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Technological Solutions for Enhancing the Marine Environment

Qualitative research of factors influencing investments in environmental technologies in the Oslofjord

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Sammendrag

Masteroppgaven er en del av det tverrfaglige masterprosjektet "Oslofjord 2.0" ved Norges miljø- og biovitenskapelige universitet (NMBU). Prosjektet har vært et samlingssted for studenter på tvers av fakultetene, med Oslofjorden som felles fokusområde, og vært en plattform for kunnskapsdeling og inspirasjon. Motivasjonen for denne masteroppgaven har vært å lære mer om bærekraftige marine løsninger og hva som kan gjøre dem lønnsomme og realiserbare.

I løpet av de siste to tiårene har flere rapporter gjort rede for de miljømessige utfordringene i Oslofjorden. Regjeringen har utarbeidet en omfattende handlingsplan med fokus på måling av forurensning, naturrestaurering og bevaring av biodiversitet. Denne masteroppgaven ser på løsninger på utfordringene relatert til tilførsel av næringsstoffer og dets påvirkning på miljøforhold og biodiversitet i Oslofjorden. Gjennom å ta utgangspunkt i Ocean GeoLoops miljøteknologi "GeoLoop Column", utforskes hindringene for finansiering av miljøteknologi i Oslofjordens marine økosystem.

Oppgaven er en kvalitativ studie inspirert av Grounded Theory-metoden med induktivt forskningsdesign, som tillater fleksibel datainnsamling og analyse underveis i arbeidet. Dette er en egnet metode for utforsking av komplekse fenomener, som barrierer for implementering av miljøteknologier i marine økosystemer. Gjennomgangen av empiriske data innhentet i semistrukturerte intervjuer resulterte i to overordnede tematiske konsepter for problemstillingen: "Faktorer som påvirker investeringsviljen" og "Faktorer som påvirker risikopersepsjonen" ved marin miljøteknologi. Funnene angående de tre forskningsspørsmålene ble først adressert gjennom et PETL-rammeverk, og deretter videre drøftet i en diskusjonsdel. Gjennom denne analytiske ble de mest sentrale funnene fra de tre utvalgene undersøkt og knyttet opp mot innhold i relevante rapporter og handlingsplaner relatert til Oslofjorden og blå bioøkonomi.

Problemstillingen blir til slutt adressert i konklusjonsdelen, der to sentrale funn presenteres som grunnlag for anbefalinger for fremdriften av implementering av miljøteknologi i Oslofjorden.

Abstract

This master's thesis is part of the interdisciplinary master's project "Oslofjord 2.0" at the Norwegian University of the Environment and Life Sciences (NMBU). Students from various academic disciplines examined the condition of Oslofjorden and proposed solutions, sharing knowledge and sparking inspiration. The underlying motivation for this master's thesis is to delve into sustainable marine solutions and explore avenues to make them economically viable.

In recent decades, many studies have shed light on the environmental issues plaguing the Oslofjord. In response, the Government formulated a comprehensive action plan centered on pollution assessment, ecological restoration, and biodiversity preservation. This master's thesis strives to clarify the determinants affecting the environmental status of the Oslofjord while also examining the barriers hindering the incorporation of environmental technologies into marine ecosystems. Specifically, it examines the GeoLoop Column technology and its path to commercialization and long-term financial viability in the Oslofjord.

This project is a qualitative study, inspired by the Grounded Theory-method. With an inductive design for flexible data collection and analysis, suitable for exploring complex phenomena like barriers to implementing environmental technologies in marine ecosystems. The review of the empirical data resulted in two overarching thematic concepts for the research question: 'Factors Influencing Investment Willingness' and 'Factors Affecting Perception of Risk' in marine environmental technology. Findings concerning three research questions were addressed using a PETL framework, and further discussed. This analytical review involved examining the most critical findings from the three samples and linking them to relevant reports and action plans related to the Oslofjord and blue bioeconomy.

The problem statement is ultimately addressed in the conclusion section, where two key findings are presented as the foundation for recommendations on advancing the implementation of environmental technology in the Oslofjord.

Key words: Bio-based technology, marine environmental technology, investment barriers, sustainable finance, marine ecosystems, Oslofjord, nutrient emission, PESTEL analysis, sustainable innovation, environmental policy.

Preface

This master’s thesis is the final work of our master's degree in Bioeconomy—biobased value creation and business development, at the Norwegian University of Life Science (NMBU). The thesis is worth 30 credits out of the 120 credits required to complete the degree and complements the specialization in "Aquaculture and Food Systems".

We would like to express our gratitude to our supervisor, Thore Larsgård, for his guidance, feedback, and support throughout this challenging period. His encouragement has been instrumental in completion of this work.

We would also like to extend our gratitude to Ocean Geoloop, particularly Ole Magnus Svara and Viggo Iversen, for their engaging and insightful discussions, their assistance in addressing various issues, and, not least, the opportunity to visit you and SINTEF in Trondheim. Additionally, we are grateful to Oslofjorden 2.0 for the valuable knowledge and new connections provided. Finally, we wish to thank our families and friends for their unwavering support, encouragement, and patience throughout this process, without which the completion of this work would not have been possible.

The period spent working on this master's thesis has been both instructive and intense, offering a rewarding experience. The process of writing, while demanding, has been thoroughly engaging. Our interest in bioeconomy has significantly grown during our years at Ås, and we both aspire to leverage this knowledge in our futures.

Ås, 15. mai 2022

Maren Snøve, Mona Rønning

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Abbreviations

UN – The United Nations

EU – The European Union

SDG – Sustainable Development Goals

GT – Grounded Theory

WTP – Willingness to pay

Vocabulary explanation:

Blue bioeconomy – Bioeconomy based on marine organism

Ecosystem approach - solutions based on ecosystems-services

Bio-marine technology – her: environmental technology involving marine biological resources

1. Introduction, problem statement and research questions

The purpose of this section is to introduce the environmental issues surrounding the Oslofjord and to outline the approach taken to address these challenges and potentially offer solutions. Following this, the problem statement and the associated research questions will be presented, shedding light on the current state of environmental technologies and the limitations of the study. By establishing these boundaries early on, we aim to provide a clear framework for the reader.

1.1 Introduction

The Oslofjord's marine ecosystem is under significant pressure due to increased urbanization, population growth, agricultural activities, and industrial expansion. The Oslofjord is a prominent geographical feature, spanning 120 kilometers from Bunnefjord in the north to Færder in the south. By Drøbak, the fjord divides into the "Inner Oslofjord" and the "Outer Oslofjord," separated by a depth threshold of approximately 20 meters (Arvnes et al., 2019, p. 8). It is recognized as one of Norway's most productive and species-rich fjords (The Ministry of Climate and the Environment, 2021, p.6), characterized by diverse topography consisting of bays, varied depths, widths, and narrow passages that limit natural water exchange. The interaction of human activities in and around the fjord and its geographical layout leads to a notable influx of nutrients from the outlets and run-off. The Drøbak threshold creates an environmental divide between the outer and inner parts of the fjord, where the inner part is characterized by limited water exchange and more significant temperature differences between summer and winter.

Figure 1.1: The Oslofjord, overview Inner and Outer parts (Arvnes et al., p.8)

Nevertheless, the entire fjord's current state is considered critical (Arvnes et al., 2019). Approximately 1.6 million people live around Oslofjord today, with forecasts

suggesting an increase to 2 million by 2050 (Givskud et al., 2023, p.5). This implies an anticipation of a more significant burden upon the fjord in the coming years, resulting in unintended consequences for the marine environment.

Currently, the marine environment in the fjord faces significant impacts from inputs such as nutrients, environmental toxins, microplastics, and resource harvesting. In Outer Oslofjord, nutrients, particularly nitrogen and phosphorus, are now acknowledged as a pervasive risk factor, carrying long-term detrimental effects on the marine environment. This primarily stems from municipal wastewater, agriculture, and industrial sources (Aarflot et al., 2024, p. 31-38). Considering escalating apprehensions regarding the fjord's state, the Norwegian Ministry of Climate and Environment introduced a comprehensive action plan in 2021 titled "A holistic action plan for a clean and thriving Oslofjord, with an active outdoor life" (The Ministry of Climate and Environment, 2021) (our own translation). This initiative, the first to consider multifaceted impacts, was a response to a directive from the Stortinget:

> *"The Storting urges the Government to present a comprehensive action plan for the Oslofjord – With the objective of attaining a favorable environmental state, fostering significant natural assets, fostering active outdoor pursuits, and preserving the fjord's biodiversity."* (Innst. 203 S. 2017-2018) (our own translation)

Following this directive, the Norwegian Environment Agency orchestrated a five-year action plan to enhance the environmental condition of the fjord, identifying five primary issues (The Ministry of Climate and Environment, 2021). These include an excessive influx of nutrients, overfishing, agricultural runoff, environmental toxins, and construction activities in coastal zones, all of which severely stress the fjord's ecological state.

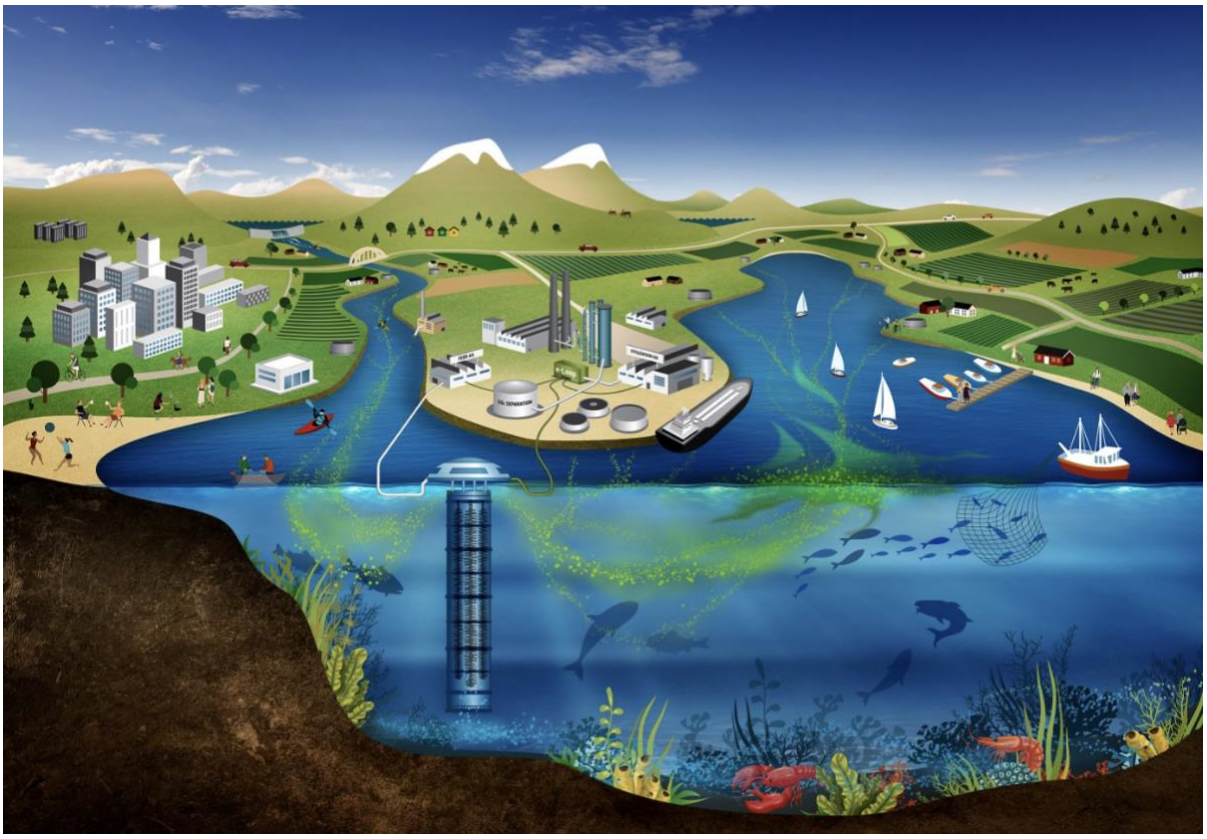
The Norwegian Environment Agency (Miljødirektoratet) prepared the "Implementation of a holistic Action Plan for the Oslofjord - Report for the Year 2022-2023" (our own translation), which was released in 2023. This report emphasizes one of the primary issues, "restoration of natural values", as a critical component within the broader efforts to enhance the Oslofjord (Givskud et al., 2019, p. 19). Concurrently, the United Nations declared 2021-2030 as the Decade for Ecosystem Restoration. Additionally, the "Guide for Natural Risks in the Norwegian Financial

Industry," published in 2022, underscores the need for technological innovation to mitigate the adverse effects of economic development on nature (Deloitte; WWF, Finance Norway, 2022). Marine restoration presents considerable challenges, calling for a thorough strategy to tackle environmental concerns in the Oslofjord. In 2023, funding was allocated to 18 projects within the Oslofjord catchment area aimed at both improving environmental conditions and restoring natural value, accounting for 28% of the allocated budget (Givskud et al., 2023, p. 22).

Through an innovative bioeconomic approach to marine resources leveraging new technology, efforts aimed at enhancing the Oslofjord environment can be combined with sustainable value creation and fostering a transition towards a more circular society (The Norwegian Research Council, Innovation Norway, Siva, 2020; The Departments, 2016). This approach is pivotal in improving the conditions of the Oslofjord, which has become a focus area for innovative, sustainable solutions amid the global transition towards a more environmentally conscious practice (The Ministry of Climate and Environment, 2021).

Although innovative solutions and technologies hold promising potential for the marine environment, the path to realization is not straightforward. There are numerous elements that create uncertainty of investments in such novel initiatives. Our study aims to examine the investment barriers to implementing innovative solutions in the Oslofjord, by exploring factors that influence investment decisions of the private sector.

The topic of this study is centred around the implementation of innovative solutions for the marine environment, by using the company Ocean GeoLoops "GeoLoop Column" technology as a springboard. The Column is novel, multi-functional, ocean-based dome-system that is designed to serve in as an installation for "*ocean filtration/cleaning, oxygenation of lower ocean layers, and biomass generation via the filtering process, farming and harvesting*" (Ocean GeoLoop, 2023, p. 6). This technology combines for improvement of sea water quality with incorporated generation of algal biomass, providing both ecosystem restauration and bio-based raw materials for sustainable value creation. By conducting this study, our aim is to enhance comprehension of the intersectoral investment obstacles to the realization of these solutions and to offer suggestions for future initiatives aimed to mitigating these barriers.



Figur 1.2: Illustration of implemented GeoLoop Column technology in marine environment (Ocean GeoLoop, personal communication, 24th April 2024).

1.2 Current status for environmental technology

Environmental technologies in marine areas attract interest due to the ecosystem services they provide and their potential to enhance natural processes. Despite global interest, extensive literature searches reveal that these solutions are still largely in the development stage. However, patterns of barriers to investment and implementation are beginning to be documented.

Marine environmental technologies have diverse potential uses, including pollution control, biodiversity loss mitigation, and sea-based solutions for carbon capture and storage (Röschel & Neumann, 2023, p. 1). Yet, the effects of these technologies on marine ecosystems are not well understood, and studies are ongoing to assess their impacts. In a study by Röschel & Neumann (2023), all eight reviewed solutions of their research were assumed to impact the marine environment both positively and negatively, with technological scale and geography being crucial factors (Röschel & Neumann, 2023, p. 5).

Considering potential effects and scale, Martiniussen (2014) argues that the barriers to realizing environmental technology in Norway stem from a policy focused on "breakthroughs" rather than gradual development after initial implementation. He compares wind technology development in Denmark and the USA, noting Denmark's success with a gradual approach, while the USA's breakthrough strategy fell short. Martiniussen (2014) advocates for facilitating incremental development of Norwegian environmental technology to build competitiveness against existing or alternative solutions.

In addition to the technological and environmental bottlenecks of the technology development, significant financial barriers exist to implementing sufficient measures for marine environments. There is a substantial gap in capital flow to marine nature and economy compared to what is needed for sustainable marine management, termed "ocean finance" (Tirumala & Tirawi, 2022; Sumaila et al., 2021). It is estimated that only about 0.002% of global GDP (Sumaila et al., 2021, p. 4) is allocated to the sustainable use of marine bioresources and conservation of vulnerable areas. The financial gap for many marine solutions is attributed to inadequate facilitation for economic activity based on marine resources and low market regulation towards sustainable activities (Sumaila et al., 2021, p. 4).

Instruments that enhance the financial attractiveness of addressing environmental issues seem to be crucial for promoting these "end-of-pipe" technologies, which combat pollution after it occurs. Without such incentives, these measures only increase costs for the parties responsible. Therefore, it is argued that the attractiveness of ocean economics and innovative marine technologies will not improve unless the public sector provides support. (Golombek et al., 2015, p. 3).

In the Norwegian government strategy "Business Development and Green Growth" from 2010, investment in environmental technology was deemed essential for a competitive future industry (Espelien et al., 2014, p. 9). The Environmental Technology Program, launched in 2010 with a 3-year support package of 500 million NOK, aimed to promote the development and commercialization of Norwegian environmental technology solutions. Along with the "Environmental Technology Scheme" (NTS), the targets have been technologies in the developmental phase toward commercialization, with potential markets in Norway and internationally. From 2010 to 2013, approximately 80 million NOK was allocated to marine and aquaculture projects (Espelien et al., 2014, p. 12, Figure 1). In 2022, the support package for environmental technology projects reached 680 million NOK (Innovation Norway, 2023, p. 144).

1.2 Purpose

Given the critical environmental conditions in the Oslofjord and the need for measures to save its ecosystem and the economic foundation it provides to society, solutions based on biological resources and innovative technology is an interesting measurement approach. Therefore, this study aimed to explore external factors imposing investment barriers in environmental technologies in the Oslofjord, in this thesis defined as "marine environmental technology". To achieve this, the triple bottom line was used as a mapping framework of relevant background theory. Based on an inductive, Grounded Theory research approach, the background theory resulted from insights gained through a literature review and collected empirical data based on three research questions.

1.3 Problem statement

The definitive problem statement was derived from holistic, empirical research and a thorough literature review. The initial development of a focused theme and a preliminary research question was achieved through active collaboration with Ocean GeoLoop. Significant insights and understanding of the topic were gained as data was gathered and relevant literature was reviewed.

The problem statement examines both challenges related to sustainable transformation and the development of the novel blue bioeconomy. The blue bioeconomy encompasses economic activities that responsibly utilize marine biological resources to produce goods and services, aligning with global initiatives like the UN's sustainability goals and the EU's Green Deal. This inquiry is further contextualized by the increasing recognition of human impact on the environment and climate, alongside the subsequent rise of sustainable finance. The problem statement for the study will be formulated as follows:

> *"Factors influencing investments in the implementation of environmental technologies in the Oslofjord ?"*

1.3.1 Research questions

To address the problem statement, data collection was guided by the following three research questions:

1. *"How do existing regulations and political frameworks influence investment in and realization of environmental technologies, and how can changes affect barriers?*

The research question aimed to investigate how political actions and regulatory frameworks influence investment decisions in environmental technology. It also examined cooperation

between the public and the private sectors, and the impact of international governance, particularly the EU's sustainable transition efforts, on Norway's transition efforts.

2. *"What are the attitudes of actors towards investing in environmental technology solutions, and what are the main factors influencing their decisions?"*

The research question aimed to explore actors' current engagement in environmental technology and factors influencing investment. It provided insights into their efforts towards sustainable transformation of society, attitudes towards investment in novel solutions, and how current circumstances affect their involvement in this sector.

3. "*How does increased attention to the circular economy influence the attractiveness and profitability of nature restoration in the Oslofjord?*"

The research question aims to explore the impact of heightened focus on circular economic concepts on the appeal and profitability of nature restoration efforts in the Oslofjord. It aims to deepen understanding of how sustainable approaches can influence the potential for nature restoration in the region, while also identifying potential benefits and challenges associated with the implementation of environmental technologies. Additionally, the research question aims to establish a foundation for developing strategies to optimize the effectiveness of nature restoration projects in the Oslofjord.

1.4 Research limitations

This study was defined based on three key limitations. The first was the specific chosen environmental technology, where the Ocean Geoloop "Column" technology was decided to be the basis for defining environmental technology. The Column is a sea-based environmental installation specifically designed for water purification in marine environments and microalgae harvest. Throughout the text, we will refer to it as environmental technology to improve the study's coherence and reader-friendliness.

The second was a geographical limitation to the Oslofjord, including both the inner and the outer parts. The environmental state of the Oslofjord corresponds with the water purification technology of Ocean Geoloop. Based on this correlation, the Oslofjord is deemed the optimal geographical area for this study. Furthermore, the environmental condition of the Oslofjord bears resemblance to other fjords both nationally and internationally, offering a degree of generalizability that the study can utilize to improve comparability.

For the third, the study only examined the influence of external or general factors, which restricts the thesis to not including internal elements specific to the chosen technology. In that way, the relevance of this study is kept broad enough and may contribute to the realization of additional bio-based solutions for the Oslofjord.

1.5 Thesis Structure

The thesis is structured to provide an understanding of the current situation in the Oslofjord, explain why sustainable finance has become a crucial means of action, and explore the challenges of implementing innovative blue bioeconomy solutions despite their potential benefits.

In the first chapter, the Oslofjord and the ongoing environmental crisis are introduced as the background for this study, explaining why this scenario is relevant to bio-based environmental technology. Chapter two reviews relevant background theory for the research question, based on literature reviewed during the preparatory work, and insight gathered through the inductive research method. Chapter three gives a thorough overview and explanation of the qualitative research method used for the study.

In chapter four, empirical data is analyzed using a PESTEL-approached framework and linked with current secondary data relevant to the Oslofjord, sustainable finance, and future strategies for the bioeconomy. Chapter five discusses the findings from the analysis in relation to the research questions, aiming to draw conclusions regarding the problem statement. The final conclusion is presented in chapter seven.

2. Background Theory

The theoretical section comprises three integral components of the issue and seeks to provide a contextual grasp of the topic; the scope of opportunity presented by the marine environment in the Oslofjord and how this correlates with the willingness to invest and implement innovative biological solutions. The literature review, forming the foundation of this section, constitutes preliminary research, and concepts that have proven relevant through empirical data collection and gained insights into the topic.

The first sub-section introduces the theory concerning the concept "sustainable transition", reflecting the state society is now transitioning into. The second sub-section, "economic theory" creates a transition from sustainability theory to the economic aspects. The third sub-section seeks to provide an overview of the theoretical background of a “biobased technology”. Together, they aim to describe how value can be created in marine environments and describe its contribution to society.

The overall purpose of the background theory is to demonstrate the interdisciplinary scope of the study by exploring its connections to natural sciences, and illustrating how these intersect with economic and social science aspects. Essentially, the theory sections reveal that bioeconomy encompasses all three aspects of the triple bottom line, forming the foundation for the concept of "sustainability".

2.1 Sustainable transition

To contextualize the problem statement and research questions within a political and societal framework, it is relevant to examine the evolution of sustainability within the international community and its impact on Norway. In this section, we explore the evolution of the concept and its influence on Norwegian private sector, followed by an examination of key concepts.

2.1.1 What is sustainability development?

In 1987, the Brundtland Commission presented the report "Our common future" and the term "sustainable development", defined as "development that meets today's needs without destroying the possibilities for future generations to meet their needs" (Brundtland & Dahl, 1987, p. 42). By prioritizing the sustainable development of society, both national and international authorities must reassess the relationship between humanity and nature. Humans rely on the environment for survival, and in turn, the environment thrives when cared for by humans, indicating a mutual interdependence (Hernández et al, 2012, s. 2). Individuals with an anthropocentric worldview perceive themselves as superior to nature, viewing natural resources and ecosystems as existing solely to serve their needs and survival (Allen et al., 2017, p. 784). As humanity grapples with its relationship to the environment, understanding the evolution of sustainable development provides valuable insights into our changing perceptions and practices towards nature.

2.1.2 Historical view: From the UN, through EU, towards Norway

The United Nations (UN) was founded in 1945 after the Second World War, aiming to maintain global peace through a treaty outlining rights and obligations for its member states. After the Second World War, there was a growing interest in climate policy, and in the 1980s environmental issues were increasingly institutionalization. Over the years, the UN has emerged as a crucial actor in combating climate change, notably through initiatives such as the Kyoto Agreement and the Paris Agreement (United Nations, 2024). During the UN General Assembly in 2015, they adopt 17 sustainability development goals, with the intention of achieving them by 2030. The intention

behind the sustainability goals was for them to serve as a unified global roadmap guiding nations, business and civil society towards common goals (United Nations Sustainable Development Group, 2019), they provided the world with a new framework for adapting socially, environmentally and economically. The sustainability development goals have significantly impacted the European Union (EU), influencing the shaping of policies and strategies. To achieve these goals, the EU established a targeted strategy, including The European Green Deal and the EU's action plan for sustainable financing. These initiatives have established standards and guidelines which promote sustainable practices throughout the EU region (European Council, 2023).

2.1.3 Sustainable development goals and Norwegian policies.

In 2021 the Norwegian government released "Purposeful Goals - Norway's Action Plan to Achieve the Sustainable Development Goals by 2030" (our own translation). Several SDG's influence the Norwegian governments management of marine environments with five goals being particularly relevant for this study: SDG 2, SDG 6, SDG 8, SDG 9 and SDG 14. SDG 2 aims to eradicate hunger through sustainable food systems, concerning climate, soil, water, and biodiversity. As one of the world's leading aquaculture and fishing nations, Norway has a significant responsibility to preserve its marine environment. SDG 6 targets water pollution, necessitating integrated management. SDG 8 focuses on decoupling economic growth from environmental harm. SDG 9 emphasizes sustainable resource management. SDG 14 underscores the importance of marine ecosystem conservation in Norway's ocean policy (Confederation of Norwegian Enterprise (NHO), 2018).

2.1.4 Greenwashing

According to de Freitas Netto et al. (2020), greenwashing was first used in 1986 when an environmental activist named Jay Westerveld published an essay in which he described a hotel experience. The hotel encouraged guests to reuse towels as part of their environmental strategy, when it was about cost savings (De Freitas Netto et al., 2020, p. 2). In recent years, the term has

been extensively discussed, yet there is currently no clear definition (Lyon & Montgomery, 2015, p. 225). Lyon and Maxell (2011) try to describe greenwashing in the way of "*Selective disclosure of positive information about a company's environmental or social performance, without full disclosure of negative information on these dimensions, so as to create an overly positive corporate image*" (Lyon & Maxwell, 2011, p. 9). There are many different approaches to defining sustainability in literature, a common denominator with most is the description that actions do not harmonize with what is communicated.

2.2 Economic theory

In this sub-section, the study delves into the societal transition from linear to circular economy, aiming to draw connections to corporate social responsibility and stakeholder theory. Analytical tools will be introduced, along with economic factors that contribute to shaping a forthcoming analysis

2.2.1 Circular economy

Circular economy is defined as an economic system focused on reducing, reusing, recycling, and recovering materials in production, distribution, and consumption. Operating at micro, meso, and macro levels, circular economy aims to achieve sustainable development by promoting environmental quality, economic prosperity, and social equity (Kirchherr et al., 2017, p. 229). The concept has gained popularity among businesses, stakeholders and policymakers due to its ability to contribute to profitable sustainable development (Kristoffersen, et al., 2020, p. 229). Aligning with the goals of sustainable development, it emphasizes resource efficiency and waste reduction. Neglecting resource management not only harms the environment but also leads to decreased profitability. Since the industrial revolution, society has benefitted from abundant access to natural resources, operating within linear value chains. Within this framework, resources are transitioned from raw materials to finished products and ultimately to waste, with products following a defined lifecycle from creation to disposal.

The objective is to minimize marginal costs to optimize profit margins. Lower marginal costs lead to reduced production costs, thereby affording the product a competitive advantage in the market. The linear model of resource consumption (extract-produce-use-dispose) has witnessed a threefold increase in consumption of natural resources due to a growing global population. Human consumption of natural resources outpaces nature's ability to replenish them. Circular economy contrasts with linear value chains by prioritizing the efficient utilization of existing materials and minimizing waste generation, rather than relying on the extraction of virgin resources. Transitioning to circular business models aims to preserve input factors and product quality as much as possible, thereby contributing to increased profitability further down the value chain (Kristoffersen, et al., 2020, p. 221-232)

2.2.2 The triple botton line

Transitioning from circular economy principles to triple bottom line, organizations are embracing a holistic vision for the future where their commitment to the planet, people and profit converge seamlessly, fostering sustainability at every level. The triple bottom line delineates what should be to be measured and how, it is based on the statement "In modern organizations, what gets measured gets managed" (Taplin et al., 2006, p.353). In 1997, John Elkington introduced a framework illustrating how individuals can work with sustainability across three dimensions, known as the triple bottom line. The intention was to establish a framework for assessing a company's performance not only based on economic viability but also on environmental quality and social justice (Elkington, 2004, p. 2). Today, it not only emphasizes financial profits but also considers the environmental and social impacts of business operations. This evolution reflects a broader recognition of the interconnectedness between economic prosperity, environmental stewardship, and social well-being in achieving sustainable development goals.

In a later publication, Elkinton (2004) discusses the ongoing sustainable transition that society as one of the most intricate transitions the humanity must navigate. In the seven revolutions, Elkington (2004) points out that we are shifting from one paradigm to another and defines seven revolutions for driving society towards a sustainable transformation.

	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 2.1: "The seven sustainability revolutions". Seven transitions from towards a sustainable society (Elkington et al., 2004, p.3).

These revolutions are driving a fundamental transformation towards sustainable capitalism, in which environmental, social, and economic factors are given equal weight and consideration in business decision-making. This shift signifies a departure from traditional profit-driven approaches towards a more holistic and responsible business model that aims to balance financial success with societal and environmental well-being. In this paradigm, companies strive to achieve profitability while also actively contributing to environmental conservation, social equity, and community welfare. (Elkington et al., 2004, 5-6)

2.2.3 Corporate social responsibility and The Stakeholder Theory

Corporate social responsibility is a prominent topic in both theory and practice, with growing attention being paid to it in companies, public organizations, and educational institutions. Carrol and Shabana (2010) trace the modern understanding of social responsibility back to World War II. However, this understanding has been the subject of ongoing debate over the years. Milton Friedman, argued in 1970 in his article "The Social Responsibility of Business Is to Increase Profits," argued that when companies spend money on responsibilities beyond legal requirements, they are essentially taking money out of the owners' pockets. In 1984, Edward Freeman presented a clear counterargument, suggesting that companies have significant responsibilities to various external and internal stakeholders affected by their activities. Freeman believed these responsibilities were as fundamental as the company's obligations to its owners, as stakeholders

are exposed to numerous externalities from the company's operations. Both morally and strategically motivated, Freeman's stakeholder perspective has become well-established in economic contexts, and most companies today have formed an opinion on this perspective (Jørgensen & Pedersen, 2013, p. 57-59)

The EU's "A Renewed Strategy 2011-2014 for Corporate Social Responsibility" highlights the ability of businesses to integrate social and environmental goals and challenges into their strategy, governance, and practices, closely aligned with the triple bottom line logic. The EU views responsible business operations as a multidimensional understanding of corporate performance and activities, which will have implications for governance, strategies, and management. To ensure that a company upholds its responsibility towards social and environmental values, it follows that the company must measure the impacts of such non-financial dimensions and ideally incorporate them into the company's reward and incentive systems. This approach naturally leads to a consideration of stakeholder theory, which emphasizes the importance of addressing the needs and interests of all parties affected by the company's activities (Jørgensen & Tyrnes, 2013, p. 57-59).

Stakeholder theory aligns closely with sustainability, as both underscore the company's duty to its stakeholders and investors, encapsulating the thoughtful consideration of their interests (Freeman & Dmytriyev, 2017, p. 7). In 1984, Freeman published "Strategic Management - A Stakeholder Approach", outlining the foundational principles of stakeholder theory. Emphasizing the importance of ethical standards and values in managing organizations, highlighting the priority of safeguarding the welfare and interests of stakeholders (Philips, Freeman & Wicks, 2005, p. 481). In stakeholder theory, stakeholders are delineated as an individual or group with the inherent ability to exert influence upon or be influenced by the goals or decisions of the company. The theory posits that the enduring viability of the company depends upon the support and satisfaction of its stakeholders, thereby necessitating that management prioritize addressing their demands, expectations and needs.

The stakeholder theory elucidates how companies can engage in collaborative endeavors with their stakeholders to foster relationships and equitable value distribution. While Freeman delineates various stakeholder relationships, Freidmen argued in 1970 that companies primarily owe a social responsibility towards their shareholders (Parmar et al., 2010). Managers solely accountable to

shareholders often prioritize short-term gains to maximize the company's return, yielding clear and immediate results.

The foundation of societal responsibility lies in the acknowledgment that companies generate externalities. By this, we mean positive or negative effects of a company's activities that directly or indirectly affect stakeholders within or outside the company. For this study, an example of negative externalities could be heavy industrial activity from private actors in the Oslofjord or increased nutrient supply from municipal treatment plants. An example of positive externalities could be measures that reduce activity. The company has a responsibility towards internal and external stakeholders affected by its business activities, meaning those experiencing negative externalities due to business operations. This forms the basis for the stakeholder perspective in this study (Jørgensen & Tyrnes, 2013, p. 57-59).

2.2.4 Strategic Analysis

To assess the market opportunity holistically, strategic analysis proves invaluable for gaining insights into both internal and external factors, thereby discerning strengths and weaknesses. It can be divided into two parts, external and internal analysis. We will delve into macroeconomic factors impacting the implementation of environmental technology and employ a PESTEL analysis to discern potential avenues for value creation (Roos et al., 2002, p. 85-87).

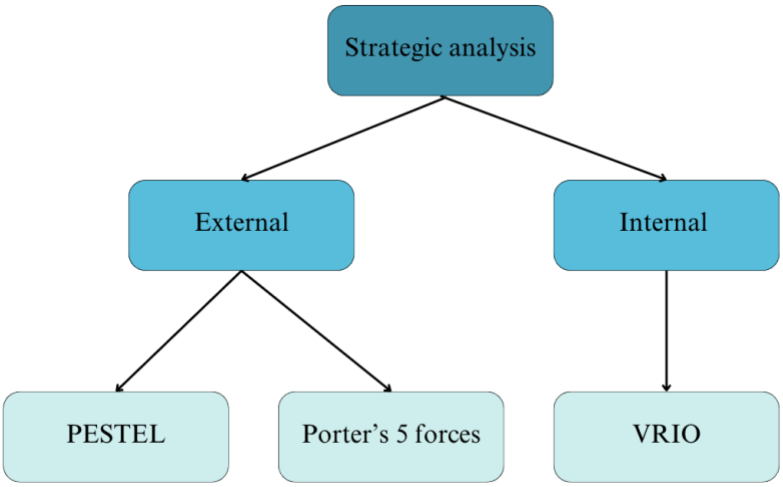


Figure 2.2: An overview of the purpose and scope of the strategic analysis. (Roos et al., 2002)

A strategic analysis can be aligned with stakeholder theory by identifying and evaluating how strategic decisions impact the stakeholders of a company. By understanding stakeholders' needs, interests, and priorities, a company can develop strategies that balance these with its own goals and priorities. This may involve considering stakeholders' perspectives on ethics, sustainability, and social responsibility. In this way, a strategic analysis can help ensure that a company's strategies are in line with stakeholders' expectations and needs, thereby enhancing the company's reputation and long-term success (Roos et al., 2002, p. 90)

The PESTEL framework

PESTEL is a framework for analyzing external factors affecting a business or situation. It encompasses political, economic, socio-cultural, technological, environmental, and legal aspects, providing a comprehensive view of the surrounding environment and potential impacts (Whittington et al., 2020, p. 36). This analysis tool, often called situation analysis, helps companies predict market conditions and identify key drivers of change. Key drivers are elements that significantly influence various parts of the company's environment and its development within the sector (Johnson, Scholes & Whittington, 2008, p. 56).

The PESTEL framework is adaptable and can be tailored to focus on specific aspects relevant to the study. For instance, an analysis might concentrate on political, economic, socio-cultural, and legislative factors, utilizing a "PESL" framework. Additionally, other relevant aspects can be incorporated, such as PESTEL+I, where Blümel et al. included "infrastructure" in their study (Blümel et al., 2023, p. 5). This is widely used in organizational strategy work and can enhance the understanding of influences on specific situations.

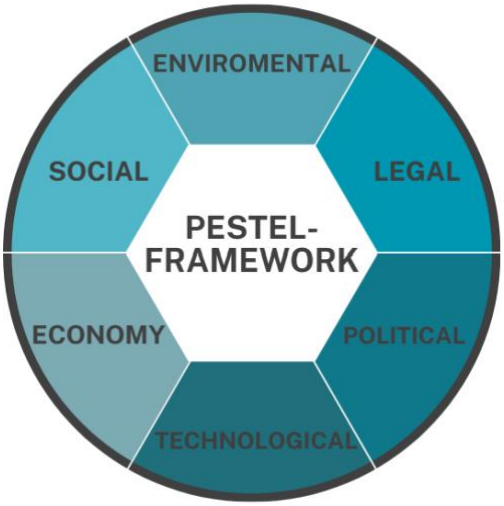


Figure 2.3: Illustration of the six elements of a PESTEL framework (Roos et al., 2002, p. 90)

2.2.5 Innovation – Investment and risk

Innovation was conceptualized by Schumpeter as "destructive creativity" and defined the term as "new combinations of new or existing knowledge, resources, and equipment" (Morch & Yeung, 2000, p. 5; Burton et al., 2020, p. 108). Although "creative destruction" refers to the destructive effect on the actor who fails to keep up with development, innovation is a positively charged concept that defines new solutions, products, and services that replace or increase the value of a previous solution (Morch & Yeung, 2000, p. 5).

The implementation of innovations, whether within development projects or start-up enterprises, diverges significantly from traditional investments due to their elevated risk and considerable costs. Hall (2002) elaborates on these factors in his article concerning the financing of research and development. Examining a startup in its early stages, particularly one focusing on technology development, it typically faces significant expenses and a lack of both stable income and tangible assets. The high costs are largely due to the requirement for highly skilled employees needed to develop or advance the relevant technology. Such expertise constitutes invaluable intangible assets during the startup phase, secured through adequate salary. Additionally, the absence of tangible assets increases both the venture's risk profile and thus the challenge of obtaining external funding, particularly when future returns for investors are uncertain or absent. (Hall, 2002, p. 36).

2.2.6 Market gap

A functioning capital market is central to sustainable transformation as it is necessary to optimize the allocation of capital and ensure value creation and a competitive business environment. Although the capital market serves to distribute risk, in the context of implementing innovation and sustainable solutions, it may suffer from risk aversion, leading to inefficiency. There are various reasons why risk aversion occurs, but uncertainties related to lack of expertise and communication, adapted regulations, and absence of liquidity are described as sources of a reticent market (NOU 2018:5).

2.3 Natural/technological background theory

This sub-section aims to provide an understanding of the scientific and technological aspects on which this study is based. A theoretical review of relevant concepts within marine ecosystems and anthropocentric impact through the release of nutrients. This will link current scientific work on how the marine ecosystem creates opportunities for new bio-marine industries through innovative nature-based solutions and technology for the development of an innovative blue bioeconomy.

2.3.1 Marine ecosystems and pollution

Aquatic environments serve as the final destination for nutrients originating from land-based activities, through runoffs and rivers, which flow into the sea at coastal areas. Runoffs from land are a natural part of the land-sea interacting, transporting organic matter into the ocean and enriching marine ecosystems with nutrients. Natural ocean currents contribute to the efficient distribution of both nutrient and oxygen, while the influx of nutrients into the marine environment sustains primary producers. These primary producers form the foundation of the marine food chain, supporting life throughout the entire water column (Hughes et al., 2022).

The growth in human population globally, development of society and improved prosperity has provided an extended use of nutrients, such as nitrogen (N) and phosphorus (P) (Thomas et al., 2022). This has happened due to an increased need for food and other biomaterials, hence the efficiency of agriculture and industries to cover the demand for raw materials both for livestock feed and direct human consumption. The exceeded use of nutrients in anthropogenic activities has thus increased the input to the sea, which has a disruptive effect on the balanced natural nutrient cycle with further repercussions to the ecosystem (Hughes et al., 2022). An ecosystem in imbalance, where access to nutrients exceeds naturally seasonal fluctuations affects the thrive of species and biodiversity. In aquatic environments, such disturbances tend to have a more extensive effect due to less clear physical boundaries and a greater degree of nutrient flow between habitats.

In the case of the Oslofjord, a complex ecosystem, its capacity to adapt to changes will largely depend on its resilience (Folke et al., 2002). Long-term disturbance of the marine ecosystem can result in decrease resilience of the system. Weakened resilience makes the effect of disturbing

factors greater compared with the same disturbance to a healthy ecosystem that has better ability to retain normal state after an abnormal event (Folke et al., 2002, p. 437; Aarflot et al., 2024, 36).

Circular economic thinking is gaining prominence, resulting in a shift where pollution in marine environments is reinterpreted as misallocated resources. By leveraging nature-based solutions rooted in marine ecosystem services to reutilize excess nitrogen in pollution-impacted areas, there exists the potential to develop value chains for "blue nitrogen". Marine nature-based solutions for nutrient monitoring could provide several benefits, such as contribution to restoration of marine biodiversity and make nutrients and biomass resources available, while not competing for land-based food production areas (Hughes et al., 2022).

2.3.2 Low trophic marine organisms

there is a sparked interest in marine organisms at lower trophic levels duo to the problem of nutrient release, the increased concentration of carbon dioxide (CO2) in the atmosphere and subsequent climate change, has sparked interest in marine organisms at lower trophic levels. The trophic levels describe where in the food chain the species are located. At the low trophic level, you find primary producers that grow on dissolved nutrients, CO2 and photosynthesis, and organisms that collect nutrients by filtering the water for smaller organisms and particles. Microalgae, zooplankton, macroalgae, tunicates and mussels are species defined as low trophic and categorized at second trophic level and below (Kaiser et al., 2020, p.116).

The increased interest is based on the possibility of using the biological processes, and the ecosystem services they provide, with the absorption of inorganic and organic nutrients, CO2 and heavy metals from bodies of water and air. Through developments in technology and processing methods, biomass from these marine organisms can be included as sustainable raw materials for many products, such as food, feed, materials and energy. For example, microalgae-based technologies have been implemented in the treatment process of wastewater in treatment plants, in order to limit the pollution of rivers, water and the sea (Inobeme et al., 2023, p.207).

2.3.3 Ecosystem services

The term ecosystem services are used for all products, services and other benefits we get from nature. Defining ecosystem services is a tool used in nature management and helps to place value on nature and the resources it constitutes for humans. More specifically, it can be defined as an anthropocentric valuing of nature (Folke et al., 2002, p.437).

According to Kaiser et al. (2020), ecosystem services can be categorized into four main types. Firstly, key services form the foundational value basis for other ecosystem services, including primary production and the decomposition and circulation of waste and nutrients. These are also referred to as supporting services, as they underpin other levels of ecosystem services; their efficiency and functionality directly impact the availability of other services. Secondly, concrete services encompass goods that can be directly obtained from nature, such as marine organisms harvested for human consumption or as raw materials for production. Thirdly, regulating services involve the ecosystem's inherent functions, such as carbon storage, climate regulation, protection against extreme weather and floods, and the filtration and circulation of air and water. Lastly, cultural services provide non-material benefits derived from nature, including nature-related traditions, opportunities for recreation and outdoor activities, aesthetic value, and inspiration (Kaiser et al., 2020, p. 499).

Hughes et al. (2022) argues that valuation of marine ecosystem services through nature-based solutions, which enhance biodiversity and provide societal benefits, could increase the interest of doing investments in emerging businesses like integrated low trophic aquaculture. Economic growth and increasing prosperity have resulted in a change in people's view of nature. We have moved from an earlier eco-centric view of nature, where natural resources were managed and had great value for the individual's own survival and well-being. To an anthropo-centric view of nature where there is a perception that man has taken the step out of nature and that nature and ecosystems must deliver according to man's needs (Hernández et al., 2012, p.2).

Increased understanding and valuation of the ecosystem services has spurred interest in more interaction with nature to address societal impacts on the environment and climate (Seddon, et al., 2019). Nature-based solutions refer to ecosystem-based initiatives that harness natural processes for carbon storage, water purification, and nutrient recycling. In the case of marine environments,

the natural cycles of nutrient and carbon dioxide are crucial for maintaining water quality and promoting productivity and biodiversity. These mechanisms can be optimized, for example, through the management of increased water exchange – enhancing the nutrient flow through the water column, or establishment of low trophic aquaculture installations. Besides the specific objective it aims to address, a marine nature-based solution also opens possibilities for additional advantages, such as integrating it with the creation value in the blue bio-marine sector (Hughes et al., 2022)

2.3.4 Environmental technology

Enabling technologies encompass a range of technological solutions capable of fundamentally altering societal practices and provide major economic benefits both domestically and international (Innovation Norway, 2020; Stat meld. 7 (2014-2015)). Among these solutions, biotechnology and innovative material technology stand out, distinguished by their reliance on intensive knowledge development and innovation (Stat meld. 7 (2014-2015)). Such transformative technologies, with their profound impact on industry and society, are seen as pivotal in transition to a circular economy and reduced carbon footprints. The European Commission regard enabling technologies as "*the most important driver for the modernization of European industry and transitioning toward a knowledge-based, low-emission society*" (our own translation) (Stat meld. 7 (2014-2015), p. 30).

Environmental technology may be described as a subcategory of the enabling technologies. The term is used for technology developed to increase the productivity or efficiency of an installation or activity, while contributing to a reduced negative impact on the climate and environment. Examples of such activity can be waste reduction, making energy use more efficient or reducing greenhouse gas emissions. One finds several synonyms under the same definition, such as "cleantech", "envirotech" and "green technology" (Johnsen & Hansen, 2014, p. 28-32).

In addition to reducing the footprint of human activity, environmental technology can also generate further value for stakeholders. Either for customers where technology becomes a source of green products, or investors who contribute financially to green transition and seek a return on sustainable investments. The EU's "Green Give" also includes investment in environmental

technology as a tool in its restructuring and defines this category as "all technology that creates value and welfare with reduced environmental impact". As sustainability is making its way into all parts of our society and is an obvious factor in today's research and development, "*...that environmental technology can eventually include the vast majority of technologies, as the definition of environmental technology opens up a general and principled restructuring of almost all technology in an environmentally friendly direction*" (Meld St. nr7 (2008-2009), p.81) a realistic assumption.

In the same way as with the establishment of new bio-marine industries, increasing needs and demand for technological solutions for environmental management can also create a need for more expertise, thereby contributing to societal sustainability via the creation of job opportunities. As described in Rangel-Buitrago et al. (2024), the ongoing development of infrastructure for handling pollution and protecting nature from sewage and runoff has contributed to increased employment in a global perspective. In the same article, it is argued that "*By investing in these sectors, governments and private entities can stimulate job creation...The economic benefits extend beyond employment, as cleaner water bodies and restores natural sites enhance tourism, recreational activities, and real estate values, contributing to the overall economic resilience and sustainability of communities"* (Rangel-Buitrago et al., 2024, p.3). Which can describe possible overall motivation factors for making investments in environmental technology.

2.4 Blue Bioeconomy

The concept of Bioeconomy is not novel within social and economic context, given that biological resources have historically underpinned the evolution of modern society. Nevertheless, Bioeconomy was not included in political context until the 2000s, wherein the EU took the lead in investing greater attention in this field (Burton et al., 2020, p.18).

Today, Bioeconomy is frequently linked to both traditional and emerging industries, like agriculture, forestry, aquaculture and biotechnology. However, the concept is multifaceted, and it broadly encompasses the utilization of biologically based raw materials and technologies rooted in biological processes, which evolve alongside advancements in knowledge (Burton et al., 2020,

p 107). As outlined in the “EU 2018 Bioeconomy Strategy Plan” (updated version of 2012 original publication), biological resources and processes are regarded as renewable. Apart from serving roles in food, feed and traditional materials (wood, fiber, skin), they can also serve as substitutes for fossil raw material in various industries, such as energy (biogas, bioethanol) and bioplastic material production (European Commission (bio), 2018, p.42).

The report "Value creation based on productive oceans in 2050" from 2012 presents value creation potentials and important drivers for new Norwegian bio-marine industries against the background of ongoing strong population growth and increasingly greater purchasing power among a growing middle class (Olafsen et al., 2012, p. 5). The need to add more harvesting and production to the marine part of the planet is argued for through the current lower degree of land and resource utilization in the sea, together with the use of land. In the report, opportunities for increased utilization of marine resources are seen in the light of a strong need for resources to cover the demand for food, energy and materials, without exceeding nature's tolerance limits. In the report's projection of future marine value creation, it is shown that through new enabling technologies—such as sea-based environmental technology and new processing mechanisms for biomaterials—and the development of the knowledge base, the working group behind the report estimates a possible marine value creation of NOK 550 billion by 2050 (Olafsen et al., 2012, p. 34).

Among new bio-marine resources, marine microalgae are presented as an opportunity for new industries by being included both as a source of valuable components or fatty acids for the feed industry, and as raw material for fuel production. In order to fulfill the ambitions for growth in marine value creation for 2050, the recommendations from the working group are, among other things, to strengthen the development of new marine industries through clearer instruments and predictable framework conditions to reduce risk and build up the value chains, as well as to build up knowledge and cooperation for good management and competitiveness (Olafsen et al., 2012).

Subsequently, the report “The Sea Chart towards 2050” was prepared by SINTEF (Almås, 2017), where the status of the industries presented in the report from 2012 is explained, as well as further recommendations to achieve the projected increase in value creation. The industries described in the reports are industries of considerable economic importance both now and in the years to come. Great growth is expected and desired, but to achieve this it is necessary to overcome several

challenges associated with the industry. Among these are challenges linked to the environmental impact and climate footprint traditional fish farming brings with it today. New bio-marine industries, through increased utilization of the lower trophic levels, are today considered one possible replacement for the vegetable protein and fat sources in current feed composition. As described by Almås (2017), marine biomass from trophic level two and below could be sourced through increased investment in the cultivation of primary producing species and filter eaters. This involves more utilization of areas with "upwelling" or creating "upwelling" for increased circulation of nutrients up from the seabed, as well as development of technology to make the harvesting of microalgae more efficient (Almås, 2017, p.38).

3. Research Method

The section outlines and justifies the methodological approach adopted for the study, detailing the collection and analysis of data. It begins by presenting the chosen research design, followed by an elaboration on the data collection methods and the analytical process. Finally, the section concludes with a critical assessment of the methodology employed and reflections on the research's quality. Methodological adaptation is a crucial factor in maintaining the quality of research. To ensure coherence, the research design must align with previous studies, the problem statement, and the research questions. It bridges the research questions, collected data, and the analytical approach employed during the study (Bell et al., 2022, p.363).

This study aims to enhance comprehension of the challenges Norwegian companies face in implementing environmental technology in marine areas, and factors that influence willingness to invest in such technologies in the Norwegian market. To address the problem statement, a conceptual literature review combined with qualitative inductive semi-structured interviews has been employed to obtain empirical data (Tracy, 2019, ch. 2).

3.1 Empirical context

The study's empirical context is on the Oslofjord's environmental status, and the utilization of environmental technology to improve its status. The primary rationale for selecting Oslofjord as the study's focal point is its potential for national and international comparison. By narrowing the geographical scope to the Oslofjord, we aim to contribute to a deeper understanding of how new technological solutions can address environmental challenges and facilitate nature restoration. Additionally, we aim to examine implementation barriers within the public and private sectors and identify factors influencing the willingness to invest. To achieve this, we leverage tree theoretical framework to understand the cross-sectoral topic comprehensively.

As outlined in the previous section, the Oslofjord is currently facing a critical situation due to prolonged disruptions to the ecosystem caused by human activities. The continuing nutrient influx has disrupted the marine ecosystem, leading to significant imbalance. This condition, often likened

to a desert in the media, highlights the severity of the situation (Simonsen, 2021), which was previously an ecosystem of high productivity through rich biodiversity. The Oslofjorden area experiences high population density, leading to stress on the marine ecosystem that exceeds its tolerance limit. The current scenario aligns with the UN report "Code Red" for the planet, emphasizing the widespread recognition that humanity's dependence on linear economic growth has pushed us to a point where we are testing tolerance limits for climate, environment, and nature.

3.2 Literature review

When conducting an empirical study, it is essential to possess a comprehensive theoretical frameworks and prior research related to the project's theme. The aim is to review previous findings and identify relevant theories to gain insight into any unanswered questions, controversies, and possibly barriers that have arisen on the topic (Bell et al., 2022, p.93). By identifying unanswered questions, the literature review can serve as a foundation for developing research questions and further support the research process.

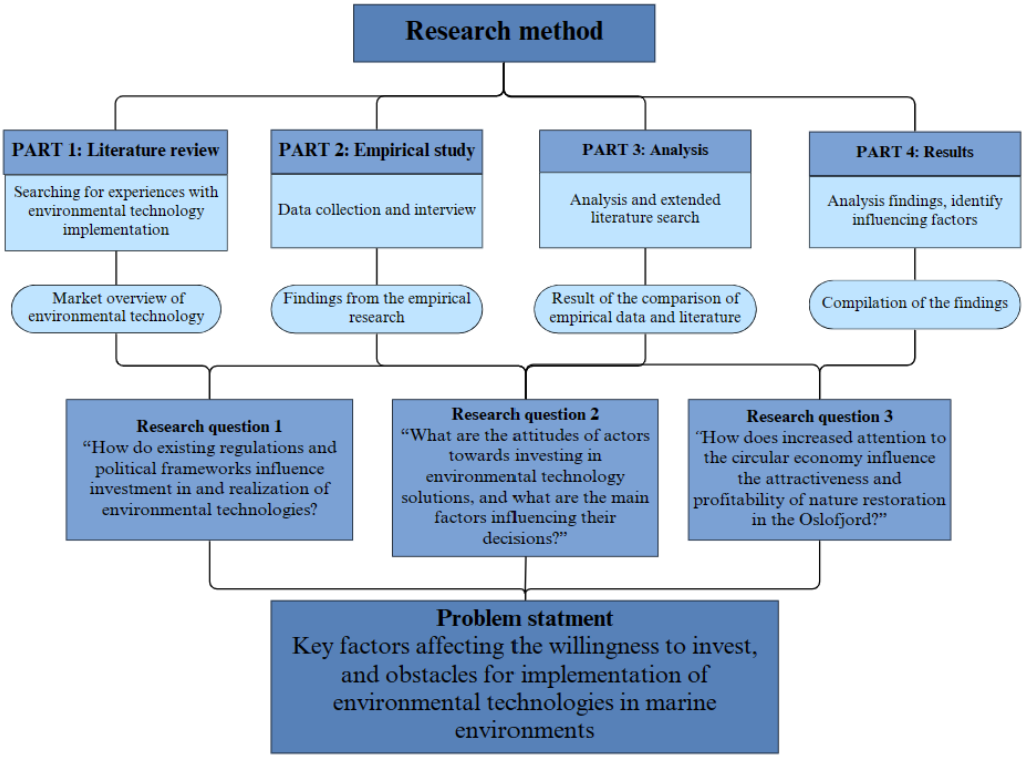


Figure 3.1: Systematic overview of research method. The connections between the parts of the research method, the results section, and the research questions for the overall problem statement describe the study's method of progress.

3.3 Qualitative study with inductive method

The qualitative method is a research approach that describes the data collection process and subsequent analysis of collected data. Unlike quantitative research methods, which use measurable units and statistical analyses to formulate models and predictions, qualitative research methods encompass a broad spectrum of techniques, including interviews and textual analysis (Tracy et al., 2019, ch.2).

To collect data for this study, we have conducted interviews to gain in-depth knowledge and a holistic understanding of the specific contexts in which our selected informants are situated. When the research questions require more than simple "yes" and "no" responses, the qualitative research method is the preferred research method. The primary objective of the research methodology is to

elicit pertinent variables and descriptions from the informants' perspectives. Thereby, facilitating an in-depth comprehension of the phenomenon within the broader framework of other informants' perspectives. In analysing the collected data, the transcript from the in-depth interview underwent a process of coding, sentences or keywords were identified and categorized according to research objectives.

3.3.1 Grounded theory

Grounded theory (GT) involves a systematic analysis of data, particularly beneficial for discerning connections and patterns among various data elements to characterize a phenomenon or a context (Tracy, 2019). According to Bell et al. (2022), Barney G. Glaser and Anselm L. Strauss developed Grounded Theory through the book "The Discovery of Grounded Theory: Strategies for Qualitative Research," which was published in 1967. The book describes an inductive approach where theories are developed systematically from empirical evidence, making it an advantageous framework (Bell et al., 2022; Lindgreen et al., 2021; Jacobsen, 2005). Since the book's publication, Glaser and Strauss have chosen two approaches to the GT method. Glaser argued for a conservative stance, where GT-based research should refrain entirely from literature review before data collection, as it could influence the analysis process and, consequently, the results. Strauss, on the other hand, argued that a preparatory literature review would not necessarily affect the results to a significant extent as long as the researcher consciously separates the developed theoretical framework from the process of data collection and analysis (Ramalho et al., 2015, p. 4).

Our GT methodology involved conducting an extensive literature review to comprehensively understand the subject matter through systematically analysing collected data. The insight provided an indication of the necessary information required to establish a relevant knowledge foundation that addresses the research questions. The conducted literature review highlights limited specific themes within the subject matter addressed in this study.

GT refers to a "bottom-up" methodology, which analyses data against a phenomenon or context (Tracy, 2019, ch.2). Therefore, this study is based on empirical evidence from informal conversations, reports on the environmental condition of the Oslofjord, social transition, and the

role of bioeconomy in the future. Strauss's methodology is often characterized by the researcher moving back and forth between the collection of empirical data and theoretical literature analysis, as the empirical evidence indicates the relevant theoretical background (Bell et al., 2022, p 532). We adopt abductive logic when we engage in imaginative thinking about intriguing findings and then return to the field to check our conjectures. This research methodology became central throughout our project as information from empirical analysis constantly gave rise to the need to develop the theoretical basis for the problem.

Through the master's project, we aimed to find connections between empirical primary data and published relevant documents. The coding central to GT methodology was a valuable tool for analysing and forming the theoretical framework. The coding was used to categorize different nuances of the issue under common concepts that represented different factor groups that impacted investment and realization.

3.4 Collection of data

In this section, we will delve into the distinction between primary and secondary data in the context of this study. We will further elucidate our data collection methods, outlining how we procured and utilized primary and secondary data sources for our analysis.

3.4.1 Primary data

Primary data consists of information gathered through direct engagement between the researcher and the informant. In the context of this study, primary data signifies the data acquired through in-depth interviews with informants drawn from three distinct samples.

Focus groups vs in-depth interview

A focus group shares a similar structure to an in-depth interview, where open-ended questions are utilized to capture the participant's experience, followed by probing questions. Initially, we considered it a valuable approach for data collecting, aiming to gather insights from a broader

range of individuals. However, we conducted in-depth interviews because we believed the interviewees would feel more comfortable sharing information individually than in a group setting. We recognized that group dynamics could influence the information obtained, potentially impacting the authenticity of responses provided by participants. Additionally, we realized that conducting group interviews may not be an efficient approach to gathering insights from a substantial number of participants within our limited timeframe.

Selection of participants

Establishing the preferred sample of interviewees constitutes a crucial aspect of the study. Within qualitative methodologies, ensuring a representative sample is paramount. The process of selecting participants for in-depth interviews involved striking a balance between obtaining detailed descriptions of experiences from interviewees while ensuring equitable representation in the various selections we have in this study.

We included three selections of interview participants, each representing three distinct categories: public actors, private actors, and professional or interest organizations. The public actors possess the capacity to impact the Oslofjord through political directives and regulatory frameworks. The selection of private actors' shows the commercial sphere. The group of professionals or interest organizations provides insight into the knowledge base and commitment to the environmental condition of the fjord. The purpose was to compare the insights from the three groups to create a deeper understanding of the intersectoral obstacles.

Randomly selecting interviewees will make data easier to obtain. However, it may result in data irrelevant to the task, data that needs to be more specific or have the correct details. Therefore, it was not optimal to base our selection on interview subjects who are "convenient". They do not necessarily have the expertise desired to answer every research questions. However, with their knowledge and expertise, we will be able to integrate their responses. To find the right interviewees for the sample in this study, we used a sampling approach such as targeted sampling to recruit the optimal sample. Individuals were invited as interviewees because they were assumed to have experience and knowledge relevant to the task. We then used the snowball effect to obtain contact with additional relevant informants. After the interview, we asked these informants to recommend other potential participants who might provide valuable insights. This method allowed us to

progressively reach a larger pool of relevant informants, leveraging each interview to identify further contacts and thereby expanding the scope and depth of our data collection (Bell et al., 2022, p. 394).

Interview guide and execution

Determining the method for conducting in-depth interviews is crucial. We have chosen to conduct the interviews digitally, using a transcription tool. This approach eliminates geographical constraints and mitigates time limitations for participants. Digital interviews are cost-effective and enable quick results, and more advantageous than phone interviews due to the observation of nonverbal cues. Some participants provided written responses via email, allowing them time to reflect. This method is useful when time is limited, but it's important not to overload participants with questions, as verbal responses are quicker to generate and opens for more reflection than written ones.

Personal interviews are essential to account for potential biases. The informant's responses reflect their perspectives, material may be influenced by their understanding of our research, preparedness, role, and ability to reflect on the questions.

3.4.2 Secondary data

The collection of secondary data used in the discussion of primary data and research questions was a selection based on reports, action plans, and literature related to the thesis introduction, a status review of marine environmental technology, as well as the tripartite background theory that was developed through the work. In the discussion, secondary data was contextualized with the information gathered from the interview-based data collection and then placed in the context of the Oslofjord through reports and action plans related to environmental measures and the development of the marine (blue) bioeconomy.

3.5 Categorization of collected data

In this subsection, we will describe the transcription and coding of the findings. Several methods exist for analysing qualitative data, and the determination of which analysis method to use is influenced by the research approach employed in the study and the interactive nature of data collection (Anker, 2020, p. 73).

3.5.1 Transcription

A substantial amount of information is produced during interviews with informants, mainly semi-structured interviews that allow for reflection. Audio recordings were made during all interviews with the informant's prior approval to ensure essential details and information in the responses were not overlooked. Subsequently, these recordings were transcribed into text format after each interview. Handling the data material becomes significantly more manageable by downloading audio recordings for coding, analysis, and comparison across datasets. The tool we used employs artificial intelligence (AI) to convert audio files into text format. Considering the inherent inaccuracies in text precision associated with AI tools, it became imperative to undertake a meticulous review of the transcriptions in conjunction with the audio recordings. However, such tools still yield substantial time savings relative to manual transcription approaches.

3.5.2 Coding

Coding is a fundamental pillar within the operational framework (Bell et al., 2022, p. 282). Coding the data material aims to identify similarities, differences, and connections between samples. To generate a thematic overview, we employed a conceptual model. Conceptualizing the data material is a crucial aspect of the coding process. The resultant concepts from the analysis should be sufficiently clear to allow for verification by others. (Glaser and Strauss, 1967, p.3).

A systematic approach was employed to sift through the collected material, categorizing it step by step, with only potentially relevant material initially isolated from the text. The initial step involved

examining recurring themes and opinions to discern patterns and facilitate information organization. After reviewing the transcripts of interviews and email correspondence, we implemented a color-coded system to aid in organization. This system enabled us to categorize segments of data using distinct colours, aligning them with the research questions they addressed. The findings diverged into seven categories: motivation drivers, market predictability/security, effectiveness/measurability, responsibility, collaboration/interaction, and resources/prioritization (attached in the appendix). In the final step, the categorical framework was interconnected into two overall thematic concepts for comparison and discussion against the secondary data considering the three research questions.

By applying this coding method, we aimed to attain a more profound comprehension of the data and uncover any patterns or correlations among the informants' responses. This approach let us discern whether multiple informants converged on similar themes or issues. Consequently, we could effectively evaluate the consistency and validity of our observations, potentially highlighting significant findings that were reiterated across various informants or contexts.

Assessment of codes and theme

Our coding approach and theme selection do fulminations or potential weaknesses. One critical consideration for our coding method is its susceptibility to subjectivity and interpretation by the researcher. This may result in specific perspectives or aspects of the data being overlooked or undervalued while others are overrepresented. The researcher's preconceptions or theoretical foundations can influence the choice of topics, potentially leading to bias in the analysis and interpretation of the data. It is crucial to remain open to alternative interpretations and continually reflect on our assumptions and preconceptions throughout the coding process.

3.6 Presentation of data

This section delineates the methodology employed for analysing primary data amassed in this study. We will commence by elaborating on our approach to presenting the findings derived from the data collection process. Subsequently, we will use an analysis tool to contextualize the findings within broader societal macro conditions, informing the ensuing discussion chapter.

The thematic content analysis of the interview results is conducted utilizing a framework inspired by PESTEL. Throughout the data collection process, it became evident that it was fitting to categorize the empirical findings into overarching themes based on four of the six factors encapsulated within this tool, making up a PETL-framework. The selection of analytical tools aligns with the GT- approach in our research methodology. This approach underscores that predefined themes did not predetermine the outcomes of the research questions; instead, the empirical material served as the starting point for selecting theoretical analysis tools.

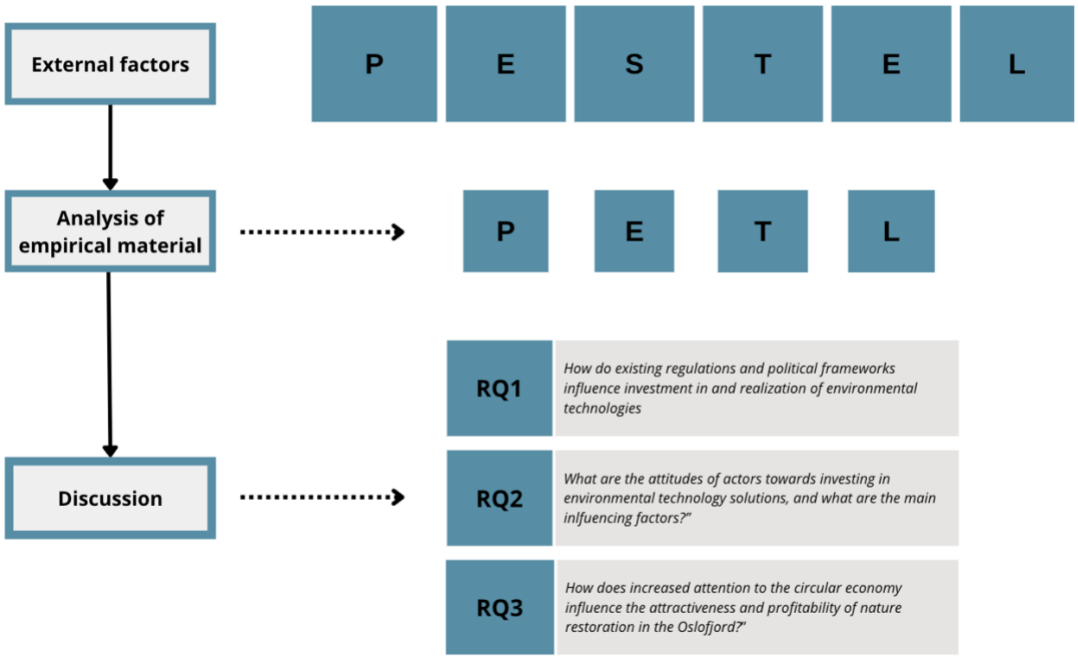


Figure 3.2: A visual presentation of the utilization of the PESTEL framework as a result of the review and basis for empirical data and discussion.

3.7 Protection of privacy

Before starting the interviews and collecting primary data, this project was registered and approved by SIKT - the Knowledge Sector's service provider. Submitting a registration form to Sikt serves the purpose of ensuring that the processing of data material and personal information pertaining to the study adheres to legislation. It is essential to guarantee the study's high-quality completion and privacy protection. The registration included the interview guide and the informant letter, which were submitted for approval regarding the type of personal data planned to be processed. The informant letter was sent to all participants in advance, apprised of their rights concerning the study and were presented with a consent form to participate as informants in the study. Requests for audio recording during the interviews were included in the informant letter and verbally confirmed before the start of each interview. During the transition from audio recordings to storing the interviews in text form, the interviews were anonymized to prevent documents with named informants from being stored on external devices.

The informants had the opportunity to withdraw their participation at any time. Additionally, a quote check was sent out towards the end of the project for approval, allowing them to review and adjust their own quotes if desired.

3.8 Evaluation; Reliability, validity, limitations and challenges

Critical assessment of the collected information is vital; hence, quality assurance is imperative. Reliability and validity serve as two criteria through which quality standards can be empirically evaluated. In this section, we evaluate the study's quality based on these two criteria and its limitations and challenges of our research method.

3.8.1 Reliability

Reliability concerns the extent to which consistent results are obtained when measurements are conducted multiple times; it relates to consistency. The concept is divided into two categories: internal reliability and external reliability.

Two students ensure internal reliability by collaborating, conducting interviews, and agreeing on assumptions about data and analysis. External reliability concerns whether the data collection and analysis techniques would yield the same results if another researcher or if the study had been conducted on another occasion. We dedicated generous time conducting thorough literature reading and communication with relevant actors for crafting the interview guide. During interviews, we focused on avoiding leading questions, maintaining neutrality, and minimizing body language to enhance external reliability. Further enhancement could involve diversifying participant demographics, such as age or gender (Tracy et al., 2019, ch.11)

Potential threats to study reliability include biases towards participants or researchers. We conducted individual interviews to avoid group dynamics, which can influence perspectives and lead to false positive responses due to social pressures. We set interview durations early to manage time constraints and scheduled interviews at the informants' convenience, all during working hours. However, this might have caused a rush for some, contributing to participant error.

Research errors, including misinterpretation, bias, and lack of preparation, can hinder fair interpretation of participants' responses. Collaborating on the study has helped mitigate these errors to some extent.

3.8.2 Validity

Validity assesses research quality, encompassing relevance, method and measure appropriateness, result analysis accuracy, and findings generalizability. Internal validity concerns accurately measuring intended variables. The interview guide and reports are pivotal for the study's outcomes. We encountered a challenge in collecting relevant literature to design the interview guide, as this was our first time doing so. These factors could weaken internal validity. External validity pertains to generalizing study findings to other relevant groups, projects, or settings (Tracy et al., 2019, ch.11)

During our study, nine informants divided into three different samples participated, indicating relatively low external validity. We prioritized an even distribution of informants across selections and expertise in the field rather than focusing on gender as a significant factor in the informant selection process. The researchers' shared educational background may impact the study's external validity, as they are enrolled in the same master's program at the same institution. However, the selected informants' diverse backgrounds, skills, and responsibilities enhance external validity. Variations in background knowledge among the researchers contribute to differing attitudes and assumptions, mitigating the impact on external validity.

3.8.3 Limitations

Articulating the limitations of a study serves multiple purposes. Firstly, it delineates and confines the study's scope, clarifying included and excluded areas or thematic aspects. This fosters a clear comprehension of the specific issues under investigation. These limitations establish realistic expectations for the study's outcomes, minimizing misunderstandings. Transparent acknowledgment enhances the study's credibility and integrity. Delimitations also guide future research, fostering ongoing knowledge development.

3.8.4 Challenges

Our project aimed to identify barriers to sustainable investments hindering the realization of marine environmental technology in the Oslofjord. The quote is relevant today, emphasizing that action on the environmental crisis must progress from planning to actual implementation of innovative solutions. As of today, there is little theoretical material or research specifically addressing investment barriers or the implementation of this type of marine technology, despite public acknowledgment of numerous barriers to realizing such solutions.

If time constraints were not an issue, we could have expanded our pool of interviewees. We categorized our interviewees into three primary groups: private actors, public actors, and subject/interest actors. Each interviewee provided unique perspectives on the Oslofjord issue, enhancing diversity among participants. The results would have been more representative of the Oslofjord and the case if representatives from the entire area had participated. Additionally, it would have been beneficial to gather more informants focused on the bio-based aspects of the study, as this perspective was lacking among the informants. However, it was still valuable to gain insights from those outside the bio-based industries to understand the perceptions other stakeholders have of innovative biological solutions for the fjord.

The research questions were initially designed in conjunction with the information letter and the application submitted to Sikt in January. These questions and the central issue have remained unchanged, maintaining consistency across all informant interviews. As we neared the completion of this study, it became apparent that a refinement of the questions' phrasing was necessary. This refinement was undertaken not to alter the fundamental understanding of the questions but to enhance clarity and precision, thereby facilitating a more straightforward comprehension of the study's objectives for its readers.

External reliability has been impacted by our decision not to utilize any form of digital storage or traceability for the collected data. As a result, it will be challenging for other researchers to replicate the study. Primary data were gathered through oral interviews, and the informants have been anonymized, making it difficult for researchers to determine the original sources of the data.

4. Analysis

The empirical data collected was to gain a more comprehensive understanding about external elements affecting investments in marine environmental technology. Reviewing the transcriptions and categorizing the data revealed it was appropriate to organize the findings through two thematic approaches:

- Factors impacting the motivation to invest in environmental technology.
- Factors impacting the perception of investment risk in environmental technologies.

A total of 9 stakeholders participated in the interviews of this study, each contributing their perspectives on the realization of environmental technology in the Oslofjord.

To reference statements from the semi-structured interviews, participants have been coded according to their respective selection and number. Table 4.1 shows the distribution of informants within each selection and a description of the informant codes.

Table 4.1: Selections and informant codes for the collection and analysis of primary data.

Selection	Number interviewed	Informant code
Private actors	3	Private actor 1, 2, 3
Public actors	4	Public actor 1, 2, 3
Interest and professional organizations (Others)	2	Others 1, 2

Based on the review and categorization of the empirical material, it proved useful to focus the findings and further discussion on four of the six PESTEL factors to address the research question more closely. The following is a review of findings from interview data related to the political, economic, technological, and legislative/regulatory aspects of implementing marine environmental technology in the Oslofjord.

4.1 Factors affecting motivation to invest

Political aspects

Political priorities were emphasized as a decisive factor for promoting the implementation of measures in the Oslofjord, where all the selections pointed to this as a factor influencing the willingness to invest in sustainable innovation. However, the perspective from the different selection varied somewhat. One of these priorities was specified by the establishment of incentives facilitating the development of new markets.

The lack of political will, in terms of inadequate adaptation of regulatory frameworks, was described by both the "Private" and the "Others" selections. A quote from informant Private actor 3 illustrates this well:

"Absence of political will to promote sustainable technology negatively affects investment willingness, and regulatory constraints are often perceived as significant barriers to the development of sustainable technology and new bioindustries. Stable and clear regulatory frameworks promote investment." (Private 3)

From the Public selection, it was also expressed that the absence of adequate tools to facilitate investment in innovation could be perceived by businesses as a lack of political engagement.
It was further clarified that there are often underlying reasons for what private actors or society at large perceive as a lack of engagement among public authorities. The informants emphasized the lack of resources and expertise within the administration as a key factor.

«*It's not about absence of engagement. But it's about the absence of resources. It comes down to money and it comes down to expertise and professionals. In small municipalities, professionals often have multiple roles. That means you can't always work as focused as you might want to*. » (Public 1)

This had a clear impact in terms of case processing and permits for innovative actors, where a lack of knowledge about new innovations, combined with the absence of regulations to support the assessment of such cases, was evident.

Political engagement and will, in the sense of inadequate facilitation for sustainable investments and innovation, were also emphasized as significant reasons why new solutions and products are difficult to realize today due to the lack of markets. For participants from every selection (P, O, M), facilitating a change in the direction of capital flow is seen as an administrative responsibility. Informant Others 2 exemplified this by highlighting facilitation to increase the demand for sustainable services and products:

"*In that case, I mean that the administration must facilitate, either by imposing taxes on the cheap raw material, which is not so environmentally improved and sustainable. And then they must find incentives at the other end, and provide economic incentives on what is good, so they can level it out*." (Others 2)

As a "best practice" example, the EU's efforts to facilitate sustainable finance and transformation in the business sector were highlighted. In selection M, the international market, especially in the EU, was described as important for Norwegian business. In the context of sustainable transition and investing in marine resource industries, the EU is perceived as leading the way, both through addition of requirements and stimulating instruments, compared to Norwegian environmental and climate policy, which is perceived as more backward and tied to existing guidelines.

The establishment of incentives facilitating the development of new markets was highlighted as an important priority for the authorities. This approach was crucial in the context, not only for promoting sustainable bio-based industries in general, but also for its applicability to the Oslofjord and potential environmental improvement measures. This was further identified as one of the factors contributing to the market gap currently seen in emerging bio-based industries.

Economic aspects

By all the selections (Private, Public, Others) profitability, or realistic expectations of future profit, was stated as the most important motivational driver for the willingness to invest in or develop sustainable bio-based solutions or environmental technology in general. According to this thematic approach, the expectation of profit stemmed from the idea that the Oslofjords' marine environment could serve as a supply of materials for sustainable value creation. Nevertheless, making investments solely to contribute to the restoration of nature or the production of environmentally friendly products, without a certain degree of profitability, was considered unrealistic for any business.

«*Return on investment is vital for any investor. Investing in environmental measures must give some kind of return, either in the form of avoided penalties and reduced cost / taxation, or through improved reputation and in turn increased demand/ improved income. In the short run, however, many environmental initiatives do not instantly lead to an improvement of the bottom line. From a business point of view, this is the most obvious barrier for environmental investments*." (Others 2)

Two central reasons for the absence of profitability emerged from the empirical data. First, there was mentioned a lack of willingness to pay (WTP) for more sustainable products, compared to more cost-efficient alternatives. In addition, the lack of markets for innovative, bio-based materials was also cited as a determining factor. These two were described as a consequence of the absence of economic instruments promoting the transition to novel bioeconomic value chains, favoring more cost-efficient but less environmentally friendly alternatives.

There was described that investments are often directed towards what is considered attractive rather than morally correct. More capital in the direction of environmental technology or other innovative solutions were also described as specifically necessary for actors in start-up/scale-up phases because of their limited resources, and it was considered an administrative responsibility to create a change in direction of the capital in this way.

Technological aspects

Statements of the Private selection encapsulating the entirety of the technological dimension of bio-based environmental technologies in the Oslofjord today was as follows:

> "*Environmental technology must contribute to a positive social and economic development, while at the same time it should not affect the entirety of the marine ecosystem in a negative direction ... It is, on the other hand, perceived as there are few real technological solutions that actually change the documented state"*. (Private 3)
>
> **«***It can indeed reduce the need for finance, or for support, much less. And that can be very positive. I have not seen many circular economic measures that I have seen had real economic potential.*" (Private 2)

The transition from project to commercial scale in new bio-marine technologies faces challenges due to limited knowledge and experience. Participants of the empirical study highlighted the requirements of efficacy of these environmental technologies, emphasizing the importance of a measurable impact. In this time, where sustainable attributes often fail to surpass considerations of cost-effectiveness and pricing, the selections underscore the necessity for new solutions to exhibit significant positive effects, not inferior to their unsustainable counterparts. However, while laboratory and pilot projects provide valuable insight, and the development of the technological processes mainly takes place here, operating in scale may yield unpredictable outcomes. Therefore, achieving a certain scale is deemed necessary for generating resources sufficient for a market and profitability.

The impact of bio-based technology, both positive and negative, and the requirement of surface area for sea-based solutions was central to the participants (Private, Public, Others) in questions about the implementations of these solutions in the Oslofjord. A certain skepticism emerged about the impact of such new solutions on existing activities in the area from the Public Selection. For several participants, it was important that any bio-based technology, including different types of aquacultures, should not seize areas that could lead to major conflicts of interest. The impact of

existing stakeholders on the marine environment compared to the impact of new activity was generally not included in the reflection. Participant Public 2 describes this by:

"*It's both the impacts it will have on the marine ecosystem and how much limitations it will impose on the use of the areas it occupies. There can be many aspects of a measure that one doesn't have complete knowledge about how will have effect*." (Public 2)

A statement indicating that a potential environmental improvement in one area does not necessarily mean the ripple effects of the technology are positive.

Legislation and regulation aspects

There is widespread agreement among participants from selections of Private, Public, and Others actors that current laws and regulations do not effectively facilitate the implementation of marine bio-based technologies. Perceptions of these factors are twofold. Firstly, current laws and regulations are described as poorly adapted to innovative marine solutions, as existing frameworks are still insufficiently adjusted for new raw materials and value chains. Participant Others 1 describes it as follows:

> "*Today's regulations are outdated and rigid.... And appears as a precautionary principle with an absence of scientific foundation* » (Others 1).

On the other hand, the Private selection described a demand for clearer requirements and laws as tools to direct investments toward specific areas, such as sustainable investments in general or new solutions for the marine environment. It became evident that clear regulations can increase investment willingness by creating more predictability for investors and businesses, when the actors are "forced" to one direction. Considering the situation in the Oslofjord, the Environmental Agency and the Pollution Control Act were cited as examples of this:

> *"The Agency normally sets strict requirements and limits to emissions or pollution allowed. I have heard companies complain about the requirements being too demanding and costly. In reality, however, the enterprises usually find a way and the Agency thus plays an important part in mobilizing environmental effort from Norwegian producers."* (Others 2)

It was further emphasized that regulations must be adjusted to a balance point that steers businesses towards environmentally friendly activities without driving them to relocate outside of Norway:

> "*If strict regulations result in enterprises shutting down operations in Norway and moving the polluting activities elsewhere, the purpose is defeated. This, however, cannot be the overriding principle in environmental regulation. If so, the threat of outsourcing will effectively stop needed national environmental ambitions and regulations. In short, this is a tricky balancing act*" (Others 2)

By directing capital towards specific areas, regulations and directives can function as market-promoting instruments. This was particularly noted in the context of marine low-trophic aquaculture and the lack of a tailored framework for both sea-based aquaculture permits and the processing from raw material to consumer, and the potential circular value chains of nitrogen and phosphorus from open sea cage aquaculture (Others 1). This lack of regulation was described as not only discouraging investments in marine bio-based solutions but also creating delays in the bureaucratic system that handles such cases without sufficient expertise to make adequate assessments.

4.2 Factors affecting perception of risk

Economic aspects

The absence of guarantees for investors of marine bio-based technology today was of the selections (Private, Public, Others) perceived as an element of high-risk perception and is limiting the number of projects that become realized. From the empirical data the low expectations of return on investments were considered a risk factor both for the technology companies and the investors. The risk was perceived high for innovative start-up companies, but rather low for larger, more solid businesses which also have the potential to mitigate risk through diversification into another, more secure income source.

In the context of realizing innovative ventures, various support mechanisms were highlighted as crucial aids for startups or unimplemented innovations, serving as tools to reduce risk for private investors. The impact of public financial involvement was described as having a positive effect on access to private capital once public support was granted. This is not only because it mitigates some of the initial risks related to profitability for the company and investors but also because the involvement of support mechanisms can provide administrative assistance to newly established, inexperienced businesses.

Technological aspects

For bio-based technologies in the marine environment in the Oslofjord, there was still an absence of technological maturity and measurable effects. In order to be able to commercialize and scale a technological solution, it was assumed as crucial to be able to show actual, desired results (as positive environmental effect or value creation). According to participant Private 3, it acknowledged that it is still not known any real, such technological solutions on the market today.

It was emphasized that the development of innovative technologies was a time consuming, expensive process requiring sufficient expertise in both the environment and the solution itself. And the uncertainty and risk this entails meant that enterprises that who want to commercialize

and scale such innovative solutions should be tolerant by i.e., being strong of capital, have another diversified source of income or strong investors on the team.

Of the Public selection, the uncertainty linked to lack of experience with environmental technology and the effect of collection was widely discussed. This uncertainty raised concerns regarding potential unanticipated negative consequences and risk of adverse effects from the implementation of technologies or ecosystem-based solutions. Reasoned with "*there is always a relatively large potential of damage, at least in any case uncertain*" (Public 1). The selection pointed to a perception that solutions of the type of bio-based technology or low trophic value creation comes with a potential of beneficial effects on the marine environment. Nevertheless, a clear emphasis was placed on an uncertainty linked to possible negative effects and consequences of implementation these types of ecosystem-based solutions. This critical thinking was often justified by lack of knowledge and experience with of such a ecosystem approaching activity in large scale.

> «*But the main problem when it comes to getting private investments to implement measures that contribute, is that they must have profitability. And very often, a certain scale is then required ... they are not tested on such a large scale. So, one knows too little about the effect, and in many cases, it will be believed that there is better with several small ones, but then it becomes unprofitable*." (Public 2)

Further in the interviews, one of the central themes regarding the technological aspects of marine environmental technology or nature-based solutions was the uncertainty surrounding the negative consequences of introducing such solutions into the marine ecosystem. This concern extends not only to the ecosystem itself but also to the potential impacts on other stakeholders who wish to utilize the shared resource that the fjord represents. The existing stakeholders' impact on the marine environment was not considered, making it unclear whether current stakeholders are prioritized over innovative actors, even if the existing ones have a greater negative impact than the new actors. Implementing nature risk as a consideration for those wishing to use the Oslofjord area could thus

be an interesting tool to facilitate business activities in and around the fjord with minimal negative impact on the marine environment.

Legislation and regulationol aspects

Uncertainty regarding rapid changes in regulations and directives creates investment risks for innovative solutions in the Oslofjord. This is seen as a risk factor due to the intense sustainability and green transition efforts in the EU, which introduce new regulations and directives impacting Norway and its industries due to close collaboration.

Informant Public 2 described the active transition work from the EU as problematic because new EU regulations are implemented in Norway with a delay. Adjusting to new directives, such as investing in a new purification plant for the fjord, is time-consuming and costly. It was therefore described as risky to invest substantial resources in technologies for environmental improvement, in case guidelines should change shortly afterward and require further investments.

4.3 Summary of empirical findings

In the empirical material from the informant groups, a range of elements related to political, economic, technological, and legislative/regulatory (PETL) aspects emerged, impacting investments in environmental technology in the Oslofjord. A summarized presentation of the most central findings is provided here in Table 4.1, and these are further discussed considering the general status of marine environmental technology and the identified needs to improve the Oslofjord and promote sustainable marine resource use.

Table 4.2: Summary of key empirical findings related to investment in environmental technology within the political (P), economic (E), technological (T), and legislative/regulatory (L) aspects.

	FACTORS IMPACTING INVESTMENT MOTIVATION	FACTORS IMPACTING THE PERCEPTION OF RISK
P	• There is a need for clearer accountability from the political side, through support and facilitation for the involvement of the private sector. • Need for improved of policy instruments that promote a market for marine environmental technology and the sustainable utilization of marine biomass.	• The innovation race and proactive management in international markets, such as the EU, can lead to rapid regulatory changes that are difficult for private actors to keep up with.
E	• Absence of profitability and realtistic exptectations of returns in case of private investment in sustainable activity. • Lack of economic incetives for choosing sustainable activities/products over cost-effective traditional alternatives.	• Absence of risk-reducing instruments, like guarantees, for invested capital in innovative marine measures. • Sufficient public financial support is crucial for risk-distribution.
T	• Sufficient measurability of impact and tangible results is necessary to increase investment willingness. • Technology development is time-consuming and costly; the positive aspects of new technology must surpass existing solutions to be attractive.	• Lack of knowledge about potential negative impact of implementation and scalation of innovative technologies in the marine environment affects perception of risk. • The affect of environmental technology on other stakeholders of the marine environment, and possibilities of conflicts of interest.
L	• Lack of tailored legislation and regulation that allows for implementation innovative solutions for both nature restoration and marine value creation. • Current legislation and regulations are not adapted to innovative marine solutions, need for regulation based on updated knowledge.	• Lack of specific requirements increases the perceived risk of investing in innovative projects.

5. Discussion

As shown, documentation and reports on the environmental condition of the Oslofjord are continuously being published, detailing the necessary measures to prevent the fjord's ecosystem from collapsing completely due to human activity and the negative externalities affecting the marine environment. As an official initiation of efforts to improve the condition of the fjord, the government developed the comprehensive action plan for the Oslofjord (The Ministry of Climate and Environment, 2021) with the goal of a "joint effort" for the environment. Subsequently, the Norwegian Environment Agency reviewed the plan and reported that the current efforts are not sufficient to achieve the ambitions for a clean fjord by 2026, as presented in 2021 (The Norwegian Environment Agency, 2023).

Direct measures in the marine environment are partially addressed in these documents, but there is emphasized that marine restoration efforts should adopt a holistic approach, incorporating biodiversity, climate adaptation, and food security. Given the critical condition, it can therefore be argued that innovative solutions and technologies for damage mitigation and resource utilization should be more prominently included in the cross-sectoral action plans.

In the study's "current status" report on environmental technology (Section 1.2), it was shown that there is still a lack of experience regarding the effects of environmental technology when implemented in marine environments, and that there is increased uncertainty about how it will impact the ecosystem if scaled up (Röschel & Neumann, 2023).

The conducted literature review strongly indicates a threatened environmental condition in the Oslofjord, with five factors highlighted as central to the challenge. Physical disturbances along the coast have caused significant and lasting changes. Overfishing has led to an imbalance in the ecosystem. Pollution by environmental toxins is an extensive and complex issue. The input of nutrients and organic matter needs to be reduced to improve environmental conditions. There is a generally high concentration of nitrogen in large parts of the fjord, especially in areas with limited water circulation and high industrial ang agriculture activity.

It was then suggested that Norwegian environmental policy should favor incremental development over expecting fully developed technology when granting permits. By allowing development closer to the market, this approach can lead to better solutions and enhanced competitiveness (Martiniussen, 2014). The financial aspect was also a central factor in the development and realization of these types of solutions, with public facilitation for blue investment and market distortion highlighted as a crucial tool for promoting investment in sea-based solutions and value creation (Sumaila et al., 2021; Golombek et al., 2015; Espelien et al., 2014).

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With this discussion section, we will examine how this status description of marine environmental technology aligns with the situation for environmental technology in the Oslofjord as revealed by the empirical data collection. By comparing the empirical findings with the literature review, previous studies on the financing of environmental technology and efforts towards a sustainable blue bioeconomy can be more effectively utilized for work on the Oslofjord and addressing the ongoing crisis in the fjord's ecosystem.

5.1 Administrative facilitation and regulations

"How do existing regulations and political frameworks influence investment in and realization of environmental technologies?

The necessity of a proactive environmental policy and administrative facilitation was presented in various ways as crucial for promoting investments in marine initiatives and innovative solutions. As long as there are no clear economic incentives to invest in marine damage mitigation or sustainable resource use, the flow of capital into the blue economy will not be sufficient to achieve the goals of sustainable management (Sumaila et al., 2021). As a result, investing in environmental technology in marine areas will not be attractive enough to achieve profitability, even if the technology offers benefits in terms of environmental improvement and sustainable value creation. To change this situation, it was pointed out that there was more a government's responsibility to intervene and facilitate greater investment willingness in the marine economy. In addition to the fact that public support for innovative projects has a significant risk-reducing effect on the perception of sustainable solutions and can help direct private capital towards the development and commercialization of these (Golombek et al., 2015, p. 3).

This was also evident in the situation of the Oslofjord. By the empirical data, it was highlighted that there is a current lack of adaptation in regulations and legislation for innovative marine measurements, and a market failure due to insufficient political incentives. It was argued that current regulations are either lacking or based on outdated science and the precautionary principle, making it difficult to obtain permits or facilitate new marine activities in the Oslofjord. The solution to market failure is described both in the empirical data and in the literature as being more governmental management of the markets, through the implementation of requirements or economic incentives that channel capital towards sustainable innovations.

On one hand, this was perceived as a lack of political will and engagement, while on the other hand, the lack of competence and resources on the part of the administration was considered crucial. In the government's action plan for the Oslofjord (The Ministry of Climate and Environment, 2021), it is stated that all stakeholders responsible for the situation must contribute to achieving the goals

of a cleaner fjord, and that sufficient knowledge gathering is necessary to reach these goals. Based on the status description and empirical data, it appears that the acquisition of sufficient knowledge and competency resources must also be prioritized in the administration to facilitate innovative marine measures and value creation in the fjord. This is challenging as technology development is rapidly advancing in R&D environments, and society is continuously moving into a sustainable innovation race. Additionally, the EU is described as both an important driver for sustainable investments and a potential source of risk due to "sudden" changes in requirements or regulations. Therefore, a Norwegian management approach that is more proactive in terms of knowledge can be advantageous both for facilitating measures in the Oslofjord and for maintaining the competitiveness of Norwegian businesses in the international market.

5.2 Private actors and sustainable investment

"What are the attitudes of actors towards investing in environmental technology solutions, and what are the main factors influencing their decisions?"

The EU's Bioeconomy Strategy highlights the potential of biological resources and processes as renewable alternatives to fossil raw materials. Reports such as "Value creation based on productive oceans in 2050" (Olafsen, 2012) and "The Sea Chart towards 2050" (Almås, 2017) underscore the significant economic potential of marine industries. These reports project substantial value creation through advancements in marine technology and increased utilization of marine resources. However, the path to realizing these projections is fraught with environmental, economic and technological obstacles.

A critical challenge is the climate footprint and environmental impact such technology can have, making the potential for ecological harm a central factor affecting attractiveness. In the development of new bio-marine industries, involving for example marine algae, significant investments in technology and infrastructure are required, alongside clear regulatory frameworks to reduce risk and build a robust value chain. The sustainability of marine industries relies on the

efficient utilization of low-trophic marine biomass and the enhancement of nutrient circulation through upwelling technologies.

Factors such as financial risk, lack of knowledge about potential benefits, and expected returns, and the absence of markets pose significant challenges for the development of bio-marine and related technological industries. Financial risk arises due to the substantial investments required in technology and infrastructure, without clear visibility on returns. The lack of understanding of the potential benefits that environmental technology can offer and expected returns complicates investors' ability to assess project profitability. Additionally, the absence of established markets limits industry growth, despite the potential for bio-marine products and services. To reduce the risk perceived by private actors and promote sustainable growth in the bio-marine sector, clear regulatory frameworks, increased knowledge dissemination, and efforts for market expansion are necessary.

Findings from the empirical data suggest that several actors are inclined to perceive reduced risk if the government has invested in the project before private entities enter. Therefore, the role of public authorities is to identify projects that are marginally profitable for private actors but offer substantial socio-economic benefits. The goal for the public sector is to find projects that provide positive societal effects that would not be realized without support, thereby increasing the attractiveness of these projects to private actors who are hesitant to invest due to uncertainty.

In the private capital market, potential sources of financing can include banks, private investors, investment companies, and venture funds. These actors must evaluate both the company's ability to execute the project, the emerging market opportunities, and the technological risks associated with commercialization. The entrepreneur will typically have better knowledge of the technology's risk aspects, their own abilities, and willingness to invest effort. This private information that the entrepreneur possesses can lead to asymmetric information between the entrepreneur and those who might contribute to financing the technology. If the information access is not sufficiently detailed, it will lead to increased investment risk and make the technology less attractive for investment from the capital market.

Uncertainty related to the outcome of a potential commercialization of environmental technology makes it prudent to secure investments from external actors to actualize commercialization. Public

support schemes usually refrain from supporting projects with high expected commercialization success. In such cases, the project is considered so low investment risk for private actors that there is no need for public support to attract capital for commercialization purposes. In cases where the risk is high, however, it is seen as ideal to obtain capital from both public support schemes and private actors. This way, the risk is diversified across the societal factors that exist in the current capital market. By obtaining capital from various actors, the project can reduce its own financial risk by transferring the risk to other actors.

The growing awareness of corporate impact on the environment and the economic repercussions of natural resource degradation are driving increased willingness among businesses to engage and take responsibility, including in the investment in marine technologies. As companies recognize the importance of sustainable practices and environmental stewardship, they are increasingly seeking out innovative solutions, such as marine technologies, to mitigate their environmental footprint while maintaining economic viability. Investments in marine technologies align with this shift towards sustainability, offering opportunities to develop eco-friendly solutions for various industries reliant on marine resources. Moreover, these investments not only address environmental concerns but also offer potential economic benefits, such as improved efficiency, reduced costs, and access to new markets driven by consumer demand for sustainable products and services. Thus, as the commitment to environmental responsibility grows, so does the inclination for businesses to invest in marine technologies as part of their sustainability strategies.

5.3 The attractiveness of marine nature restoration and circular economy

"How does increased attention to the circular economy influence the attractiveness and profitability of nature restoration in the Oslofjord?"

Further value creation based on the resources of the Oslofjord raised concerns among informants about potential negative effects on the environment and ecosystem, which are already marked by

weakened resilience. There are also concerns about how it might impact existing stakeholders. Significant uncertainty related to the effects and ripple impacts of these initiatives is expected to affect investment decisions and the willingness to take on associated risks. However, the study by Röschel & Neumann (2023) indicated that the implementation of ecosystem-based marine technologies can also have unexpected positive effects.

The situation in the Oslofjord, combined with marine environmental technology, presents an opportunity to contribute to societal benefits and establish a foundation for sustainable business activities with international relevance. Given the supportive effect that marine environmental technology can have on the nutrient cycle in the marine environment, it can facilitate the development of circular economies and more ecosystem-adapted industries. This can contribute to access to nutrients and raw materials that otherwise come from limited sources, or provide alternatives to less sustainable products, such as nitrogen and phosphorus for agriculture, low-trophic marine raw materials for the food industry, or biomass for energy purposes.

Value creation that leverages the natural ecosystem services of the Oslofjord can also be a solution for resource utilization, with a restorative effect on the ecosystem. Based on the five main challenges facing the environmental condition of the Oslofjord (The Ministry of Climate and Environment, 2021), marine environmental technology could provide improvements in the four main categories of ecosystem services: foundational, concrete, regulating, and cultural services, as described by Kaiser et al. (2020). Specifically, these technological solutions could enhance primary production, support sustainable resource use, bolster ecosystem resilience, and enrich the cultural and recreational value of the fjord, addressing key challenges in the critical environmental situation of the fjord. Through this comprehensive approach, the environmental condition of the Oslofjord can be significantly improved, fostering a sustainable blue bioeconomy and supporting long-term ecological health.

Interviews described a cleaner fjord as attractive, enhancing recreational and cultural value, and providing a better economic foundation for value creation and employment. This is primarily seen as beneficial at a societal level, with less immediate gain at the corporate level. Nevertheless, the EU's new instrument for sustainable finance, the taxonomy, has started to create a clearer

connection between climate and environmental commitment and profitability at the company level through sustainability reporting requirements. According to the empirical data, this connection is expected to become more apparent as the taxonomy's effects reach small and medium-sized enterprises.

Although the Oslofjord is not itself a focus area for the EU, increased pressure from the European market and larger companies can impact the businesses and communities connected to the Oslofjord, raising expectations for environmental engagement in the area. This could lead to a greater willingness to invest in sustainable resource utilization in the fjord, even though environmental benefits alone do not seem to have the most lucrative effect on capital investment in sustainable marine measures and value creation.

5.4 Limitation of the research method

To address the research question in this study, a Grounded Theory (GT) approach was used, where the literature review was an ongoing process throughout the work. The foundation for knowledge building was established through empirical data collection in interviews and conversations. This supported the research question and the goal of examining the factors influencing investment willingness and risk perception among stakeholders in various sectors. By gathering information and forming a theoretical basis in this way, a broad range of information was obtained. This provided a complex and valuable holistic view of the opportunities and challenges of realizing marine environmental technology in the Oslofjord, including a variety of relevant elements.

This process also leads to a transition from an inductive research method to an abductive strategy, where the theory gradually influences the study's content to a greater extent. According to Strauss's approach to GT, this is still within the initial theoretical methodology and is considered a natural part of qualitative analysis. However, such a complex overview of the topic and the selection of which elements to include in refining the study may omit other important aspects and examples that should have been included to improve the quality of addressing the research question.

How the collected primary data is processed and analyzed will also affect the results presented, discussed, and used as the basis for conclusions. The treatment of qualitative data, such as coding and conceptualization, can be done both manually and with the help of digital tools. In this study,

manual coding was chosen, and categories and final thematic concepts are thus based on the concrete data and, to a greater extent, the researcher's interpretation of the material. This makes the research method difficult for others to replicate in future research on the field.

6. Conclusion

This study focused on the problem statement, "*Factors affecting investments in innovative, bio-based environmental technology in the Oslofjord*," and explored the perceptions of investment influencing factors within both private, public and related actors to the realization of innovative measurements in the Oslofjord.

All the selections indicated a negative trend in the fjord's environmental condition, and although measures have been implemented, opinions on their effectiveness vary. There is also disagreement among the committees regarding which measures should be prioritized. The debate centers on whether indirect measures, such as nitrogen removal in wastewater treatment plants, or direct interventions in the fjord aimed at immediate environmental improvement are more critical.

There is also a demand for regulations and guidelines that establish clear rules for how stakeholders can utilize a resource such as the Oslofjord. Responsible use of the Oslofjord necessitates cooperation from all parties. If one stakeholder releases nutrients that another has spent years reducing, it will undermine the collaborative effort. Therefore, it is imperative to implement and enforce stringent regulations to ensure sustainable management and preservation of the fjord's environmental health.

Norway ranks among the wealthiest nations in the world, aspiring to maintain a reputation for environmentally friendly. However, this study, among others, has identified shortcomings in governmental responses to the deteriorating environmental conditions of the Oslofjord. Given the likelihood of abrupt climate shifts accelerating environmental degradation, enhancing initiatives to safeguard the fjord's viability becomes imperative for ecosystem resilience.

Manglende politisk tilrettelegging for markedsetablering, og regulering tilpasset biobasert innovasjon i marint miljø, ble både i empirien og litteraturen beskrevet som en avgjørende faktor for investeringsvilje i miljøteknologi. I nyere rapporter og handlingsplaner for Oslofjorden pekes det på økt tverrsektorielt samarbeid for ytterligere opparbeidelse og deling av kunnskap som avgjørende for å nå miljømålene. Basert på empirisk datainnsamling er kunnskap og erfaring om integrerte marine løsninger en begrensende faktor for etablering av tilpasset regelverk og

markedsvridning, og har dermed en videre innvirkning på attraktiviteten av å investere i marin miljøteknologi.

6.1 Further recommendations

In addressing the pressing need for holistic environmental management strategies in the Oslofjord region, two pivotal factors emerge as critical drivers for progress: the integration of enhanced expertise within governance structures and the cultivation of collaborative partnerships between governmental and private actors.

Increased competent knowledge integration into governance is crucial to ensure that innovative projects are not hindered by inadequate knowledge and regulatory gaps within the administration. Inadequate understanding and insufficient regulations can impede the progress of forward-thinking initiatives within the management sphere. As such, there is a pressing need to enhance the expertise within governance structures to facilitate the effective evaluation and implementation of innovative projects aimed at improving environmental conditions, such as those in the Oslofjord. By bolstering knowledge resources within administration, decision-makers can better assess the feasibility, risks, and potential benefits of innovative solutions, thereby facilitating their successful integration into environmental management practices.

Furthermore, fostering collaborative partnerships between governmental authorities and private entities is paramount. In Norway, there exists a high level of trust in governmental institutions, and private actors often seek regulatory frameworks that can provide clear guidelines for investment decisions. Collaborative efforts between government and private sectors can leverage this trust to develop mutually beneficial arrangements that facilitate private investments directed towards environmental remediation initiatives in the Oslofjord. By establishing frameworks that delineate responsibilities and incentives for both governmental and private actors, such partnerships can streamline decision-making processes, optimize resource allocation, and enhance the effectiveness of environmental improvement endeavours. An illustrative example of such collaborative initiatives is the NOx Fund, where governmental imposition of levies on NOx emissions facilitated the accumulation of funds for environmental improvement projects, effectively channelling private investments towards targeted environmental enhancements.

By addressing knowledge gaps and regulatory deficiencies within administration and fostering synergistic relationships between public and private sectors, we can pave the way for innovative solutions and sustainable environmental stewardship in this vital marine ecosystem.

Use of artificial intelligence (AI)

For this master's thesis, artificial intelligence has been employed to transcribe interview recordings and edit text. Since manually converting audio files to text is time-consuming, this is an excellent tool for overarching transcription tasks. The University of Oslo's "Autotekst" tool, which incorporates Whisper provided by OpenAI, was used for transcription. After reviewing the audio recordings, the transcripts were manually edited to ensure accurate reproduction, especially of proper names. For text editing, we used two different programs. ChatGPT4 by OpenAI was employed to revise our text excerpts, while QuillBot and its free "paraphraser" tool suggested synonyms and rephrased expressions or sentences.

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Appendices

Appendix 1: Interview Guide

Intervjuguide

(Eksakt formulering og hvilke av spørsmålene som tas med i hvert intervju, kan tilpasses til de ulike utvalgskategoriene)

Innledningsspørsmål:

1. Hvordan engasjerer din arbeidsplass seg i bærekraftig omstilling av samfunnet?
2. Hvilken kjennskap har du til miljøteknologi i dag?
3. Hvordan vil du beskrive miljøproblematikken i og rundt Oslofjorden?

Forskningsspørsmål 1:

Hvordan oppfattes investeringsviljen blant private aktører i verdikjeden for implementering av bærekraftige løsninger innen biobasert miljøteknologi, og hva er de viktigste påvirkningsfaktorene for denne viljen?

1.1
Hvordan kan dagens arbeid med grønn omstilling og implementering av marine bærekraftige løsninger beskrives?

1.2
Hvilke faktorer påvirker investeringsviljen opp mot miljøteknologi blant private aktører, både i dag og i fremtiden?

1.3
Hvilke egenskaper er viktig at sjøbasert miljøteknologi har for å kunne realiseres og implementeres?

1.4
Hvordan kan miljøsituasjonen og forbedringstiltak være til verdi for privat sektor og næringslivet?

Forkningsspørsmål 2:

Hvordan påvirker eksisterende regelverk og politiske rammer investering i og realisering av bærekraftige løsninger, og hvordan kan disse faktorene redusere barrierer og fremme innovasjon?

2.1
Hvordan oppfattes det at politikk og reguleringer påvirker graden av investering i og realisering av bærekraftig teknologi i privat sektor i dag?

2.2
Hvordan samarbeider offentlig sektor med private aktører for å tilpasse rammeverket i retning av mer realisering av bærekraftige løsninger?

2.3
Hvordan påvirker EUs fokus på klima- og miljøpolitikk satsingen på innovativ teknologi og grønn omstilling her i landet, både i offentlig og privat sektor?

Forskningsspørsmål 3:

Hvordan påvirker økt oppmerksomhet rundt sirkulær økonomi og biobaserte verdikjeder attraktiviteten og lønnsomheten rundt restaureringsprosjekter i Oslofjorden, som innebærer innovativ teknologi?

3.1
På hvilken måte representerer situasjonen i Oslofjorden den pågående natur- og miljøkrisen i et nasjonalt og internasjonalt perspektiv?

3.2
Hvordan kan ansvar fordeles i situasjoner hvor menneskelig aktivitet har betydelig påvirkning på natur og miljø i tett befolkede kyststrøk, slik som vi ser ved Oslofjorden?

3.3
På hvilken måte tror du biobasert miljøteknologi kan bidra i restaureringsprosjekter knyttet til miljøutfordringer i marine miljø?

Appendix 2: Informant form

Vil du delta i forskningsprosjektet

"Hvilke barrierer påvirker investering og realisering av innovativ, biobasert miljøteknologi i marine miljø, og hvilken innvirkning har disse på miljøtiltak i Oslofjorden?"?

Dette er et spørsmål til deg om å delta som informant til vår masteroppgave i Bioøkonomi ved Norges miljø- og biovitenskapelige universitet. Formålet med prosjektet er å undersøke barrierer for realisering av biobaserte løsninger i form av miljøteknologi i marine miljøer, hva som skal til for å overkomme disse barrierene, og hvilken betydning dette kan ha for håndtering av miljøsituasjonen i Oslofjorden. I dette skrivet gir vi deg informasjon om målene for prosjektet og hva deltakelse vil innebære for deg.

Formål

Formålet med prosjektet er å undersøke faktorer som påvirker investeringsvilje og skaper *realiseringsbarrierer* for *bærekraftige løsninger*, i form av *miljøteknologi* som bidrar til forbedret vannkvalitet og genererer *biologiske ressurser* til videre verdiskapning.

Det finnes i dag flere finansieringsløsninger, både fra offentlig og privat sektor, som støtter innovasjonsprosjekter og pilot-utvikling, mens løsningene for vekst og kommersialisering ansees å være mer ukjent. Vi ønsker derfor å benytte dette prosjektet til å se hvor *investeringsbarrierene* befinner seg og hvilke grep som kan gjøres for å redusere disse og øke effektiviteten av realisering av bærekraftige løsninger og miljøteknologi i marine miljø. I prosjektet defineres bærekraft ut fra den triple bunnlinjen som inkluderer miljømessige, økonomiske og sosiale aspekter. Det gjøres ut ifra følgende problemstilling:

"Hvilke barrierer påvirker investering og realisering av innovativ, biobasert miljøteknologi i marine miljø, og hvilken innvirkning har disse på miljøtiltak i Oslofjorden?".

Problemstillingen skal belyses gjennom følgende forskningsspørsmål:

1. *Hvor stor er den faktiske investeringsviljen blant private aktører i verdikjeden for implementering av bærekraftige løsninger innen biobasert miljøteknologi, og hva er de viktigste påvirkningsfaktorene for denne viljen?*

2. *Hvordan påvirker eksisterende regelverk og politiske rammer investering i og implementering av bærekraftige løsninger, og hvordan kan disse faktorene redusere barrierer og fremme innovasjon?*

3. *Hvordan påvirker økt oppmerksomhet rundt sirkulær økonomi og biobaserte verdikjeder attraktiviteten og lønnsomheten rundt restaureringsprosjekter i Oslofjorden, som innebærer innovativ teknologi?*

Oslofjorden er et område som preges av tett befolkede samfunn i kystområder og høy grad av påvirkning fra jordbruk, industri og fiskeri, som har resultert i eutrofiering og redusert biomangfold. Gitt miljøsituasjonen og relevansen for miljøteknologi i Oslofjorden er dette valgt som et aktuelt geografisk område for vårt prosjekt, da vi tar utgangspunkt i Ocean GeoLoop ASs miljøteknologi-pilot "GeoLoop Column".

På bakgrunn av valgt tema er masteroppgaven med som en del av Oslofjord 2.0 her ved NMBU. Det er et tverrfaglig masterprosjekt som inkluderer flere ulike masteroppgaver relatert til Oslofjorden, på tvers av fakultetene på universitetet. Oppsummeringer av alle masteroppgavene som inngår i dette prosjektet blir samlet i en populærvitenskapelig tekst og publisert etter endt prosjektperiode.

Dette er avsluttende gradsoppgave i masterprogrammet i Bioøkonomi - biobasert verdiskapning og forretningsutvikling ved Norges miljø- og biovitenskapelige universitet. Oppgaven vil bli på omtrent 70-100 sider og innhente data fra ca. 10 informanter gjennom semistrukturelle intervjuer.

Begrepsforklaring i prosjektet:

Realiseringsbarrierer – hvordan skal et prosjekt gå fra forskning til kommersiell fase.

Bærekraftige løsninger - anses å være løsninger som oppfyller dagens behov, men ikke vil gå på bekostning av neste generasjons bruk av ressursen.

Miljøteknologi - løsninger som er utviklet med hensikt i å forbedre en installasjon eller aktivitet, og som samtidig bidrar til redusert negativ påvirkning på klima og miljø. I vårt masterprosjekt betegner vi miljøteknologi som skaper mulighet for grønnere biobaserte verdikjeder, samtidig som det bidrar til forbedring av vannkvalitet i marint miljø.

Økosystemtjenester - Alle produkter, tjenester og materielle/immaterielle goder vi får fra naturen og økosystemene. Vi fokuserer på Oslofjorden og de økosystemtjenestene vi kan hente ut av de lavtrofiske biologiske ressursene der.

Biologiske ressurser - Økosystemet i Oslofjorden og organismene som kan være ressursgrunnlag for innovativ verdiskapning og foredling. I dette masterprosjektet fokuseres på lavere trofiske nivåer, f.eks. mikroalger og tunikater, og hvordan disse kan spille en rolle i sirkulære verdikjeder for næringsstoffer og være kilde til mer bærekraftige produkter.

Investeringsbarrierer – Faktorer som påvirker viljen i negativ grad til å gi kapital til innovative prosjekter. Her: nye løsninger for bærekraftig forvaltning av bioressurser og naturrestaurering av marine miljø.

Avgrensninger for oppgaven:

Geografiske avgrensninger – I denne prosjektet har vi valgt ut Oslofjorden som et relevant geografisk område.

Tidsperspektiv – Dagens situasjon med et historisk perspektiv med hva som har forårsaket miljøtilstanden i Oslofjorden.

Miljøteknologi - Økosystem tilnærmet teknologi som effektiviserer bruken av biologisk materiale og bidrar til naturrestaurering. I dette prosjektet tar vi utgangspunkt i en spesifikk miljøteknologi, men med en problemstilling relevant for ulike bærekraftige løsninger, både naturbaserte og teknologiske.

Hvem er ansvarlig for forskningsprosjektet?

Norges miljø- og biovitenskapelige universitet ved veileder [redacted] er ansvarlig for prosjektet.

Hvorfor får du spørsmål om å delta?

For å kunne besvare problemstillingen er det viktig for oss å innhente informasjon fra sektorer på flere sider av tematikken. Utvalgene er valgt på bakgrunn av egen kartlegging av relevante organisasjoner og virksomheter, samt anbefalinger fra personer som er kontaktet i forbindelse med innsiktsarbeid og tilvirkning av problemstillingen. Det vil innhentes informasjon fra fire ulike utvalg, som inkluderer offentlig sektor, privat sektor/næringsliv, fagpersonell/forskning/virkemiddelapparat og interesseorganisasjoner. Totalt vil ca. 10 personer innhentes som informanter.

Hvis du har spørsmål til studien, eller ønsker å vite mer om eller benytte deg av dine rettigheter, ta kontakt med:

[redacted]

Med vennlig hilsen,

Prosjektansvarlig
(Forsker/veileder)

Eventuelt student

Appenix 3: Coding

Scheme for initial coding and categorization of primary data and transcribation.

FSpm	Motivasjons-drivere	Marked	Forutsigbarhet/ trygghet	Effekt/Målbarhet	Ansvar	Samarbeid/Samspill	Ressurser/prioritering
1							
2							
3							