasn't always the easiest to recycle, but with companies such as Aquafil and PlastiX paving the future and putting forward powerful recycling solutions for the material, the outcomes seem exciting and something we can focus on, since it allows us to outsource a part of the process that we as a small project don't have the equipment or funding to accomplish alone.

(based on Franconi et al., 2022, p. 5)

Phase 2: Identifying limitations

After considering the observations made for each objective in Table 16, we made use of them in the best way we can in an attempt to generate a positive outcome for the resolution of the research problem.

As mentioned in Chapter 2 of Part I innovation processes in design are often non-linear and can be executed in any order of steps. In this particular case it seems practical to start with considering the longevity of our product (Fig. 21), which helps us identify two important aspects:

1. The "product" doesn't have a circular life cycle
2. The circularity gets broken due to durability limitations of the materials

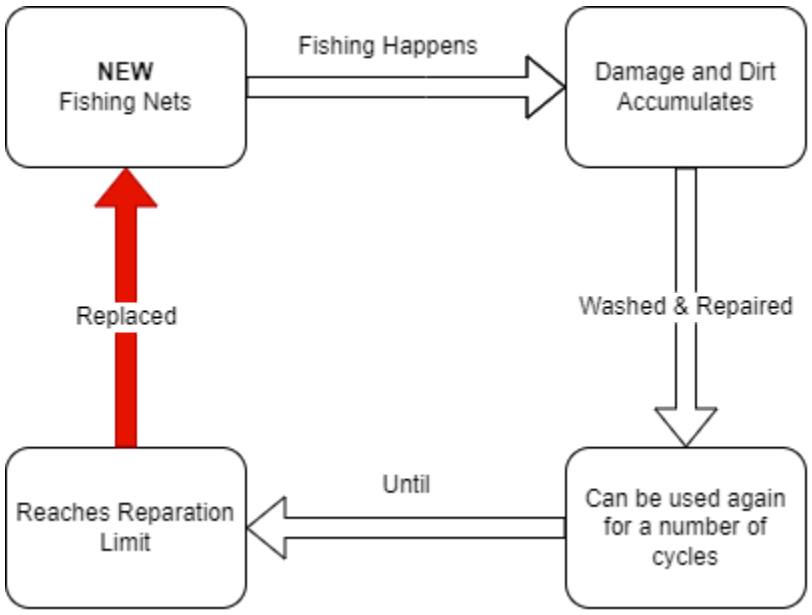

Figure 21: Fishing nets life cycle

In the replacement stage, old nets get dumped and new nets are purchased from the manufacturer; this means that we found the first point we can try to affect in order to improve on the "product"

In order to answer the identified adversity, the first step the BCpb took was to ensure that the fishing nets stop contributing to ocean pollution and are instead collected. To this effect a contact was made between the the BCpb and Docapesca (http://www.docapesca.pt/) – a state-owned company that provides public service on mainland Portugal by organizing and the first sale of fish and supervising the fishing and fishing ports sector – resulting in partnership under their sustainability project "Fishing for a Sea Without Litter" which in turn opened up the contact opportunity with their close associates – the municipality, local authorities, and the fishermen association – which we used to introduce our interference in the fishing net life cycle: two big white containers to be placed in the docks of each location for the specific purpose of fishing net disposal (Fig. 23, 24). During the projecting, the idea of using bigbags (1M3 = 30kg) personalized with logos (Fig. 22) inside of the containers came up as a way to make the transportation of the fishing nets an easier and cleaner process.

Figure 22: Personalized bigbags inside the BCpb containers

Figure 23: BCpb containers for fishing nets disposal (Ericeira)

Figure 24: BCpb containers for fishing nets disposal (Cascais)

The implementation was smooth and generated positive outcomes for the parties involved: the municipality cared for the environment without extra expense and the fishermen got a well placed container that allowed them to keep their workplace hygienic and unobstructed while mitigating extra effort and/or pollution resulting from the disposal of the nets.

Through our new partners, the containers were set to be emptied once a week – scheduled by the local municipality – or whenever they reach full capacity; in order to accomplish this a fisherman – particularly one who is directly involved with management in the fishermen association – was designated (per location) to be responsible for the task of calling up the municipality if there ever was a circumstance where the containers were filled up before the weekly retrieval, in which case the retrieval would happen immediately; we felt this detail was necessary to be employed in order to maximize our positive impact and generate good opinions from our collaborators about ourselves, so that the willingness for cooperation would rise in porportion.

Phase 3: Logistics

The system for fishing net collection was in place, but a different need arose – and that was how to store them. Through the aforementioned partners we managed to get into contact with Tratolixo[6] a local waste collection and management entity, who agreed to store our fishing nets in their facility (Fig. 25) under their social responsibility program. The fishing nets were then set to be directly transported there by the retrieval services (Fig. 26).

[6] https://www.tratolixo.pt/

Figure 25: Fishing nets stored in Tratolixo's facilities

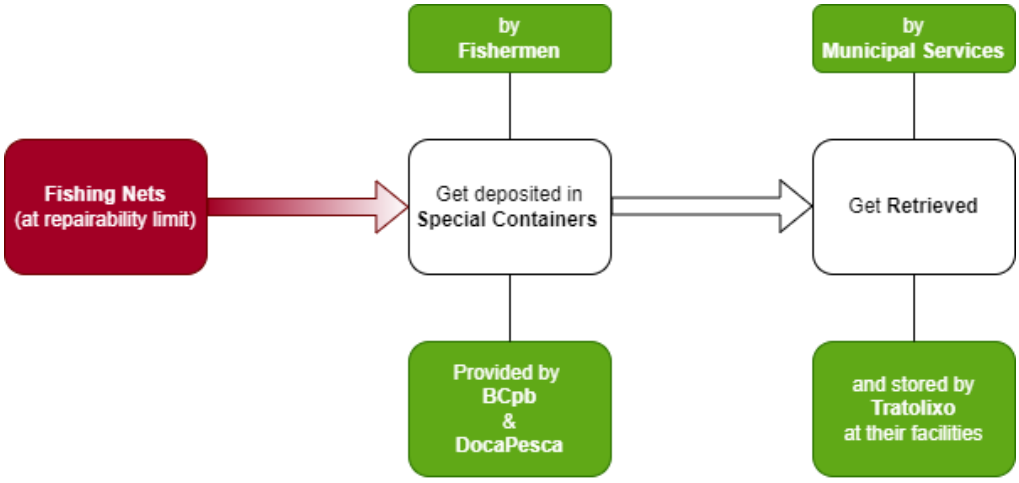

Figure 26: Collection, retrieval and storage

Since the fishing nets were now being successfully captured before turning into unrecoverable waste, our first circular objective of affecting the life cycle of the product was accomplished and thus we can go back to the remaining objectives mentioned in Table 16; in order to do that a journey map was made to help contextualize the product and its life cycle (Fig. 27)

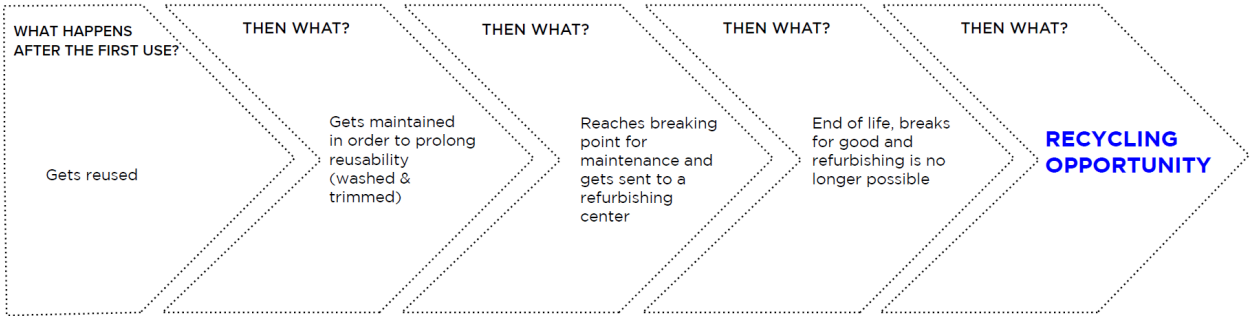

Figure 27: Product Journey Mapping (based on Circular Design Guide, McArthur and IDEO)

Knowing that there is a recycling opportunity, where it lies and the full context of its life cycle aids us in considering the circular objectives of Reusing and Refurbishing described in Table 16 by getting more intimate with the subject. As we hypothesized in a very early stage and confirmed through the interviews we conducted during the research process, it's always the case that when the fishing nets get disposed of by their users (the fishermen) they have already been heavily reused, washed, maintained, repaired and even refurbished time and time again. Asides from the fishermen's oral testimony during the conducted interviews this fact is further reinforced simply because it makes sense for it to be so financially when considering price points for new nets, repairs and the tight margins of money and time fishermen have to balance, since not only the job is very demanding physically – it's also very time consuming – and repairs are cheaper and take a very short time to finish since they are conducted by an experienced specialized third party; thus we must rule them out for interference as it seems unlikely we can create a positive change within them.

As for the Remanufacturing circular objective, let's say it's possible to take an old fishing net and extract the raw material (PA6). In this case it would be possible to infinitely manufacture new fishing nets from old ones, effectively closing the loop on this product. Not only that, different products could be made from the raw material, diversifying the outputs and facilitating the introduction of the materials originating from the old fishing nets into society; we thought this sounds very promising, but the key to this would always be our last circular objective: Recycling.

PA6, the raw material from which fishing nets are made, is a very strong, elastic and resilient fiber; it's hydrophobic characteristics and resistance against oils and many other chemicals make it ideal for this usage scenario; not only that, since they are a plastic fiber they have a low manufacture cost associated, making fishing nets made from this material very appealing. What PA6 is not is easily recyclable; or so it was, until the recycling process was optimized and put into practice by companies such as the ones we researched in the case studies section in Part II of our research. Because of this recent exciting breakthrough in recycling technology, the BCpb decided to put their focus in how to recycle the ton of broken down fishing nets they had collected, and looked for extrusion industry companies and organizations within the country to form a partnership with (Fig. 11).

At this stage the BCpb came into contact with Ambibérica[7], a Portuguese organization whose expertise is collecting and sorting marine post consumer plastics – mainly nylon – and is partnered with and supplies Aquafil[8] with raw materials, who we were already familiar with from our case study research – since their breakthroughs in nylon recycling capabilities were of particular interest. In order to get the stored nets from point A (Tratolixo facilities) to point B (Ambibérica), we could no longer rely on the municipal services (Fig. 28). We came into contact with Jerónimo Martins S.A.[9] who are one of the biggest Portuguese corporate groups that operates in food distribution and retail – operating more than 4,900 stores in Portugal, Poland, and Colombia (Jerónimo Martins SGPS S.A., 2021) – and, under their social responsibility program, agreed to sponsor the transport – provided by Veolia[10] – to make the nets reach the Ambibérica facilities.

[7] https://ambiberica.pt/
[8] https://www.aquafil.com/
[9] https://www.jeronimomartins.com
[10] https://www.veolia.pt/

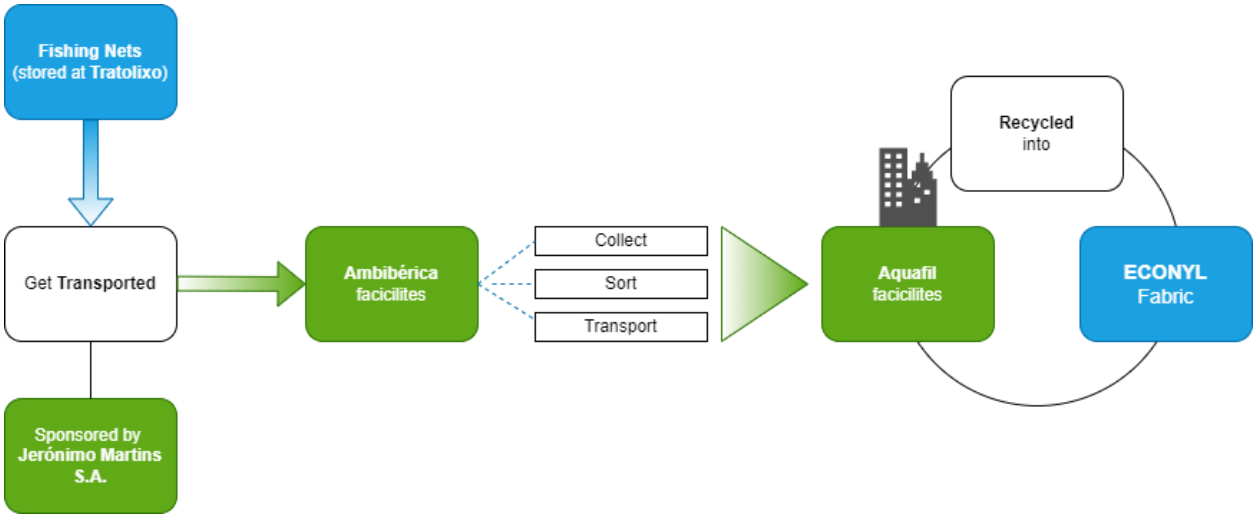

Figure 28: Sorting and Recycling

This is the point where the BCpb finally detaches itself from the logistics of the process and Ambibérica takes over as the responsible for supplying said nets to Aquafil, where they will be turned into ECONYL Fabric – which as previously mentioned in Chapter 4 (p. 51) is the proprietary Nylon fabric produced by Aquafil using end of life Nylon as a raw material, allowing them to cut up to 90% of the global warming potential when compared with traditional oil-based raw material. For the BCpb, who employs a governance model supported by good practices, this partnership meant the closing of the circular recycling loop (Fig. 29), by which we mean that the revenue generated gets reinjected back to where it all began - the fishermen community - allowing the cycle to autonomously continue to function.

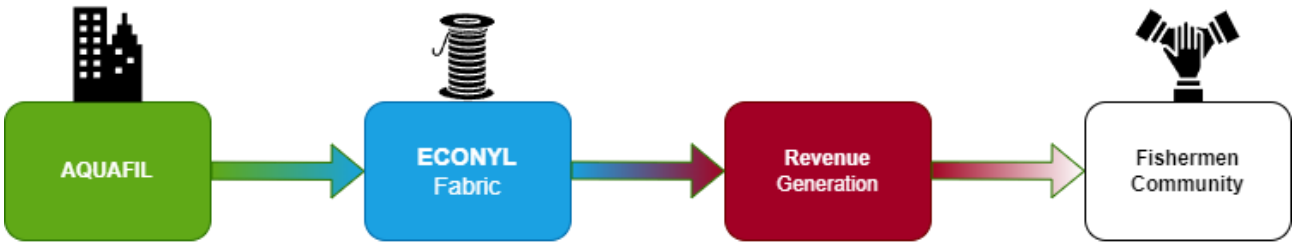

Figure 29: Back to the community

Phase 4: Summary and diagrams

To summarize, in order to achieve the BCpb ambitions of creating a simple and replicable circular model in the form of a diagram (Fig. 31) many relationships had to be built with other organizations. In order to do that we based ourselves on the circular business model canvas to lay the groundwork of processes, relationships and interactions needed (Fig. 30) in order to get the marine litter from the sea back to the shelves. The list that succeeds the circular business model figure names all of all the partners that were key to the success of the model:

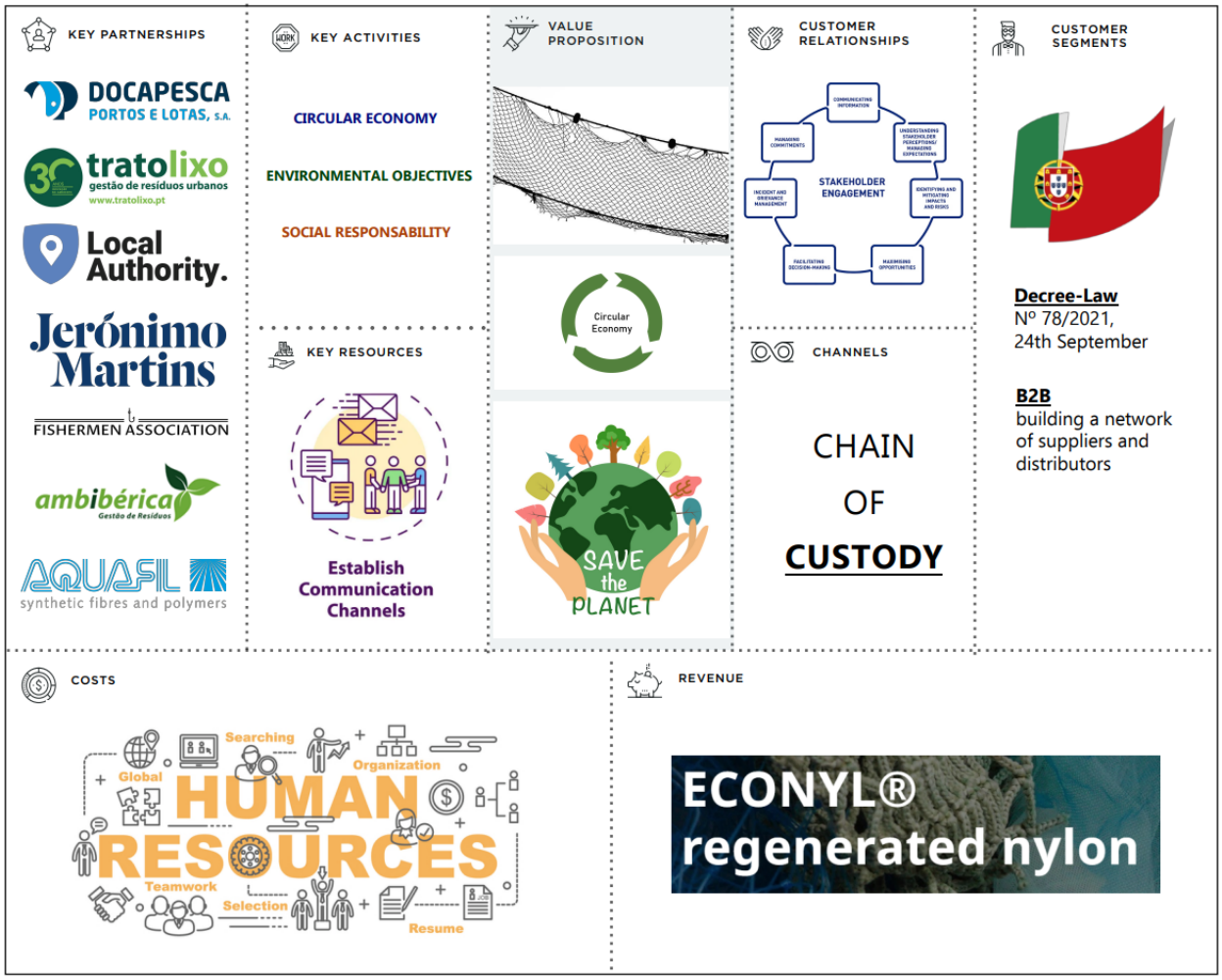

Figure 30: Circular Business Model (based on Circular Design Guide, McArthur and IDEO)

- Docapesca, a state-owned company. It provides public service on mainland Portugal by organizing the first sale of fish and supports the fishing and fishing ports sector (http://www.docapesca.pt/en/) - partnership under the project "A Pesca por um Mar Sem Lixo"[11]
- Fishing vessel owners' and fishermen's associations
- Tratolixo, a local waste collection and management entity [12]
- Jerónimo Martins, an international Group based in Portugal with over 22 years of know-how in the food business. Food distribution is their main activity and is worth more than 95% of the Group's consolidated sales [13]
- Ambibérica, an environmentally conscious waste management service provider run by environmental engineers, who specializes in sorting conditioning and transporting of waste [14]
- Mútua dos Pescadores Insurance, who develops its activity within a framework of social responsibility, intervening in communities in a sustainable way, not only developing its economic mission as an insurance company, but also promoting and supporting environmental, social and cultural projects and initiatives - engagement fishing communities and managing the added value created by the industry in favor of those communities [15]

With all these key partnerships secured and the loop closed, we came up with the circular diagram below (Fig. 31) as the project output for this research, which we based on the visual format used by the Ellen McArthur Foundation (Fig. 2).

[11] http://www.marsemlixo.com/
[12] https://www.tratolixo.pt/
[13] https://www.jeronimomartins.com/
[14] https://ambiberica.pt/
[15] https://www.mutuapescadores.pt/

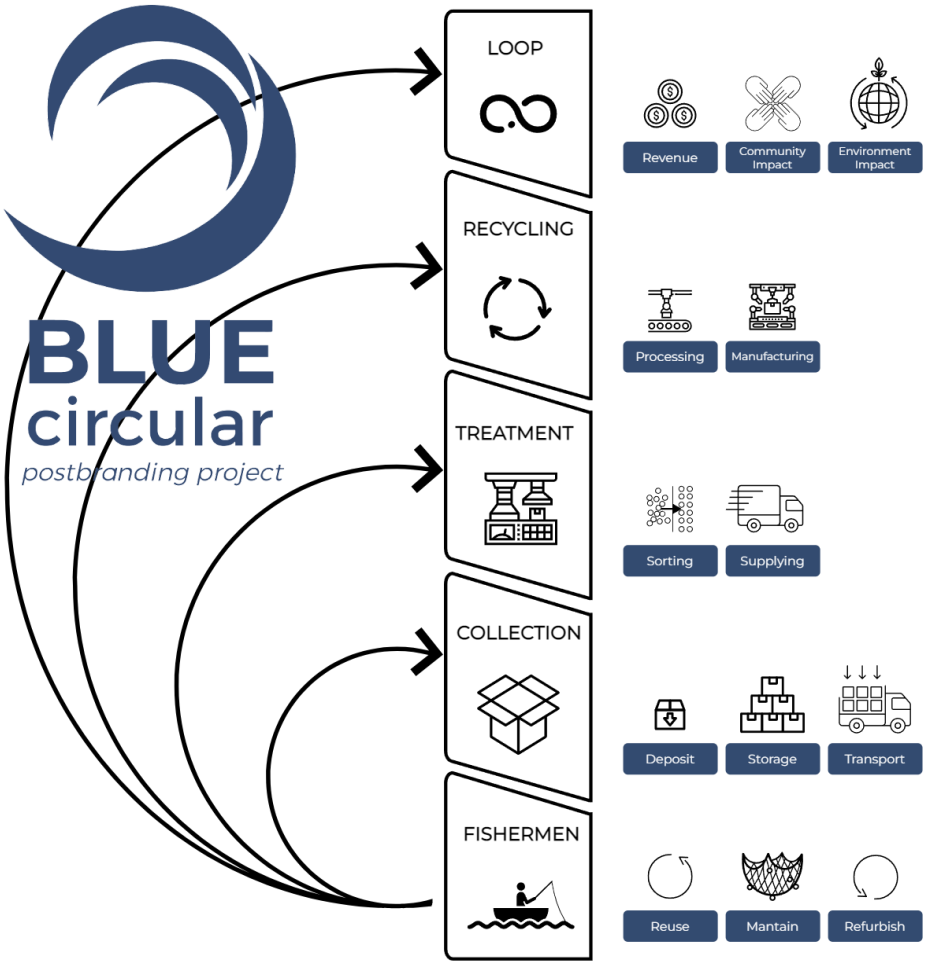

Figure 31: Diagram of the BCpb circular model

The diagram above represents the start to finish circular journey of going from point A: waste recovery from the ocean; to point B: giving it a purpose, benefiting the community and the planet and infinitely looping the system. This loop starts (and ends) with the fishermen, who for their own financial motivations do their utmost best to extract the biggest lifespan out of each fishing net and deposit them into the BCpb's containers once they finally reach their limit of usability so they can be collected by us. The collected waste is then collected by official waste management entities at the service of the municipality who bring them to Tratolixo's facilities to be temporarily stored before it gets transported to Ambiberica's facilities in order to be sorted

and treated; the costs of this transportation are supported by Jerónimo Martins SA in the context of their environmental responsibility obligations, which in turn grant them taxation benefits. At Ambibérica the waste gets packed and sent to their partner Aquafil who turns the waste materials into profit by recycling them into new nylon fibers that cut up to 90% of the pollution used in refining brand new fibers (Fig. 12) and sells them as a raw material for others to transform. Ambibérica then proceeds to donate to and support the fishermen who retrieve the waste through the donation of professional grade fishing gear.

As previously noted, the project is highly dependent on establishing strong partnerships and keeping them engaged. We believe that the key to the project's health and longevity is that each relationship formed within partners is in one way or another mutually beneficial and never just one sided, so something that could be a takeaway for future projects is to make sure that everyone in the supply chain gets involved with some depth.

CONCLUSIONS

Closing Remarks

The main objective we set out to accomplish with this research was to determine whether it was possible or not to use circular economy strategies in bettering the coastal health of the selected ports. Not only did we draw the conclusion that it was indeed possible, we took a step further and designed and put into practice a model that hopefully inspires others to think of similar long term solutions that slowly breathe life into the environment instead of sacrificing it for short term gains. We also found that among all the recycling methods currently available for plastics there is a degree of specificity in their applications and not all of them are of equal value when dealing with plastics provenient from end-of-life fishing equipment (p. 54). The recently developed industry surrounding Nylon recycling removes the previously existing limitation in the materials life cycle and allows projects such as the Blue Circular Postbranding project to focus on designing real world circular strategies that together with them can set out to achieve ambitious work in the reutilization of discarded fishing nets that can bring about massive change to the future's environment.

In order to reach this main conclusion however, we followed a structured objective plan and methodology that aims to respect scientific standards and raises our chances of success.

1. The first specific objective of this research which states the necessity of involving the community in the virtual supply chain was fulfilled through the development of a mutually benefiting 2-way cooperation strategy with the community. As the project matured, we extended this partnership philosophy to the rest of the Blue Circular Postbranding partners, which allowed us to prove that it is indeed possible to introduce the marine litter recovered by the Blue Circular Postbranding Project from the Cascais captaincy coast back into the consumer economy through the usage of a circular strategy.
2. The second specific objective of this research demanded a growth in awareness towards ocean pollution by the fishermen as a result of our intervention. What we noticed was that

the level of awareness demonstrated by the fishermen community in regards to ocean pollution is very high and the interactions between the BCpb and the community during the course of the research and into the future have and will certainly contribute to reinforcing these values within the community and thus we consider that the objective we originally set out to achieve has been accomplished. Unfortunately the bottom line for these fishermen will always be conditioned by the financial viability within their professional activities and we believe that only by redesigning certain fishing tools could we achieve a higher degree of environmental sustainability while maintaining the cost of acquisition or even lowering it; that way it would be possible for ocean health to be of a higher priority to the fishermen.

3. The third specific objective we set out to accomplish was to investigate the landscape of active companies and projects employing innovative strategies to combat our mutual foe, ocean pollution and if possible to draw inspiration from them; we accomplished this through our theoretical foundation and case study methodology. Through our case study selection process and subsequent analysis we found that different industries, companies and projects are putting strategies into practice that tackle the environmental problem of ocean pollution and that although it's in its early stages the industrial infrastructure for Nylon recycling already exists – which opens a world of possibilities for creative circular models focused on recycling to find an application in the real world. This proved to be crucial for the success of the BCpb model and will undoubtedly play an important role for other such projects in the future.
4. The fourth specific objective had to do with location practicality. Through our empirical research, namely the document analysis section, we were able to confirm that operations could indeed be kept within reasonable proximity. We also confirmed that industries in the plastics transformation sector and otherwise could indeed be recruited to the effort of bettering the coastal hygiene of the Cascais captaincy beaches. Like with the fishermen community, this is possible through the establishment of 2-way cooperation relationships

which in most cases is facilitated by the 2nd party being interested in or already having a social responsibility effort in their agenda.

Limitations

Sample size of interviewees was proportionate to the size of the two fishing locations but disproportionate to the national picture and thus might not accurately depict opinions and happenings in different locations. Furthermore, it's impossible to know whether or not the actions of the fishermen at sea match how they claim to act; the way we maximized the reliability of the answers obtained was by not representing a rigid stance about environmental practices, being quick and decisive in expressing comprehension whenever an interviewee admitted to doing or witnessing a bad practice, and employing a dialogue that was extremely relaxed and open-ended during the oral interviews.

Redesigning equipment is not within the scope of this research but would coincide with many of the objectives we listed for this research, such as improving ocean health through design and bettering the awareness and impact of the community in it. The way we dealt with this limitation was by pointing future researchers towards this path of investigation in our Further work section (p. 96).

The amount and kind of fishing devices caught on rock and stuck at the sea floor cannot be known unless further research is conducted and expensive sea floor screening equipment is employed. The way we and the Blue Circular Postbranding project dealt with this lack of information was by focusing on the materials that best fit our resources and still had a positive impact on the environment.

The time constraints associated with writing a master's degree dissertation did not allow for the long term monitoring of the project post implementation. Coupled with that, an academic paper of this size being produced individually will surely lack in many levels in comparison with the works of experienced scholars, moreover written in a non-native language. This limitation can be overcome by continuing to explore the theme of this research in the future while working with a team of seasoned scholars.

Further work

With more companies aiming to ace the environmental regulations and reproduce the success of case studies like Aquafil, avenues for further research could include how to scale this model to different waste materials – for example by aggregating the wills of various organizations in civil society the marine waste recovered by fishermen and volunteers could be placed in a shared single collection point, this could cut on residue transportation costs of the residues to the North of the country where the related industries are located. The appearance of rival companies dealing with the same materials would also be helpful in keeping the sector fresh with competition and would likely motivate new exciting research and innovation (p. 51, Ch. 4).

Further research is needed to establish if a modern fisherman, equipped with regular technology, devices and knowledge is capable of accurately discerning whether the seafloor is complete sand or rock and what new methods could be employed to further increase the accuracy of said endeavor (p. 62, Ch. 4).

There may be something to be done regarding pollution originating from “alcatruz” fishing in the future; there is a strong possibility that although the damage done is invisible to the naked eye it might be responsible for the endangerment of species in the future due to the rate at which they accumulate at the sea floor without ever having the chance of being removed, infinitely and indiscriminately fishing any species for the entire lifespan of the very durable plastic, which there are no known methods of removal for as of now. Not to mention the “alcatruz”, the anchors used for the anchoring points of the alcatruz ropes (Fig. 16) are big rubber tires from trucks, stuffed with concrete which although we weren’t able to confirm through the interviews, raised the suspicion that this is yet another object that gets abandoned in the ocean forever (p. 61 Ch. 4).

Another perhaps bizarre detail for non fishermen we found in regards to rubbers and plastics being utilized that potentially contribute to the microplastic catastrophe in the ocean is that corvina, a type of fish fished with the “aparelho” (Fig. 17) device which is a collection of hooks and lines stuck to a container, is fished not with live bait but with rubber bait (Fig. 18), that is cheap “durable” (in comparison with live fish) and that this particular type of fish will still

swallow, allowing them to fish out this specific fish from say a very big school of sardines. We feel that similarly to the rubber tires and styrofoam practices with alcatruz fishing this could perhaps be grouped with those for further investigation (p. 63 Ch. 4).

Calculating the carbon footprint of transports within the BCpb network is ultimately needed to have a clear picture of the net impact we have on the environment.

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APPENDIX

APPENDIX 1.

Results of partnership establishing attempts with 26 companies related to the plastic extrusion industry

Company name	**Reachable**	**Interest in cooperating**	**Location**
Company 1	Yes	No	Seixal
Company 2	Yes	No	Porto de Mós
Company 3	Yes	No	Chamusca
Company 4	Yes	No	Portalegre
Company 5	Yes	No	Pombal
Company 6	Yes	No	Valongo
Company 7	Yes	No	Grijó
Company 8	Yes	No	Avelar
Company 9	Yes	No	Peniche
Company 10	Yes	No	Lousada
Company 11	Yes	No	Leiria
Company 12	Yes	No	Porto
Company 13	Yes	Yes	Braga
Company 14	Yes	No	Alcobaça
Company 15	Yes	No	Vila Nova Famalicão
Company 16	Yes	No	Carriços
Company 17	Yes	No	Valongo
Company 18	Yes	No	Leiria
Company 19	Yes	No	Braga
Company 20	Yes	No	Vila Nova Famalicão

Company 21	Yes	No	Abrantes
Company 22	Yes	No	Mira
Company 23	Yes	No	Vale de Cambra
Company 24	No	No	Torres Vedras
Company 25	No	No	Pedroso
Company 26	Yes	Yes	Marinha Grande

APPENDIX 2.

Docapesca's *Fishing for a Sea Without Litter* - Cascais - Table of adherents (PT-PT)

	Embarcação	IEMBARCAÇÃO	MATRICUI	OP	Armador/Mestre	N	N.º de contentores e tipologia				Sacos	Observações
	Adelaide Maria	PRT000023847	CS-876-L	APPC	José Couto	1			x	x	30 L	7/14/2020
1	Balalaika	PRT000023845	CS-817-L	APPC	Bruno Luís Maciel Neto	1	x	x			80 L	
2	Aladim	PRT000022250	CS-878-L	APPC	André Henriques V. de Brito	2					80 L	
3	Dragão Azul	PRT000024856	CS-866-L	APPC	Carlos Pedro Faria Ambrósio	2			x	x	30 L	7/15/2020
4	**Escorpião**	PRT000025060	**SM-331-L**	**APPC**	**Fernando Ribeiro**	**2**					**80 L**	**7/14/2020**
5	Leonor e Nossa S.ª do Cabo	PRT000019209	CS-723-L	APPC	Alexandre Manuel S. Carvalho	2					80 L	
6	Maria da Luz			APPC	António Clemente Pereira	2					80 L	7/15/2020
7	Maria João	PRT000024190	CS-832-L	APPC	António Clemente Pereira	2					80 L	7/15/2020
8	Pai Mãe Júnior			APPC	Carlos Pedro Faria Ambrósio	2			x	x	30 L	
9	Praia de Algés			APPC	Carlos Pedro Faria Ambrósio	2			x	x	30 L	
10	Rainha da Praia	PRT000023722	CS-864-L	APPC	Miguel Alexandre Diogo	2			x	x	30 L	7/15/2020
11	Rei	PRT000023612	CS-820-L	APPC	Paulo Alexandre Pina Inácio	2					80 L	7/15/2020
12	Sol à vista	PRT000021784	CS-875-L	APPC	Miguel Ângelo dos Santos Mar	2			x	x	30 L	7/15/2020
13	**Terceira Vaga**	PRT000023291	**CS-809-L**	**APPC**	**Fernando Ribeiro**	**2**					**80 L**	**7/14/2020**
14	**Terceira Vaga I**			**APPC**	**Fernando Ribeiro**	**2**					**80 L**	**7/14/2020**
15	Zé Mar			AAPC	José Domingos dos Santos	2			x	x	30 L	6/17/2021
16	Cavalinha	PRT000022638	TR-1478-L	APPC	Pescratruz, Unipessoal Lda.	3			x	x	30 L	7/15/2020
17	Mestre Diogo	PRT000022289	CS-792-L	APPC	Pescratruz, Unipessoal Lda.	3			x	x	30 L	7/15/2020
18	Patrícia			APPC	António Cerqueira	3			x	x	30 L	
19	Seremos Felizes			APPC	Pescratruz, Unipessoal Lda.	3			x	x	30 L	7/15/2020
20	Silva Cruz	PRT000021277	CS-799-L	APPC	António Oliveira	3			x	x	30 L	7/15/2020
21	Vanda Isabel	PRT000020904	PM-1151-L	APPC	Carlos Gabriel	3			x	x	30 L	7/15/2020
22	Sopas			APPC	João Teles Ferreira	3			x	x	30 L	
23	Boga	PRT000024871	CS-868-L		Marco Figueiredo	3			x		30 L	11/13/2020
24	Emanuel e Furão	PRT000023973	CS-880-L	AAPC	João Florêncio	3			x	x	30 L	11/13/2020
25	Mónica Sofia	PRT000022208	CS-793-L	AAPC	António Ramos	3			x	x	30 L	11/13/2020
26	Fenda na Muralha	PRT000013183	CS-873-C	APPC	Paulo Alexandre Guerreiro	4	x	x			80 L	7/15/2020
27	Senhor do Resgate	PRT000020254	T-779-C	APPC	Heliodoro Dionísio	4			x	x	30 L	7/15/2020
28	São Bartolomeu do Mar			APPC	João Teles Ferreira	4	x	x			80 L	
29	Deus me Acompanhe	PRT000021253	CS-862-C	APPC	Rodrigo Diogo	5	x	x			80 L	7/15/2020
30	**Diogo Mar**	PRT000021338	**CS-871-C**	**APPC**	**Miguel Alexandre Diogo**	**5**	**x**	**x**			**80 L**	**7/14/2020**
31	Panta	PRT000000441	CS-684-C	APPC	Gomes de Almeida T. Ferreira	5	x	x			80 L	7/15/2020
32	**Peixe à Borda**	PRT000019909	**PE-2148-C**	**APPC**	**Torcato Fonseca**	**5**	**x**			**x**	**80 L**	**7/14/2020**
33	Praia da Ribeira	PRT000001758	CS-859-C	APPC	Pedro Alexandre Diogo	5	x	x			80 L	7/15/2020
34	Horizonte Aberto	PRT000020661	CS-829-C	APPC	Miguel Alexandre Diogo	6	x	x	x	x	80 L	7/15/2020
35					**Embarcações aderentes**	35						
36					**Percadores aderentes**	138	9	8	19	19		
37							embalag	indiferenc	embalag	indiferenc		
38	Vieguinhas				Marco Figueiredo				x		30 L	11/13/2020
39	Turbulenta				Marco Figueiredo				x		30 L	11/13/2020
40	Manuel Rigor	PRT000024388	CS-835-L	AAPC	António Ramos				x	x	30 L	11/13/2020

APPENDIX 3.

Docapesca's *Fishing for a Sea Without Litter* - Ericeira - Table of adherents (PT-PT)

	Embarcação	IEMBARCAÇÃO	NMATRICULA	OP	Armador/Mestre	N.º de	Sacos	Observaçõ
	Lua Aberta	PRT000021654	E-401-L	APPER	João Carlos Lopes Este	1	30 L	5/11/2022
1	Rochamar III		ERC-112741-L	APPER	Rui Rocha	2	30 L	5/11/2022
2	Lula	PRT000012409	E-382-L	APPER	Carlos Alberto	3	30 L	5/11/2022
3	Mestre Ló	PRT000012395	PTERC-117761-L	APPER	Marcelino Pereira	3	30 L	5/11/2022
4	Patreco	PRT000021231	E-389-L	APPER	António Alexandre	3	30 L	5/11/2022
5	Pérola da Ericeira	PRT000013093	E-358-L	APPER	João Manuel dos Santo	3	30 L	5/11/2022
6	Rochamar I	PRT000022834	ERC-119698-L	APPER	Rui Rocha	3	30 L	5/11/2022
7	Rochamar II	PRT000023293	ERC-400-L	APPER	Rui Rocha	3	30 L	5/11/2022
8	Samas		E-313-L	APPER	Márcio Barros	3	30 L	5/11/2022
9	Titanic	PRT000024178	PTERC-117-692-	APPER	Joaquim Pereira	3	30 L	5/11/2022
10	Toni Fernando	PRT000006747	E-287-L	APPER	António Franco Alberto	3	30 L	5/11/2022
11	Paulo Alexandre	PRT000023457	E-391-L	APPER	Francisco Pereira	4	30 L	5/11/2022
12	Tubarão		E-404-L	APPER	Luis Crisóstomo	4	30 L	5/11/2022
13	O Avante	PRT000023492	E-402-L	APPER	Joaquim Moraes	4	30 L	5/13/2022
14					**Embarcações aderente**	14		
15					**Pescadores aderentes**	42		

APPENDIX 4.

Fishermen's interview guide (PT-PT)

Identificação

Idade:
Escolaridade:
Genero:
Localidade:
Ocupação actual (descreva com pormenor as suas funções):

Q1. Recolher as redes de pesca dá-vos trabalho extra? Porquê?
Q2. Os serviços municipais recolhem os big bags com boa frequência?
    Q2.1. Quer fazer alguma sugestão nesta matéria?
Q3. Usam os sacos fornecidos pela "pesca por um mar sem lixo" para a finalidade suposta?
    Q3.1. Despejam os sacos nos contentores colocados no cais para esse efeito?
    Q3.2. Que outra finalidade lhes dão?
Q4. Que tipo de lixo encontram com maior frequência quando estão no mar?
Q5. Já pensou que a prevenção da poluição nos oceanos remove um competidor direto da pesca? (Os cientistas chamam-lhe pesca fantasma.) Pode pensar no lixo como um pescador adversário, o que pensa disso?
Q6. Da sua observação, qual lhe parece que é a percentagem de lixo marinho que provém da pesca? Porquê?
Q7. O que é que acha que as pessoas pensam da profissão de pescador? Como começou a pescar?
Q8. O que acha da ideia da recolha e troca das redes por recompensas para a comunidade? (BC:Pb)
Q9. Consola-lhe o facto de saber que está a contribuir para que as futuras gerações continuem a poder comer peixe?

APPENDIX 5.
Interview Content Analysis

INTERVIEW CONTENT ANALYSIS			
	QUESTION	ID	ANSWER
Q1.	Recolher as redes de pesca dá-vos trabalho extra? Porquê?	C. E1	"O pessoal hoje em dia já trás para a terra (...) a maioria (...)"
		E. E3	"Não. É só trabalho. A gente quando vai para o mar e apanha lixo, temos que *safar* as redes todas." (safar significa limpar lavar as redes)
		E. E4	"As pessoas hoje em dia estão mentalizadas! Não há ninguém que mande lixo para o mar!"
		E. E5 C. E3	"Este barco onde eu andei tinha um caixote amarelo. Quando encheu veio para terra e nunca mais foi para bordo. Mas o Miguel o meu patrão, se atirares lixo ao mar tem câmeras a bordo e grita-te ao megafone, é um 31 do caraças!"
Q2.	Os serviços municipais recolhem os big bags com boa frequência? .1. Sugestões?	E. E1	"Vem sempre alguém recolhe-las. Ou a junta ou a câmara."
		E. E4	"São as pessoas da câmera que vêm cá pôr e retirar. Telefono-lhes digo que está cheio e vêm cá buscar. Todas as semanas"
Q3.	Usam os sacos fornecidos pela "pesca por um mar sem lixo" para a finalidade suposta? .1. Despejam os sacos nos contentores colocados no cais para esse efeito? .2. Que outra finalidade lhes dão?	C. E1	"É muito raro vir alguém para aqui. Pessoal conhecido vem aqui para a conversa (...) os camones enganam-se, pensam que isto é passagem para o outro lado"
		C. E1 C. E2 C. E3.	"Aqui não nos deram. O presidente da câmara da Ericeira ajuda os pescadores, o presidente aqui de cascais rouba os pescadores!"
		C. E5.	"Eu sei que houve aí qualquer coisa dessas, mas sacos de plástico não foi falado em nada."
Q4.	Que tipo de lixo encontram com maior frequência quando estão no mar	E. E1	"... a maior parte do lixo no mar é o pescador que o manda fora. Cheguei a mandar, é a realidade. Hoje já não fazem isso, já levam baldes."
		E. E4	"(O rio Tejo) traz toda a merda por aí abaixo! Aqui

			nunca encontrei uma máscara… Viro 200, 300 redes e nunca apanhei nada disso.”
		E. E5	“É redes.”
		E. E4	“A gente não apanha lixo nenhum! Há 5, 6 anos apanhava-se mais lixo no mar do que se apanha agora. E quando se apanha mais é quando as marés correm muito a Norte, mas não é nada em quantidades, esquece! Normalmente aqui a maré é sempre a Sul.”
Q5.	Já pensou que a prevenção da poluição nos oceanos remove um competidor direto da pesca? (Os cientistas chamam-lhe pesca fantasma.) Pode pensar no lixo como um pescador adversário, o que pensa disso?	E. E1	"(acerca dos covos) … se lá ficar no fundo e partir como acontece várias vezes está sempre a pescar.”
		E. E4	“O alcatruz de plástico fica no fundo, vai enterrando, enterrando… Fica enterrado anos e anos até o mundo acabar.”
		E. E5	“Enche-se de garrafas lá no fundo, 3 ou 4 meses já não pesca (alcatruzes).”
Q6.	Da sua observação, qual lhe parece que é a percentagem de lixo marinho que provém da pesca? Porquê?	E. E4	“O oceano está muito fodido através de redes que ficam no fundo, covos que ficam no fundo, aparelhos que ficam no fundo…”
		C. E3 C. E5	“Tás a ver isto aqui? (aponta) bocados de cabo. Pensos higiênicos. Ali ao pé daquela estátua, se visses como a praia estava… pacotes de sumo, cervejas isto aquilo pela praia fora! Não é só a gente, tudo aquilo vai parar ao mar”
Q7.	O que é que acha que as pessoas pensam da profissão de pescador? Como começou a pescar?	E. E4	“Não (valorizam). O pescador é como o mineiro! O pescador para o governo é como um zero à esquerda.”
		E. E5	“Acho que sim.”
		C. E3	“Ainda à bocado te disse: um barco chegou e descarregou 19 caixas; teve que descarregar à mão. A câmara não mete a grua a trabalhar!” “Vamos fazer uma manifestação na procissão, a gente precisa de condições, não temos água aqui há anos!” “No outro dia estava aqui e (as crianças) mandaram 3 covos para dentro de água (...) eles (polícia marítima) não querem saber!”

Q8.	O que acha da ideia da recolha e troca das redes por recompensas para a comunidade? (BCpb)	E. E2	“Tudo o que seja para melhorar. A gente tem que as deitar fora.”
		E. E5	“Pá isso é top! A associação vive à pala das miserinhas que a malta vai dando bocadinho a bocadinho, senão como é que a gente tem dinheiro para manter o trator, uma grua uma máquina…”
Q9.	Consola-lhe o facto de saber que está a contribuir para que as futuras gerações continuem a poder comer peixe?	E. E6	“Sim!”

APPENDIX 6.

Audio from interviews

Cascais Interviews CUT 09/08/2022 - Audio

https://drive.google.com/file/d/17Sh8Mp8VEWjnZJJvcLAW7rEUC7rHsdPN/view?usp=sharing

Ericeira Interviews CUT 19/08/2022 part 1 - Audio

https://drive.google.com/file/d/1SIrd8OrCzPA_A_9Agv3l18Tr2Y8Up76P/view?usp=sharing

Ericeira Interviews CUT 19/08/2022 part 2 - Audio

https://drive.google.com/file/d/1YGQbRI1gaiPT-E7uoe6WLhdmNnyzjpYc/view?usp=sharing

Ericeira Interviews CUT 20/08/2022 - Audio

https://drive.google.com/file/d/1YGQbRI1gaiPT-E7uoe6WLhdmNnyzjpYc/view?usp=sharing