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Balancing Profitability and Sustainability in Circular Business Models

Local Circular Production Systems as a Pathway to Closing the Loop on Marine Plastic

Master’s thesis in Management and Economics of Innovation

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Cover: Fishermen preparing nets for the next fishing trip at the port in Peniche, Portugal.
Researchers' own picture form field study in March 2025.

Gothenburg, Sweden 2025

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SUMMARY
This study explores the design and implementation of sustainable circular business models within Local Circular Production Systems (LCPSs) that transform marine plastic waste into valuable products. Through a field study in Peniche, Portugal, and interviews with twelve globally distributed organizations, the research identifies four distinct typologies of LCPSs: Hyper-local Integrated Systems, Hub-and-Spoke Distributed Systems, Adaptable Collaborative Networks, and Circular Infrastructure Providers, each defined by unique configurations of value chains, partnership dynamics, and local integration.

The research aims to understand the structure and viability of LCPSs, addressing three research questions: (1) What types of Local Circular Production Systems exist for recycling marine plastic waste, and what value chain components define them? (2) How can business model strategies enable Local Circular Production Systems to achieve long-term economic sustainability while maintaining environmental and social impact? (3) What are the key success factors when implementing circular business models?

Findings reveal that LCPSs are not merely local production units, but dynamic, networked interventions that redistribute agency over material flows and embed circularity within communities often excluded from global value chains. Successful models combine iterative, modular business strategies with strong local partnerships, participatory storytelling, entrepreneurial spirit and diversified revenue streams, while responding to regulatory, infrastructural, and cultural conditions. As Europe confronts tightening waste regulations and the imperative to internalize plastic valorization, LCPSs emerge as critical infrastructure for circular transition. Positioned at the intersection of environmental stewardship, social inclusion, and economic resilience, they represent a practical and scalable pathway toward a more equitable, regenerative, and locally grounded blue economy. This study contributes a transferable framework to support implementation of LCPSs as resilient business ecosystems capable of turning ecological urgency into circular opportunities to close the loop on marine plastic.

Keywords: Circular economy, blue economy, marine plastic waste, local circular production systems, circular value chain, microfactories, circular business models, hybrid organizations, social enterprises.

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Abbreviations

ALDFG	Abandoned, Lost or Discarded Fishing Gear
B2B	Business-to-Business
B2C	Business-to-Consumer
CBM	Circular Business Model
CE	Circular Economy
CLP	Closed-Loop Production
CPS	Circular Production System
CSR	Corporate Social Responsibility
DM	Distributed Manufacturing
EoL	End-of-Life
EPR	Extended Producer Responsibility
ESG	Environmental, Social and Governance
LCPS	Local Circular Production System
LM	Localized Manufacturing
LSAM	Large-Scale Additive Manufacturing
MF	Microfactory
NGO	Non-Governmental Organization
OCT	Ocean Tech Hub Lda
POW	Peniche Ocean Watch
PA	Polyamide
PE	Polyethylene
PET	Polyethylene Terephthalate
PP	Polypropylene
R&D	Research and Development
SDG	Sustainable Development Goal
TBL	Triple Bottom Line

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1. Introduction

The thesis begins by providing a contextual background, including introducing the issue of marine plastic pollution and examining relevant frameworks associated with the circular economy, with particular emphasis on circularity within the fishing gear industry. The research aim is then introduced: to develop a framework for sustainable circular business models for plastic recycling through Local Circular Production Systems, specifically focusing on the transformation of ocean plastic waste into secondary raw materials and products. This is followed by the study's limitations.

1.1 Background

The background section explores critical issues and conceptual frameworks relevant to the study, including marine plastic pollution, the principles of the circular and blue economies, and the case of Ocean Tech Hub Lda and Circular Ocean.

1.1.1 The Issue of Marine Plastic Pollution

Marine plastic pollution represents one of the most urgent environmental challenges of our time. According to the United Nations Environment Programme (2021), between 19 and 23 million tons of plastic waste enter marine ecosystems annually. If no meaningful interventions are implemented, projections suggest these numbers could triple by 2040. The widespread presence of plastic pollution has severe consequences for marine biodiversity, coastal communities, and the global economy. Among the most harmful forms is abandoned and discarded fishing gear, which poses a deadly risk to marine life by entangling and killing marine mammals, destroying critical ecosystems like coral reefs and mangroves, and endangering the livelihoods and food sources of fisheries and coastal populations (WWF, 2020).

Europe plays a significant role in both plastic waste generation and mitigation efforts. In 2021 alone, EU countries generated 16.13 million tons of plastic waste, of which only 6.56 million tons were recycled (European Parliament, 2024). Notably, the EU exported a significant portion of its plastic waste to non-EU countries, particularly Turkey, India, and Egypt. However, as more countries follow China in restricting plastic waste imports, there is a growing risk that more plastic will be incinerated or landfilled within Europe (European

Parliament, 2024). This challenge is further amplified by the upcoming EU ban on plastic waste exports to non-OECD countries, set to take effect on 21 November 2026. This policy underscores the urgent need to enhance circularity within Europe, ensuring that plastic waste is effectively managed and reintegrated into the local economy.

The EU has introduced policies aimed at reducing marine litter and increasing plastic recycling, including banning certain single-use plastics from 2030, requiring 90% collection of single-use beverage containers by 2029, and enforcing stricter export rules for plastic waste outside the EU (European Parliament, 2024). Additionally, the Extended Producer Responsibility (EPR) framework has been reinforced as an essential tool for sustainable growth and key mechanism to encourage producers to take responsibility for the entire life cycle of their products, from design to end-of-life (EoL) disposal. EPR aligns with the "polluter pays" principle, ensuring that producers contribute to waste management costs and environmental cleanup efforts (Directive 2008/98/EC).

At least 46% of the Great Pacific Garbage Patch consists of discarded fishing gear (WWF, 2020), underscoring the fishing industry's major role in marine plastic pollution. In response, the European Union introduced specific guidelines under Directive 2019/904 to implement Extended Producer Responsibility (EPR) frameworks targeting the fishing gear sector. Companies that produce, import, or sell plastic-containing fishing gear are required to register with environmental authorities and report relevant product information. The aim is to enhance the collection, reuse, and recycling, while minimizing marine litter. However, the regulation does not apply to gear that has been lost at sea or to waste collected through publicly funded initiatives after being discarded or littered (Naturvårdsverket, 2024).

Government regulations are essential for addressing plastic pollution, but they often lag behind the urgency of the crisis (UNEP, 2021). In contrast, businesses can quickly adapt and implement new technologies, driven by market incentives that reward sustainability. This agility fosters innovation in transformation of discarded materials into secondary raw materials and valuable products. However, lasting change and scalable impact requires collaboration and alignment between both policy and business. A shared responsibility among producers, consumers, and policymakers in addressing plastic waste challenges and fostering a sustainable future is an absolute necessity. Such initiatives demonstrate how environmental responsibility can be aligned with financial viability, paving the way for a more sustainable future.

1.1.2 Addressing Agenda 2030

Marine plastic pollution poses a significant threat to several of the United Nations (2015) Sustainable Development Goals (SDGs) outlined in the 2030 Agenda for Sustainable Development. Effectively addressing this challenge demands innovative, circular approaches to waste management. This thesis explores one such solution: circular production systems that locally transform ocean plastic waste into valuable secondary resources.

Such circular production systems contribute to several of the SDGs. For example, building resilient infrastructure and fostering sustainable industrialization play a key role in tackling plastic pollution. These efforts align with the ambition of *SDG 9: Industry, Innovation & Infrastructure* (United Nations, 2015), by driving industrial innovation and promoting more resource-efficient production models. Moreover, by enhancing local recycling capabilities, they strengthen urban resilience and reduce the leakage of plastic waste into water bodies, supporting *SDG 11: Sustainable Cities & Communities*. In line with *SDG 12: Responsible Consumption & Production,* circular initiatives also encourage a shift toward more sustainable production and consumption patterns, by for example repurposing EoL fishing gear and promoting resource efficiency. Furthermore, expanding recycling efforts and keeping plastics in the loop can help lower these emissions while simultaneously preventing further plastic pollution, aligning with *SDG 13: Climate Action*. Finally, marine ecosystems are among the most affected by plastic pollution. Developing localized recycling solutions can prevent microplastics from degraded fishing gear to end up in the ocean and mitigate damage to ocean life, supporting *SDG 14: Life Below Water*.

Addressing marine plastic pollution is not only an environmental priority but also a societal and economic imperative. By integrating waste management improvements into the broader SDG framework, governments, businesses, and individuals can contribute to a sustainable economy that benefits both people and the planet.

1.1.3 Circular Economy

The growing global population and economic expansion intensify the demand for natural resources, underscoring the importance of shifting from traditional linear "take-make-waste" practices to a *circular economy* (CE) model (Ghisellini et al., 2016). At its core, CE focuses on designing and implementing systems that prioritize resource efficiency, waste reduction, and the restoration of natural environments.

The CE has been defined in various ways by scholars and practitioners due to its multidisciplinary nature and broad applicability. Murray et al. (2017) describe CE as "an economic model wherein planning, resourcing, procurement, production and reprocessing are designed and managed, as both process and output, to maximize ecosystem functioning and human well-being." This perspective underscores the interconnectedness of environmental health, economic systems, and societal welfare, advocating for a holistic approach to resource management.

Similarly, Kirchherr et al. (2017) emphasize collaboration among stakeholders to maximize the value of products and materials. The authors define CE as "an economic system that replaces the 'end-of-life' concept with reducing, alternatively reusing, recycling and recovering materials in production/distribution and consumption processes." The concept is emphasized to function across all levels, micro, meso and macro, to foster sustainable development both in the present and for future generations. Building on the same ideas, Geissdoerfer et al. (2017) describe CE as "a regenerative system in which resource input and waste, emission, and energy leakage are minimized by slowing, closing, and narrowing material and energy loops." This definition underscores the cyclical nature of CE processes.

Evidently, the principles of CE align with the 3R framework; reduce, reuse, and recycle. Kirchherr et al. (2017) highlight that while recycling is crucial, it is often prioritized at the expense of reduction, which is fundamental to a CE that seeks to prevent waste from being produced in the first place (Ellen MacArthur Foundation, 2019). A key challenge when designing out waste, however, is ensuring that products made from recycled plastics genuinely contribute to reducing virgin plastic consumption by replacing items that would otherwise be made from new materials. Additionally, these products must be designed for longevity and reuse to remain in circulation rather than re-entering the waste stream.

The Ellen MacArthur Foundation (2015) presents a practical strategy called ReSOLVE for implementing a circular economy (see Figure 1.1). The framework outlines six action areas: Regenerate, Share, Optimize, Loop, Virtualize, and Exchange. Regenerate focuses on ecosystem restoration, renewable energy, and returning biological resources to the biosphere. Share maximizes asset use through shared ownership, reuse, and durable design. Optimize improves product efficiency, eliminates supply chain waste, and utilizes advanced technologies. Loop emphasizes closing material cycles through recycling, remanufacturing, and organic waste processing. Lastly, Virtualize reduces resource demands via digital alternatives (e.g. online services), while Exchange promotes innovative materials, technologies (e.g. 3D-printing), and services aligned with CE goals.

Figure 1.1. The ReSOLVE framework for circular economy implementation (Ellen MacArthur Foundation, 2015).

Achieving this transformation requires a fundamental reconfiguration of how value is created and captured (Ellen MacArthur Foundation, 2015). Therefore, the transition toward a *circular business model* (CBM) is not only necessary but imperative. Nevertheless, implementation of a CE faces significant challenges. Ghisellini et al. (2016) highlight key barriers, particularly regarding the 3R principles. Design-related obstacles include ensuring product longevity, facilitating disassembly, and enabling reuse and recycling, all of which require shifts in production processes and business models. Reuse is limited by technical constraints, consumer acceptance, and inefficient take-back systems, while recycling is hindered by material contamination and fluctuating secondary markets. Additionally, inadequate infrastructure and insufficient investment in advanced recycling technologies further constrain CE scalability. Overcoming these challenges demands coordinated efforts in innovation, policy development, and economic incentives to create a truly circular system.

1.1.4 Blue Economy

Building on the principles of the circular economy, another concept focusing on the sustainable use of ocean resources has emerged, the *blue economy*. This concept integrates circular economic principles into marine-based industries to support long-term sustainable growth, while ensuring environmental sustainability (Iustin-Emanuel & Alexandru, 2014). This approach is particularly relevant for sectors like maritime transport, offshore renewable energy, and port operations, where waste materials can be repurposed into new products. Acknowledging the finite nature of oceanic resources and the detrimental impact of human activity on marine environments, blue economy seeks to promote economic growth and social inclusion while safeguarding marine ecosystems (European Commission, 2024).

Additionally, the blue economy plays a critical role in local job creation and regional development (OECD, 2024). A global survey by OECD mentions that to sustain and expand employment opportunities, targeted education and training programs are essential to align workforce skills with industry needs. Water-dependent sectors such as fisheries, tourism, and shipping provide employment opportunities, with the European blue economy alone supporting approximately 5.4 million jobs (Stanca, 2018). Among these sectors, the fishing industry is particularly relevant, not only due to its economic and social importance but also because it has historically relied on linear value streams and unsustainable gear designs, factors that have contributed significantly to marine plastic pollution. This makes the sector a strategic entry point for advancing CE initiatives, particularly through localized interventions at fishing ports and coastal areas.

1.1.5 Circularity in the Fishing Gear Industry

With nearly 90% of marine fish stocks either fully exploited or depleted, and over 3 billion people relying on fish as primary protein source, the pressure on global fisheries is immense (WWF, 2020). The growing demand has led to an increase in fishing activity, which subsequently has contributed to rising marine pollution. In response, the fishing gear industry is transitioning toward more sustainable practices, driven by environmental concerns and regulatory initiatives (European Commission, 2020). This shift includes the development of biodegradable nets, advanced gear-tracking technologies, and enhanced waste management strategies, moving away from conventional fishing equipment designed primarily for durability with limited consideration for EoL disposal.

Waste from fishing gear can be categorized into two main types: EoL gear and *abandoned, lost or discarded fishing gear* (ALDFG), also referred to as ghost gear (Ahmed et al., 2023). EoL gear often accumulates in harbor facilities due to inadequate disposal infrastructure, ultimately ending up in landfills or being incinerated. Ghost gear remains in marine environments, where it continues to trap marine life.

One of the primary obstacles to minimizing plastic waste and extending the life of fishing gear is the inherent nature of plastics, which are generally categorized into thermosets and thermoplastics. Thermoset plastics undergo a chemical transformation during curing, making them rigid and non-remoldable, which severely limits their recyclability. In contrast, thermoplastics have a lower melting point and can be remolded multiple times, making them more suitable for recycling. Common thermoplastics include *polypropylene* (PP), *polyethylene* (PE), *polyamide* (PA), also called nylon, and *polyethylene terephthalate* (PET) (Swedish Chemical Agency, 2021). Fishing nets are primarily made from PET, High-Density PE (HDPE), and PA. The fishing industry's reliance on these virgin plastics is due to their durability in the harsh marine environment, which further complicates the transition to alternative materials (European Commission, 2020). Additionally, although these thermoplastics are technically recyclable, contamination, seawater degradation and exposure to sunlight, as well as supply chain complexities and the economic feasibility in collection and processing limit their recycling (Lüdeke-Freund et al., 2019).

To overcome these limitations, two circular design strategies can be considered: *closed-loop* and *open-loop* design (Ahmed et al., 2023). Closed-loop systems aim to retain gear within the fishing industry by treating it as a service, enabling reuse through take-back schemes, repairs, and modifications. Open-loop systems, on the other hand, seek to repurpose EoL gear for use in entirely new industries. Technologies like additive manufacturing and injection molding facilitate this transformation, enabling the production of consumer goods such as sunglasses, clothing, and furniture (Charter, 2018).

Despite the numerous opportunities, most open-loop initiatives in the fishing gear industry remain fragmented, typically driven by individual entrepreneurs and lacking the systemic support and infrastructure necessary for scaling, something Aynedjian and Karlsson (2025) explores more in depth. Consequently, many of these efforts face challenges in achieving long-term economic viability. This highlights the urgent need for holistic, locally adaptable frameworks that can support the development of sustainable and scalable *circular business models*, an area this thesis aims to address.

Emerging examples, however, indicate that more integrated and local approaches may hold the key to overcoming these structural barriers. One such model is being developed in the fishing town of Peniche, Portugal, where a coordinated ecosystem of actors is working to build a blue economy rooted in local capacity and innovation.

1.1.6 Ocean Tech Hub Lda and Circular Ocean Lda

At the center of this effort is Ocean Tech Hub Lda (OCT), a Peniche-based company committed to advancing innovation and entrepreneurial opportunities within the blue economy. By connecting knowledge networks across Portugal, Norway, and Sweden, OCT works at the intersection of marine technology, digitalization, and sustainable community development (OCT, n.d.)

Figure 1.2. The Circular Ocean Model, illustrating Circular Ocean's (n.d.) value chain.

As part of their mission, OCT developed Circular Ocean; a pioneering initiative to establish a pilot model for a *blue economy* (Circular Ocean, n.d.). Circular Ocean focuses on transforming ocean-bound plastic waste, particularly EoL fishing gear, into valuable secondary raw materials used to locally produce new products, as illustrated in Figure 1.2. At the heart of Circular Ocean's operations is a *microfactory* located in Peniche, which collects, sorts, cleans, and shreds EoL gillnets (Circular Ocean, n.d.). These gillnets are then upcycled into PENYLON™, a high-quality, fully recyclable PA6 compound. These PENYLON™

plastic pellets are used for manufacturing of new products, mainly through *additive manufacturing*. Compared to virgin plastic, PENYLON™ offers similar material properties while reducing CO2 emissions by 92% per kilogram produced. According to the co-founder Jon Erik Borgen, the organization has recycled more than 150 tons of fishing nets up to date (personal communication, June 2, 2025).

Circular Ocean builds upon the foundations laid by Peniche Ocean Watch (POW), a nonprofit association also initiated by OCT. Established in 2018, POW's broader mission is to promote sustainability and CE practices in coastal communities[1]. Together, OCT, Circular Ocean, and POW represent a unique ecosystem where innovation, community empowerment, and environmental stewardship intersect to create scalable, impact-driven solutions for ocean conservation. Initial efforts in Peniche faced challenges due to limited design expertise and market interest, prompting Circular Ocean to expand internationally. Its Swedish spinoff, Ekbacken Studios AB, produced high-design furniture using PENYLON™ and *large-scale additive manufacturing* (LSAM). Though Ekbacken ceased operations in 2024, it demonstrated the potential of circular production methods to create high-design products from recycled materials (Peniche Ocean Watch, 2021).

Beyond material innovation, Circular Ocean places a strong emphasis on capacity-building and community engagement. Its repurposed warehouse unites local fishermen, researchers, and community members and acts as a collaborative hub for education and entrepreneurship. Accordingly, Circular Ocean's objectives are threefold: 1) to promote knowledge-sharing and foster an entrepreneurial mindset, 2) to unlock the economic potential of coastal communities, and 3) to advance ocean-based technologies that contribute to a sustainable blue economy. Through interdisciplinary research projects like OCEAN-LSAM and SuRF-LSAM, co-funded by Produktion2030 and Vinnova – Sweden's Innovation Agency, Circular Ocean continues to refine its microfactory concept (Ocean-LSAM, n.d.). This includes plans to scale through a digital platform that connects globally distributed microfactories, enabling localized design and production of goods using recycled marine plastics.

Although OCT has already made notable progress, its microfactory-based business model remains a work in progress, requiring further refinement to ensure financial viability while

[1] For more information, please see Aynedjian & Karlsson (2025).

staying true to its social and environmental mission. This thesis contributes to that refinement by exploring pathways toward sustainable and scalable *circular business models* in the context of local marine waste recycling.

1.2 Aim

Despite the growing theoretical and practical interest in circular production, academic research remains fragmented, often focusing on isolated environmental, technological, or social components. There is a clear gap in comprehensive frameworks that address how *circular business models* (CBMs) can be designed to achieve long-term economic viability, social value creation, and environmental sustainability in a mutually reinforcing manner, rather than prioritizing one at the expense of the others. This thesis seeks to address this gap by developing a structured and transferable framework for circular production systems that locally convert marine plastic waste into valuable offerings.

The aim of this thesis is to explore how *Local Circular Production Systems* (LCPSs) can be operationalized within broader *circular economy* (CE) systems, with particular attention to business model innovation, value chain configuration, and stakeholder collaboration. The framework will assess how such systems can close material loops while fostering inclusive economic development and community-based engagement, especially in coastal contexts facing both environmental degradation and socio-economic pressure.

While not a case study in the traditional sense, this research is anchored in a collaboration with the initiative Circular Ocean and its work in Peniche, Portugal. Circular Ocean provides a relevant empirical context and inspiration for the thesis, helping to ground the conceptual exploration in a real-world setting. The study draws from this foundation to inform the development of the framework, while aiming to produce insights applicable to a broad range of actors working to implement LCPSs in other coastal and marine environments.

Ultimately, the research offers strategic guidance for organizations operating at the intersection of CE and local development. It contributes to the academic discourse on CBMs, sustainable production systems, and hybrid organizational forms, providing actionable insights for practitioners, policymakers, and communities seeking scalable and resilient solutions to ocean plastic pollution.

1.3 Limitations

This study is subject to several scope-related limitations, which are important to acknowledge when interpreting its findings. The analysis is grounded in the context of Ocean Tech Hub Lda (OCT) and Circular Ocean in Peniche, Portugal, which operates a circular microfactory focused on the downstream stages of marine plastic recycling, specifically from shredding material onward. As a result, this thesis emphasizes business models that operate in the post-processing segment of the value chain, and less on upstream activities such as collection, cleaning, and sorting of plastic waste.

In selecting comparable initiatives, the focus remained on organizations engaged in transforming plastic waste, preferably marine-derived, into secondary raw materials or marketable products. The study does not address circular systems using alternative waste streams (e.g., textiles, glass, metals), as these require fundamentally different processing and production infrastructures. Nonetheless, to build a comprehensive understanding of production potential, the research considers a range of plastic manufacturing techniques, including additive manufacturing, injection molding, rotational molding, and textile weaving. This technical width supports the analysis of viable circular business models (CBMs) across different manufacturing pathways.

Although OCT and Circular Ocean exclusively processes fully recyclable PA6, this thesis adopts a broader lens to examine various plastic types and their implications for circular production. This choice is intended to ensure the applicability of the proposed framework beyond a single material stream or enterprise context.

Another limitation concerns the study's targeted focus on for-profit activities. The research concentrates on the commercial dimensions of CBMs, namely, the transformation of marine plastic waste into economically viable offerings. Consequently, less emphasis is placed on the nonprofit activities undertaken by Peniche Ocean Watch (POW). However, POW's critical role in enabling environmental and social value through collaboration with local fishermen, particularly in the collection, sorting, and initial processing of end-of-life fishing nets, is acknowledged and considered insofar as it supports the long-term viability of circular operations.

To complement this focus, the thesis is developed in parallel with a second master's study called "Scaling for Impact: Organizational Readiness & Scaling Strategies for Nonprofits within the Circular Economy" by Cynthia Aynedjian and Wilma Karlsson (2025). It investigates POW's nonprofit dimensions, including community engagement, grant funding, and inclusive employment. Ongoing dialogue between the two studies allows for shared insights that collectively deepen the understanding of circular economy models, even though this thesis retains a concentrated lens on commercially oriented strategies.

2. Theoretical Background

This section establishes the theoretical foundation of the study, identifying research gaps and guiding the empirical data collection on the sustainability and feasibility of *Local Circular Production Systems* (LCPSs). A structured literature review ensures that high-quality academic sources inform the analysis. This study adopts a semi-systematic approach, suitable for interdisciplinary research and fields lacking a well-defined theoretical framework, facilitating a broad yet structured exploration (Bell et al., 2022).

The review examines key literature on *circular business models* (CBMs) and *hybrid organizations*, addressing concepts such as the *triple bottom line* (TBL)*, corporate social responsibility*, and *hybrid organizations*. It further explores the characteristics and models of LCPSs and common manufacturing processes for circular plastic production.

Relevant academic literature is sourced primarily from Scopus and Google Scholar, chosen for their extensive peer-reviewed content, industry reports, and policy papers. Snowballing is also applied to identify further key references (Bell et al., 2022). Search terms include; *circular economy, circular business models, localized production, circular production systems, microfactory, closed- and open-loop production, plastic manufacturing methods, social enterprises, triple bottom line, corporate social responsibility, hybrid organizations,* and *ocean plastic recycling*, ensuring a comprehensive review of environmental and social sustainability, as well as business viability, for recycling systems operating local marine plastic waste streams.

2.1 Circular Business Models

The *circular economy* (CE) presents significant business opportunities for both established and emerging actors (Ellen MacArthur Foundation, 2019). Conversely, its success depends on the adoption of these innovative business models and the engagement of responsible consumers (Kirchherr et al., 2017). This underscores the importance of understanding how businesses can innovate to integrate circular practices, the challenges they encounter, and the strategies that facilitate successful transitions. A key innovation in this context is *circular business models* (CBMs), which creates, delivers, and captures value by closing material loops and maximizing resource efficiency (Geissdoerfer et al., 2017).

To understand CBMs, it is first essential to define the broader concept of a business model. A business model outlines how a company creates, delivers, and captures value. According to Teece (2010), it is essentially a framework that identifies customer needs, their willingness to pay, and how the firm organizes to meet those needs profitably. For a business model to offer a competitive advantage, it must go beyond logic and be uniquely tailored to specific customer segments. Ideally, it should also be difficult or undesirable for competitors to replicate (Teece, 2010).

Building upon this foundation, CBMs evidently extend the traditional business model concepts by integrating sustainability and resource efficiency. Linder and Williander (2017) define CBMs as "a business model in which the conceptual logic for value creation is based on utilizing economic value retained in products after use in the production of new offerings." This approach shifts the focus from linear value chains to circular ones. Hence, CBMs are closely linked to *closed-loop* supply chains, with the degree of circularity often measured by the proportion of new products derived from used ones.

The adoption of CBMs necessitates a fundamental shift in how businesses approach their value propositions and strategies. These strategies may involve innovations in design to reduce environmental impacts while maintaining profitability, such as extending product life or using renewable resources (Bocken et al., 2016). Moreover, Antikainen and Valkokari (2016) argue that these models are inherently networked, demanding businesses to cooperate within ecosystems that facilitate the flow of materials and knowledge. Consequently, their successful implementation depends on a systemic transformation, one that aligns diverse business actors, fosters technological innovation, adapts organizational practices, and builds supportive infrastructure (Teece, 2010).

Antikainen and Valkokari (2016) have developed a sustainable CBM framework incorporating sustainability considerations into existing business model innovation tools, such as the Business Model Canvas (Osterwalder & Pigneur, 2010). As presented in Figure 2.1, this framework emphasizes the continuous evaluation of business models for sustainability and circularity across three levels: the business ecosystem, the organization itself, and its broader sustainability impacts. Furthermore, it highlights the interconnected nature of the supply chain and the necessity of considering value creation for all stakeholders involved.

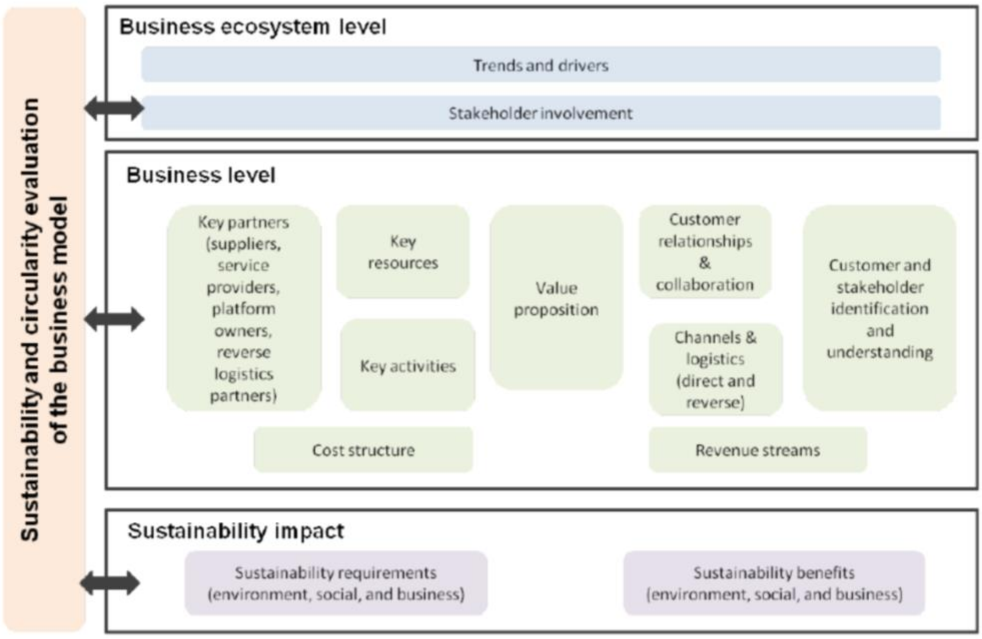

Figure 2.1. The sustainable circular business model innovation framework (Antikainen & Valkokari, 2016).

The aim of this thesis is to use the model of sustainable business model innovation to create a framework supporting LCPSs. A framework tailored to the specific context of marine plastic waste recycling makes it possible to identify the critical components required for business model sustainability within these localized systems. The new framework will explicitly integrate a *triple bottom line* approach, ensuring that economic viability, environmental regeneration, and social value creation are all considered in the design and implementation of CBMs. These models can open avenues for strategic innovation, enabling businesses to create shared value and align their operations with broader societal and environmental goals, an opportunity that a tailored framework can capture and make actionable (Porter & Kramer, 2006).

2.2 Hybrid Organizations

Hybrid organizations are entities that integrate social objectives with commercial operations, aiming to address societal challenges while maintaining financial sustainability (Battilana and Dorado, 2010). This dual approach allows them to pursue missions such as environmental sustainability alongside traditional business goals. In this thesis, we refer to these enterprises as *hybrid organizations*, in line with Battilana and Dorado (2010). In some cases, these are also categorized as *social enterprises*, particularly when the social mission is central to their identity.

A prominent legal structure that has emerged to support hybrid organizations is the *benefit corporation*. This model integrates social and environmental objectives into corporate governance, requiring companies to consider the interests of a broad range of stakeholders, including employees, customers, communities, and the environment (Rawhouser et al., 2015). Unlike traditional for-profit corporations, which primarily focus on maximizing shareholder value, benefit corporations are legally bound to balance profit with purpose, ensuring that their business operations contribute to societal well-being.

The benefit corporation structure aligns closely with *stakeholder theory*, advocating that businesses have responsibilities beyond generating returns for investors (Rawhouser et al., 2015). This legal form enhances transparency and accountability by mandating companies to report on their social and environmental impact, typically using third-party standards. Moreover, the development of benefit corporation legislation reflects broader institutional changes, as governments and regulatory bodies recognize the growing role of businesses in addressing global challenges such as climate change, economic inequality, and social justice (Rawhouser et al., 2015).

Benefit corporations first gained legal recognition in the United States and have since expanded globally. Italy became the first European country to introduce a legal framework for benefit corporations in 2016, followed by France and several other nations (B Corporation, n.d.). This development reflects a growing acknowledgment of the need for corporate structures that facilitate long-term, sustainable value creation. Understanding the role and impact of benefit corporations is therefore essential for analyzing the broader transformation of business practices toward more sustainable and socially responsible models.

2.2.1 Triple Bottom Line

The rise of businesses committed to being "best for the world" rather than just "best in the world", aligns closely with the *triple bottom line* (TBL) framework, which assess corporate performance across three dimensions: economic, social, and environmental. Initially introduced by John Elkington in 1994, TBL has since become a cornerstone concept in sustainability discourse, emphasizing the need for businesses to move beyond traditional financial metrics to incorporate broader societal and ecological considerations (Elkington, 1994). The three dimensions of TBL, also referred to as "people, planet, and profit" or "the

3Ps", capture the multifaceted nature of sustainable development. The economic aspect extends beyond financial performance to include long-term value creation, ethical business practices, and fair wealth distribution (Henriques, 2004). The social dimension addresses corporate responsibilities toward employees, communities, and other stakeholders, promoting fair labor practices, diversity, and social equity. Finally, the environmental component emphasizes the importance of minimizing ecological footprints, reducing waste, and adopting sustainable resource management practices.

Elkington (2004) later expanded on the TBL concept, introducing seven key drivers that influence the transition toward sustainable capitalism, which can be seen in Figure 2.2. These drivers highlight the complexity of implementing sustainability, as businesses must navigate competitive market forces, shifting societal values, increasing transparency demands, and the integration of life cycle considerations into product and service development. Moreover, forming strategic partnerships, shifting to long-term perspective and adapting governance structures are also necessary for a sustainable transition.

	Old Paradigm	→	**New Paradigm**
1 Markets	Compliance	→	Competition
2 Values	Hard	→	Soft
3 Transparency	Closed	→	Open
4 Life-cycle technology	Product	→	Function
5 Partnerships	Subversion	→	Symbiosis
6 Time	Wider	→	Longer
7 Corporate governance	Exclusive	→	Inclusive

Figure 2.2. Seven sustainability revolutions driving sustainable capitalism (Elkington, 2004).

A more recent discourse on the TBL emphasizes its role not merely as an accounting tool, but as a catalyst for systemic change (Elkington, 2018). Its effectiveness hinges on businesses embedding sustainability into strategic decision-making and viewing TBL as a transformative framework. Driving meaningful change requires radical innovation, bold leadership, and cultural shifts that reflect a genuine commitment to regenerating economies, societies, and ecosystems. Making it possible for organizations to advance the three dimensions simultaneously, without compromising one for another.

2.2.2 Corporate Social Responsibility

Corporate social responsibility (CSR) integrates social and environmental considerations into corporate strategy and operations, positioning it as more than just a cost or philanthropic effort. Porter and Kramer (2006) distinguish between *Responsive CSR*, which is reactive and focused on compliance and mitigating harm, and *Strategic CSR*, which proactively integrates social and environmental considerations into core business strategy. While Responsive CSR often consists of fragmented initiatives, Strategic CSR fosters a shared value, defined as creating economic benefits while addressing societal challenges through innovation, operational efficiencies, and long-term competitive advantage (Porter & Kramer, 2006). A key dimension of Strategic CSR is its role in competitive positioning and resource leveraging. By embracing circular practices, companies can not only gain a competitive edge but also improve cost efficiencies and enhance brand reputation by meeting the growing consumer demand for environmentally responsible products and services (Bocken et al., 2014). For circular businesses, this means investments in advanced recycling technologies, closed-loop supply chains, and eco-friendly product designs. Moving beyond compliance-driven CSR toward Strategic CSR allows companies to integrate sustainability with profitability, fostering long-term innovation and competitive advantage while delivering meaningful societal impact.

2.2.3 Mission Drift in Hybrid Organizations

While hybrid organizations offer a framework for balancing purposeful impact and financial objectives, they also face significant governance challenges that can threaten their ability to sustain their hybrid nature over time (Ebrahim et al., 2014). Balancing financial viability with social and environmental objectives presents the risk of *mission drift*, where social goals become secondary to financial priorities (Santos et al., 2015). Similarly, Ebrahim et al. (2014) identify two key governance challenges for hybrid organizations: "accountability for dual performance objectives" and "accountability to multiple stakeholders".

Hybrid organizations must align their commercial activities with their mission, unlike traditional businesses that prioritize profit or charities that focus only on social impact (Ebrahim et al., 2014). This creates the challenge of "accountability for dual performance objectives". While financial success is easily measured, social and environmental outcomes lack standardized assessment frameworks (Santos et al., 2015). Without clear accountability structures, the risk of prioritizing profitability over sustainability increases (Ebrahim et al., 2014; Santos et al., 2015). This highlights the gaps in existing governance models and the need for integration of sustainability metrics into financial models to prevent mission drift.

"Accountability to multiple stakeholders" refers to the challenge hybrid enterprises face in managing competing expectations from investors, regulators, customers, and communities

(Ebrahim et al., 2014). These organizations require governance structures that address diverse demands, unlike traditional businesses focused on shareholder value or nonprofits accountable to donors or sponsors. Hence, the absence of established governance frameworks presents an opportunity to explore strategies that ensure transparency, stakeholder trust, and long-term commitment to CE principles.

Hybrid organizations offer a promising model for sustainable business practices, particularly within CE initiatives (Santos et al., 2015). However, as Ebrahim et al. (2014) emphasize, ensuring their long-term viability requires governance mechanisms that mitigate mission drift and effectively balance financial and social objectives.

2.3 Local Circular Production Systems

The term *Local Circular Production Systems* (LCPSs) is not yet established in academic discourse. However, the concept draws upon elements from several other frameworks within literature. To understand how LCPSs might be theoretically situated and practically implemented, it is essential to examine these related concepts within the domains of CE, distributed production, and local recycling initiatives. This section therefore explores these adjacent frameworks, identifying their defining characteristics, points of convergence, and key distinctions in relation to the emerging notion of LCPSs.

2.3.1 Existing Circular Economy Production Models

LCPSs are closely aligned with several established paradigms within the CE, each emphasizing different aspects of sustainability, localized production, and resource efficiency. One such paradigm is *distributed manufacturing* (DM), which refers to decentralized, small-scale production units located close to end users (Srai et al., 2016). These units are characterized by flexibility, scalability, and the ability to meet customer demands through just-in-time delivery and adaptive production. Unlike traditional centralized manufacturing that is often located far from points of consumption, DM enhances sustainability by promoting distributed economies, utilizing local resources, and enabling energy- and resource-efficient production systems (Srai et al., 2016). A key enabler of this shift is 3D printing, which supports on-demand, small-scale production and contributes to the broader transition toward *localized manufacturing* (LM). LM similarly aims to reduce supply chain inefficiencies, transportation costs, and increase responsiveness to regional needs (Srai et al., 2016).

Another relevant concept is *closed-loop production (CLP)*, which maintains continuous material cycles and emphasizes sustainable manufacturing practices (Juraschek et al., 2017). CLP systems reintegrate materials from end-of-life (EoL) products through reuse, remanufacturing, and recycling. As noted by Juraschek et al. (2017), advancing knowledge and competencies in CLP strategies is crucial for wider industry adoption. One method for fostering this knowledge is through learning factories, which simulate CLP in practice. For example, process chains involving 3D printing can demonstrate how EoL materials are converted into new inputs, as illustrated in Figure 2.3 (Juraschek et al., 2017).

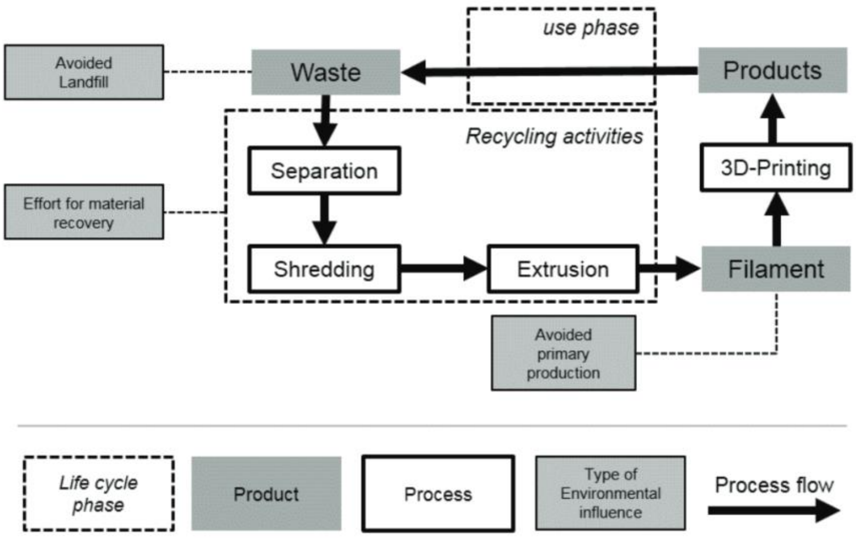

Figure 2.3. Process steps for closed-loop production using 3D-printing (Juraschek et al., 2017).

The broader framework of *circular production systems* (CPSs) integrates both forward and reverse supply chain flows, encapsulating CLP and CE principles (Santibanez Gonzalez et al., 2019). CPSs aim to systematically reintegrate materials and components, reinforcing both sustainability and resource efficiency.

An additional emerging concept is the *microfactory* (MF), typically associated with operational efficiency in advanced manufacturing. Within operations management, MFs are compact, highly automated systems designed to increase efficiency and reduce costs (Klein, 2024). However, within the CE context, the term shifts to emphasize localized, resource-efficient production rather than pure technological optimization (Teigland et al., 2025). These adaptable units integrate material recycling, digital fabrication, and local production to minimize waste, reduce transport needs, and support regional economic resilience. Many leverage *additive manufacturing* to convert local industrial waste into new, usable raw materials.

When examining academic discussions on localized production in support of circular economy development, various networking models emerge as essential to scaling impact. Among these, *hub-and-spoke* or *star-type* networks are particularly prominent. Originally used in logistics and aviation to consolidate operations through a central hub, this structure has been adapted for systemic circular transitions. In this context, hubs manage strategic coordination, while spokes implement activities at the local level (Chowdhury et al., 2022). The circular hubs can also function as centers for collecting, processing, and redistributing materials for reuse, repair, remanufacturing, and recycling (Mogos et al., 2021). A notable feature is the localization of remanufacturing labs near collection centers and consumers, which significantly reduces the environmental footprint of logistics (Franzè et al., 2024). As such, this model not only operationalizes CE principles but also offers a viable approach to sustainable and socially beneficial regional production.

2.3.2 Social, Environmental and Economic Opportunities of LCPSs

While the concept of LCPSs will be further developed in this thesis, various studies have explored their TBL potential, either implicitly or explicitly. Buch et al. (2021) examine how empowering informal waste pickers through cooperative networks and local micro-manufacturing technologies can improve their economic situation. They argue that an effective CE strategy should adopt a bottom-up approach, supporting waste pickers through training, organizational infrastructure, and access to appropriate technologies. This enables them to move up the value chain by transforming recyclable materials into value-added products, rather than remaining dependent on fluctuating commodity prices.

Buch et al. (2021) further stress the importance of decentralized micro-manufacturing, supported by low-cost recycling technologies. This approach shortens supply chains by allowing materials to be processed close to their source, thereby reducing transportation costs and emissions. The use of open-source recycling technologies further democratizes access, allowing small-scale producers in both developed and developing regions to participate. A prominent example is Precious Plastic, a U.S.-based initiative offering recycling equipment such as shredders, extruders, and injection machines for under $10,000.

Similarly, Andrés et al. (2022) case study on the local transformation of PA6 fishing nets shows that localized CBMs reduce transportation needs, lower environmental impact, and improve competitiveness. The integration of recycling and production at the local level also creates significant social value by generating jobs in local communities, particularly among marginalized groups. Buch et al. (2021) reinforce this point, arguing that incorporating waste picker cooperatives into micro-manufacturing ecosystems can promote long-term, sustainable employment and contribute to broader goals of economic empowerment and social equity.

Andrés et al. (2022) also emphasize the importance of financial viability, pointing to material and production costs as key success factors. However, they note ongoing challenges such as optimizing chemical recycling processes and improving logistics. The study concludes that a holistic, European-level strategy is needed to address capital investment barriers and optimize facility locations based on material availability and transportation efficiency.

2.3.2 Conceptual Variations and Gaps in Production Models

The reviewed literature aligns with the purpose of LCPSs and offers valuable insights into their success factors and potential for positive societal impact. Table 2.1 provides a comparative overview including definitions and key characteristics, thereby aiding in the classification of existing and emerging circular production models.

Table 2.1. Comparative overview of existing models for circular economy production.

Source	*Definition*	*Key Characteristic*
Teigland et al. (2025)	**Microfactories** as compact, adaptable units integrating material recycling, digital fabrication, and localized production.	Focus on waste minimization, transport reduction, and use of local resources.
Srai et al. (2016)	**Distributed manufacturing** as decentralized production close to consumers, enhancing flexibility and scalability.	Emphasizes just-in-time, demand-driven, flexible production for sustainability.
Juraschek et al. (2017)	**Closed-loop production**, reintegrating end-of-life materials into manufacturing cycles.	Focuses on reuse, recycling, and remanufacturing to maintain resource flows.
Santibanez Gonzalez et al. (2019)	**Circular production systems**, integrating forward and reverse supply chains.	Broad framework unifying circular economy and closed-loop production for systemic material reintegration.

Buch et al. (2021)	**Cooperative networks** and micro-manufacturing technologies to empower informal waste pickers.	Emphasizes local empowerment, short supply chains, and low-cost recycling.
Andrés et al. (2022); Srai et al. (2016)	**Localized manufacturing** of end-of-life materials to reduce transportation and generate social impact.	Highlights cost efficiency, social inclusion, and logistics optimization.
Nam & Song (2011); Mogos et al. (2021); Chowdhury et al. (2022); Franzè et al. (2024)	**Hub-and-spoke network** model for circular economy transitions, where centralized hubs coordinate strategies, and decentralized spokes implement local actions.	Combines central strategic coordination with local implementation.

As shown in Table 2.1, some definitions emphasize waste reduction, while others focus on decentralized, demand-responsive production, systemic material reintegration or community empowerment. Together, these perspectives illustrate the conceptual versatility of LCPSs. However, much of the literature treats these concepts in isolation, without fully integrating them into a coherent, comprehensive framework for local circular production. Further research is needed to understand how LCPSs can operate as holistic systems that are simultaneously financially viable, socially equitable, and environmentally sustainable. This includes identifying optimal combinations of technology and organizational structures, and addressing barriers to scaling, such as those related to logistics and infrastructure (Andrés et al., 2022). Such insights are critical to the development and widespread adoption of LCPSs.

2.4 Manufacturing Processes for Circular Plastic Production

To support the development of a CE for marine plastic waste, a range of manufacturing methods can be employed to transform recycled materials into new products. This section examines key techniques including *injection molding, rotational molding, additive manufacturing,* encompassing both 3D printing and large-scale applications, and *textile weaving*. The selection of a production process depends on several factors, such as the material's properties, the intended production scale, and specific end-use requirements. Table 2.2 provides an overview of each process, outlining typical applications, as well as their respective advantages and limitations.

Table 2.2. Manufacturing methods applicable for recycled plastics.

Production Process	***Description***	***Common Applications***	***Advantages***	***Limitations***
Injection Molding	Plastic granules are melted and injected into molds to create precise, repeatable products (Rosato et al., 2000).	Packaging, consumer goods, industrial components, such as automotive parts.	High efficiency and high-volume production (Garcia et al., 2021).	High initial setup costs; dependency on existing molds; material waste generation; maintaining material quality (Garcia et al., 2021).
Rotational Molding	Plastic powder is heated and rotated within a mold, forming hollow, seamless products (Ogila et al., 2017).	Large, hollow products like storage tanks, bins and kayaks, outdoor furniture.	Lower tooling costs; flexible for low-volume production and complex shapes; supports resource conservation (Memon et al., 2023).	Longer cycle times; process variability; limited to certain polymers, mainly polyethylene.
Compression Molding	Pre-measured material is placed in a heated mold and shaped under pressure, then cured with heat (Tatara, 2011).	Automotive parts, electrical components, consumer goods, protective gear.	Lower tooling costs; accommodates high-strength composites; produces durable parts; cost-effective for high volumes.	Longer cycle times; higher labor requirements; less suited for complex geometries; precise temperature and pressure control.
Additive Manufacturing	Objects are built layer-by-layer from digital designs without specialized tooling (Garcia et al., 2021). Includes robotic-assisted additive manufacturing for greater flexibility (Urhal et al., 2019).	3D-printing: Rapid prototyping, medical, small, customized parts.	Customization; minimal material waste; rapid production; no specialized molds (Garcia et al., 2021).	Limited scalability for mass production; variability in material properties and surface finish; long production time; high cost per produced part.
		Large-Scale Additive Manufacturing: Large components in construction,	Complex geometries without extensive supports; greater build volumes; enhanced	

		furniture, aerospace etc.	efficiency and material savings with robotic systems (Urhal et al., 2019).	
Textile Weaving	Plastic flakes are melted, extruded into fibers, and woven into fabrics (Sezgin & Yalcin-Enis, 2022).	Clothing, upholstery, industrial textiles.	Reduces carbon footprint; versatility; durability; promotes recycling of plastic waste.	High energy demands; generate microplastics; recycled fibers with lower mechanical properties.

2.5 Research Questions

Local Circular Production Systems (LCPSs) are emerging as a promising approach within the *circular economy*, particularly for addressing the challenges posed by marine plastic waste. However, there remains a lack of clarity around the operational structures and value chain configurations that define such systems. To address this gap, the study explores the following question:

> *RQ1. What types of Local Circular Production Systems exist for recycling marine plastic waste, and what value chain components define them?*

While LCPSs offer notable environmental advantages, their long-term success hinges on the development of robust, sustainable business models. Ensuring economic viability while preserving environmental and social benefits requires strategic integration. Accordingly, the second research question is:

> *RQ2. How can business model strategies enable Local Circular Production Systems to achieve long-term economic sustainability while maintaining environmental and social impact?*

A central objective of LCPSs is to close material loops by transforming ocean plastic waste into valuable offerings. The effectiveness of this transformation depends on choices related to value proposition, market positioning, and strategic execution. To further explore this, the thesis addresses:

> *RQ3. What are the key success factors when implementing circular business models?*

Together, these research questions will inform the development of a comprehensive framework for sustainable, locally anchored *circular business models* in the context of recycling ocean plastic waste.

3. Method

This chapter outlines the methodological approach used to explore the viability and sustainability of LCPSs in the context of recycled marine plastics. The chapter begins by describing the data collection process, including the rationale for using semi-structured interviews and the purposive sampling strategy. This is followed by a description of the field study conducted in Peniche, Portugal, which enabled direct observation and contextual validation of findings. Finally, the analytical approach is presented, focusing on the use of thematic analysis to identify patterns, generate insights, and relate empirical findings to theoretical concepts.

3.1 Data Collection

Given the exploratory nature of the research and its focus on understanding complex, context-dependent phenomena, such as organizational dynamics, stakeholder interactions, and value creation processes, a qualitative approach was believed most suitable (Bell et al., 2022). This methodological choice is particularly relevant for emerging or under-researched areas where existing theoretical frameworks may fall short in capturing empirical realities. Qualitative research is well-suited for unpacking the intricacies of CBMs, as it allows for the exploration of subjective perspectives and the interrelations between environmental, economic, and social dimensions. It also enables collection of rich, nuanced insights that are difficult to obtain through quantitative methods.

The primary data collection method consisted of semi-structured interviews with organizations involved in plastic waste recycling, complemented by direct field observations and document analysis.

3.1.1 Interviews

To generate rich, contextual insights semi-structured interviews were conducted with organizations operating across various stages of the plastic recycling value chain. This method was selected for its ability to balance structure with flexibility. It allowed systematic coverage of key themes while also enabling interviewees to elaborate freely on topics of particular relevance to their experiences, uncovering unexpected insights that may have been overlooked in more rigid interview formats (Bell et al., 2022).

An interview guide was developed based on a preliminary literature review and iteratively refined throughout the data collection process as new themes emerged. The guide provided a consistent reference framework across interviews while allowing for follow-up questions and detours when relevant. This adaptive approach increased the potential to uncover context-specific knowledge and challenge initial assumptions (Bell et al., 2022). The final interview guide is included in Appendix A.

Sampling

A purposive sampling strategy was employed to ensure the inclusion of organizations with the expertise and operational relevance necessary to inform the research questions (Bell et al., 2022). Companies were selected to reflect a diversity of characteristics, including business model structures, value chain integration, organizational size, degree of circularity, and material specialization. All participating organizations actively engaged in several activities of plastic waste recycling, with a particular emphasis on ocean-bound plastic such as EoL fishing gear. To further broaden the empirical base, a snowball sampling technique was used in parallel where initial interviewees were asked to suggest other relevant organizations or individuals who could provide valuable insights. This adaptive, iterative approach allowed the study to capture a wide range of perspectives and adjust the scope of inquiry in response to new developments during the research process.

Interviews continued until theoretical saturation was reached, meaning until additional interviews no longer yielded new insights or themes relevant to the research questions (Bell et al., 2022). Reaching saturation strengthened the credibility of the findings by ensuring that the data collection was both sufficiently comprehensive and grounded in diverse, practice-based perspectives.

Overview of Interviewees

A total of twelve organizations were interviewed for this study, representing a diverse range of actors across the circular plastics value chain. These organizations vary in terms of organizational size, geographic scope, business model and plastic input type. The broad scope of organizations enables a comprehensive understanding of the operational, strategic, and socio-environmental dimensions of circular production.

To ensure participant confidentiality and encourage openness during the interviews, all organizations have been anonymized. Identifying details have been removed or altered in references to the organizations and in participant quotations. Any modifications to quotations for clarity or anonymization are indicated with brackets. The anonymized organizations are referred to using pseudonyms based on animals living in the marine environment. These pseudonyms have been deliberately chosen to reflect the organization's operational and symbolic proximity to the environment, reflecting the study's focus on the blue economy. Moreover, the pseudonyms are broadly indicative of organizational scale, where smaller actors are represented by species such as *Shrimp*, while larger global organizations are denoted with species like *Orca*. The twelve organizations are grouped into three thematic categories based on their plastic material sourcing and level of marine engagement, as presented in Table 3.1.

Table 3.1. Categorization of pseudonyms.

Category	***Description***	***Organizations***
Marine Animals	These organizations work primarily with ocean-bound plastics, including end-of-life fishing gear and marine debris. They demonstrate a strong environmental mission focused on protecting marine ecosystems and supporting coastal communities. These actors tend to be mission-driven and closely tied to their geographic context.	*Shrimp, Octopus, Dolphin, Orca, Herring*
Coastal Animals	This group includes organizations that maintain a strong symbolic or strategic link to the ocean (e.g., branding, storytelling, sourcing channels), yet do not exclusively process ocean plastics. They process a mixture of ocean plastics and other waste streams, and sometimes even incorporate virgin plastics. In some cases, ocean and non-ocean plastics are blended within the same product, in others, the organization offers separate product lines based on distinct material sources.	*Crab, Seal, Walrus*
Seabirds	These organizations primarily process non-ocean plastics but operate within the circular value chain of plastic waste. Although they may participate in some ocean-linked projects or campaigns, that does not constitute the core of their business model. These actors often target broader sustainability goals such as local job creation, education, and urban resilience.	*Seagull, Puffin, Albatross, Penguin*

Table 3.2 below provides a detailed overview of the interviewed organizations, including their pseudonym, the interviewee's job role, interview duration time, and geographic region.

Table 3.2. Overview of interviewees.

Category	*Pseudonym*	*Interviewee's Job Position*	*Date*	*Duration*	*Region*
Marine Animals	Shrimp	Program Director	2025-03-27	46 min	North America
	Herring	Site Manager	2025-03-05	42 min	Europe
	Octopus	Recycling & Impact Manager	2025-03-14	51 min	Europe
	Dolphin	Co-founder & COO	2025-03-11	46 min	North America, Global
	Orca	Operation Project Manager	2025-03-17	47 min	North America, Global
Coastal Animals	Crab	Founder & Owner	2025-03-20	51 min	Europe
	Seal	Chairman & Co-owner	2025-03-26	40 min	Africa
	Walrus	Account Manager (interviewee A)	2025-03-06	48 min	Europe, Global
	Walrus	CEO (interviewee B)	2025-03-10	45 min	Europe, Global
Seabirds	Penguin	Head of Business Operations & Development	2025-03-07	38 min	Europe
	Seagull	CEO	2025-04-11	40 min	Europe
	Puffin	Senior Director & Co-leader	2025-03-10	58 min	North America
	Albatross	Sales & Business Developer	2025-03-18	1h 4 min	Europe

3.1.2 Field Study

A field study was conducted in Peniche, Portugal, from March 2nd to April 1st, 2025, with the aim of gaining contextual and experiential insights into circular production systems within a coastal setting. The fieldwork was centered around Ocean Tech Hub Lda (OCT) and its microfactory operations.

Figure 3.1. Researchers' own pictures showing their participation in the preparation of EoL gillnets in OCT's microfactory.

Through active engagement in OCT's daily activities, such as sorting EoL fishing nets and participating in operational workflows, see Figure 3.1, the researchers were able to gain a practical understanding of material flows, labor dynamics, and on-site challenges. Interaction with OCT employees and collaborators, including individuals with disabilities from the local integration center CERCI Peniche, provided valuable perspectives on social inclusion.

Figure 3.2. Researchers' own pictures from the visit to Peniche fishing port.

In addition to participation at the microfactory, the field study involved broader ecosystem exploration. This included stakeholder dialogues and site visits to regional suppliers of plastic manufacturing and extrusion machinery, and informal engagement with residents of the coastal community. For instance, a visit to the Peniche port where discarded fishing nets are collected, enabled direct conversations with local fishermen and provided insights into how OCT raises awareness and collaborates with Docapesca (Figure 3.2). Circular Ocean also had an exhibition during the World Surf League to spread awareness, as seen in Figure 3.3. These activities contributed to a more holistic understanding of the circular value chain, the local socioeconomic context, and the interdependencies between industrial, environmental, and community actors. They also revealed the practical challenges of operating within coastal and marine settings, highlighting both the enabling and constraining roles of governmental and regulatory actors in shaping circular initiatives. Field-based observations served as a critical complement to interviews and literature review, enhancing the study's internal validity and enabling the triangulation of findings (Bell et al., 2022).

Figure 3.3. Researchers' own picture of them, the researchers from the parallel thesis and their supervisor at Circular Ocean's exhibition during the World Surf League in Peniche.

3.2 Data Analysis

As suggested by Bell et al. (2022), a carefully designed analytical strategy is essential to manage the large volume and inherent complexity of the dataset when working with qualitative data. In order to ensure this, thematic analysis was employed to systematically examine the collected qualitative data, following the principles outlined by Braun and Clarke (2006). This method enabled the identification of recurring patterns and meaningful themes related to the dynamics of CBMs for marine plastic recycling. The analysis proceeded through a structured, iterative process, ensuring both empirical richness and theoretical relevance.

All interviews were video-recorded and transcribed using AI-assisted tools in Microsoft Teams, followed by thorough manual reviews to ensure accuracy and contextual validity. These transcripts were then compiled into an interview matrix, where excerpts were systematically categorized under a set of pre-defined analytical headings derived from the Business Model Canvas and sustainability theory. These included: *Customer Segments, Circular Value Chain, Key Resources, Cost Structure, Revenue Streams, Stakeholder Relationships, Communication & Sales, Unique Value Proposition, Local Production & Circular Economy, Environmental Impact, Social Impact, Problems and Challenges,* and *Success Factors.*

This structured approach allowed for consistent comparison across cases and provided a foundation for first-order code generation. Although this study employed a thematic analysis approach, the coding process was guided by the structure outlined by Gioia et al. (2013). First-order codes were extracted from the data, closely reflecting the language and concerns of the interviewees. These were then aggregated into second-order themes through pattern recognition and iterative coding discussions, aiming to abstract broader mechanisms and insights relevant to the research questions. Finally, the second-order themes were synthesized into overarching aggregate dimensions, which corresponds to the themes of the study's guiding research questions. This process is illustrated in, Appendix B, which shows the thematic logic from raw data to theoretical dimensions.

3.3 Ethical Considerations and Quality Measures

Conducting qualitative research involving multiple stakeholders across diverse regional and organizational contexts requires careful attention to ethical considerations and research quality. This study followed established research ethics and methodological standards to ensure the integrity, transparency, and credibility of both the research process and its outcomes.

3.3.1 Ethical Considerations

In line with the guidelines outlined by Bell et al. (2022), the research was conducted in a manner that safeguarded participants' autonomy, confidentiality, and comfort. All interview participants were provided with clear information regarding the purpose of the study, its intended use, and their rights as participants. Informed consent was obtained prior to each interview, and participants were explicitly asked to consent to audio or video recording. They were also given the option to review their transcripts or withdraw contributions post-interview, although no such requests were made.

To maintain participant anonymity and protect organizational confidentiality, each interviewed organization was anonymized. Respect for participant privacy was upheld throughout the research process. Data was handled with discretion, and potentially identifying information, such as organizational names, geographic specifics, and project details, was excluded or generalized. This approach enabled interviewees to speak freely about challenges, trade-offs, and strategic decisions without concern for reputational risks.

The dual role of the authors, as master's students conducting research and as temporary collaborators with certain field partners during the field study with Ocean Tech Hub Lda, was disclosed to all participants to maintain transparency. Any potential for perceived conflicts of interest was mitigated by clarifying our academic independence, and no partner organization influenced the design, execution, or conclusions of the research.

3.3.2 Quality Measures

To ensure methodological rigor, this study employed several measures to enhance the trustworthiness of the research, drawing on the framework proposed by Bell et al. (2022), which includes four key criteria: credibility, transferability, dependability, and confirmability.

Credibility refers to the accuracy and plausibility of the findings in relation to participants' experiences (Bell et al., 2022). To strengthen credibility, data was triangulated through multiple sources: interviews with twelve organizations from different regions and stages of the value chain, field observations during a one-month visit to Peniche, Portugal, and document review of secondary materials. Furthermore, interviews were transcribed and coded thematically using a transparent, systematic process grounded in the data rather than pre-existing assumptions.

Transferability concerns the extent to which findings may be applicable to other contexts, in adherence with Bell et al. (2022). While the study does not aim for generalizability in a statistical sense, the diversity of organizations and geographies involved allows for analytical transferability. Thick descriptions of the cases, system typologies, and contextual factors are provided to allow readers and practitioners to assess the relevance of the findings to their own settings.

Dependability addresses the consistency and replicability of the research process. As suggested by Bell et al. (2022), detailed records of each step, from research design, interview planning, and data collection to analysis, have been maintained to ensure that the study could be replicated under similar conditions. The interview guide and thematic categorization are included in the appendices to support methodological transparency.

Confirmability relates to the objectivity of the findings (Bell et al. 2022). While complete neutrality is rarely possible in qualitative research, this study took measures to ensure that interpretations were rooted in participants' own narratives. Thematic coding was conducted collaboratively by both authors, and peer feedback was regularly sought from supervisors and fellow researchers to minimize bias and validate interpretations.

4. Findings

This chapter presents the empirical findings from interviews with organizations operating within the field of circular production systems and a primary focus on marine plastic waste recycling. Identifying information has been anonymized when referring to the organizations and in quotations. Alterations to expressions within quotations are indicated using brackets.

The findings are structured according to the research questions guiding this study. First, Section 4.1 introduces four overarching typologies of *Local Circular Production Systems* (LCPSs) and analyzes their key characteristics. Section 4.2 investigates the business model strategies employed by these organizations, examining how they define their value propositions, capture value through diverse revenue streams, position themselves within the market, and simultaneously achieve environmental and social impact. Finally, Section 4.3 addresses the success factors critical to implementing and sustaining *circular business models* (CBMs) for LCPSs, drawing attention to the importance of mindset shifts, verification mechanisms, strategic entry points, and long-term economic resilience.

4.1 Local Circular Production Typologies

This section presents the main empirical findings of the study seeking to answer the research question: What types of Local Circular Production Systems exist for recycling marine plastic waste, and what value chain components define them? Based on interviews with twelve organizations operating across diverse regions and stages of the plastic recycling value chain, the analysis identifies four distinct system typologies, each reflecting a unique approach to organizing circular economy (CE) production. The following section examines the circular value chains, partnership dynamics, and locality of each typology. Subsequently, the broad concept of LCPSs is unpacked through these empirical insights.

4.1.1 The Four System Typologies

Our analysis reveals four distinct types of LCPSs: *Hyper-local Integrated Systems, Hub-and-Spoke Distributed Systems, Adaptable Collaborative Networks,* and *Circular Infrastructure Providers*. These system typologies, depicted in Figure 4.1, differ along three key dimensions: 1) the configuration of their value chains to enable circularity, 2) the nature of their collaborative arrangements, and 3) the extent and intensity of their local integration.

Some systems pursue full in-house integration, while others operate through distributed networks or function as enablers within broader circular ecosystems. These differences reflect underlying system logics for transforming waste into valuable resources and shape the foundations of their respective business models, which are explored in Section 4.2. A summarized comparison table with concise definitions and key dimensional distinctions is presented at the end of this analysis (see Table 4.1).

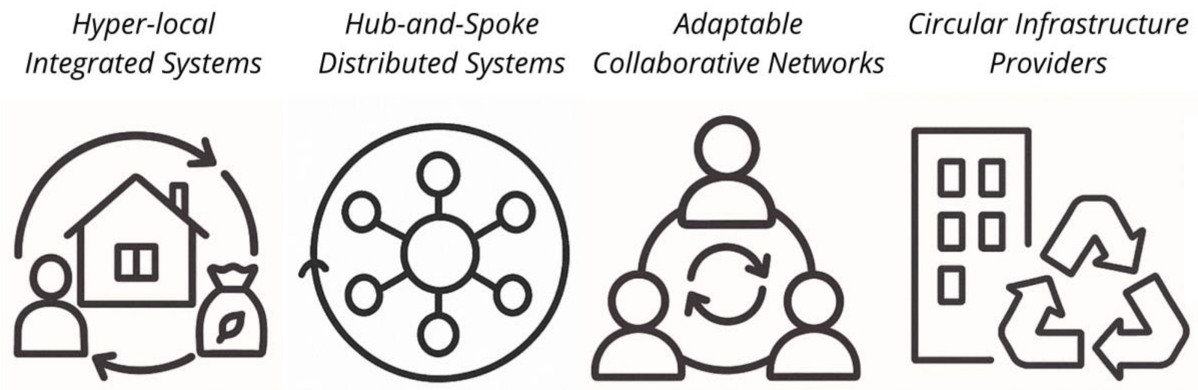

Figure 4.1. Illustrations of the four LCPS typologies, generated by prompting OpenAI with the name and respective definition from Table 4.1.

Hyper-local Integrated Systems

The following section addresses the characteristics of *Hyper-local Integrated Systems*, comprising the companies Crab, Seagull, Puffin and Shrimp. From the text, the following key points can be summarized:

- Circular value chains are either vertically integrated with mono-material precision or oriented toward high-volume, lower-quality outputs using adaptive technologies.
- Partnerships span from informal, community-driven collaborations to formal institutional alliances, reflecting a wide spectrum of engagement models.
- Strong local integration in labor, sourcing and impact is paired with aspirations for scalable, replicable models in other regional contexts.

Circular Value Chain

The interviews reveal two primary approaches to material quality and process integration in circular value chains. Crab and Puffin pursue mono-material processing with high vertical integration. Crab began by crafting surf accessories from plastics collected on local beaches but now also process post-consumer plastics donated by individuals and businesses. Materials are sorted and processed in-house using machines from Precious Plastics. Similarly, Puffin operates a fully integrated system, with collection, sorting and pelletizing co-located in a microfactory. An article describes that Puffin's plastic processing begins with the material being transported via a conveyor belt into a shredding chamber. These fragments are then subjected to a water-based separation process, allowing different types of plastic to be sorted based on their buoyancy. Once cleaned, the resulting plastic flakes are lastly collected in bulk containers in preparation for the pelletizing stage. Puffin explains that the infrastructure, adapted from China-imported machinery, "was not plug and play". It required extensive customization for the small scale.

In contrast, Seagull and Shrimp work with mixed plastics to produce lower quality but high-volume outputs. Seagull uses machine learning to manage material variability: "We're trying to develop intelligent manufacturing systems [...] using this combination of characterization technology and machine learning to adjust parameters within the manufacturing line." Their open-loop system produces plastic lumber and aims to scale impact through volume. Similarly, Shrimp processes lower-grade plastics into durable infrastructure components, prioritizing bulk production over material purity. Their model works with Non-Governmental Organizations (NGOs) to collect and process waste for reuse in long-life products: "We shred, process and recycle, so that then other companies can create these long-life infrastructure products."

Despite differences in material strategy, all initiatives emphasize EoL responsibility. Crab ensures all products are mono-material in order to ensure onward recyclability. Seagull shows the same commitment on their website: "Our materials don't become someone else's problem. [...] everything can be turned back into products." Puffin incorporates RFID tags for traceability and product return, ensuring materials can re-enter the production cycle. Lastly, Shrimp embeds longevity in design: "We want to make long-lasting products [...] and embed the carbon that is already in the polymers into products."

Partnership Dynamic

The interviews reveal continuous partnership models, ranging from grassroots community engagement to formalized institutional collaborations. Crab represents a deeply embedded, community-based approach, where the founder operates independently with support from volunteers and informal collaborators. The collaboration with the Precious Plastics network reinforces this openness and provides connections to a global community: "There's other people that I connect with through Precious Plastic who are doing a similar thing [...] we're friends already before we've even spoken."

Seagull engages more formally with universities and research partners, and Puffin's approach is even more institutionalized. Embedded within a university, the initiative stays updated on the latest material science and partners strategically with organizations to share risk and reward. Puffin frames this as part of a broader systems approach, emphasizing the need for value chain-wide collaboration: "You need strategic partners across that entire value chain, to realize it from your feedstock, to understand the manufacturing piece, to the material science." Their circular living lab serves as a hub for this interdisciplinary cooperation. Here, Shrimp occupies a middle ground. Though situated within an academic setting, it relies on external partnerships with local NGOs and processors.

Local Integration

All four initiatives demonstrate strong local integration through their strategic choices in facility location, value chain partnerships and customer focus. Crab exemplifies hyper-local engagement by sourcing materials, producing goods and targeting customers within a single town, actively collaborating with local schools, community groups, and businesses to keep operations embedded in the immediate area. Puffin's microfactory also consolidates all processing stages in one facility, where plastic waste becomes clean dry flakes that then are pelletized on site. This modular and decentralized model is designed to minimize transport emissions and support local employment. Puffin envisions a regional hub-and-spoke system: "Working with other municipalities [...] sending the materials to the larger hub to maximize the amount of materials that we can process. So, we're condensing that global supply chain into a region."

Shrimp and Seagull also prioritize localized systems, aligning facility placement and partnerships with regional contexts. Shrimp, who operates on an island, seeks to identify solutions specifically suited for that geographic and infrastructural constraint. Moreover, Seagull designs its operations for localized impact, inspired by principles of decentralized production. Though grounded in local contexts, many initiatives express the possibility to replicate their models elsewhere. For example, Crab thinks that their model easily could be replicated in other towns. Puffin imagines their microfactory model evolving into a cooperative format, while Seagull plans to scale after achieving profitability: "We want to get to proper profitability and understand how we could actually scale up factories in other environments."

Hub-and-Spoke Distributed Systems

The analysis of Octopus, Seal and Albatross reveal the following key characteristics for *Hub-and-Spoke Distributed Systems*:

- Circular value chains interweave local processing with centralized or regional hubs, balancing proximity with scalable efficiency.
- Partnerships are co-creative and community-anchored, enabling decentralized collection systems within a centrally coordinated operational framework.
- Distributed locality is operationalized through adaptable satellite units that embed regionally while contributing to scalable, system-level circularity.

Circular Value Chain

Within Hub-and-Spoke Distributed Systems, circular value chains are designed to efficiently transform plastic waste into new products through a combination of localized collection and centralized or specialized processing. This model enables scalability while maintaining cost-effective and adaptable infrastructure.

Octopus begins with community-driven beach cleanups, after which collected waste is sorted and shredded at their own facility. For the more technically demanding extrusion stage, the pre-processed materials are then sent to a specialized partner abroad. This model reflects a strategic division of labor, balancing community engagement with efficient use of external technical capacity. Seal decentralized, community-integrated approach starts with mapping and stakeholder engagement in targeted municipalities. Proprietary container-based recycling units, each equipped for shredding, cleaning, drying and granulating, are deployed locally and can be operated by a single individual. Plastic is collected, processed into flakes on-site and sold through offtake agreements. Next, Albatross offers a fully integrated model that processes mixed and low-value plastics: “We actually don’t want material that is too clean. We really want the material that no one else can recycle.” In-house operations include crushing, grinding, and pretreatment, followed by composite material production and compression molding. Albatross manufacturing method allows for a wide range of potential product outputs, and the only real constraint is the dimensions of the press.

EoL strategies are a defining feature. Octopus focuses on durability and offers a lifetime warranty, as described on their website: “If they have been broken, and are no longer wearable, we will repair or replace them for free, forever.” To support this ambition, Octopus actively explores product design modifications that enhance repairability. In addition, Seal and Albatross emphasize digital traceability, using platforms that provide full material visibility.

Partnership Dynamic

Partnerships play a foundational role in this typology model, allowing companies to combine centralized coordination with localized implementation. These collaborations enable access to local knowledge, infrastructure and stakeholder networks while supporting scalable operations. Octopus illustrates this through a close cooperation between their local processing hub and local organizations and small-scale facilities for waste collection: "Competition doesn't make a lot of sense for anyone, so instead we will support people who are doing that a lot more." Besides, the company actively engages with the local tourism sector, partnering with hotels and event organizers to strengthen its role in marine conservation efforts.

Seal builds on this decentralized engagement by fostering long-term, community-rooted partnerships. Its modular recycling units are typically funded and owned by municipalities yet operated by local individuals. While this ensures deep community integration, their sustained relationships with plastic product manufacturers are also essential to reintegrating recycled materials into supply chains. Albatross also prioritizes strategic partnerships, promoting a "triple win" approach: "We are open to any kind of collaboration under one premise: We must generate a triple win for the partner, [Albatross] and above all for the environment!" The company emphasizes co-creation, particularly when expanding into new markets, viewing partner-driven sales and collaboration with customers as key to success.

Local Integration

Locality within Hub-and-Spoke Distributed Systems is defined by a deliberate balance between regional responsiveness and system-wide coordination. Companies in this typology pursue modular scaling strategies that combine localized processing with centralized efficiencies.

A core feature identified across interviews is the development of small, strategically placed processing units, informally referred to as "satellite facilities". These facilities typically handle early-stage tasks such as sorting and shredding, and subsequently channel materials into broader value chains for further processing. As described by Octopus, "We go a bit more down the model of almost like satellite facilities dotted around, that are small, doing important parts and then feeding in for where you can get those efficiencies of scale." It is important to note that the term satellite facility in this context does not appear in the academic literature on CE production systems. Rather, it emerged organically during interviews to describe a decentralized production strategy. The concept is inspired by the idea of a central satellite coordinating between multiple distributed ground stations, paralleling the hub-and-spoke model. In this arrangement, a central unit (the “satellite”) collects, processes, and relays materials or information between smaller, locally embedded facilities. This structure enables both localized processing and the achievement of efficiencies of scale by consolidating further stages of production or recycling at a centralized location.

Albatross reinforces this approach, advocating for compact, semi-mobile factories to minimize transportation needs and associated impacts: “I really believe in small factories strategically placed instead of one huge one.” These facilities are positioned to optimize regional material flows while preserving system adaptability and responsiveness to local demand. Seal applies a similar logic through its network of modular recycling units, which are designed for region-specific implementation. Each unit undergoes a fine-tuning period to adapt to local environmental conditions and consumer behaviors.

Despite the strong local emphasis, companies recognize the trade-offs involved in scaling. Octopus acknowledges the value of fully local systems, however, stresses the need for balance: “There is absolutely a place for local facilities that do everything in them, but I think there’s also an element of scale and efficiency that comes with it.” Seal echoed this view, describing the process as “taking big steps, the right steps and doing it right.” The model ultimately rests on the premise that many small, locally integrated systems can collectively generate significant circular impact.

Adaptable Collaborative Networks

The common characteristics among the companies studied under the *Adaptable Collaborative Networks* typology, Penguin, Dolphin, Walrus and Orca, include:

- Circular value chains rely on outsourced production and localized operations, enabling plug and play scalability and full traceability without the need for owning physical infrastructure.
- Strategic partnerships are long-term and trust-based, built on value alignment and distributed responsibility across diverse value chains.

- Local adaptability meets global scalability through decentralized models that prioritize community involvement, minimized transport and contextual responsiveness.

Circular Value Chain

The circular value chains in Adaptable Collaborative Networks are defined by flexible, decentralized structures in which companies manage specific activities, such as sourcing, design or coordination, while outsourcing others within a broader ecosystem. These firms act as integrators rather than owners, enabling scalable, responsive systems without the need for full vertical integration.

Penguin exemplifies a service-oriented model that begins with a consulting-style engagement to help clients design closed-loop systems and subsequently transitions into operational management through a network of partners. Penguin outsources manufacturing and logistics, emphasizing its intermediary role: "We don't want to own a lot of materials ourselves, because that's someone else's job." Instead, the company allows clients to delegate functions such as order handling, logistics, and returns, reinforcing its position as a facilitator of closed-loop processes.

With four main collection points worldwide, which all serve different markets, Walrus integrates recycling and manufacturing steps differently across regions. In North America, the chain is completely vertical to reduce emissions, and at the collection point in Asia partners locally transform polymers all the way into reusable products. However, at the collection points in Africa, all process steps from collection to pellets are done locally, while the yarn is spun in Europe for the European market.

Dolphin's model centers on traceability and engagement, working with actors ranging from small artisanal communities to large industrial fishing companies. Without owning processing infrastructure, Dolphin partners with mills to create a scalable, plug-and-play system. Orca employs a similar partnership-based model. Local teams across selected coastal communities globally, mainly in Asia and the U.S., collect and sort marine waste by type and color. Thereafter recycling partners clean, sort, flake and pelletize the materials. These pellets are transformed into yarn, woven into fabric, and used to produce products like footwear, apparel and accessories.

Most companies in this typology target *business-to-business* (B2B) markets, allowing for controlled return systems. For example, Penguin emphasizes the importance of establishing an effective return system to ensure that plastic products are recovered and reintegrated into the production cycle. On the contrary, Interviewee A at Walrus explained that they do not maintain an end-of-life system, placing that responsibility with brands: "Well, it's their responsibility. It's not our main focus. Our main focus is to clean up the oceans."

Partnership Dynamic

Partnerships are the cornerstone of the Adaptable Collaborative Networks typology, serving as strategic instruments for scaling, ensuring traceability and adapting operations to diverse local contexts. As Orca puts it on their website, "Collaboration is the nucleus of [Orca], and the heart and soul of our mission," emphasizing a networked approach to environmental impact.

These organizations rely on long-term, trust-based relationships rather than owning production infrastructure. Instead, they integrate into existing supply chains to increase flexibility and reduce capital intensity. Dolphin illustrates this model: "We work with a network of existing partners [...] to basically just be a plug and play," enabling manufacturers to swap virgin materials for recycled alternatives without altering existing systems. Similarly, Orca delegates operational tasks like sorting and recycling to local partners, while the core organizations maintain oversight, coordination and standard setting across their networks.

Partner selectivity and value alignment are critical. For example, Dolphin stresses the importance of shared ethics: "It's been really about being very strategic with which brands we partner with," while interviewee B at Walrus underlines building partnerships with organizations that support its social mission. Such alignment allows these networks to prioritize long-term impact over rapid returns. Strategic agreements also support network stability. As Dolphin explains, "What we're looking for is more of what's called an off-take agreement," ensuring predictable demand from aligned partners. Orca echoes this with a commitment to selective partnerships to uphold brand integrity and reinforce consistent standards across its ecosystem.

Local Integration

Organizations within this typology have the ability to adapt operations to local conditions while maintaining a broad, often global, presence. This flexibility is as mentioned enabled by extensive partner networks and a decentralized business model that favors collaboration. As Penguin explains, "it makes sense for us to be more flexible, in terms of locations, in terms of where to spend our money." Rather than investing in proprietary facilities, organizations in this typology typically rely on existing partners with available capacity: "unless there is a super shortage of recycling capacity, then it doesn't really make any sense for us to invest in our own recycling facility," Penguin elaborates. This geographically adaptive logic is also seen in Orca's emphasis on reducing transport emissions and maximizing local processing: "it's ideal to be able to turn some of this waste into something without having to transport it […] It's always best to keep these local solutions as local as possible." However, Orca also recognizes the challenges of matching local capacity with operational needs.

To balance these demands, companies implement decentralized operational models that leverage multiple partners across regions. Penguin explains that they work with different recyclers depending on the location of the plastic, adapting their operations to local conditions and available infrastructure. Similarly, Orca uses localized sorting and washing before transferring materials to larger partners for further processing, strategically positioning these partners near the next stage of their operations: "for the pelletizing stage [...] we have larger partners that are working closer to where our next piece of the operation is." Minimizing logistics remains a key consideration which many interviewees aim to address. Penguin, for example, utilizes existing transport routes, while Dolphin emphasizes the importance of convenient logistics and saving on returning trucks to reduce costs and environmental impact.

Circular Infrastructure Providers

This typology captures circular economy actors that focus not on creating products but on enabling others to do so. Herring, Shrimp and Seal belong to this type, sharing the following core features:

- Circular operations focus on early-stage processing, including sorting, shredding and conditioning, to supply standardized feedstock for downstream innovation.
- Partnerships span public, private and nonprofit sectors, forming dense, cross-sector networks that operate shared infrastructure and extend material utility.
- Locally anchored yet systemically impactful, these models are tailored to local waste flows and economic contexts while connecting to broader circular networks.

Circular Value Chain

Circular Infrastructure Providers operate as upstream enablers within the CE, transforming discarded plastics into standardized, processable feedstock. Rather than producing end products, they provide infrastructural services, such as sorting, shredding, cleaning and conditioning, connecting waste streams to downstream manufacturing while allowing others to innovate further along the chain.

At the Herring, materials are roughly sorted before being sold to larger specialized recyclers who carry out pelletizing and refinement: "Once that's done, we try to sell the plastic for recycling." Similarly, Shrimp processes low-grade, mixed plastics into bulk materials for durable applications such as lumber. Revenue is also generated by granting access to shared infrastructure. Shrimp envisions a cooperative model, where users pay a fee to access shared machinery: "In the same way as when you have an apple orchard, you then pick your apples, you take it to the mustery, and you get some juice out of it."

While upstream in the value chain, these systems influence downstream outcomes by prioritizing durability and long-term carbon storage, as previously exemplified by Shrimp. Seal similarly partners with manufacturers to reintegrate recycled materials into their original flows, supporting full-loop circularity.

Partnership Dynamic

Collaboration emerges as a defining characteristic, whose operational models depend on interorganizational partnerships across sectors and scales. These systems rely on dense networks to secure material flows, leverage infrastructure and extend the utility of recycled materials further along the value chain.

Herring builds on a cross-sectoral ecosystem involving municipalities, academic institutions, NGOs and state agencies. Guided by the principle that "one company's waste should be another's resource," Herring works closely with organizations to drive innovation and material circulation. Shrimp also partners with NGOs for collection and downstream players for material repurposing: "We want to work with local NGOs to bring this material to us, we shred, process, recycle, so that then other companies can create these long-life infrastructure products." While Shrimp emphasizes shared infrastructure, adding that "there has to be some kind of cooperative system where people, companies, pay in a membership and then they get free material to use on their products," Seal adopts a decentralized strategy, embedding modular recycling units in local communities to foster trust, ownership, and grassroots legitimacy.

Local Integration

While the customers and partners of Circular Infrastructure Providers may operate nationally or internationally, these companies build their operations around local waste streams, infrastructure and communities. By doing so, they can better respond to local environmental challenges while also creating jobs and value in the places where they work.

Situated in a coastal area in Europe, Herring's recycling center collects marine waste from across the country, with a focus on nearby fishing communities. The facility engages in direct collaboration with local stakeholders, maintaining close contact with fishing associations and individual fishermen in the region, and providing them with the opportunity to deliver materials directly on site. On the other hand, Herring's primary buyer is an international recycling company based in a neighboring country, showing that even highly local systems may need to connect with international markets to ensure the recycled materials are used. In comparison, Shrimp operates on an island and sees locality as a necessity due to the isolation and dependence on tourism: "[The island] doesn't have any manufacturing infrastructure. [...] It's highly tourism dependent, so we want to bring manufacturing of this huge debris to [the island]." Their goal is not only to manage marine debris locally, but also to use it to build a new type of local industry, illustrated by the line: "being able to handle your own waste stream and convert it into locally necessary long-life products and help upscale the community."

Comparative Summary of Typologies

Building on the preceding analysis, the comparative Table 4.1 synthesizes key characteristics of each typology, providing concise definitions and highlighting their core distinctions across three dimensions: circular value chain, partnership dynamics, and local integration.

Table 4.1. Definition and comparison of the four typologies.

Typology/ Dimensions of Comparison	***1. Hyper-local Integrated Systems***	***2. Hub-and-Spoke Distributed Systems***	***3. Adaptable Collaborative Networks***	***4. Circular Infrastructure Providers***
Definition	A single organization or tight local collective manages the entire value chain within a small geography. Emphasizes self-contained circularity, manual processing, and community-rooted infrastructure.	A central actor coordinates regional or modular processing units. Value chain activities are partly geographically distributed but centrally governed, aiming to scale without losing local adaptation.	The value chain is spread across independent but coordinated actors, adapted to local infrastructure, partnerships and regulations. Typically involves external processors or manufacturers, with the organization acting as connector, system orchestrator or material aggregator.	Focus on material preparation, not product creation. Often municipally supported or positioned as upstream enablers, providing high-quality recycled material to others in the chain.
Circular Value Chain	Mono-material or mixed plastics processed locally; high vertical integration; focus on recyclability and durability; open- and closed-loop models; local sourcing and EoL accountability.	Combines localized collection with centralized or specialized processing; modular infrastructure; medium vertical integration; durable design with strong EoL strategies and traceability systems.	Decentralized and service-oriented; companies manage design, sourcing and coordination while outsourcing processing; plug-and-play using existing infrastructure; geographically flexible; designed for recyclability and material return.	Upstream value chain role; transform waste into feedstock; provide shared infrastructure; enable downstream innovation; low-grade material uses and long-life applications; durability and carbon retention.
Partnership Dynamic	Community-based to institutional partnerships; ranges from grassroots to formal; collaboration with local NGOs and global networks;	Mix local and strategic partnerships; close cooperation and co-creation with municipalities, NGOs, small enterprises and customers; long-	Deeply relational and trust-based; strategic alignment and shared values guide partnerships; core organization focus on coordination, logistics and system	Dense, cross-sector partnerships; infrastructure as shared, cooperative resource; trust-building with grassroots

	strategic academic and nonprofit partners to support innovation and scaling.	term engagement for loop closure; act as central nodes coordinating decentralized operations.	design; outsourcing to local operators and recyclers; long-term agreements to stabilize.	communities; support for value chain integration and innovation; focus on enabling others.
Local Integration	Highly localized systems; processing and production within a single facility or town; designs to minimize transport, embed regional contexts and enable replicability; strong links to local schools, municipalities, and communities.	Modular, regional implementation; satellite or semi-mobile facilities process early-stage waste locally before central refinement; emphasizes scaling through replication and regional responsiveness.	Adaptive and decentralized; rely on partners with regional capabilities; avoid owning facilities to remain agile; solutions tailored to the region's infrastructure; global reach with local execution; logistic optimization.	Deeply rooted in local waste ecosystems; infrastructure matches regional material streams and needs; close engagement with local communities; link to international markets where necessary.
Organizations	*Crab, Seagull, Puffin, Shrimp*	*Octopus, Seal, Albatross*	*Walrus, Dolphin, Orca, Penguin*	*Herring, Shrimp, Seal*

4.1.2 Exploring Local Circular Production Systems

This section explores the concept of LCPSs through the lenses of practice and lived experience. Drawing on qualitative insights from interviews, it examines how participants conceptualize local circular production and the core ideas and practices they associate with it. These findings lay the groundwork for the definition developed in the discussion section.

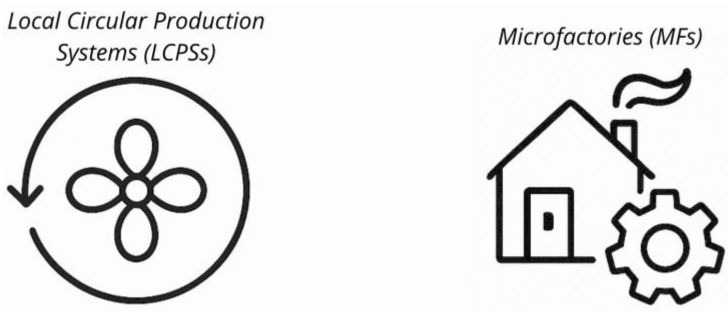

Figure 4.2. Illustrations of LCPSs and MFs, generated by prompting OpenAI with each concept's definition, scope and primary goal.

Before delving into the empirical insights, it is necessary to clarify key conceptual distinctions. As CE models continue to evolve, so too does the vocabulary used to describe them. Among the terms employed in this report are *Local Circular Production Systems* (LCPSs) and *Microfactories* (MFs), depicted in Figure 4.2 above. While often used interchangeably, these concepts represent distinct frameworks. Table 4.2 summarizes the key differences between the two concepts. LCPSs encompass a broader and more systemic approach to localized, circular production, positioning them as an umbrella term under which various models including MFs, *distributed manufacturing* and *closed-loop production systems*, may fall. Though both emphasize localization and material circularity, MFs typically refer to technologically enabled, compact and highly adaptable production units. Clarifying this distinction is essential to avoid conceptual overlap and to accurately interpret the findings presented.

Table 4.2. Conceptual distinction between LCPSs and MFs.

	Local Circular Production System (LCPS)	***Microfactory (MF)***
Definition	Broad, systemic framework for localized, circular production	Compact, adaptable unit for local, resource-efficient manufacturing
Scope	Systemic and place-based; includes social, economic, and environmental dimensions	Operational and technical; focused on production efficiency and localization
Technological Emphasis	Technology is accessible, pragmatic, and embedded in local contexts	Often technologically advanced (e.g., additive manufacturing, automation)
Primary Goal	Regenerative systems prioritizing community agency and systemic change	Waste valorization and efficient, small-scale production of needed goods
Scale & Network	Often involves networks (e.g., hub-and-spoke) with collaborative circularity	Typically, modular and independent, though can be networked
Output	E.g. Infrastructure products, furniture, tools tailored to local needs	E.g. 3D-printed parts, recycled-material goods, small-scale manufacturing products

To begin with, the interview data underscore a shared vision among participants: one in which communities regain control over material flows, reframe waste as a resource, and co-create production systems aligned with local values and needs. Importantly, LCPSs are not defined solely by their technological infrastructures, production scales, or specific outputs.

Rather, they are shaped by the social, economic, and environmental contexts in which they are embedded. As such, LCPSs signal a paradigmatic shift, from extractive and linear supply chains toward regenerative, resilient systems that are rooted in place and designed for circularity.

Shrimp explains that the aim is not to create fleeting consumer goods, but to build meaningful infrastructure from waste. They use the concept of microfactory, describing it as *"*local communities handling their own waste stream so that it doesn't have to go to landfill or incineration, to create locally necessary infrastructure products." At its heart, the system is about reclaiming agency over material flows and value creation within communities. It reorients production away from global, extractive models and instead uses local waste as a resource to serve local needs, what Shrimp describes as turning "these lemons that [the island] is being fed into lemonade for [the island's] community." This transformation is not just environmental, but social and economic. It enables local ownership, upskills residents and retains value within the community.

These systems stand apart in their holistic and systemic nature aimed to create long-term behavioral and structural shifts. As Shrimp puts it: "A circular economy model is systemic. It's not something that you can make a quick buck. It's never going to be the next Amazon or the next Uber. It's something that you want to change people's attitudes, behaviors and have a long-lasting impact with." The vision of the microfactory centers on producing locally necessary and durable products rather than "trinkets" destined for landfill: "We want to make long lasting products, from furniture to car bumper to supermarket trolleys, and embed the carbon that is already in the polymers into products that are used locally."

Something else that distinguishes LCPSs is their ethos: they prioritize local ownership, adaptability and traceability. Companies like Seagull and Dolphin emphasize the importance of managing every stage of production internally, enabling transparency and oversight. Seagull's approach of end-to-end, in-house manufacturing gives them the ability to monitor and optimize energy use at every point. Similarly, Dolphin builds its value chain on local labor and knowledge: "We find that it's most cost effective in terms of direct impact going towards the community, but also they're the ones that are most experienced with those specific communities and their needs."

Technology in local circular systems tends to be accessible and pragmatic, allowing for diverse levels of entry. As Crab notes, high-end machinery isn't required to get started: "You can literally start with a sandwich toaster. Don't even need a sandwich toaster. You can just start with an iron." The openness of these spaces to community input is a defining feature. Innovation often emerges not from technical expertise alone, but from everyday creativity and collaboration. "Some of the best ideas might even come from people who don't necessarily have a background in any of it," Crab explains.

As for structure, while networks like hub-and-spoke models or satellite systems are not essential to the definition, they are often employed to increase reach, impact and efficiency. Seal, Puffin and Octopus all describe networks of modular facilities, whether they be containerized rural spokes or mobile satellite units, as tools for scaling without sacrificing local responsiveness. Puffin explains that it's about "condensing that global supply chain into a region. [...] The spokes could actually be units that support the hubs, or they could actually be almost their own mini hubs." Still, these systems don't require every unit to independently close the loop; instead, the network as a whole achieves circularity. Puffin clarifies this: "The facility doesn't have to, but the networked model has to."

Ultimately, LCPSs aim to reclaim social, environmental, and economic agency by embedding circularity into the places and people often left out of global value chains. They are built on relationships over scale, adaptability over standardization, and stakeholders over shareholders. As Puffin puts it, they challenge "Friedman shareholder-based capital models" by centering "stakeholders [as] communities more broadly, but also the planet."

4.2 Business Model Strategies

This section presents key empirical findings addressing the second research question: How can business model strategies enable Local Circular Production Systems to achieve long-term economic sustainability while maintaining environmental and social impact?

Based on interviews with organizations engaged in various aspects of circular production, the findings highlight business model strategies that support LCPSs in balancing financial viability with environmental and social objectives. This section first examines the value propositions identified across the different organizations, before discussing value capture mechanisms such as revenue diversification, funding strategies, and cost structures. Finally, it explores how these organizations actively work to achieve environmental and social impact alongside their economic goals.

4.2.1 Value Proposition

The organizations interviewed demonstrate a wide spectrum of product offerings, strategically tailored to align with their environmental missions, resource availability, and target markets. While these offerings vary from pellets and raw materials to infrastructure components and consumer lifestyle goods, they share a common purpose; turning plastic waste into value.

Product Offerings

To better understand the strategic role of different products, the offerings are grouped into four overarching categories based on their function and market orientation. These categories reflect distinct approaches to value creation of plastic waste, as summarized in Table 4.3 below. Some organizations operate upstream, converting waste into materials as *Sustainable Material Providers*, while others focus downstream on producing either *End-consumer Goods* or industrial applications, including *Circular Industrial Solutions* or *Construction & Infrastructure Materials*.

Table 4.3. Overview of the product offering categories.

Offering Category	***Description***	***Organizations***
1. Sustainable Material Providers	Intermediate recycled materials for use by external manufacturers (e.g. pellets, yarn, sorted plastics)	*Walrus, Octopus, Dolphin, Herring, Orca*
2. End-consumer Goods	Products aimed at individual consumers (e.g., apparel, accessories, home goods)	*Octopus, Crab, Orca, Puffin, Dolphin*
3. Circular Industrial Solutions	Custom B2B solutions for use in logistics, industry, or retail (e.g., trays, pallets)	*Penguin, Seal, Albatross*
4. Construction & Infrastructure Materials	Long-life larger plastic products (e.g. lumber, furniture, estate materials)	*Seagull, Shrimp, Puffin*

A clear trend among several organizations is the pursuit of scale as a lever for impact. This is evident both in the strategies of material providers, who embed circular materials into large supply chains, and in producers of infrastructure-grade goods designed for long-life cycles and high-volume deployment. Seagull demonstrates this: “We’ve really gone down the commodity material route because we think that volume is essential. Volume is impact for us." These models often depend on securing institutional demand and navigating more complex value chains. On the other hand, Circular Industrial Solutions, offers less public visibility but more operational leverage. These offerings are especially appealing to organizations aiming for system-level change and scalable, repeatable contracts rather than consumer brand engagement.

Organizations in End-consumer Goods focus on products such as eyewear or surf accessories. While smaller in scale, these items are highly visible and emotionally engaging, often doubling as storytelling tools that raise awareness and strengthen local community ties. As Crab articulates, the primary objective is therefore not financial gain but meaningful impact: "It's not about making money. It's about making an impact, and that happens when we scale the solution."

Together, these strategies highlight how circular organizations adapt their product choices to match their mission, market position, and infrastructure. Whether prioritizing volume, visibility, or value-chain control, the offering is a deliberate expression of both impact ambition and creating a viable business.

Connection between Product Offerings and LCPS Typologies

The four offering categories *Sustainable Material Providers, End-consumer Goods, Circular Industrial Solutions,* and *Construction & Infrastructure Materials*, occur in different combinations across the interviewed cases. While some organizations focus narrowly on one product category, many engage in hybrid strategies, offering multiple types of products to diversify revenue streams or increase systemic impact. For example, Octopus operates both as a Sustainable Material Provider and a producer of End-consumer Goods, leveraging its modular infrastructure to serve both upstream industrial clients and downstream consumer markets. Understanding these patterns reveals the functional alignment between an organization's structure and its position in the value chain. Drawing on the system typologies introduced earlier, this section explores how product strategies are shaped by the underlying organizational logic. Each typology carries specific infrastructural capabilities, partnership dynamics, and degrees of vertical integration that either enable or limit certain types of product offerings.

Hyper-local Integrated Systems tend to favor End-consumer Goods and Construction & Infrastructure Materials. Their strong local presence, vertical integration, and close community ties make them well-suited for visible, durable, and regionally relevant products. *Hub-and-Spoke Distributed Systems* span a broader range of offerings, including Sustainable Material Providers, End-consumer Goods, and Circular Industrial Solutions. Their modular structure and centralized coordination enable them to handle both consumer and B2B offerings while ensuring material quality and supply chain control. Moreover, *Adaptable Collaborative Networks* are the most versatile, offering Sustainable Materials, Consumer Goods, and Circular Industrial Solutions. By acting as system orchestrators and avoiding infrastructure ownership, they tailor their offerings to local capabilities and market needs, making them ideal for coordinating complex, multi-actor product strategies. Finally, *Circular Infrastructure Providers* specialize in Sustainable Materials and Construction & Infrastructure Materials, and occasionally Circular Industrial Solutions, to enable infrastructure and feedstock for others in the circular plastic ecosystem.

Conclusively, the product offering strategy is not merely a market decision, but an outcome of organizational architecture. Product offerings emerge where infrastructure, governance, and local integration enable them, making the system typology a critical determinant of what circular value creation looks like in practice.

4.2.2 Value Capturing

A core challenge for circular production organizations is how to design business models that enable economic sustainability, while still delivering on environmental and social objectives. This section presents how the interviewed organizations capture value through diversified revenue streams, managing operational costs, and navigating profitability trade-offs.

Revenue Streams

While most of the interviewed organizations rely on the sale of products, materials or a combination of these, their business models often involve a diverse mix of revenue streams. This diversification is essential for navigating the challenges of a CE context, where margins are thin, and customer willingness to pay for recycled products remains uneven. The revenue strategies used often reflect the organization's product offering and target segment, as outlined in Section 4.2.1. Below is a breakdown of the most common types of revenue streams observed in the study.

1. Material Sales

Revenues through material sales directly correspond with the product offering of *Sustainable Material Providers*. These organizations specialize in producing intermediate materials, such as recycled pellets, yarn, or sorted plastic fractions, which are then sold to external manufacturers. While these inputs typically have lower profit margins than finished goods, they enable larger processing volumes and unlock long-term partnerships with high-volume buyers. As Octopus notes: "We don't expect the pellet to make lots of money, critically, what the pellets are about is providing a solution for as much of this fishing gear as possible. If we can sell it on a small margin above cost price to keep everything going, keep everything expanding."

To address cost-related challenges, many organizations focus on industries that can support premium pricing strategies, such as textiles, automotive, and packaging. Dolphin identifies the textile sector as particularly promising, citing its high volume and relatively high product value. Although recycled materials may carry a price premium compared to virgin nylon, Dolphin notes that this additional cost becomes marginal when considered on a per-garment basis rather than per kilogram, making it more acceptable within the context of apparel production.

2. Product Sales

Product sales are one of the most common revenue models among the organizations, particularly those offering *End-consumer Goods* and *Construction & Infrastructure Materials*. Beyond revenue generation, these offerings act as storytelling vehicles, embedding narratives of circularity, ocean recovery, and community empowerment directly into tangible products. Several of the interviewees emphasize how their products are positioned as "solutions to a problem", helping to shift perceptions of waste while promoting marine conservation. For instance, Octopus strategy is to create products with purpose and genuine value: "Obviously it is a pollution issue, but also a value. These materials were going into the environment and there was a way of them being reused, if they could be put into something that people actually valued."

Different distribution channels are used depending on the target market. Some organizations prioritize direct-to-consumer sales via e-commerce and local markets. Crab highlights strong community engagement, noting that locals were eager to participate once they could see the tangible outcomes of the recycling efforts: "they really got on board straight away." Others focus on B2B procurement contracts and public sector frameworks. For example, Puffin collaborates with city and industry partners to distribute recycled products for civic and commercial use.

3. Services

Several organizations generate revenue by offering non-physical services that complement their core operations, particularly those offering *Circular Industrial Solutions*. These include traceability systems, circularity consulting, impact reporting, and system design. As an example, Penguin charges for tracing materials and providing associated impact reporting. There is a growing demand from corporate clients for tailored circular logistics, materials management, and impact reporting, making these services increasingly valuable. Albatross explains that "it's a very strategic product that hits like eleven of the SDGs" and that it makes them "a strategic partner in driving our partners' sustainability journey." These service offerings allow organizations to monetize their know-how and infrastructure without depending solely on physical products.

4. Alternative Income Streams

Beyond product and service offerings, many organizations utilize alternative income streams to reinforce their mission and improve financial flexibility. One recurrently mentioned model that several organizations are looking into is plastic credits. Similarly to carbon credits, plastic credits represent verified volumes of recycled plastic which are issued as certificates and sold on the open market. Walrus is preparing to launch such a program to help companies offset plastic use through clean-up sponsorship.

Granting access to shared infrastructure presents a valuable opportunity for additional revenue generation. As Shrimp explains, this involves "monetizing on the high-value things that we do have, which is people who sort this stuff, machines to be able to process and manufacture more." Similarly, other organizations explore the alternative to capitalize on byproducts of their operations. Albatross recognizes surplus heat generated from factory processes as both an economic opportunity and an environmental asset. Given the national need for greater resource efficiency and ongoing energy challenges, the company aims to channel excess heat back into the district heating network, thereby contributing to a more sustainable energy system.

Community-based income models such as donations, memberships, and local fundraising also exist. For instance, individual donations and plastic collection drives contribute meaningfully to Crab's income. Furthermore, custom commissions, educational workshops, and public events serve as awareness tools but can also contribute as an income stream. Although eco-themed trophies for events like ultramarathons are a major revenue source for Crab, workshops for schools also contribute to its income.

These diversifying income streams can also strengthen community ties and increase organizational resilience. By tapping into creative and mission-aligned opportunities, organizations enhance their financial sustainability while reinforcing their broader environmental and social goals. In doing so, they build more adaptable business models that can better withstand market fluctuations and resource constraints.

Funding

Nearly all interviewees have received public or impact funding at some point, most commonly during early stages, to support infrastructure, pilot projects, or innovation. Puffin launched with a major grant from their city, while Orca operates through a global donor network supporting education and cleanup initiatives.

While grants are vital in getting circular ventures off the ground, the interviewees are nearly unanimous in their view that long-term reliance on this form of support is unsustainable. Several emphasize the difficulty of balancing mission-driven work with the administrative demands and short timelines associated with project-based funding. Moreover, once the initial funding period ends, many initiatives struggle to maintain continuity if no complementary revenue model has been established. Seagull illustrates, "You cannot keep orienting the business so that it becomes better and better at staying on this bottle," referring to grants as a baby bottle that sustains the organization. Similarly, Octopus points out that many initiatives in the sector are short-lived, as they often depend heavily on grant funding that is not sustained over time. The organization stresses that long-term success requires market viability; without economic value attached to the recovered material, such efforts are unlikely to be maintained.

Several interviewees also highlight the difficulty of accessing capital that aligns with their mission. Octopus notes that while some investors are driven by passion rather than profit, however such funding is scarce: "There aren't that many pots of money like that available, whether it's grants or investment rounds." Dolphin had the luck of securing early-stage seed funding from a global outdoor apparel company known for supporting environmental initiatives. They also get growth capital from impact-driven investors who embrace a long-term vision and support the company's mission to remove and transform ocean plastic. These types of investors, who enable companies to prioritize environmental stewardship without the constant pressure to maximize short-term profits, are seen as essential. Additionally, Shrimp highlights that access to high-impact funding varies significantly by region, noting that such opportunities are more readily available in some geographic contexts than others. For example, securing financial support is reportedly more challenging in parts of Europe, due to comparatively limited financial capacity among potential funders.

Taken together, these findings illustrate that while external funding is a necessary enabler for organizations in their early stages, it cannot serve as a long-term substitute for financially resilient business models. Grant funding and mission-aligned investments are most effective when used strategically as tools to de-risk innovation or support infrastructure development. Hence, organizations that succeed in transitioning from externally funded pilots to revenue-generating operations are better positioned to maintain their mission and scale their impact over time.

Cost Structure

Contrary to common assumptions, working with waste is not inexpensive. Interviewees consistently emphasize that plastic recycling is a high-cost endeavor, especially when competing with the low cost of virgin materials and linear disposal systems like incineration. It requires significant investment in labor, logistics, and technical processes. Penguin confirms that "the recycling cost is one of the biggest cost factors" and that "virgin plastic is just too cheap in comparison." Recycled plastics are often degraded or mixed, requiring labor intensive, manual and time-consuming sorting and processing activities. Hence, labor costs represent a significant expenditure. However, many companies deliberately opt for manual operations to support local employment and generate social value, despite the added cost.

Logistics and transportation represent significant financial and operational challenges. Marine and post-consumer plastics are typically low-density, bulky, and widely dispersed, making their collection and transport inefficient and costly. As Herring notes, the volume and inconsistency of the material necessitate full transport loads to remain viable: "Plastics from fishing gear become quite voluminous [...] and to transport it, you would almost need some kind of baler or something because otherwise it will transport air." Similarly, Albatross emphasizes that beyond economic considerations, transport-related emissions must also be accounted for. Reducing transportation not only lowers CO_2 emissions but also cuts costs.

Research and development (R&D) functions as both a critical enabler of innovation and a substantial cost driver within CE organizations. For Octopus, Dolphin, and Seagull, continuous experimentation has been necessary to develop novel applications, enhance processing methods, and increase the viability of hard-to-recycle materials. While vital for competitive positioning and technological advancement, these efforts often lack immediate profitability. As Octopus reflects, "It's kind of like you have to spend a lot but you're not necessarily going to get a lot of money back. You're just going to be able to do more good with it." Similarly, Seagull emphasizes the operational challenges associated with maintaining R&D capacity. A significant portion of staff costs is allocated to R&D personnel, placing considerable financial pressure on the organization. While maintaining in-house research capabilities is often essential for securing grant funding, doing so also introduces risk, as hiring commitments can limit flexibility and increase long-term cost burdens.

4.2.3 Market Positioning

The interviewees illustrate a range of strategies for identifying, engaging, and adapting to customer segments. Most operate within B2B contexts and build close strategic relationships with partners. Still, their market positioning is shaped and sometimes constrained by factors such as customer expectations and the need for local adaptation.

Competitive Advantage through Differentiation

Across interviews, LCPSs emphasize strategically designing products and value propositions to differentiate from cheaper virgin alternatives while simultaneously conveying their environmental and social missions. Interviewees highlight that the high costs of collecting, sorting, and recycling marine plastic make cost leadership an unrealistic strategy. Octopus explains that adopting a differentiation strategy is inevitable because they cannot compete with the price of virgin plastic for manufacturers. By positioning themselves as sustainability leaders offering added value through transparency, traceability, and environmental impact, organizations can instead create distinct value propositions that resonate with environmentally conscious customers and partners.

Across all product categories, organizations design products with the full life cycle in mind. Several interviewees emphasize that traceability of materials, from collection to final product, provides a powerful way to communicate environmental value. For example, Dolphin integrates full traceability from discarded fishing nets to consumer goods. Similarly, Octopus frames their offerings as "solutions to a problem" rather than just commodities, reinforcing the idea that their products are embedded with purpose and measurable impact. Seagull notes that traceability is increasingly important to their B2B clients, not only as a brand asset but as a strategic service that enables measurable reporting on sustainability goals, something that many of their customers' demand: "That's really important because some of our customers really want to use a low carbon or a carbon negative material. So, we need to have quite a lot of visibility on whether that diversion is really happening." Likewise, Penguin explains that they offer detailed documentation of the sustainability impact of their offerings. By helping corporate clients measure and report their environmental impact, companies align their value proposition with rising demands from investors, regulators, and consumers for verifiable sustainability performance. Accordingly, traceability and demonstrable sustainability performance are not optional features but essential differentiators for circular production organizations.

Strategic Customer Partnerships

Most interviewees operate within B2B markets to allow them to manage complexity, design for circular return loops, and retain control over product life cycles. These conditions are essential for maintaining traceability, capturing environmental data, and ensuring materials are recycled or reused appropriately. For example, Penguin deliberately avoids entering *business-to-consumer* (B2C) markets due to the challenges of tracking materials once they reach individual consumers. Penguin explains that: "The success factor is the ability to get the material back in a good way. So that's why we focus on B2B items such as the trays. They stay in the restaurant, they don't leave the restaurants and if they are broken, [the company] puts them aside and we can take them back." Working directly with larger B2B clients Penguin co-develops closed-loop systems, such as tray return programs, that preserve oversight of the product from design through end-of-life. This setup not only aligns with their sustainability commitments but also supports their clients' ESG (Environmental, Social & Governance) and circular procurement goals.

Alongside operational benefits, B2B engagement often takes the form of strategic partnerships with high-profile brands. These partnerships provide smaller, mission-driven organizations with a platform to scale their impact without needing to build standalone consumer brands. Dolphin, for instance, collaborates with sustainable mission-driven brands offering end-consumer fashion goods to integrate its recycled nylon into finished products. Dolphin explains, "We found that to be much more effective, to just find platforms where these other parties with large audiences already have an interest in telling and promoting us. It is much more effective to equip them with our storytelling." These alliances amplify the visibility of the organization's environmental mission while leveraging the marketing power and credibility of established partners. Orca adopts a similar approach, collaborating with global brands, such as a major international sportswear company, to connect their materials with broader narratives of ocean conservation and innovation.

It is evident that the B2B orientation and strategic partnership model allow circular production organizations to scale effectively while maintaining the control, traceability, and alignment necessary to uphold their environmental and social commitments. This combination emerges as a central pillar of viable business model strategies within the CE.

Market Scale

A central tension in circular business models is the trade-off between local production and the limited market scale or infrastructure found in local contexts. This can be exemplified by Herring, who despite operating a well-developed local collection and sorting system, remains unable to process or sell its materials regionally due to a mismatch between the scale of its waste streams and the capacity or willingness of nearby actors to manage them.

Similarly, many highlight the constraints of remaining small and local, noting that limited scale often precludes access to economies of scale and necessitates positioning within niche markets. As exemplified by Seagull: "If you stay small, you don't get economies of scale. So, your products need to be sold for a premium that often therefore are sold in slightly more boutique markets." Expanding beyond the local context becomes essential not only for growth, but for achieving a viable business model. Having high market penetration increases the potential to fully support the business model within that market alone. Consequently, to remain strictly local, either quality or price has to be compromised in order to attract a larger market share, as noted by Seagull: "If you want to stay on the local market, you often need a lower price to attract them, or compromise with a lower quality product." Hence, geographic expansion is necessary to access customers who both recognized the value of their offering and could meet the associated price point.

In conclusion, while local operations support the core principles of circularity, achieving financial sustainability frequently demands scaling up or out. For many circular production enterprises, success hinges on balancing local impact with broader market access, whether through cross-regional partnerships, diversified sales channels, or strategic positioning in higher-volume markets.

4.2.4 Achieving Impact

A central theme emerging from the interviews is that circular production organizations are, above all, driven by a mission to create positive environmental and social impact. Their business models are carefully crafted to enable impact at scale, often by embedding it into the core of their operations, partnerships, and product offerings.

Environmental Impact

Most organizations are founded on a desire to address plastic pollution, particularly in marine environments. As Dolphin describes their work: "We've been working for 11 years now on finding positive end of life solutions for end-of-life fishing nets. So, we do it by working really together with communities, and fishing communities specifically, and basically providing fishermen environmentally sound options for when their nets are no longer used to them." The interviewees contribute to environmental sustainability through a variety of approaches; cleaning up existing waste, diverting plastic from incineration, and reintegrating materials into existing value chains or new, valuable products. Several organizations have waste recovery systems in collaboration with local actors, especially fishermen and municipalities, to intercept before ocean-bound plastic waste enters the environment. Octopus engages in both beach cleanup activities and partnerships with fishermen to facilitate the recycling of collected waste into pellets. In addition to supporting community-led recovery efforts, the organization provides free collection bins and containers for end-of-life fishing gear at harbors of various sizes. Demonstrating that someone's waste can become someone else's resource not only reduces reliance on virgin plastic but also communicates a powerful message about circularity: "We're not just recycling, we're redefining the value of waste. That's how you shift perspectives and create long-term environmental outcomes," as phrased by Seagull.

Environmental impact is further advanced through educational initiatives such as workshops, school programs, exhibitions, and creative collaborations aimed at raising awareness about plastic pollution, particularly among the fishing community and younger generations. For Orca, education is a huge part of their business: "All of our teams work with youth, they work with schools. Connecting kids as much as we can to their oceans, to their natural environment, to their community, is going to be what's going to change our future." Others engage in similar activities, such as Crab who partners with schools and local communities to host workshops, or Octopus who distributes demonstration pieces and learning tools to support circular education. These efforts reflect a belief that impact is not limited to waste recovery but also involves shifting consumer mindsets and sparking broader cultural change.

Social Impact

The findings suggest that, in parallel with environmental goals, LCPSs are deeply committed to generating social value. Many organizations embed social impact directly into their business models by fostering inclusive employment, empowering local communities, and creating meaningful educational and economic opportunities.

A central strategy among the interviewed organizations is localization of production and ownership. Orca ensures local ownership of impact by building teams that are deeply rooted in the communities they serve: "Everyone who works on those teams, lives and breathes in those countries." In the same way, Dolphin aims to achieve social impact in the local communities by a shared value model and Orca by differentiating their response depending on the scale and resources of their partners. Orca compensates individual low-income fishers directly for the materials they provide, whereas for larger commercial fisheries with established infrastructures, the company channels funds to local nonprofit organizations that carry out community development projects. This strategy extends the impact beyond waste removal by generating additional social value in the surrounding areas.

Another commonly occurring way of incorporating the social mission is by working with local job creation. Puffin for example deliberately locates and designs its production facilities to maximize social benefit, emphasizing that "when you move the material, you're actually also moving the jobs." Rather than relying on highly automated processes, they prioritize labor-intensive operations to generate livelihoods: "There's so much conversation right now around automation [...] but there are also 7 billion people in the world, and so the need for livelihoods and jobs is also there." Inclusive employment is a core part of their mission.

Puffin tries to create different points of access and pathways regardless of educational levels of attainment, which includes hiring individuals who have been previously incarcerated. The initiative also targets systemic youth unemployment, particularly among those not engaged in work or education. Herring also integrates workplace training into its daily operations, providing opportunities for individuals who have been excluded from the workforce due to illness, mental health, or other challenges to gain experience and reintegrate into working life. Moreover, Seal structures its model around local control, ensuring that machines are operated and maintained by community members. The interviewee explains that this creates jobs, fair salaries, and empowers the community. Through localized production, inclusive long-term employment and work training, these organizations generate livelihoods, reduce inequalities, and build resilient local economies.

4.3 Success Factors for Circular Business Models

The interviews reveal several critical challenges faced by organizations implementing circular business models. Two primary challenges emerge in relation to environmental and social impact, one at the inception stage and another affecting long-term sustainability. Similarly, two distinct challenges pertain to financial sustainability, concerning both short-term viability and enduring organizational survival. This section addresses these four dimensions by identifying and analyzing the key success factors that enable companies to effectively navigate the complexities of a CE. In doing so, it responds to the research question: *What are the key success factors when implementing circular business models?* Table 4.4 below summarizes the success factors identified in the interviews, mapping them onto the specific challenges they address across different time frames of circular business model implementation.

Table 4.4. Challenges and their related success factors.

Dimension	***Time Frame***	***Challenge***	***Success Factors***
Environmental and Social Sustainability	Inception	Changing the mindset from linear to circular	‣ Community engagement and visibility ‣ Education and awareness building ‣ Local ambassadors and strategic partners ‣ Building trust and relevance ‣ Navigating regulations

	Long-term	Verifying and tracing environmental impact	‣ Third-party certification ‣ Transparent traceability systems, such as digital chain-of-custody solutions
Financial Sustainability	Short-term	High entry barriers, capital demands, and uncertain demand	‣ Entrepreneurial mindset (small-scale, agile, iterative) ‣ Openness and inclusivity ‣ Aligning with existing customer demand
	Long-term	Ensuring financial resilience and operational continuity	‣ Financial self-sufficiency as enabler of impact ‣ Combining revenue streams ‣ Strategic compromise and adaptability ‣ Starting small and iterating (minimum viable product approach)

4.3.1 Changing the Mindset from Linear to Circular

One of the most commonly cited challenges among the interviewed organizations is the need to shift deeply ingrained mindsets. Beyond technical adaptation, moving from a linear to a circular business model requires a fundamental transformation in how value is understood, how decisions are made, and how collaboration is fostered.

Several interviewees emphasize that many customers and stakeholders are still locked into a profit-first, efficiency-oriented logic that underpins the traditional linear economy. Penguin mentions that "the linear economy has formed the investment and decision processes in our customers," and elaborates that legacy procurement systems are still based on outdated standards. Likewise, Albatross describes the difficulty of working within industry structures where customer standards were established before circularity became a consideration. This reliance on linear standards makes it more complicated for circular innovators to introduce new solutions, even if they are environmentally superior and more resource-efficient in the long run. "Even though it makes a lot of sense to move to a circular product that can be used over and over again, people are so used to the linear way of doing things," Penguin explains.

Additionally, interviewees note that consumer appreciation for impact does not always translate into willingness to pay higher prices, particularly in more traditional or cost-sensitive markets. Albatross shares their challenge in converting interest into actual business:

“Everyone says that sustainability is important, but very few actually drive sustainability from a commercial perspective.” This points to a gap between value-driven narratives and tangible purchasing behavior, posing a challenge for financially sustainable scaling. Seal also describes this issue, noting that many companies resist circular solutions due to perceived higher costs and remain focused on profit over environmental impact. A successful strategy to change this mindset is by engaging the local community, building trust and making the circular transition visible, participatory, and relevant. Crab, for example, involves residents directly in the transformation process, allowing people to bring in plastic waste and watch it in real time as it is being processed into products: “They can stand in the doorway [...] handing it over, and they can see that it’s being shredded in the back, melted in the front, and in the window as products.” Puffin and Octopus also emphasize the importance of involving people in the process, allowing them to see waste turning into value and at the same time building a sense of ownership and pride.

Furthermore, engagement with strategic partners and community ambassadors emerge as a critical success factor. Seal highlights the importance of having both influential customers and trusted local connectors: “It helps having influential partners, but most of all, having somebody from the community.” Hence, local engagement is more important than traditional top-down partnerships, especially in tight-knit or skeptical environments such as fishing communities, where outsider interventions often are met with resistance. To enable lasting change, many organizations invest in education and awareness building. Dolphin teaches fishermen about the long-term environmental damage of plastic nets as behavioral change is only possible once people understand both the consequences and the inherent value of waste. “When they know there’s value tied to it, they’re not going to throw it away,” Dolphin clarifies.

Finally, interviewees discuss the role of regulations and policy frameworks in reinforcing or impeding mindset shifts. While regulation can serve as a critical driver for circular transformation, delays and inconsistencies are frequently cited as barriers. Penguin expresses concern over repeated delays in implementing EU circularity targets. The lack of clear and enforceable regulations creates uncertainty, making it challenging for businesses to commit to sustainability actions. Other organizations, like Herring and Albatross, emphasize the need to proactively engage with emerging policies such as extended producer responsibility and CE roadmaps, while still maintaining independence from public subsidies.

Evidently, changing mindsets is one of the most foundational and persistent challenges in circular business model implementation. Success depends not only on having a compelling product or system but on the ability to build local trust, demonstrate value, educate stakeholders, and navigate the cultural and structural legacies of the linear economy.

4.3.2 Lasting Impact through Verification and Traceability

A considerable challenge for circular plastic production facilities is the discrepancy between public perception and the reality of plastic waste volumes. As Octopus explains, "what you don't see behind the scenes is way, way more plastic. There's so much, crazy amounts." Despite the scale, Octopus notes that the primary incentive for brands to use recycled plastic is enhancing their image and marketing appeal. This suggests that without consumer visibility, brands lack motivation to invest in recycled materials. In addition, the industry faces widespread concerns about greenwashing. For recycling companies, it is essential to demonstrate credibility, not only to customers, but also to partners and stakeholders. Long-term commitment depends on trust, and that trust requires more than claims; it requires verifiable action.

To address these issues, interviewees emphasize two key success factors: third-party verification and material traceability systems. Third-party certification is seen as a minimum requirement for credibility. According to Dolphin: "Third-party verification, that's a must. [...] Someone that's an expert in this area, that's completely independent of you, has to look at what you're claiming and verify it." They highlight B Corporation status as a practical approach, providing a trusted third-party verification that adds credibility to sustainability claims. Equally critical is traceability, being able to track materials throughout the supply chain. Technologies such as Seal's tracking and tracing, Seagull's digital system and Walrus's chain-of-custody model help ensure transparency. As interviewee B at Walrus clarifies: "The governance is really about trust. That we show that we trace the material from end to end so there is no place for any green washing."

4.3.3 Entering the Loop and Forging a Path

The plastic recycling industry presents substantial barriers to entry, including capital-intensive processes, high upfront investments, limited market demand and low profit margins. Establishing a circular production facility in this emerging sector is therefore perceived as both difficult and costly. Developing innovative solutions to close the loop on plastic use necessitates extensive research and experimentation. However, Octopus explains that the R&D side is incredibly expensive and takes a lot of effort. Nonetheless, such investment is considered crucial for expanding the applicability of recycled plastics.

Based on interview insights, three key success factors emerge for companies navigating these challenges. Firstly, a strong entrepreneurial mindset, characterized by small-scale beginnings, agility and iterative experimentation, proves foundational. Crab exemplifies this approach, describing the early phase as: "I just sort of, you know, rented the shop and opened the doors type of thing." Emphasizing the value of resourcefulness, Crab explains that success relies less on expensive equipment and more on passion and creativity.

Secondly, openness and adaptability are essential. Crab highlights the value of inclusivity and communication: "It's very much about being completely open and approachable. [...] Talk to everyone because actually sometimes some of the best ideas might even come from people who don't necessarily have a background in any of it." Similarly, Orca stresses the importance of continuous and proactive planning to expand and sustain long-term impact.

Lastly, aligning operations with existing customer demand is critical. Seagull echoes this, noting that "demand will power the chain." However, this goes beyond identifying demand, it involves avoiding a common pitfall among circular economy entrepreneurs. As Seagull warns, "it's very easy to be in love with your supply chain, when you need to be in love with your customers." This customer-centric orientation is key to commercial viability, as Crab agrees with: "I'm not sitting here trying to think what would the customers want, when the customers are telling me what they want."

4.3.4 Securing Long-term Survival

Another challenge for circular production organizations lies in achieving long-term operational and financial resilience. While many initiatives are driven by strong environmental and social missions, several interviewees emphasize that a failure to secure consistent income streams often causes promising projects to dissolve once initial funding runs out. This risk is particularly evident in organizations that begin with grant funding but fail to transition to financially sustainable, self-supported business models. Without establishing clear value and stable revenue streams, many initiatives emerge temporarily but eventually cease operations once grant support ends, Seagull explains.

A key insight from the interviews is that financial self-sufficiency is not in opposition to impact, but rather a precondition for sustaining it. Several organizations describe this as a necessary trade-off: while the focus remains on maximizing positive outcomes rather than profits, a functioning business model is essential to continue delivering those outcomes at scale. Several interviewees agree that the financial aspect is not about generating large profits, but about covering the costs necessary to sustain and expand recovery efforts. Orca articulates the challenge as one of efficiency: "The trade-off is usually as much impact as you can have from as low of an operational or CapEx cost as you can have." Moreover, profitability is repeatedly described as offering strategic freedom. Seagull believes that "if you're a profitable business, the degrees of freedom you have to stay in the world and continue to serve the world are far greater." This framing repositions profitability not as a goal in itself, but as a strategic tool that enables independence, adaptability, and reinvestment. Another common success factor is the combination of revenue streams, as described in 4.2 Business Model Strategies. These diverse models help organizations reduce risk and adapt to fluctuations in market demand, regulation, or funding landscapes.

Importantly, several interviewees caution against perfectionism and over-optimization, referred to as The Innovator's Dilemma. Instead, a "start small and iterate" approach is seen as more viable in the long term. Crab's philosophy emphasizes the importance of launching simple, meaningful products rather than waiting to develop the perfect solution. This approach also aligns with ideas such as the Minimum Viable Product and Satisficing, which prioritize learning and adaptability over ideal, yet unsustainable outcomes. Seagull concludes that "we need to be effective businesspeople. [...] You have to have an ability to dirty your hands slightly. [...] If you refuse to make any compromises, that's OK, but you've chosen to work within a transactional system, and you need to understand what that means."

In summary, long-term survival in circular production requires more than a promising idea or environmental mission. It calls for the ability to navigate the tension between purpose and practicality by generating revenue, making strategic trade-offs, staying adaptable, and scaling sustainably. Those who succeed are often those who recognize this early and design business models that evolve without compromising their core impact objectives.

5. Discussion

This chapter critically examines the theoretical and managerial implications of the study's findings. By exploring how LCPSs are operationalized by organizations recycling marine plastic waste, the discussion aims to bridge the gap between practice and theory. The insights contribute to developing a framework for CBMs that integrate economic, environmental, and social objectives without one dimension compromising another, offering guidance for actors seeking to implement LCPSs in similar coastal communities.

5.1 Theoretical Implications

This section situates the study's findings within the existing body of literature on CBMs and local sustainable development. It examines how these findings align with, diverge from, or extend theoretical frameworks such as the ReSOLVE framework. Particular attention is given to defining LCPSs, understanding the operational dynamics of balancing *profit* and *purpose* in hybrid organizations, and comparing value creation logics and business model configurations across LCPS typologies.

5.1.1 Contribution to Circular Production Systems

This discussion explores how the concept of LCPSs manifests in practice, comparing theoretical frameworks with insights from the twelve interviews conducted with organizations recycling marine plastic waste. The section challenges, refines and advances understanding of current concepts related to LCPSs, to then conclude with a refined definition of LCPSs.

Rethinking "Local"

In theory, LCPSs are described as decentralized, resource-efficient, and integrated systems that leverage localized recycling and digital fabrication, as illustrated in Srai et al.'s (2016) concept of distributed manufacturing. The findings from this study reaffirm many of these attributes, particularly in terms of decentralized operations and the use of local resources. However, the interviews suggest that *local* extends beyond geographical proximity. It signifies being deeply embedded in the community: socially, economically, and operationally.

End-to-end in-house production, commonly found among the interviewees, enhances control over energy use and quality, reinforcing the resource efficiency aspect of LCPSs. For example, one organization identifies surplus heat generation during production and expresses a desire to redirect this excess energy back into the district heating network, thereby enhancing overall resource efficiency. This practice reflects the regenerative principles of CE as defined by Geissdoerfer et al. (2017), where energy leakage is minimized through the narrowing and closing of energy loops.

Furthermore, the emphasis on community empowerment, particularly the inclusion of waste pickers and local labor, supports Buch et al.'s (2021) argument for bottom-up circular strategies. Yet, a key insight often underdeveloped in current theory is how LCPSs actively build local infrastructure from waste, addressing community-specific needs in highly contextualized ways. As noted above, Shrimp skillfully states, "We want to turn these lemons that [the island] is being fed into lemonade for the [the island's] community" a phrase that captures both the resilience and place-based orientation of these systems.

Circularity in Practice

Theoretical models often emphasize closed-loop production as the ideal for circular systems (Juraschek et al., 2017). However, this research reveals that few local systems achieve fully closed loops in their primary operations. Instead, circularity is often partial and collaborative, involving reuse, recycling, and remanufacturing within broader, semi-closed networks. Organizations like Seal and Penguin are exceptions, managing to reintegrate products back into commercial supply chains, but this is not the norm.

Contrary to theoretical expectations of LCPSs being supported by low-cost and easily deployable technologies, machinery emerges as a significant challenge for many organizations. Buch et al. (2021) describe local production systems as utilizing "accessible, low-cost recycling technologies" and micro-manufacturing setups. However, findings from this study suggest a more complex reality. While technologies such as injection molding, compression molding, and open-source solutions like Precious Plastic are commonly used, they are rarely inexpensive or easy to integrate. Puffin, for instance, faced major adaptation challenges when importing machinery from China, stating: "It was and is extraordinarily hard to find small equipment. That was one of the first things we learned, [...] you either have Precious Plastics or industrial scale."

Even minimal setups can be creatively improvised. Crab uses a sandwich toaster to recycle plastic waste, but this is more a testament to entrepreneurial ingenuity than a reflection of system simplicity. Although open-source platforms lower the threshold for entry, organizations still face substantial financial and technical barriers in acquiring equipment that matches their scale and waste stream. In practice, advanced technologies such as additive manufacturing, emphasized by Teigland et al. (2025), remain the exception within LCPSs, typically appearing in the operations of downstream partners rather than forming the backbone of local production systems themselves. Hence, while LCPSs are pragmatic and accessible in spirit, they are neither inherently low-cost nor easily implementable without external support.

One of the strongest alignments between theory and practice in LCPSs is their demand-driven nature. As highlighted by Teigland et al. (2025) and Srai et al. (2016), these systems are characterized by flexibility, scalability, and the ability to respond swiftly to customer needs through just-in-time production and adaptive capabilities. This is consistently reflected in the interviews, where demand is not merely a logistical factor but the primary force shaping operational models and product strategies. Seagull captures this concisely: "Demand will power the chain." For LCPSs operating with thin margins and high setup costs, responsiveness to demand is not optional, it is essential for survival. Locational choices are made not only to align with waste availability but to remain close to markets, enabling agile production and strong customer relationships. For example, Crab includes customers directly in the creation process, turning production into a co-creative act. Others, such as Penguin and Octopus, focus on long-term B2B partnerships, building holistic value propositions that include take-back schemes and durable product design. In contrast to traditional economies of scale, LCPSs rely on economies of scope and adaptability. They are built on relationships, customization, and responsiveness, making them inherently demand-driven by design.

Circular Production as a System

Existing literature often lacks a holistic understanding of how LCPSs function as systems. While supply chain integration is acknowledged (Santibanez Gonzalez et al., 2019), the deeper systemic balance of financial viability, environmental stewardship, and social value remains underexplored. This research addresses that gap by illustrating how LCPSs operate as interconnected systems rather than isolated production sites.

Scaling in this context is not about expanding single units but replicating adaptable, modular factories within decentralized networks. As Andrés et al. (2022) emphasize, conquering challenges in local scaling and production optimization is critical. Interviewees reinforce this, revealing a growing trend toward networked models such as hub-and-spoke or the informal notion of satellite systems, evident in Seal, Puffin, and Octopus. These networks extend impact while retaining local relevance and responsiveness.

Importantly, the findings on LCPSs advance our theoretical understanding by emphasizing that circularity can emerge at the system level rather than being confined to individual production sites. As Puffin aptly puts it, "The facility doesn't have to [close the loop], but the networked model has to." This insight reflects a key distinction: circular impact can be distributed across interconnected nodes, rather than embedded within a single, self-sufficient unit. For instance, Crab operates as a fully integrated, end-to-end facility, whereas Seal achieves circularity through a networked hub-and-spoke model. This structural flexibility is critical to the scalability and adaptability of LCPSs yet is often underrepresented in existing frameworks.

The findings also support Santibanez Gonzalez et al.'s (2019) conception of circular systems integrating both forward and reverse supply chain flows. Different LCPS typologies reflect this: *Circular Infrastructure Providers* focus on upstream value creation, while *Adaptable Collaborative Networks* like Penguin serve as connectors and material aggregators, and *Hyper-local Integrated Systems* manage full-cycle, place-based production. These models demonstrate that LCPSs are not fixed or uniform production sites. Rather, they are dynamic and responsive architectures, designed to adapt to local conditions, foster collaboration, and evolve as part of broader circular ecosystems.

Alignment with the ReSOLVE Framework

The findings from this study demonstrate a strong yet implicit alignment between the operational strategies of LCPS organizations and the six action areas of the ReSOLVE framework, i.e. Regenerate, Share, Optimize, Loop, Virtualize, and Exchange (Ellen MacArthur Foundation, 2015). Although the Ellen MacArthur Foundation's terminology is not explicitly referenced by the actors themselves, their practices reflect a practical application of CE principles.

Regenerative efforts are evident across typologies, particularly through localized ecosystem restoration and material recirculation strategies such as marine plastic collection and reintegration into long-life infrastructure products. The principle of Sharing emerges in modular design, reuse of assets, and strong inter-organizational collaborations that maximize the use of infrastructure and knowledge across both grassroots and institutional levels. Optimization is integral to most LCPS models, as they streamline processes, minimize transport through local integration, and leverage digital tools to increase operational efficiency. Looping is foundational, with organizations embedding take-back systems, material traceability, and open- and closed-loop strategies that facilitate recyclability and repeated material use. While Virtualization is less pronounced in physical production, digital platforms and service-based models such as circularity consulting, impact reporting, and e-commerce extend both reach and flexibility. Lastly, Exchange is actively demonstrated in the adoption of novel materials through experimenting with different additives and mixing plastic types, manufacturing technologies, and innovative service models like plastic credits and surplus energy reuse.

These action areas manifest differently across the LCPS typologies, from hyper-local systems emphasizing vertical integration to collaborative networks leveraging external partnerships. However, they all demonstrate engagement with these strategic elements in diverse and context-specific ways. This suggests that, even without formal adherence to CE theory, LCPS actors are already enacting its core principles in practice, illustrating the practical relevance and adaptability of the ReSOLVE framework.

The Missing Element of Entrepreneurship and Innovation

One of the most overlooked dimensions in the existing literature is the central role of *entrepreneurship* and *innovation* in the functioning of LCPSs. While theoretical frameworks often emphasize technological capabilities or system design, they tend to understate the entrepreneurial energy and iterative problem-solving that drive these systems forward. In reality, LCPSs are entrepreneurial out of necessity, operating in resource-constrained environments where adaptability and innovation are prerequisites.

Organizations like Crab, Octopus, Dolphin, and Seagull exemplify this through continuous R&D efforts, exploring new applications for waste, and innovating around constraints. Their approach blends experimentation with execution, resulting in systems that are as much innovation labs as they are manufacturing setups. As noted before, Crab justifies that “you don’t need lots of expensive equipment. You just need a lot of passion and just a little bit of creativity really.” This quote captures a defining trait of LCPSs, that is its form of grassroots ingenuity that traditional manufacturing theory often fails to capture. This entrepreneurial character reframes the systems not simply as production models, but as platforms for localized innovation. It is this capacity to navigate uncertainty and transform constraints into opportunities that underpins their long-term resilience and impact, which must be more fully integrated into theoretical understandings of circular production.

Defining Local Circular Production Systems

The discussion reveals that while theoretical frameworks offer important entry points into the concept of localized circularity, they often fall short in capturing how these systems actually function on the ground. Through a comparative analysis of theoretical models and empirical insights from practitioners, this research contributes to a more grounded and nuanced understanding of LCPSs. It emphasizes how these systems blend innovation, entrepreneurial spirit, community-rootedness, and circularity into context-specific manufacturing models. The resulting definition is not a rejection of existing theory, but an enrichment, offering a fuller, practice-informed understanding of what LCPSs truly entail:

> *A Local Circular Production System is a community-rooted, low-footprint and innovative manufacturing model that empowers local populations to handle their own waste streams, transforming them into long-lasting, locally relevant products, while generating income and environmental value through a closed or semi-closed-loop process.*

By aligning theoretical ambitions with operational realities, this definition aims to offer both conceptual clarity and practical relevance, highlighting LCPSs not as peripheral experiments, but as vital, scalable models for circular production in a post-linear economy.

5.1.2 Contribution to Hybrid Organizations

This discussion explores how circular production organizations operate as hybrid enterprises by integrating social and environmental purpose with commercial viability. Building on theories of *hybrid organizations* the discussion examines how these organizations navigate the tensions between mission and market. The analysis highlights three key themes: the balancing of profit and purpose, the strategic use of impact as a differentiator, and the seven sustainability revolutions. Together, these perspectives offer a deeper understanding of the practical governance, strategy, and value logic shaping hybrid circular enterprises.

Balancing Profit and Purpose

The concept of hybrid organizations emphasizes the integration of commercial and social missions, requiring organizations to balance financial viability with the pursuit of impact (Santos et al., 2015). In theory, this duality introduces a central tension: the risk of *mission drift*, where financial pressures begin to overshadow social and environmental goals. Ebrahim et al. (2014) argue that hybrid organizations face two core governance challenges in managing this balance, that is "accountability for dual performance objectives" and "accountability to multiple stakeholders."

However, our findings challenge the assumption that mission drift is the dominant risk. The interviewees' goal is not profit maximization, but rather economic viability that supports the continuation and scaling of impact. Almost all the interviewed organizations identify as mission-led, and many operate as hybrid organizations, where revenue generation is a means to sustain the work. As Seagull explains during the interview, "as a social enterprise, we are driven by purpose, not profit. Our mission is to create a positive impact on the environment while supporting our community." Many organizations similarly describe their objectives in terms of systemic change, not commercial expansion. The observation suggests potential reframing of Ebrahim et al.'s (2014) concern regarding "accountability for dual performance objectives". Our findings reveal that these organizations often face the inverse challenge of mission drift. This phenomenon could be described as "profit drift", wherein the dominant tension lies not in the loss of mission, but in the difficulty of securing sufficient income streams that align with deeply held social and environmental commitments.

Moreover, the challenge of "accountability to multiple stakeholders" (Ebrahim et al., 2014) echoes in the organizations' experiences with funding partners, local communities, and regulatory bodies. Rather than conflicting expectations leading to mission erosion, many organizations express a need for governance structures that could reinforce their social purpose while enabling financial resilience. This underscores the importance of designing tailored governance models, impact measurement tools, and collaborative partnerships that reflect the unique demands faced by hybrid organizations engaged in circular and mission-driven work.

The emergence of legal forms such as the *benefit corporation* supports these governance needs by embedding social and environmental objectives into the organizational DNA. As Rawhouser et al. (2015) argue, benefit corporations institutionalize stakeholder theory by requiring companies to consider the interests of a wide range of stakeholders, not just shareholders, and to publicly report on their social and environmental performance. While only a few of the studied organizations have this legal structure formally, several describe internal governance and accountability practices that closely mirror its principles. This suggests that even in the absence of formal benefit corporation status, hybrid enterprises often adopt stakeholder-oriented frameworks to legitimize their purpose-driven strategies and enhance transparency.

Conclusively, findings do not dispute the existence of tensions in hybrid organizations but suggest that in practice the threat of *mission drift* may be overstated for these types of purpose-driven organizations. Instead, the more pressing concern is how to build governance and accountability systems that allow these enterprises to thrive *economically* without losing sight of their foundational values. These findings also raise important questions about the TBL framework (Elkington, 1994). While the three pillars are theoretically equal, in practice the economic "bottom line" often lags behind, despite uncertain or unstable economic returns. This imbalance appears not due to strategic neglect, but because systemic conditions inhibit financial performance; including low willingness to pay, policy gaps, and the expensive recycling process. As organizations highlight the need for scale and structural cost efficiencies to reach long-term sustainability, the idea of simultaneously achieving balance in TBL may need to be replaced by one of *sequencing*. Many organizations prioritize environmental or social goals early on to build legitimacy, partnerships, and market entry points, using these as steppingstones toward eventual financial resilience. This dynamic approach to hybridity, relying on impact first and economics second, calls for more nuanced models of sustainable entrepreneurship in CBMs.

Impact as a Differentiator

The concept of *Strategic CSR* by Porter and Kramer (2006) offers a useful lens for understanding how sustainability can be leveraged as a competitive advantage. Many LCPSs monetize impact through services such as traceability and life cycle data, particularly those in the *Sustainable Material Providers* and *Circular Industrial Solutions* categories. For instance, Penguin offers impact documentation that helps clients report on scope 3 emissions, turning sustainability into a marketable service. This supports the idea that environmental and social impact can serve not only as ethical commitments but also as strategic differentiators. By aligning with the growing demand for ESG accountability, organizations are transforming their impact into a tangible value proposition, which is a central idea in Strategic CSR.

However, the findings also challenge some of the assumptions in the literature, particularly around financial viability. While Porter and Kramer (2006) suggest that aligning sustainability with core strategy should unlock long-term competitive advantage, this appears only partially true in the context of circular production. Organizations in this study emphasize that the strategy of monetizing impact, while essential for differentiation, does not easily translate into profitability. Albatross explains that it is especially difficult in markets where willingness to pay remains low and regulatory drivers are weak, adding that "Everyone says that sustainability is important, but very few actually drive sustainability from a commercial perspective." This insight complicates findings from prior studies (Andrés et al., 2022; Srai et al., 2016), which suggest that localized CBMs, especially those processing EoL fishing nets, enhance competitiveness and profitability. While social impact, such as job creation in marginalized communities is indeed evident, most organizations operate close to break-even at best. Walrus states that they are "almost at breakeven", and Puffin reports being "really close" to self-sufficiency. These statements reinforce that plastic recycling is far from a lucrative business, and that the pursuit of financial sustainability remains a continuous balancing act.

In addition, current literature tends to underplay the contextual dependencies of Strategic CSR. Our findings suggest that its effectiveness largely depends on the market and culture. In Northern Europe, sustainable value propositions are more likely to resonate with customers, supported by stronger regulation and greater consumer awareness. In contrast, organizations operating in regions like Southern Europe or Africa report more limited willingness to pay and lower access to aligned investment capital. Considering this, the concept of Strategic CSR could benefit from further theoretical refinement, including a deeper integration of three key dimensions. First, it should account for the geographical and cultural variability in sustainability perceptions and consumer purchasing behavior. Second, it must consider longer timeframes for realizing returns on impact investments, acknowledging that social and environmental benefits often accrue over extended periods. Third, the framework would be strengthened by incorporating standardized alternative value metrics capable of quantifying social and environmental outcomes, thereby complementing conventional financial key performance indicators.

Ultimately, the findings highlight that for hybrid organizations in CE, impact is both a moral compass and a market differentiator. However, its translation into economic resilience remains unreliable, requiring strategic partnerships, systemic transparency, and constant navigation of complex market dynamics. Consequently, Strategic CSR is not simply about integrating sustainability into business, it is about building an entire business model around sustainability, even in the absence of strong market or policy incentives.

Seven Sustainability Revolutions

Elkington's (2004) seven sustainability revolutions offer a comprehensive framework for understanding the systemic shifts needed to move from linear, profit-driven capitalism toward more sustainable circular business practices. Our empirical findings show that many of the organizations studied are already embodying these shifts in the design of their daily operations and long-term strategies. In this way, they may serve as examples of how a new sustainability logic is being implemented at the organizational level.

Markets: From Compliance to Competition towards Collaboration

Elkington frames the market transition as one from compliance to competition, where sustainability becomes a source of differentiation. Although our findings support the rise of sustainability as a differentiator, an additional shift from competition to collaboration is also evident. Many of the interviewees see themselves as part of a broader mission-driven ecosystem This is particularly visible in the ways organizations share knowledge, infrastructure, and lessons learned with others in the CE space, instead of pursuing exclusivity or proprietary advantage. As Crab articulates: "It's all about collaboration rather than competition. So, I'm always happy to share ideas and knowledge to help others set up." In doing so, they reinforce a post-competitive model, where collective progress toward circularity is seen as more valuable than individual commercial gain.

Values: From Hard to Soft

A dominant theme across the interviews is the centrality of soft values, such as environmental restoration, social inclusion, and purpose-driven work. Profitability is almost always framed as a means to sustain impact, not as an end in itself. This soft value orientation supports

Elkington's paradigm shift but also challenges traditional assumptions in business model theory claiming that economic incentives are the primary driver of organizational behavior.

Transparency: From Closed to Open

Transparency is more than a reporting tool for these organizations, it is a strategic asset. Several organizations offer traceability and impact metrics as part of their value proposition, enabling customers to incorporate sustainability into their own reporting. This open approach to data, processes, and supply chains serves both ethical and commercial purposes, signaling a maturing of transparency as a core business function.

Life Cycle Technology: From Product to Function

In line with the life cycle perspective, organizations design their offerings not as static products but as solutions embedded in broader systems. Penguin's trays return program with a global fast-food chain and Seagull's plastic lumber used in long-life infrastructure projects demonstrate this shift from product ownership to functional utility and extended life cycle thinking.

Partnerships: From Subversion to Symbiosis

Strategic partnerships are not simply transactional, but mission critical. Demonstrated by Dolphin's partnership with a large sustainable fashion brand, these organizations use partners both to scale operations and to amplify shared values. Herring's partnerships with municipalities and social services to deliver both environmental and social outcomes is another example of this symbiotic alignment, where success is jointly defined by impact and operational resilience.

Time: From Wider to Longer

Where traditional businesses may focus on short-term quarterly results, most circular organizations in our study adopt long-term horizons. Investments in community engagement, R&D, and infrastructure are made with the understanding that returns may take years to materialize. This patience, while risky, reflects a deeper commitment to system-level change.

Corporate Governance: From Exclusive to Inclusive

Lastly, many of the organizations demonstrate inclusive governance structures, whether formally or informally. This includes local hiring, co-design with communities, and stakeholder-driven decision-making. Seal's model of locally operated small-scale factories and Puffin's commitment to inclusive employment are examples of how governance can be restructured to empower rather than exclude.

Implications

This discussion affirm that Elkington's (2004) seven sustainability revolutions are not just abstract ideals but are actively being practiced, and in some cases advanced, by existing LCPSs. However, they also highlight that these transformations neither occur evenly or easily. Structural barriers, such as pricing pressures, regulatory delays, and limited access to impact capital, often constrain these organizations' ability to fully realize the potential of each paradigm shift.

5.1.3 Contribution to Circular Business Models

This section explores the interplay between the four LCPS typologies and the strategic configurations of product offerings and revenue models identified in the findings. By comparing how each typology conceptualizes value creation and business model setup to achieve circularity in plastics, the discussion reveals common patterns and divergences. The section concludes with a synthesized typology table using Antikainen & Valkokari's (2016) sustainable circular business model innovation framework, offering a multidimensional evaluation across ecosystem, organizational, and sustainability levels.

Comparative Analysis of System Typologies

This section provides a comparative lens on the four identified system typologies, examining the ways in which these typologies approach system design, strategic product offerings, and revenue generation, to uncover the varied pathways businesses are adopting to transition toward circular business models.

Circularity through System Design

The four typologies demonstrate diverse yet complementary approaches to achieve circularity in plastic manufacturing. *Hyper-local Integrated Systems* internalize the entire value chain within a geographically confined area, promoting local labor, direct community engagement, and high traceability. Their models exhibit vertical integration, either through high-quality mono-material processes or adaptable, low-tech solutions. This contrasts with *Hub-and-Spoke Distributed Systems*, which decentralize operations across satellite units while retaining central coordination to enable scale. These systems balance local responsiveness with system-wide efficiencies.

Adaptable Collaborative Networks embrace decentralization further, orchestrating circularity through a network of specialized partners. These actors often do not own physical infrastructure but manage the flow of materials and information to enable modular scalability. Finally, *Circular Infrastructure Providers* decouple production from product-making entirely, focusing on upstream material preparation and infrastructure, which are critical enablers of circularity across other typologies.

Together, these systems reflect a spectrum from self-contained operational loops to platform-based orchestration, with varying degrees of control over the physical production process.

Product Offerings as Strategic Levers

Products across the four typologies are not merely means for value capture. They function as strategic interfaces between systemic circularity, brand identity, and user engagement. Product design decisions reflect both the constraints and ambitions of each business model, especially in their capacity to influence behavior, close loops, and extend material value.

Hyper-local Integrated Systems typically produce *End-consumer Goods* or *Construction & Infrastructure Materials*, which serve dual functions: tangible outputs and powerful storytelling mediums. Their product offerings are tightly coupled with local identity and community participation. Crab's handmade surf accessories and Puffin's modular outputs are designed to be tangible representations of local stewardship and material closure. Crab's mono-material logic enhances recyclability, while Puffin's use of RFID tech enables take-back that reinforces a complete loop. Seagull, while less artisanal, uses plastic lumber to scale impact. In this case, the product becomes a platform for material absorption and environmental utility, rather than emotional or aesthetic value. The strategic lever lies in embedding recyclability and post-use returnability into the physical product.

Hub-and-Spoke Distributed Systems use products as boundary objects that tie together local collection systems and central processing efficiency. Therefore, these system's often favor *Circular Industrial Solutions* and *Construction Materials*, reflecting their capacity to serve institutional buyers at scale. Octopus's eyewear and Seal's localized flake products are designed for both symbolic and functional value. Repairability, lifetime warranties, and recycled origin not only appeal to users but legitimize the model's circular claims. Next, Albatross's infrastructure components are a compelling example of using product durability as a strategic pathway. They "lock in" carbon and prevent plastic leakage through their extended lifespans. Hence, offerings are functional, modular, and suited for system-level change.

Adaptable Collaborative Networks often use service-based or B2B products to align incentives and enforce circular behavior using their plug-and-play model, which can be enabled through a variety of different product offerings. With minimal fixed assets, these organizations focus on embedding recycled materials into broader value chains by being *Sustainable Material Providers*, especially in sectors like textiles, automotive and packaging, where scalability and traceability are crucial. Organizations in this typology can achieve this by providing *Circular Industrial Solutions*. Penguin for example helps their customers set up and maintain circular systems that turn their waste streams into closed-loop products. Products are modular and optimized for return. Additionally, these offerings can be complemented by *End-consumer Goods*, like Dolphin's sporting goods and Orca's footwear, which embody both narrative and material recycling, and are designed to make the circular story visible to consumers and partners. In this case, the product is both a physical good and a storytelling device, driving awareness, funding, and behavioral change.

Circular Infrastructure Providers consistently act as *Sustainable Material Providers*, positioning themselves upstream in the value chain. Their goal is to generate high-quality feedstock for manufacturing companies, aligning with their role as ecosystem enablers. By producing intermediates, they also enable others to innovate. In this typology, the *product* is infrastructural, such as sorted flakes, shredded plastic, or pelletized outputs, and their strategic value lies in material standardization, compatibility, and reliability. These foundational offerings, rather than final products, support a wide range of downstream applications and are distinguished by their quality and consistency.

Revenue Streams and Business Resilience

The revenue models reflect the inherent tensions of circularity; thin margins, fluctuating material flows, and evolving regulatory frameworks. The typologies differ not only in terms of how they generate revenue, but also what their revenue model enables in terms of resilience, scalability, and long-term impact. Most organizations however blend multiple income streams to ensure financial stability.

Material Sales dominate among Sustainable Material Providers, especially within Adaptable Collaborative Networks and Circular Infrastructure Providers. These streams allow for scale, though margins are slim, through adopting asset-heavy, partnership-driven models. Organizations like Dolphin and Octopus aim to access high-volume markets such as textiles as they offset lower prices per unit through volume and premium positioning. Moreover, Shrimp imagines a cooperative model where members fund operations and receive processed material. Resilience here comes from distributed ownership and localized demand. These models are less agile but potentially more durable, as they fulfill systemic functions that are hard to substitute.

Product Sales are more prominent in typologies producing tangible goods, such as Hyper-local Integrated Systems, Hub-and-Spoke Distributed Systems, and parts of the Adaptable Collaborative Networks. These sales serve both economic and symbolic functions, helping reinforce the brand's mission. Hyper-local Integrated Systems often operate on lean, low-cost models supported by community engagement and volunteer labor. For instance, Puffin, integrates research funding and partnerships to allow cross-subsidization between experimentation and product sales. Seagull has a more commercially ambitious model where they aim for scale and profitability through high-volume production, supported by R&D funding and tech-forward positioning (e.g., machine learning optimization). Hub-and-Spoke Distributed Systems, as exemplified by Octopus, generates revenue via branded consumer products, but supports it with nonprofit or event-based partnerships, creating a hybrid model. Similarly, Albatross's model is built around efficiency and collaboration: material processing fees, co-creation with partners, and a "triple win" approach align business with mission.

Services such as consultancy and impact tools play a key role for Circular Industrial Solutions and upstream actors, where proprietary systems, traceability solutions, and impact reporting offer opportunities for monetization. For instance, Penguin, Albatross and Seal belong to Adaptable Collaborative Networks and Hub-and-Spoke Distributed Systems. They derive strategic value and income by offering impact verification services. These network systems thrive on service-oriented or platform-like revenue models. Penguin earns through consultancy, operational outsourcing, and circular logistics, which scale with client networks rather than manufacturing volume. This reduces asset risk and enables rapid adaptation. Hence, the networks decouple revenue from production scale, offering resilience through value-adding services and relational capital.

Alternative Income Streams, from plastic credits and surplus heat recovery to education programs and public workshops, are vital supplements as they tie financial sustainability to social mission delivery among these community-rooted initiatives. Therefore, this approach can be seen across all typologies.

Convergence and Divergence across Typologies

While each typology employs distinct approaches, three patterns in their circular business models emerge. To begin with, all typologies balance local responsiveness with the potential for replication or networked expansion. Whether through modular microfactories or plug-and-play partnerships, scalability is seen as a pathway to impact. Next commonality is strategic diversification. Organizations pair core offerings with complementary services or alternative funding sources to reinforce their mission, improve financial flexibility, and increase overall revenue. Lastly, circularity is seen as systemic innovation. The most mature models transcend product innovation and engage with infrastructure, data, logistics, and governance to actively shape the ecosystem and accelerate circular practices.

However, tensions remain. Hyper-local Integrated Systems face challenges in scaling without compromising community roots. Circular Infrastructure Providers risk dependency on policy or municipal partnerships. Adaptable Collaborative Networks must manage complexity in multi-actor governance, while Hub-and-Spoke Distributed Systems must maintain coherence across expanding geographies.

Typology Summary Table

Table 5.1 below synthesizes the key characteristics of each typology through the lens of Antikainen and Valkokari's (2016) sustainable circular business model innovation framework. It highlights how different organizational models align with circular principles across three levels: the business ecosystem, the organizational level, and sustainability impact.

Table 5.1. Characteristics of typologies along three levels.

Typology	*Business Ecosystem*	*Business Model*	*Sustainability Impact*
Hyper-local Integrated Systems	**Drivers**: Community-driven, local waste valorization. **Stakeholders**:	**Key Activities:** Manual processing, end-product making.	**Environmental:** Low transport, high traceability. **Social**: Local employment,

	Informal networks to institutional alliances.	**Value Proposition:** Local impact, circular storytelling. **Revenue:** Product sales, workshops, donations.	education. **Economic:** Grassroots entrepreneurship.
Hub-and-Spoke Distributed Systems	**Drivers**: Modular scale-up, regionalization. **Stakeholders**: Community collection hubs, central governance.	**Key Activities:** Coordinated production, logistics. **Value Proposition:** Functional circularity, system integration. **Revenue:** B2B contracts, industrial sales.	**Environmental**: Efficient processing. **Social**: Regional empowerment. **Economic**: Scalable, repeatable revenue.
Adaptable Collaborative Networks	**Drivers**: Traceability, transparency. **Stakeholders**: Long-term strategic alliances.	**Key Activities:** Aggregation, outsourcing, platform coordination. **Value Proposition:** Verified circular input, system integration. **Revenue:** Material sales, services, licensing.	**Environmental**: Lower transport, closed-loop materials. **Social**: Distributed value sharing. **Economic**: Flexible scaling.
Circular Infrastructure Providers	**Drivers**: Upstream standardization. **Stakeholders**: Municipalities, private and nonprofit sectors.	**Key Activities:** Sorting, shredding, feedstock supply. **Value Proposition:** Reliable input for others. **Revenue**: Material sales, infrastructure access, plastic credits.	**Environmental**: High reuse rate. **Social**: Infrastructure sharing. **Economic**: Public-private synergies.

The typologies explored illustrate not only diverse pathways to circularity but also varied expressions of entrepreneurship, partnership, and innovation. By embedding sustainability into both organizational practices and wider systems of production and consumption, these models highlight how circular businesses can evolve beyond experiments to systemic alternatives. Furthermore, the discussion confirms that the theoretical foundations of CBMs are reflected across all four typologies. Value is created through material recovery and reuse, consistent with Linder and Williander's (2017) definition of post-use value creation. Strategies to reduce environmental impact through design and localized systems (Bocken et al., 2016) are evident throughout, while the ecosystemic nature of CBMs, emphasizing interorganizational collaboration, is central to their implementation (Antikainen & Valkokari, 2016). These findings support the academic framing of CBMs and contribute practical insight into how such models operate in localized, networked efforts to close the loop on plastics.

5.2 Managerial Implications

From a managerial standpoint, the findings offer actionable insights for for-profit organizations seeking to implement CBMs that simultaneously pursue *profit* and *purpose*. These insights and recommendations are synthesized into a strategic framework, informed by the structure of Antikainen and Valkokari's (2016) sustainable circular business model innovation model.

5.2.1 Recommended Circular Business Model for LCPSs

Establishing CBMs within LCPSs involves multifaceted challenges, many of which are well-established in the literature and strongly reflected in this study's empirical findings. Ghisellini et al. (2016) identify persistent barriers across the 3R principles, including design limitations that hinder disassembly and reuse, consumer resistance, and infrastructural deficiencies. These are mirrored in practice, where interviewees emphasize the high costs of recycling and local production, the difficulty of competing with virgin plastics, as well as the challenge of communicating the value embedded in circular products.

Teece (2010) argues that CBM implementation necessitates technological innovation, restructured value chains, and shifts in business practices. In line with this theory, organizations in this study report that operating in uncharted market spaces calls for new value chains, high quality control, and an optimal scale for balancing local embeddedness and economic viability. These overlaps between theoretical and practical challenges point to a clear managerial need: frameworks that address not only the technical aspects of circularity, but also its systemic and strategic dimensions. The findings indicate that the success of LCPSs hinges on more than operational efficiency. It requires deep community engagement, adaptive business strategies, and decentralized, partnership-driven models.

Building upon the preceding analysis, this study proposes a conceptual framework designed to support organizations in establishing CBMs for plastic recycling through LCPSs in for instance coastal and marine environments (see Figure 5.1). Synthesizing the principal findings and drawing on Antikainen and Valkokari's (2016) three-level framework, the model articulates how high-performing LCPSs function across business, ecosystem, and sustainability dimensions to deliver integrated circular outcomes.

Figure 5.1. Three-level framework for implementing CBMs in LCPSs (researchers' own).

This framework offers practical guidance for organizations seeking to design resilient, community-embedded, and adaptive CBMs, thereby contributing to the systemic closure of material loops in plastic recycling. The subsequent sections provide a detailed examination of each level within the proposed framework.

Business Level: Operating Models that Enable Circularity

At the core of an LCPS is a lean but adaptable business model that prioritizes modularity, visibility, and engagement. Products serve multiple roles, including tangible outcomes, storytelling devices, and circularity enablers. Many LCPSs begin with low-cost, small-scale production setups, allowing for fast iteration and localized learning. Communication and sales are not just channels to market but crucial mechanisms to build trust, create visibility, and educate stakeholders, particularly in skeptical and traditional communities.

Customer relationships are built through transparency, participatory storytelling, and service-based take-back or reuse models. Third-party certification, traceability systems, and circular design principles reinforce the credibility and functional viability of the system. Critically, successful LCPSs combine multiple revenue streams such as product sales, services, or even plastic credits, to mitigate risk and adapt to fluctuations in demand, funding, and regulation. However, for organizations to stay agile and navigate changing policies, resource access, and cultural expectations, continuous business model innovation is a must. This involves aligning operations with existing customer demand, resisting the trap of perfectionism, and cultivating an entrepreneurial mindset that embraces experimentation.

Business Ecosystem Level: Collaborative Structures for Resilience

LCPSs thrive in dense and diverse ecosystems, where collaboration, community participation, and public-private alignment generate stability and legitimacy. Unlike centralized industrial systems, LCPSs often rely on community ambassadors, local actors, and educational institutions to amplify impact and reinforce local buy-in. Here, trust is a strategic asset. Furthermore, both formal and informal strategic partnerships play an important role in scaling and de-risking operations. Municipalities, nonprofit actors, schools, and even informal labor networks can all function as enablers or accelerators. Where national regulations lag, LCPSs sometimes create soft norms or standards themselves, using transparency and verification to build voluntary compliance and investor confidence.

Sustainability Impact Level: Measurable, Holistic Value Creation

The sustainability value of LCPSs lies not only in reducing plastic waste but in creating localized circular ecosystems that regenerate social, economic, and environmental capital. Measured impacts include emission avoidance, inclusive employment, behavioral change, and increased traceability of material flows. True impact is achieved when LCPSs embed circularity into daily life, making sustainable practices visible, tangible, and accessible to communities. This requires not only technology and funding, but cultural adaptation, iterative experimentation, and the ability to balance profitability with long-term system transformation.

6. Conclusion

Drawing on empirical insights from practitioners, and Ocean Tech Hub and Circular Ocean in Peniche, Portugal, this study identifies four distinct typologies of *Local Circular Production Systems* (LCPSs): *Hyper-local Integrated Systems, Hub-and-Spoke Distributed Systems, Adaptable Collaborative Networks,* and *Circular Infrastructure Providers*. These types reflect diverse configurations of value chains, forms of partnership, and degrees of local integration. By examining the structural characteristics and operational dynamics of these systems in coastal and marine contexts, this research advances theoretical understanding of viable *circular business models* (CBMs) and how they are successfully implemented.

Amid tightening global waste regulations, most notably the EU's forthcoming ban on plastic waste exports to non-OECD countries, Europe faces an urgent imperative to internalize plastic valorization and develop circular systems domestically. With their entrepreneurial and adaptive nature, LCPSs offer a place-based response to this challenge. Operating in resource-constrained environments, they empower local communities to manage their own waste streams by converting them into durable, locally relevant products. These systems rely on modular infrastructure, strong community engagement, and continuous innovation to close material loops. Rather than being confined to single sites, their circular impact is distributed across networked structures in which interdependent actors perform complementary roles, which is essential to scalability and resilience, yet often overlooked in dominant frameworks. This study positions LCPSs not merely as production models, but as platforms for localized experimentation, value creation, and social empowerment that integrate circularity with entrepreneurial agency.

Furthermore, the study reveals that business model strategies for LCPSs are inherently shaped by their dual orientation toward environmental and social value creation alongside economic viability. These organizations often pursue diverse revenue models, ranging from end-consumer goods to the provision of raw materials, where scale is not merely a pathway to financial growth but a means to amplify systemic impact. Given the limited ability to compete on cost, differentiation is instead achieved through sustainability-led value propositions, such as material traceability, end-of-life solutions, local legitimacy, and demonstrable social contributions.

In the context of LCPSs, sustainability is not merely an operational consideration but a strategic asset and identity marker. Ensuring long-term sustainability therefore requires governance structures and accountability mechanisms that allow these enterprises to remain purpose-driven while securing the economic resources necessary to survive and scale. However, translating this impact-centric logic into long-term financial resilience proves challenging. This study reveals that rather than *mission drift*, these organizations have a persistent difficulty of generating stable income streams that are compatible with deeply held environmental and social commitments. This risk of deprioritization of profitability, suggestively noted as “profit drift”, highlights the fragility of CBMs, particularly in the absence of enabling market conditions or policy frameworks.

Responding to a fragmented research landscape where circular initiatives are often framed as purely technological or environmental, this thesis concludes with a multi-level framework for CBMs. The framework offers a practical and adaptive guide for organizations aiming to establish resilient, community-anchored LCPSs in coastal and marine contexts that generate environmental, social, and economic value in tandem. At the *business level*, success depends on lean, modular models that prioritize local relevance, participatory storytelling, diversified revenue streams, and continuous innovation. At the *ecosystem level*, strong strategic partnerships with public, private, and civic actors, forming diverse ecosystems, are essential for sustainable scale and resilience. At the *impact level*, long-term viability is achieved by embedding circularity into visible and accessible community practices through cultural adaptation, local and inclusive employment, iterative experimentation, and values-driven leadership where minimization of plastic pollution and emissions are top of mind. Together, these factors show that LCPSs succeed not by efficiency alone, but through collaborative, embedded, and regenerative approaches to transformation. In a world increasingly defined by resource constraints, environmental urgency, and economic volatility, these systems exemplify a path forward where profitability and sustainability are not competing goals but mutually reinforcing pillars of a more inclusive, circular, and resilient future.

6.1 Future Research

While this thesis offers a grounded framework for implementing LCPSs, several avenues merit further exploration. Future research should investigate how operational innovations, such as adaptive design, automation limitations, or modular production, can improve the cost-efficiency of recycled materials, which currently remain less competitive than virgin alternatives. The enabling role of regulation also warrants closer attention, particularly how national and regional policy instruments influence the viability and scaling of LCPSs. Comparative studies across countries or regions with differing policy landscapes could reveal critical success factors and gaps. Moreover, the contribution of intermediaries, such as incubators, knowledge hubs, and funding bodies, to bridging infrastructure and governance gaps remains underexplored. Our study features the importance of cultural and narrative strategies (e.g. participatory storytelling) to legitimize circular initiatives and sustain long-term engagement, however these topics deserve more attention. Lastly, longitudinal research is needed to understand how LCPSs evolve in response to shifting regulatory, financial, and social conditions, offering insights into their resilience and long-term impact.

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8. Appendices

Appendix A - Interview Guide

Interview Guide	
Interviewee:	*Interviewer:*
Company & Job Position:	*Date:*

Before we begin, do I have your consent to video record this interview for the purpose of transcription and analysis? All data will be anonymized, and no identifiable information shared.

Background & Context

- Could you briefly describe your professional background and your current role at [the company]?
- Where is [the company] headquartered, and where are your collection and production sites located?
- How large is your organization in terms of employee count and operational scale?
- What are the core activities and mission that define [the company]?
- How did your journey into marine plastic recycling begin, and how has it evolved?
- What types of plastics are integrated into your products, and how would you characterize your current product offerings?
- Which industries or sectors do you primarily serve?

Business Model

- How do you acquire plastic waste and other raw materials for production?
- Could you describe your primary revenue streams and your pricing approach?
- Do you have additional sources of income such as grants, partnerships, or service offerings?
- Who are your main customers or client segments (e.g., B2B, B2C), and how do they engage with your offerings?
- How do you approach distribution and market outreach? Is it locally, globally, or via specific channels?
- What would you say distinguishes your products from others in the recycled plastics market?
- What are your most significant operational costs, and which resources are most critical to your business model?
- Is your business currently profitable, or are you operating with a longer-term profitability horizon?

Circular Value Chain

Interview Guide

- Which stages of the value chain do you directly manage from sourcing to production to distribution?
- How do partnerships and collaborations (with suppliers, policymakers, NGOs, etc.) influence your supply chain strategy?
- What processes are in place for managing your products at end-of-life? Do you operate or participate in take-back schemes?
- In what ways do you engage stakeholders to help close the material loop?
- How do you ensure quality control and material traceability throughout your supply chain?

Local Circular Production

- To what extent is your business model locally rooted in terms of sourcing, production, and distribution?
- What kind of infrastructure is essential for running your circular production system?
- What technological or operational innovations have you adopted to improve circularity and recycling effectiveness?
- How do you envision the development of Local Circular Production Systems in the coming years?

Social & Environmental Impact

- In what ways does your organization contribute to social impact, such as employment, education, or community initiatives?
- Does your social or environmental mission provide a strategic or competitive advantage in your market?
- How is environmental impact integrated into your core business model and decision-making?
- How do you navigate the trade-offs between achieving sustainability goals and maintaining financial viability?

Challenges, Opportunities & Success Factors

- What are the most significant challenges you face in operating a circular business within this industry?
- Are there particular regulatory, financial, or operational barriers to scaling your model?
- What have been the key success factors in your journey so far?
- What trends do you foresee shaping the future of (marine) plastic recycling?
- Looking ahead, what are your strategic goals or long-term ambitions?

Appendix B - Overview of the Gioia Coding Process

Illustrative Quotes	First-Order Themes	Second-Order Themes	Aggregate Dimension	Research Question
"Yeah, yeah, this is it. We are based in a town in that can connect with local schools, local community groups… it doesn't have to go further than that."	Locally embedded microfactory	Community engagement	**Locality**	**Local circular production systems**
"we transform marine litter locally at strategic locations… to contribute to the local economy."	Localized processing ambition	Strategic local integration		
"It helps very much having somebody from the community in the team"	Local trust-building	Embeddedness and legitimacy		
"You have to sort it, and if you don't have the machinery, you have to do it by hand… each location has its challenges."	Flexible, site-dependent setup	Regional adaptation		
"This is very much about placing micro-recycling pods (MRPs) strategically across communities, five or more per region."	Modular micro-facilities	Hub-and-spoke infrastructure	**Hub-and-Spoke model**	
"It could be replicated in other towns really easily… engaging with local schools and businesses."	Replicable microfactory model	Model scalability from local base		
"Satellite facilities… sort or shred, then send to the main hub"	Distributed value chain steps	Hub-spoke logic		
"We shred, process, recycle so that other companies can create these long life infrastructure products… because Hawaii doesn't have any manufacturing infrastructure."	Upstream infrastructure provision	Circular infrastructure	**Circularity**	
"A circular economy model is systemic… not the next Uber… but about long-lasting impact."	Systemic design thinking	Circular logic vs. linear logic		
"The goal is not to make trinkets… but long-lasting products that embed the carbon already in the polymer."	Material longevity & local value	Local circular design logic		
"We don't own the production. We connect people. We set up the value chain and manage the recycling and return flows."	System orchestration, not ownership	Coordination-based network model	**Partnership collaboration**	
We are open to any kind of collaboration under one premise: We must generate a triple win for the partner, for us and above all for the environment!	Collaboration criterias	Stretegic Partnership Alignment		
"So we add value through things like traceability… Our price point isn't to make profit, it's to enable impact."	Value-added services (traceability)	Strategic differentiation over cost	**Unique Value Proposition**	**Hybrid business models**
"Textile/fashion is a lucrative business, … a higher price per kg."	Niche market targeting	Premium segments for high-margin goods		
"Now our staff is 50% R&D."	Process innovation	Differentiation through technology		
"We help clients reduce their CO_2 and trace their plastic flows"	Problem-solving & consulting	Circular service-based offering		
"We're not trying to sell plastic — we're selling a solution."	Mission-centered messaging	Sustainability as a core narrative		
"It's easier to work through platforms like Patagonia who already tell our story."	Strategic brand partnerships	Storytelling via trusted intermediaries	**Market Positioning**	
"We work with public playgrounds and local councils."	Mixed B2B and public sector clients	Broad segment targeting		
"We make revenue through material sales, but also offer rental of equipment."	Diversified income streams	Multi-pronged revenue models	**Value Capturing**	
"The pellet isn't about profit — it's about enabling us to scale impact."	Low-margin, high-impact product sales	Impact-driven pricing		
"Grant funding is essential… but you can't be fully dependent."	Funding reliance as vulnerability	Need for financial independence		
"We took a risk to prove our material could be used in industry-grade products."	R&D experimentation	Product validation as credibility	**Cost Structure & Scaling**	
"Our costs are higher because we pay fair wages across the network."	Ethical employment	Social sustainability influencing costs		
"All of the toothbrushes I've ever had still exist somewhere. That keeps me up at night."	Emotional storytelling	Environmental mission as brand identity	**Achieving Impact (Environmental & Social)**	
"We offer art workshops and school programs about ocean plastics."	Education and awareness	Social engagement and outreach		
"We hire people with disabilities and give them a role in the system."	Inclusive employment	Social impact through workforce integration		
"We reinvest in fishing communities — the more we grow, the more we give back."	Shared value creation	Economic participation of communities		
"People are so used to the linear economy… the way the linear economy has formed investment decisions"	Entrenched linear thinking	Legacy procurement logic	**Changing the Mindset**	**Successfactors and Challenges**
"Everyone says sustainability is important, but few drive it commercially"	Greenwashing vs. real commitment	Misalignment between values and actions		
"They can stand in the doorway… handing over the plastic and seeing it turned into something"	Visualizing value creation	Tangibility as a mindset-shifting strategy		
"Having someone from the community is most important"	Local anchoring	Community trust and ownership		
"Third-party verification, that's a must"	External certification	Building credibility and trust	**Verification & Traceability**	
"Track & Trace system… showing transparency from end to end"	Transparent supply chains	Digital and physical traceability		
"We don't expect pellets to make money – they enable us to do more"	Low-margin recovery model	Mission-aligned economics	**Financial Viability & Resilience**	
"If you're a profitable business, the degrees of freedom to serve the world are far greater"	Profit as enabler of freedom	Financial independence and impact alignment		
"We start small, then iterate from there"	MVP and experimentation	Iterative innovation as resilience strategy		
"We catch the big fish first… but need someone local to vouch for us"	Strategic partnerships and local anchors	Dual-level legitimacy	**Navigating Stakeholders & Ecosystems**	
"Unless you guarantee value, it disappears"	Post-funding survival	Value generation over dependency		
"Creating long-lasting products used locally… to reduce reliance on tourism and imports"	Embedded regional solutions	Socioeconomic resilience through design		
"You have to dirty your hands slightly… if you refuse to compromise, you'll struggle"	Realism and trade-offs	Pragmatism in circular entrepreneurship	**Strategic Adaptability**	
"If there's no visible incentive, most won't act"	Incentive-driven engagement	Motivation through reputation and recognition		

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