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The role of new technologies in upgrading traditional sectors of the Blue Economy: A case study in the Metropolitan Area of Lisbon

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Master in Enterprise and Competition Economics

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October 2023

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Acknowledgements

I'd like to thank my Supervisor Cristina Sousa for her availability and help throughout this period, as well as my insightful friends for their bright ideas and suggestions.

A huge thank you to my friends and family for giving me all the support, cheerfulness and motivation necessary throughout this process, your reassurance guided me through this challenge, and in particular thank you for putting up with me and my stubbornness, although you know I would call it perseverance.

To my friends, thank you for believing in me, and for forcing me to get out of the house and see the world when I was too absorbed by my student-worker life.

Thank you to the Ocean, for being a constant inspiration for this thesis.

Resumo

O objetivo desta tese é perceber o impacto das novas tecnologias e da inovação na modernização dos sectores tradicionais da Economia Azul, dando particular atenção ao papel da sustentabilidade. Para tal, foi adotada uma abordagem indutiva e realizado um estudo qualitativo que consiste em entrevistas semi-estruturadas a uma amostra de 8 empresas sediadas na Área Metropolitana de Lisboa e que operam em diversos sectores relacionados com o Oceano, como o transporte marítimo, a pesca ou a reparação e construção naval. Foram também entrevistadas duas fundações que trabalham em estreita colaboração com estas indústrias. Foi identificada uma diversidade de padrões para cada um dos resultados de interesse (estado da tecnologia; inovação; sustentabilidade; papel da regulação) e foram sugeridas teorias de interpretação baseadas na intuição económica e na literatura que podem e devem ser postas à prova através de estudos quantitativos de maior escala. Em termos gerais, foi verificado a existência de potencial para que as ferramentas tecnológicas e a inovação aumentem a escala dos sectores tradicionais da Economia Azul, mas também foram identificados vários desafios - principalmente o financiamento e a falta de concorrência ou de regulamentação rigorosa, que atrasam o crescimento transformador deste sector promissor.

Palavras-Chave: Economia Azul, empreendedorismo, inovação, sustentabilidade, novas tecnologias, Área Metropolitana de Lisboa.

Abstract

The aim of this thesis is to gain insight on the impact of new technologies and innovation on the modernization of the traditional sectors of the Blue Economy, paying particular attention to the role of sustainability. To do so, we adopt an inductive approach and conduct a qualitative study consisting of semi-structured interviews with a sample of 8 companies based in the Metropolitan Area of Lisbon and operating in a host of different sectors relating to the Ocean, such as maritime transportation, fishing, or naval repair and construction. Two foundations working in close contact with these industries were also interviewed. We uncover a diversity of patterns for each of our outcomes of interest (state of technology; innovation; sustainability; role of regulation) and suggest theories of interpretation based on economic intuition and the literature that can and should be put to the test through larger-scale quantitative studies. Overall, we see that there is potential for technological tools and innovation to upscale the traditional sectors of the Blue Economy, but several challenges were identified - primarily funding and lack of competition or stringent regulation, which slow the transformative growth of this promising sector.

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1. Introduction

The Ocean is a large direct provider of food, energy, minerals, natural assets, shipping lanes, and CO2 absorption. The presence and well-being of the Ocean has important social, economic, and environmental implications. For example, the OECD (2019) reports that the oceans account for around USD $1.5 trillion of global Gross Value Added economic activity, and the projections point at double. Similarly, the European Commission (2020) has also long recognised the Blue Economy, namely the ensemble of all economic activities relating to the ocean, as a main driver of European growth thanks to the development of new competences and activities that enable a sustainable exploration of ocean resources.

Given the relevance of the Blue Economy, it is important to recognize the potential of the ocean in the industrial sphere but also to be conscious of the threats that the industries may pose to it and to address them appropriately. Economic growth must be supported by healthy and resilient oceans, and therefore economic growth objectives must be in line with sustainability guidelines.

While the fundamental role of technological development in the revitalization and upgrading of established sectors has been widely addressed by the literature (Dolata, 2009); much is yet to be known about how this upgrading process takes place in the Blue Economy. The aim of this project thesis is therefore to survey how new technologies contribute to the development of traditional sectors of the Blue Economy, considering the perspective of companies from those sectors through case studies in the framework of the Metropolitan Area of Lisbon, a major player in the Portuguese Blue Economy. For this purpose, interviews were conducted with corporations and empirical case studies were elaborated, characterised by a qualitative assessment of the answers provided by the participants. This research contributes to the literature by shedding light on how traditional sectors related to the ocean and the sea are being revitalised through the development and adoption of new technologies.

The thesis is organised as follows: Chapter 2 presents the literature review; Chapter 3 describes the methodology; Chapter 4 describes and discusses the results; and chapter 5 concludes.

2. Literature Review

2.1. Definitions

Nowadays, the Blue Economy represents an integrating part of society. The concept was originally conceived in the 2012 United Nations Conference on Trade and Development [UNCTAD] (UNCTAD, 2014), and has been used in a variety of contexts and different ways ever since, often being used interchangeably with the terms "*ocean economy*" and "*marine economy*" (Lee et al., 2020). One of the first, general definitions of what constitutes the Blue Economy comes from the World Bank, which defined the term as "*the sustainable use of ocean resources for economic growth, improved livelihoods, and jobs while preserving the health of the ocean ecosystem*" (World Bank, 2017). The inherent trait of social and environmental sustainability of the Blue Economy was emphasised in an earlier paper by the United Nations (UN) as well, which identified the scope of the Blue Economy as "*the improvement of human well-being and social equity, while significantly reducing environmental risks and ecological scarcities*" (UN, 2014).

Hence, under its more general definition, the term encompasses all economic activities that take place and relate to the Ocean, but extreme importance is given to the sustainability of these practices.

Generalising, the Blue Economy encompasses both the economic uses of the Ocean and ocean resources, and the natural assets and ecosystem services that the ocean provides. This definition comprises of a variety of sectors, including some that are considered as the traditional sectors of the Blue Economy, namely fisheries and aquaculture, oil, gas and mining, coastal tourism, and ports and warehousing, as well as emerging large-scale industries with a higher technological intensity, such as certain renewable energies, marine defence, and marine biotechnology (European Commission, 2019; Rayner et al., 2019).

Because traditional sectors can benefit the most from technological advances (Sousa et al., 2021), the focus of this project will be limited to traditional industries of the Blue Economy, namely shipping, capture fisheries and aquaculture, tourism and marine recreation.

Historically, natural resources and, as such, marine resources as well were seen as raw materials to be extracted or physically converted to be used as input in production. While this is still true in many sectors, marine resources have been employed more and more in recent

years thanks to their scenic value to provide non-extractive services, such as outdoor recreation, which in turn propelled new roles for the agents in the sector, now interested in biodiversity preservation as well as the preservation of a meaningful natural heritage (UNEP, 2021).

Developed in this setting, coastal tourism encompasses all leisure activities and related services that take place in coastal regions as well as the housing dedicated to tourism in coastal areas. This sector has the most significance for Portugal within the Blue Economy, generating around 50% of the total revenue of the industry and employing almost 70% of the total workforce employed in it (Santos et al., 2017).

As a second key sector within the Blue Economy, traditional fishing has broadened into aquaculture, also known as aquafarming, which is defined by the Encyclopedia of Energy (Troell, 2004, p.97) as "*the farming of aquatic organisms including fish, molluscs, crustaceans, and aquatic plants. Farming implies some form of intervention in the rearing process to enhance production, such as regular stocking, feeding, protection from predators, etc*". Farming also "*implies individual or corporate ownership of the stock being cultivated*" (Troell, 2004, p. 97). The process involves cultivating freshwater, brackish water, and saltwater populations of said organisms under artificially natural conditions.

The potential of Aquaculture can only be achieved through extensive research and monitoring activities (Leal et al., 2014), and it should be noted that mussel culture has a positive effect on the environment by removing the excess of nutrients from the water column by biofiltration (Riisgård and Larsen, 2010). As reported by Massa (2017, p.106), "*a positive aspect of mussels and oysters is that they are filter feeders and grow only on the basis of available nutrient and available carbon in the environment*".

While always significant, the economic relevance of the fishing industry has grown more in recent years, constituting a potentially key player for blue growth. This is partially due to the higher demand for high-quality food protein that has increased together with the population (Boyd et al, 2022).

As for Portugal, the fishing sector contributed more than any other sector of the Blue Economy to the industry's total production in 2017, being able to generate almost 2 billion euros in production value despite employing less than 30,000 people (Santos et al., 2017).

The third sector in terms of relevance within the Portuguese Blue Economy corresponds to the management of ports, transportation, and their logistics, which includes a series of

goods and services related to the transportation of both goods and people as well as rental services of transportation means. The shipping industry includes the use of sea as means of transportation, with the objective of exchanging goods. The sector's business volume in 2017 hovered around 711 million euros, corresponding to almost 25% of the total generated within the Blue Economy in Portugal, while the Gross Value Added was estimated at around 310 million euros, or just under 10% of the industry's total (Santos et al., 2017). These figures are considerable, taking into account that the sector only employs little more than 3,000 people according to the Portuguese Blue Economy Observatory (2017).

2.2. The role of new technologies

The role played by technological development within the economy has been extensively discussed in the literature. Perhaps one of the most famous contributions comes from Joseph Schumpeter (1942), who identified innovation as the primary cause of economic development, implicitly claiming that the absence of technological progress would halt economic growth. He further argued that new inventions and innovative efforts by new entrepreneurs entering the market were largely responsible for rapid economic growth in developed countries. This resonates with the philosophy of other economists who believed that the growth of net income in developed countries could not be due to the accumulation of capital alone, most notably Solow (1957) who developed a model to show that technological development was accountable for around two-thirds of the US economy's growth.

For most advanced economies in the past 50 years, technological development has been enabled by the spreading of new information and communication technologies, taking the form of drastic changes to existing organisational patterns, competition dynamics, and the structure of established sectors and markets, where it did not directly create new ones (Dolata, 2009). In doing so, technological progress often influenced the lifestyle of individuals and their preferences as consumers, affected the behaviour of producers and firms in general, and required policymakers to adjust their legal frameworks to the new changes (Dolata & Werle, 2007).

The disruptive role of technology as an enabler of development also within the Blue Economy was clear already at the UN Conference on Trade and Development, where it was

noted that technological advances could enhance access and extraction capacity of additional marine resources (UNCTAD, 2012).

However, besides policy experts, the potential of technology as a driver of progress and economic development is recognised by experts in the field of the Blue Economy as well. For example, the director of the Center for Marine Robotics at the Woods Hole Oceanographic Institution, James Bellingham, predicts the future of ocean research to be tech-driven as the field rapidly matures. The researcher noted that "*the majority of Ocean exploration today is conducted by robots, and the rate of advancement of marine robotics technology is incredible*" (National Academies of Sciences, Engineering, and Medicine, 2020, p. 4).

On the topic, Hebert (2017) from the American Society of Mechanical Engineers recognised the role of artificial intelligence as improvement to robotics, with algorithms allowing robots to collect new types of data, such as the direction and intensity of currents, to then make more efficient decisions on the paths to take, saving energy and allowing for longer expeditions, reducing costs, and boosting productivity.

Making sure the Blue Economy includes knowledge-intensive sectors is crucial, and R&D plays a big part in the intellectual and technological development of certain sectors. Ocean observations that derive from diverse platforms contribute to deepening the knowledge of the ocean. These platforms may be research vessels, satellite remote sensing, ocean monitoring. Most data centers that provide ocean information related products and services specified scientific communities as their end-users (Rayner et al., 2019).

The importance of technological development is reinforced by the fact that ocean exploration and research is a sector that can offer plenty of opportunities, given that only 5% of the oceans have been explored so far (Melo et al., 2022).

Ocean data is also used to support strategic decision making in drilling procedures. This is of special relevance when considering the damages poorly executed drilling procedures may cause on the ecosystems involved. Ocean engineering is another scientific area that derives from the application of engineering methods to ocean-based industries (Walsh, 2021).

Training is vital when it comes to giving continuity to the know-how in the Blue Economy, as the digital transformation in all sectors of the Blue Economy is an on-going process, and enabling workers in this sector to work with digital tools is crucial (Walsh, 2021).

Another way in which new technologies are applied in the Blue Economy is to allow for a better management of resources, reducing uncertainty. Once implemented, this kind of technology can have long lasting positive impacts on the competitiveness of the companies and thereby the whole industry (Walsh, 2021). Technologies used for this purpose include shipping vessel tracking systems, such as automation identification systems and vessel monitoring systems data; fisheries fleet monitoring data; new remote sensing technologies; unmanned aircraft systems; and citizen science data (Barkai & Flanagan, 2014).

To quote a specific example, electronic data-recording and reporting systems allow for greater predictability of economic activity for companies operating in the Blue Economy. New software such as Olrac Electronic Logbook Software solutions, developed by Olrac's consulting, a South-Africa based organisation, presents data collection and reporting systems. "*To this day, Olrac is the only comprehensive commercial e-logbook solution implemented in South Africa. It can be found on every SCRL fishing vessel*" (Barkai & Flanagan, 2014, p.181).

A very important technological advance that would be beneficial in the spectrum of the Blue Economy should be investing in surveillance and monitoring activities for the benefit of marine ecosystems (European Commission, 2022).

When it comes to reducing uncertainty and allowing for improved monitoring, the development of Ocean Sciences is also key as it allows for predictive information about the ocean, including forecasting marine weather, locating, and determining the quality of a fish stock and acquiring knowledge of the subsea floor geology that provides gas and oil finds. Additionally, this knowledge allows for better conservation measures (Walsh, 2021).

According to Makowski & Kajikawa (2021), automation has an important role in the course of future innovations, this is based on two main levels:

1) on a cognitive micro-level, automation allows time to be allocated to creative problem-solving and management innovation, as a result of the resources that are saved and the time that is made available. According to the authors, this cognitive transformation impacts not only both human activities and capabilities, but also allows the development of automation technologies.

2) on an organisational and societal macro-level: through the direct transformation of management practice, this means that automation has an influence on the routines and

practices of an organisation, including on its management practices and principles (Kudesia 2019; Levinthal and Rerup 2006).

Nerhus (2014) stated that *"routine automation along with technological improvements have caused a skill-biased technical change"* (p. 69). Skill-biased technical change (SBTC) workers are essentially workers who benefit from their abilities to work with new technologies that foster productivity, while others may be negatively affected by the rise of technological developments such as robotics, artificial intelligence or information and communication technologies, causing the replacement of monotonous tasks by automation alternatives. This being said, complex and innovative duties require more know-how and education in order to create innovation.

As for the tourism sector, a study based on surveys by the European Commission (2020) identifies several communication technologies that can contribute to its revitalization. These include e-learning platforms, such as tailored training for coastal businesses and employees, e-commerce platforms, web-marketing, improved use of social-networking, as well as visual tours with high quality web cameras of coastal areas and underwater technologies that allow for better monitoring and safeguarding marine life, among many others.

The literature has recognised a role for public regulation as well in the revitalization of traditional sectors in that it can stimulate technological development. In particular, it is argued that policymakers should allow technological innovations to replace obsolete practices by avoiding locking specific technologies into place through regulation. Porter and Van der Linde (1995), in particular, contend that innovation should always originate from the industry and not the regulatory agent; that is, it should not be imposed. According to Sharpe (2008) the more competition there is, the bigger the incentive to innovate, this is also in line with the author's idea that *"competition is the main driver of managerial innovation" (p. 6)*.

Besides national legislation, there is consensus that international cooperation also plays a crucial role in the development of innovative technologies and practices as it fosters research and provides access to larger pools of data and resources (Zygierewicz, 2019). In doing so, enhanced cooperation and joint research efforts can be a driver of the revitalization of the Blue Economy. One example is the EU-funded project *"OCEANETS"*, a project that guarantees the reuse of certain fishing gear throughout the development of an Information Communication Technology (ICT) for preventing loss while optimising the recycling of technologies. These ICT tools may also signal the presence of fishing gears and it allows for

their recovery. OCEANETS optimised a pilot plant to chemically recycle the plastics fishing gears to produce high quality yarn (Directorate-General for Maritime Affairs and Fisheries, 2021). At the moment, OCEANETS has produced a "*pilot fabric*" made of polyamide to be tested for the production of sports gear (Directorate-General for Maritime Affairs and Fisheries, 2021).

In the framework of a 2019 study by the OECD involving innovation network centres working on the development of innovative technologies, it was found that the three most common technologies among surveyed network centres were autonomous systems, wave and tidal systems and materials and structures, all constituting 40% of the dominant technologies, followed by biotechnology (20%), offshore oil and gas (10%), marine sensors (10%), and fisheries gear (10%). This gives us a perception of the output of technology. Rayner et al. (2019) mention that, based on the OECD literature review, the variety of operational products and services includes mostly weather forecasts, sea state forecasts, climate forecasts.

According to the Global Ocean Science Report (ICC, 2020), the most frequent class of patents in the field of the Blue Economy is "*Technologies or applications for mitigation or adaptation against climate change*" (p. 32). This is the result of the potential that that technology has in the Blue Economy, and how relevant it is in the mitigation of the impacts of climate change, while ensuring a future characterised by technological developments.

While patents do not necessarily imply economic growth and development, they are relevant in fostering technological and scientific growth and may be used as an indicator of innovation. This is further supported by Kronfeld-Goharani (2018), who defends that in order to achieve further growth and competitiveness, the presence of innovation and operational excellence is key, aligned with a secure, safe and healthy work environment.

2.3.   The challenge of sustainability

The Blue Economy is intrinsically linked to sustainable development as it is a core part of its very definition. For this reason, the contribution of new technologies to the sector must not be limited to enhancing the economic growth and returns of its activities but also be functional to a sustainable development. The 2030 United Nations Agenda outlines three main pillars for such a development: social, economic, and environmental development. While these dimensions should be accounted for at all stages of the Blue Economy to achieve a liveable,

durable, and viable industry, profit may still be placed above the longevity of the planet's well-being, causing threats to the sustainability of the Blue Economy that are both environmental and social in nature. Bennett et al. (2021) analysed how a fast and reckless economic expansion of the Blue Economy can create social and environmental damage, creating injustice and disrupting natural resources irreparably. They were able to identify 10 threats, including ecosystem degradation and biodiversity loss; unequal access to the economic profits from the Blue Economy, skewed towards big firms; and the exclusion from governance of coastal communities, who are those who experience the consequences of the policy first-hand.

Lee et al. (2020) argued that the tension between economic returns and sustainability that arises within the Blue Economy is due to the differences in interests and preferences of the various stakeholders. In fact, in addition to the more obvious conflict between profits and environmental protection, more disagreements may arise since some actors prefer short-term results while others think about the long run.

The authors argue that alignment of stakeholders with the 17 sustainable development goals defined by the United Nations can help reduce the risk of uncertainty and conflicting goals. However, the authors also argue that the SDGs framework remains somewhat vague. It is necessary to clearly identify stakeholders within the Blue Economy as well as levels of interest and commitment to design appropriate and achievable goals that can guide the sector towards a harmony of economic growth and sustainable development, to end all forms of poverty while protecting and building economic growth.

Identifying stakeholders, their preferences, and more generally quantifying socio-economic benefits are challenges that technology can help address. Providers of data on the ocean could, for example, increase their efforts to track users, their downloads, and use of the data, which would help identify marketable societal values (Rayner et al., 2019).

Auad & Fath (2022) bring to attention the concept of the so-called 'citizen science', or 'citizen monitoring', which empowers citizens to contribute to the development of scientific development in the Blue Economy by providing geographic coordinates, photos, videos, sounds, and other useful information.

This connects citizens with the scientific community, and it allows them to engage with conservation programs, as well as take part in natural resource management efforts (Cigliano et al., 2015; McKinley et al., 2017) and it may help contribute to better ocean data collection.

Defining clear objectives and properly engaging stakeholders are also two out of the five rules of thumb that Burgess et al. (2018) identified as conditions for a truly sustainable Blue Growth. The other three are the optimisation of data collection and analysis; the systematic and rigorous measurement of the impact of interventions and policies; and finally, the need to design institutions, such as regulations, norms, and markets, rather than behaviours, namely how agents in the Blue Economy act, because it is much harder to shape behaviour than it is to control institutions, which will however later inevitably influence the conduct of stakeholders in the Blue Economy.

Lee et al. (2020) describes a context in which new technologies can help greatly, as improved data collection is essential in the definition of objectives and stakeholders, as well as in their engagement and in the measurement of impacts. Technology is crucial also when it comes to the design of institutions as well, however. In fact, Barbesgaard (2018) argues that the growth of the Blue Economy can only be truly sustainable if it creates win-win-win outcomes, namely nurturing simultaneously the needs of coastal communities, the environment, and investors. In this perspective, Blue Growth would not occur at the cost of marine and coastal resources but rather through market-based incentives that foster economic growth while being mindful of the environment's preservation. The author mentions individual transferable quotas as an example, where fishers exchange the right to fish certain amounts of fish and the total quantity allowed adds up to a pre-specified level. Because the overall maximum fishing level is fixed by the government, it can be set at a sustainable level. Here, it is clear that monitoring the use of marine resources by the companies in the sector is crucial for the success of this type of policy, so that technology is once again instrumental to this objective through improved data collection. At the same time, however, when such a policy is in place, firms might find it more profitable to innovate their business in order to comply with the regulation and avoid paying too high prices to purchase permits.

The literature also mentions reporting as a part of corporate social responsibility. According to Reverte (2009), certain determinants were suggested as leading reasons as to why companies feel compelled to invest in sustainability reporting. Some of these are media exposure in the shape of public relations, the competitive advantage that reporting may provide, the moral and ethical obligation to do so, international corporate listing and the sensitivity of the industry. Furthermore, reporting may bring financial benefits to the company (Whetman & Lancee, 2017).

Additionally, Zrnić et al. (2020, p. 278) stated that "*the main reason for sustainability reporting is to fulfill the legislative requirements. On the other hand, the legal requirement has a role to play in how the size of firms will affect sustainability reporting, without neglecting SMEs that can contribute to sustainability.*"

Thanks to innovative technologies, companies can aim at lowering costs in the face of constant output, thus increasing their profit margins. Here, technology is therefore not only instrumental to the design and effective execution of new institutions, but also enables actors to change their behaviour in response to the new institutional setting, as foreseen in Burgess et al. (2018).

In addition to improved data collection, new technologies can also reduce emissions and the footprint of the Blue Economy on the environment. In fact, the traditional sectors of the Blue Economy are the largest emitters of pollutants within the industry and therefore have the potential to become more sustainable thanks to the development of new technologies. Technological advances such as cold-ironing, electrification of equipment, advanced energy storage systems, lighting advancements may boost the sector, and in particular the use of energy sources and autonomous vehicles, as well as energy storage devices, renewable sources and clean fuels can help meet the sustainability goals companies should prioritise (Iris & Lam, 2019).

Markard et al. (2012) observed that sustainable development in traditional sectors is hindered by strong path-dependencies and technological lock-ins, namely the tendency of the actors and institutions in these sectors to not deviate from established procedures and technological standards, which are often outdated and environmentally detrimental. As a result, these industries undergo rare incremental changes rather than much needed radical shifts to new and more sustainable practices. In their paper reviewing the literature on how these radical transitions come into existence, whether these new pushes are imposed from policymakers, informed through research on new technologies, or from niches of the sector where innovative inventions are developed, gain momentum, compete, and eventually overthrow existing obsolete practices, the central role of technology in these sustainable transitions is evident. It follows that a conscious growth of the Blue Economy would also require continuous research on more sustainable practices and a strategic management of these niches where innovations can be conceived and prosper. In these circumstances, the

governance and institutions can and should play a crucial part in fostering technological advance and protecting it against the competitive advantage of established practices is key.

For example, co-opetition between private and public agents might represent a driver of innovation in the Blue Economy in the future, establishing public-private partnerships as the industrialization of oceans becomes larger. Government and philanthropic grants help de-risk investments, clusters, incubators, accelerators, and push new deals.

Technologies that are the outcome of these partnerships offer improved data collection for fisheries, seabed mining, shipping and transportation and oceanographic data. These projects may constitute support of sustainable coastal tourism, strengthening of the sustainability of the shipping sector, green fisheries, marine conservation, mangroves restoration, landscape protection and reduction of polluting components (ICC, 2020).

Lastly, the Global Ocean Science Report (2020) recognises that ocean literacy could be the key to break down socio-economic and political barriers, promoting responsible and well-informed behaviours towards marine and coastal resources services. Training guarantees not only ocean literacy but a well-equipped workforce for the challenges arising in the Blue Economy. As an example of this, Mission Starfish 2030, an ambitious project proposed by the Mission Board on Healthy Oceans, Seas, Coastal and Inland Waters, aims to restore the ocean and waters by 2030. This is supported by five crucial pillars, which are "*(i) Filling the knowledge and emotional gap, (ii) regenerating marine and freshwater ecosystems, (iii) zero pollution, (iv) decarbonising our ocean, and waters (v) revamping governance.*" (European Commission, 2020, p. 90). According to Mission Starfish's Report, "*generating a new blue workforce will require a complete review of training and education provision for people of all ages, including a diversified skill and competences framework focusing on the blue jobs of the future and on preservation and protection of marine biodiversity, ocean and human health and specific attention to lifelong gender-balanced learning opportunities*"(p. 30). As such, the European Commission highlights the importance of training as a key for a sustainable future that fosters the Blue Economy.

2.4. The role of regulation

The Blue Economy must have well established governance rules, transparent regulations with frequent and effective communications in order to guarantee sustainable growth (Lee et al., 2020).

In Portugal the major regulator for the Blue Economy sector is DGRM, the Directorate General for Natural Resources, Security and Maritime Services. It is the Portuguese authority for inspection, monitoring and control of maritime activities. The main functions of DGRM comprise Maritime Administration, the National Fisheries Authority, the National Maritime Traffic Control Authority, the Competent Authority for the Protection of Maritime Transport and Ports, and the National Waste Dumping Authority (DGRM, 2023).

The attributions of the regulating entity range from Maritime Administration, including Flag state, Port State and Coastal State, to Fisheries, comprising the many types of traditional fisheries, aquaculture and salt farming, industry and markets and control and inspection, and finally Planning and Sustainability, which englobes Environmental Monitoring, Maritime Spatial Planning, Marine Protected Areas and Defence and Protection of Fishing Ports (DGRM, 2023).

This entity has a major role in managing the natural marine resources, monitoring and implementing community funds destined for marine natural resources, defining common fisheries policy and ensuring its implementation, monitoring and control. Asides from this, DGRM has a set of assignments that is much too varied and descriptive to be included in this thesis, and they encompass all sectors of the Blue Economy.

Another important mechanism worthy of special attention is the National Ocean Strategy for the Sea (ENM) 2021-2030. ENM was outlined by DGPM, the Directorate General for Maritime Policy, a sovereign Portuguese entity responsible for the maritime spatial planning throughout in all its possible uses, as well as monitor and participate in the development of Integrated Maritime Policy of the European Union (IMP) and promote national and international cooperation within the Sea (DGPM, 2021). The ENM is, according to the official website of DGPM, the instrument that guides public policies for the Ocean in the current decade, having been approved by the constitutional government of Portugal in 2021. This strategy is based on the importance of scientific knowledge in the protection of the Ocean, valuing marine ecosystems and recognizing their role as vectors of sustainable management and, in parallel, solidifying the traditional and emerging sectors of the Blue Economy.

The principles presented in this program are in line with the 2030 Agenda of the UN, as well as a set of EU Pacts and Policies presented by the European Commission to conserve and protect the Ocean.

This set of strategies aligns sustainability objectives with innovation targets, while focusing on the positioning of Portugal in the industry and its economic flourishment through a maritime nation.

In order to implement strategies that truly boost entrepreneurship while promoting a circular economy, decarbonization and sustainability and have positive conservation impacts (DGPM, 2021), there must be regulatory incentives for both public and private donors to capitalise on sustainable ocean-based economic activities (Yoshioka, 2020).

Spaniol & Hansen (2021, p. 11) suggested that "*that policy action is needed to spur technology development and investments, and industrial actors must be convinced of the viability of such large-scale investments over long payback periods.*"

According to Sumaila (2021), while talking about ocean finance, which deals with the demand and supply for financial capital that is meant to be allocated to ocean-related economic activities and governance, one of the keys to encourage the right environment for a booming Blue Economy is effective regulations and policies in order to attract investors and financiers.

Additionally, the authors agree current policies and regulations that should strengthen the sustainable development of the Blue Economy are insufficient as information and knowledge about the ocean and its economic and social value is missing or faulty (Sumaila, 2021) This is the key ingredient that is missing to enhance the ocean's economy, as information and comprehensive data about the ocean's significance and value is still being explored and published (Sumaila, 2021).

A regulatory environment that attracts investors must aim to overcome the financial higher risk profile that a sustainable Blue Economy carries. These issues include, according to Sumaila (2021, p. 6), "*human capacity constraints, data challenges and higher risk of operation*". It is, however, necessary to de-risk sustainable development projects and activities in the Blue Economy, whether through insurance or other strategies that mitigate the risk.

Sumaila (2021) defends the primary current obstacles to a sustainable Blue Economy are an incapacitated environment to attract sustainable ocean finance, lack of governmental support, limited corporate investment and the high-risk profile of sectors that encompass the Blue Economy.

3. Methodology

3.1. Empirical strategy

The objective of this study is to understand the role of new technologies for the Blue Economy in the Metropolitan Area of Lisbon, focusing explicitly on the role that technological advancement has for the sustainability of these economic activities. While each chapter of this project until now helped provide the necessary context to understand the starting point of this thesis, this chapter defines the methodology followed to conduct this study. Since this thesis' focus lies on a variety of sectors within the Blue Economy and encompasses firms that differ in size, lifecycle, financial performance, and sector of activity, we opted for a qualitative approach in our research effort, adopting a research method that consists of interviews with companies deemed relevant for our study.

Following Bryman et al. (2011), the research adopts an inductive approach that aims at the generation of one or a set of theories, rather than analysing hard data to test pre-existing theories. As opposed to a deductive approach, which departs from a specific hypothesis to test it and assess its general applicability, inductive research starts with the observation of phenomena to isolate repeated patterns and create initial hypotheses on it. In this case, the insights required to build these theories about the role of new technologies and sustainability in the sectors of the Blue Economy within the Metropolitan Area of Lisbon come from interviews with firms that are part of these industries. As such, the approach adopted in this study is primarily phenomenological, which is described by Bhandari (2023) in her classification of the different strategies within qualitative research as the thorough description and interpretation by the research of the specific experiences lived by the participants.

Interviews represent the best tool for collecting data for this research for a variety of reasons. First of all, interviews allow for a degree of flexibility that is not present in surveys where questions are fixed and cannot be changed in the process. By contrast, while maintaining an overall similar structure to enable comparisons, the questions in an interview can be adapted based on the specific interviewee, for example based on the type of business or sector, but also adapted to include tailored follow-up questions if a specific interview provides insights that are particularly interesting.

The choice of conducting interviews also falls on the fact that there are many different sectors, as well as a great variety of companies that need to be addressed. Due to the lack of homogeneity between different kinds of industries, it is essential that each case is studied individually, keeping in mind there are intrinsic complexities to each case that deserve to be dissected, and giving the interviewees a chance to explain and develop their answers is the best way to account for these differences.

Moreover, providing the interviewee with a list of options to choose from forces a loss of detail in the answer that is instead possible to capture in full with an interview. There is a crucial engagement aspect in this approach. This means that leading an interview allows for the obtaining of in-depth responses that may be deserving of follow-up questions or further clarifications.

Additionally, contacting companies that are selected to be interviewed may cause a sense of visibility for the companies, which should encourage participation and make it easier to obtain useful information that can help us understand the company and the sector in which it operates. In line with this, another positive aspect of this approach is that we have the opportunity to obtain personal knowledge and detailed insights about the different industries, discovering information that is, in a way, usually only reserved to employees in the industry.

Moreover, the descriptive nature of interviews also allows us to be led by our curiosity, which is a great driver to the elaboration of a thesis.

The biggest difficulty was to manage to find companies that were willing to participate in an interview. Oftentimes, the corporate fabric is very engaged in their economic activities, not leaving much room to provide interviews.

Interviews were conducted with companies with seasonal activities, which means that during some periods the workload is superior, contrasted by weaker periods in terms of work. Consequently, some companies might not have been very receptive to conducting interviews as they were, at the period in which interviews were being conducted, in a high season in terms of workload, but may have been available during other periods, so it was important to fully take advantage of seasons with an inferior workload.

It was also complicated to get in touch with companies that do not have many employees, as this means the information may not be well distributed throughout the structure. Centralization may pose a hardship when obtaining answers, as the few employees or the only

employee that could answer all of the questions may not have been available to participate in an interview.

Ergo, this means that in case of smaller companies oftentimes there were not enough employees available to conduct an interview and speak on behalf of the companies about the several aspects of its activity.

The number of interviews depended on the saturation point, which according to Bryman et al. (2011, p. 4) is reached when "*successive interviews/observations have both formed the basis for the creation of a category and confirmed its importance*" and "*there is no need to continue with data collection in relation to that category or cluster of categories*" (p. 442). In the case of this research, this point was reached when 8 companies were interviewed.

The focus was then on generating hypotheses out of the categories that are building up (Bryman et al., 2011). While it is hard to estimate the number of interviews needed to reach the saturation point, it was taken into account that companies that belong to a determined sector may not provide significantly different answers when compared to their industry peers. Hence, it was found that the saturation point in determined sectors was reached, while in some other sectors there was more information that could have been explored or acquired, but time constraints and the below expectation response rate posed a hardship in the attainability of the saturation point of these sectors.

In order to compensate for the lack of responses in certain sectors, foundations and associations were taken into account, given they were more likely to participate in interviews as their core activity is sharing information and awareness and the mission is not profit based.

The interviews had the duration of approximately 40 minutes to one hour, and they were highly dependent on the information that was provided. When in need to explore a certain subject of a determined sector or company, additional questions were asked in order to cover up a certain topic or clear a doubt.

3.2. Sample construction

The interviews were conducted with several companies in the field of Blue Economics, ranging from naval construction and repair, professional training, maritime transportation, together with aquaculture and fisheries. These sectors were previously defined when choosing the object of study, and they are based on the list of traditional sectors of the Blue Economy.

The selection of the interviewed companies was based on how they adjusted to the object of study, which consisted of companies in traditional sectors of the Blue Economy. Characteristics such as their economic activity, number of employees, and overall possibility of the presence of new technologies were vital to determining the adequacy of the subjects.

The list of companies was compiled from the online database Orbis from the Bureau van Dijk, which contains financial and administrative information on almost 450 million companies across the globe and it is a great tool for better decision making. Being updated regularly, it represents one of the most powerful sources to obtain reliable data on private entities. Moreover, thanks to its filtering features, it allows to easily isolate and extract data on a specific sample of units. In this case, we retrieve all available information on companies that satisfy three key conditions: (1) are registered in either Lisbon or Setúbal- constituting the Metropolitan Area of Lisbon; (2) their activity status is either active or unknown; (3) their code in the framework of the Statistical Classification of Economic Activity falls within the sectors of the Blue Economy that are under analysis in this thesis.

This geographical area was chosen because it is a big player in the Blue Economy, and there is a big concentration of corporations in the area of Setúbal and Sesimbra, specifically, that are adequate for this study. Additionally, the companies were filtered based on their business status, which removed all companies that were not exercising their activity at the time of download or companies whose status was unknown. Next, we applied a filter to sort companies by their economic activity. The economic activities considered were: 03 – Fishing and aquaculture, 301- Building of ships and boats, 50- Maritime and waterborne transport, 521- Warehousing and storage, 55- Accommodation services, 79 – Travel agency, tour operator and other reservation service and related activities, 90 – Creative, arts and entertainment activities, 93- Sporting, entertainment and recreational.

In addition to the name of the firms and their contact information, data regarding the company's current business status was downloaded, along with their location, the code of their economic activity in the Statistical Classification of Economic Activities in the European Community, the last year the company had publicly available information in, the number of employees, the production value in USD, together with other financial figures. This type of information is useful to study whether there is any evident correlation between these characteristics and the degree of innovation or the predisposition of a firm to sustainability.

Interviewed companies have also been asked to provide elements such as their financial information to complement and validate the figures obtained from Orbis.

After setting all necessary filters and options, the file generated contained information on 14,992 firms. This list had to be optimised further, however. For example, companies with only one employee (*Unipessoal*) were excluded from the list as their limited dimension is assumed to deter innovation and the use of new technologies.

Certain CAEs were irrelevant to the object of the study. Hence, these companies were filtered out. It is important to filter out companies because not all companies have technological advances that are relevant enough for this study, and not all companies are integrated in what we have considered Blue Economy companies.

Even though some filters were applied, the final Excel file still had many corporations that were not a fit. Hence, companies were individually evaluated from the file and contacted if determined that they could provide valuable input. Because the number was very high, not all companies were considered, but enough to potentially reach the point of saturation with interviews, as desired.

Among those remaining, the companies to be contacted were then selected randomly to guarantee the absence of bias during the interviewing process. Because not all companies in the final list were interviewed, but only those required to reach the saturation point, it is important that the companies selected for the interview are not chosen based on an explicit factor. Random selection therefore grants that there is no discrimination based on the alphabetical order of companies, their location, their size or financial performance.

3.3. Data collection

The companies were invited to attend the interview via email first, using the same adapted template for all contacts that informed them about the expected duration of the session as well as the general points of discussion and the aim of the research project they would be contributing to. In case a company was not responsive via email, contact via telephone proved to be an effective alternative. This first contact is important as it should let each company know that the ideal interviewee is someone with enough knowledge about the firm and its sector of operation to fully comprehend the questions and answer them in detail; this person

could be for example the CEO, a chief engineer, managers, or anyone else playing a key role within the firm.

Interviews were conducted face to face and through video conferences via Zoom or Microsoft Teams. The content of each discussion was anonymised, and companies were informed about this as it likely elicited responses that were as honest and accurate as possible. Whenever possible, interviews were recorded and transcribed.

Interviews were semi-structured, meaning that the same base questions were asked in every session but there was still room to personalise the interviews based on the specific case This approach was deemed to be ideal because it allowed for a certain degree of comparability, allowing for the recognition of patterns across heterogeneous firms and industries, but also made it possible to delve deeper into the individual realities within the sample.

The base questions that were asked consistently throughout the study pertained to the 4 main areas of interest for this thesis that were introduced in the previous sections and whose relevance was discussed in the literature review: (1) state of technology; (2) new technologies and innovation; (3) sustainability; (4) regulation. It is important to note that the scope of these questions and therefore the company's answers may overlap, as these elements are not mutually exclusive and are actually tightly interconnected.

The first set of questions relates to the existing level of technology within the industry at large and the specific firm. A solid understanding of the starting point is crucial as it represents the benchmark against which technological innovation, regulation changes, and improved sustainability practices are to be contrasted. To this end, the following questions were asked:

- What are the technological trends in your industry?

- What technologies is your company adopting?

The second variable of interest is innovation, which has been recognized by scholars as a critical source of growth and competitiveness (Schumpeter, 1942; Kronfeld-Goharani, 2018). It is therefore fundamental to inquire what constitutes and what drives innovation within the Blue Economy directly. While Kronfeld-Goharani (2018) identifies it as striving towards operational excellence in safe, healthy, and secure work environments, others attribute a great

potential to artificial intelligence solutions, which could diminish risks associated with repetitive labour, as well as shifting the focus on the know-how, rather than the processes themselves (Herbert, 2017; Melo et al., 2022). Making sure the Blue Economy includes knowledge-intensive sectors is crucial, and R&D plays a big part in the intellectual and technological development of certain sectors. To understand how these views hold in the specific context of the Metropolitan Area of Lisbon, we ask the following questions to elicit the role of innovation in a given industry or firm:

- Do you think that companies in the Blue Economy in general and/or in your specific sector would be able to survive without adapting to new technologies?

- Is automation common in your industry?

- Do you consider there is pressure in the sector to innovate? What originates this pressure? Is it external or internal factors, namely your own company, direct or indirect competition?

Next, we explore how the firms in our sample deal with sustainability. This is one of the focal points in this thesis as the interest lies in whether technological development can go hand in hand with the preservation of the environment or if the two are mutually exclusive. Recalling the vision of Barbesgaard (2018), we try to understand whether the firms of in the Metropolitan Area of Lisbon operating in the Blue Economy are able to cater for the needs of coastal communities, the environment, and stakeholders at the same time, and are thus truly sustainable, by asking the following:

- What is the value placed on sustainability within your company?

- What sustainability measures does your own company adopt and do you think there is room to adopt more? If none, do you think there is room to adopt them?

- Is it possible to harmonise profits with the well-being of the environment and the oceans, given the current state of the technology in your company as well as its financial situation?

Finally, we are interested in understanding the role that the regulator plays both in terms of innovation and sustainability. This focus spawns from the strand of literature that

acknowledges how policy affects the behaviour of firms in the private market. Recall for instance that Dolata & Werle (2007) go beyond the more direct role of governments as defenders of the public good and recognize that consumer preferences may ultimately be the root of government action that mandates certain technology or sustainability standards in an effort to please voters. In this sense, it is important to explicitly address this aspect to isolate the possible causes of change within the Blue Economy, which might indeed be externally mandated but also caused by competition forces, as Schumpeter (1942) contended, or intrinsic company values. Note that the latter two hypotheses enter previous question sets but could also be included here. Conducting semi-structured interviews helps in this case, as these types of questions are asked where deemed fitter in order to ensure a natural flow to the conversation, but the results are then aggregated and contrasted under this last section. Hence, concluding, we try to understand the role of government action by asking the following:

- Are regulators involved with innovation in your sector and, if so, how?

- Are there any sustainability standards or practices directly or indirectly imposed by the regulator? Are they stringent?

In addition to qualitative information, some quantitative data was gathered in order to see if there are any correlations between the characteristics of the firm in the sample and the answers that they provide. One can expect the year in which the company was founded, the number of employees, or any measure of their financial performance be related to their attitude towards innovation and sustainability. For example, as mentioned, Lee et al. (2020) suggests that profits and sustainability exist in a trade-off and that financially constrained companies will overlook environmentally conscious practices to safeguard their bottom line.

Overall, these questions allowed us to collect plenty of information about several topics, namely how tech-friendly the industry is, or how traditional it is, the degree of pressure to innovate that there is in the industry, where does the pressure to innovate come from, what the role of new technologies is in the company, as well as what the role of regulators is, and if they exert any influence in the presence of innovation. It is also important to determine if sustainability has a relevant part in the company's activity, as it is clear the notion of sustainability is ingrained in the concept of Blue Economy.

Each company was analysed individually, and the contributions of each interview was qualified according to the size of the company and the sector in which it is inserted. In line

with an inductive type of reasoning, in the following, we try to trace common patterns within the answers provided by the companies during their interviews. For easier reference, we group sets of questions based on their underlying macro-topic; that is, new technologies and their role, innovation, sustainability and regulation. Nonetheless, the answers from the interviewees often spaced across macro-areas, as it is expected when conducting semi-structured interviews. Accordingly, answers that were originally given to a set of questions but were more related to a different outcome of interest are discussed and given salience in the relative, more appropriate topic.

Some comparisons were made between companies to determine what companies from the same and different sectors have in common. The comparisons are based on how technology impacts the sector, what technologies are common between sectors and between companies in the same sector, this includes analysing emerging tendencies. It was also investigated how traditional or innovative companies in the sector of Blue Economy are in general terms, how sustainability affects each sector, and each company in the same sector, and in particular how the corporate fabric is in terms of all the aspects that encompass Blue Economics in the geographical area in hand.

Despite efforts being made to get in touch with the selected companies, the response rate was below expectations. Out of the approximately 40 companies that were contacted, 14 initially agreed to the interview while 1 declined to participate. However, six firms that had previously accepted became non-responsive to our repeated efforts to schedule an appointment. Nonetheless, interviews were fruitful in terms of both quantity and quality of information provided.

In addition to the companies, a foundation and an association were also interviewed. For these entities these questions were adopted according to what was found appropriate given that non-profit organisations were being taken into account.

3.4. Limitations

Before looking at the results from this study, it is important to have a clear understanding of the limitations of the approach that was adopted. In particular, two aspects should be noted.

First, qualitative studies have limited generalizability. This is often due to the limited sample size available for this type of research, which typically requires more time and greater

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effort of participants, but also to the specific setting where participants operate (Bhandari, 2023). This research effort is no exception to this observation. Still, the purpose of this thesis is not to contend that the insights it generates hold elsewhere; rather, they offer an interesting in-depth analysis of the specific case of the Metropolitan Area of Lisbon. This contribution remains valuable in its specificity as they potentially can contribute to improve the knowledge of local business owners and policymakers. By the same token, it might also be interesting for members of the academia that wish to study the local context with quantitative methods that enable the creation of results that are generally applicable.

Related to this last point, one should bear in mind that a second limitation to this thesis is that it does not allow us to establish causality; that is, conclusions from qualitative data are necessarily noisy as it is not possible to control for hidden factors that might influence what is observed in the real world (Bhandari, 2023). For instance, we might find that companies in our sample do not think that environment protection regulation is stringent enough to push them to innovate. Deducting that government action is not or would not be effective in fostering sustainability-geared innovation would be wrong, however, as it might be the firms that chose to participate in our study are those that care the most about the oceans in the first place and therefore innovate more than the average firm in the Metropolitan Area of Lisbon regardless of environmental policies. Note though that this is not a real shortcoming, as inductive research is but the first step in the development of a theory. Recall in fact that the inductive approach starts from the observation of the real world to seek patterns that would support a more general, necessarily preliminary theory that is then to be tested by resorting to quantitative data. Taking the conclusions of this thesis to the real world is left as an avenue for further research.

Additional concerns relate to the bias that respondents might introduce in their answers. For example, they might gloss over certain aspects of their company to emphasise more positive sides. It could also be the case that representatives twist the truth to comply with what they think is the correct answer or the answer that the interviewer wants to hear, which is a concern that is especially valid when it comes to sustainability and its interplay with profit.

4. Results

4.1. Participants

As of July 31st, 8 companies were interviewed. To ensure their anonymity, these are called companies A, B, C, D, E, F, G, H, respectively. Descriptions of each of these companies follow:

- Company A operates in the naval construction and repair sector, and its core business is mostly focused on the repair of ships. The personnel is 20 people. Its CAE, the Economic Activity Code, is 30111 - Construction of metallic vessels and fluctuating structures, excepting recreation and sports. The spokesperson was a manager.

- Company B is a first-sale fish selling company. As this is a seasonal activity it means the number of employees may vary, therefore there are 80 employees working within the company's headquarters. However, the company as a whole employs around 500 to 550 people. The company's CAE is 03111 - Maritime Fishing. It participates in fish-selling auctions and performs the sale of the fish, constituting the bridge between fishermen and the business consumers.This company's interviewee was an Advisory Board President.

- Company C has between 55 and 60 people as of the end of December 2022. Its activity is characterised by CAE number 50300 - Inland waterway passenger transport. The interview was conducted with a manager.

- Company D has between 90 and 100 employees as of the end of December 2022. Its activity is characterised by 03111 - Maritime Fishing. The spokesperson was the Administrative Secretary.

- Company E has around 100 employees, and its main activity code is 85591 - Professional training. Its main technologies are software related to training, such as e-learning platforms, simulation rooms, and some machines necessary to the training. The interview participant was the firm's Director of the Department of Planning, Training and Certification.

- Company F has around 30 workers, and its main activity is 03111 - Maritime Fishing. This company is inserted into a very traditional activity, and its main technologies are

simple technologies related to the activity of the company itself, as well as probes and radars. The company's spokesperson was the General manager.

- Company G has 15 workers, and its main activity is 33150 - Vessel repair and maintenance. Its main technology is only related to the acquisition of new materials. The interview was conducted with the General manager.
- Company H has 40 personnel, and its main activity is 3210 - Aquaculture in salt and brackish waters. Its main technology is filtering systems, water quality monitoring systems, and a software tool that recognizes molluscs' lifecycle. The interview's participant was a Manager.

Additionally, a foundation and an association were interviewed. These were Oceano Azul Foundation, a Portugal based foundation dedicated to promoting ocean literacy and a sustainable use of the ocean, as well as working towards the conservation of ocean resources and Marine Protected Areas (MPA) (Fundação Oceano Azul, 2023). The interview's participant was the foundation's project manager for Blue Bioeconomy; and CoLAB+ATLANTIC, a non-for-profit R&D Portuguese Collaborative Laboratory Association that aims to gather both science and technology and sustainability while promoting initiatives such as coastal monitoring, ocean literacy, and conceiving knowledge-based products in fields related to the Blue Economy, such as marine science, marine ecosystem's health, climate change and science communication (CoLAB+ATLANTIC, 2023). The interview was carried out with the association's president and Marine Sciences specialist.

4.2. State of the technology

When asked about the technologies they are adopting and the trends in their industries, the answers from the companies in our sample mostly point in two directions. On the one hand, there are technologies that relate to the core activity of the sector and are therefore inherently sector-specific. On the other hand, companies mention technologies that improve on the efficiency of corollary activities to the main business, such as more administrative tasks or coordination and communication, and are, thus, to a certain extent, common across different companies regardless of their sectors. Whereas in the first case technologies usually consist of

types of equipment, machinery, or materials, supporting technologies seem to mostly substantiate in the form of IT tools and computer apps or software. Importantly, while the distinction between sector-specific and supporting technologies emerges quite clearly from the recorded answers and is intuitively easier to maintain, it is generally harder to confine IT to either of these classifications, as often companies make use of tools that are developed to become useful only within the limits of their sector. Finally, a minority of firms explicitly recognizes the appeal of automation and smart technologies for their businesses but remain sceptical of the limitations that this promising field possesses.

As far as sector-specific machinery is concerned, most companies in our sample seem to rely on resources and techniques that have been used for many years and are resistant to change. Companies in the naval construction and repair sector, for example, report that they still utilise traditional vessels and materials because of the prohibitive cost of upgrading to newer, more sustainable technologies. Closely related, Company C further expands on this issue by noting that returns are only seen in the long run; that is, besides capital expenditures being substantial, with even smaller equipment being highly expensive, the spokesperson argued that "*large investments [in technology] do not reflect quick enough and the payback is slow*", meaning that large investments take time to result in financial gain.

Noting that this issue is transversal across all companies in our sample that work with ships and vessels, the generalisation that for the Metropolitan area of Lisbon that capital-intensive sectors may see more modest technological advances due to the high initial costs of investments and their delayed returns might be proposed. This is indeed in line with the literature, which suggests that "*policy action is needed to spur technology development and investments*", referencing the need to convince industrial actors of the viability of such large-scale investments over long payback periods (Spaniol & Hansen, 2021). Importantly, however, while there are multiple explicit references to financial constraints, no spokesperson mentioned impediments arising from a lack of expertise or infrastructural capacities, nor to any resistance or support from political or regulatory bodies. We therefore conjure that these impediments may not be as relevant in the local context and delegate the empirical testing of this hypothesis to further research. If confirmed, the policy implications of such findings could guide local and central governments in designing funding opportunities that could provide firms in the Blue Economy the needed resources to bring their equipment and materials to the current standards. if not even beyond.

Additionally, and specifically for the fishing sector, a clear difference can be noticed regarding the state of technology and the attention reserved to new trends based on firm size. This comes as no surprise as the anecdotal evidence is in line with empirical results linking smaller business size to reduced investments as a result of binding capital constraints (Czarnitzki & Binz, 2008). Building on the previous suggestion, focusing explicitly on firm size when empirically testing the obstacles to innovation in the traditional sectors of the Blue Economy may provide insights on how to best target policies to overcome binding budget constraints.

It should be noted however that improvements in equipment and materials are not completely absent according to the interviewed companies' experience. In fact, Company A (naval construction and repair) reports that machines have become lighter and easier to carry, while company B (maritime fishing) mentioned the use of smart scales, species recognition machines, as well as recently renovated computer equipment. While purchasing this type of tools requires less financing, this still suggests that capital-intensive sectors are not immune from technological improvements over time.

Irrespective of the specific sector, all companies describe a process of digitalisation that has put IT, hard coding and programming, and automation under the spotlight. Used for a myriad of purposes, these tools seem to support firms greatly in their daily activities, from performance evaluation and optimisation to billing and financial management, from the estimation of their productive capacity to improved communication and coordination among their personnel. In contrast to the technologies mentioned previously, these tools appear to be less sector-specific and are indeed implemented by all companies across the spectrum we consider. For example, the importance of using online storage units to centralise and share information is mentioned equally by Company B (maritime fishing) and Company H (training), as well as consumption monitoring systems used by Company B (maritime fishing) and Company C (Inland waterway passenger transport).

Coupled with the lower cost of implementation and faster rate at which benefits of adoption can be reaped, investing in IT seems to be a more common and urgent concern for all firms. Interestingly, despite not recognising room for technological trends in its sphere, Company G (Vessel Repair and maintenance) has also pointed out that IT plays a central role in their activity, further stressing how digitalisation appears to indeed be an all-encompassing trend, affecting even more conservative businesses.

As an illustrative example, the spokesperson for Company C, from the sector of inland waterway passenger transport, the use of radars as well as telecommunication and monitoring systems that can record and evaluate breakdowns and accidents to understand troubles and guide interventions. They are also able to register ship velocity and fuel consumption and to compare performances among crews, providing valuable information on consumptions that can be used to optimise processes and reduce resource waste. Further, there is software that can track all equipment and its interventions, facilitating maintenance management. Besides physical assets, these IT tools, such as SAP, can also help with customer relations as well as financial and human resources management, supporting financial planning, on the one hand and the handling of performance evaluations, career development and training on the other.

The example of Company C showcases a trend that is evident across our sample, namely that digitalisation-driven optimisation is a priority for these firms. Yet, the intensity and speed at which this process unfolds may not be equal across sectors. Interestingly, in fact, a remark from the interviewee from Company B (maritime fishing) introduces two possible frictions that may hamper the spread of IT. In particular, the transcript of the interview reads:

> "*There is a lot of room to use new technologies. Despite the fact a lot of people have not completed higher education, there is a growth in the number of people with higher education in the industry; sometimes they conciliate* [fishing] *with other activities. The younger generations have a bigger aptitude to use new technologies.*"

In this extract, the spokesperson admits that there is potential for an even larger degree of digitalisation in the sector, and one may therefore wonder why this potential is not fully exploited. Based on the description of the sector in the following sentences, we know that, on the one hand, there are few people with higher education and that there are now more and more younger workers being employed. Therefore, if one's level of education correlates with the willingness and ability to adopt new technologies, it may be that the lower level of education in the sector may be an obstacle to technological development. Similarly, and perhaps more interestingly, if younger generations indeed have a bigger aptitude towards new technologies, as captured by our interviewee, then sectors where the average age of employees is higher will be characterised by lower degrees of digitalisation. As a follow-up, it would be interesting to empirically assess if the ease with which hires of young people occur within a firm influences its business performance through its degree of digitalisation and

innovation. This proposal is further supported by evidence pointing to the existence of status quo bias (Kahneman et al., 1991), which, if present, would explain why older and more experienced workers are reluctant to switch to new methods and technologies.

Finally, as a third and final technological trend, one fishing firm argued that automation and smart technologies could greatly help fishermen but warned that these tools are still not completely self-sufficient. Talking about "*apps designed for fisherman and shipowners* [...] *that allow for the smart recognition of fish*", Company B (maritime fishing) stated that "*the machine may aid in the recognition of the species, but the final word belongs to the operator, as the machine may cause doubts despite having a high degree of confidence*".

Implementing all the technologies mentioned requires training, and this is also the key to a sustainable and knowledge intensive Blue Economy. Nowadays we notice an increasing use of digital platforms as a way of learning, and the Blue Economy sector is no exception. To better understand the impact training has on the agents in the Blue Economy, a training company, company E, was interviewed. The company mentioned the use of "*e-learning platforms*", as well as, for the more specific topic of Blue Economy, mentioned the use of "navigation simulators, machinery simulators".

Company E (training) made a reference to tools such as "*e-learning platforms, navigation simulators, machinery simulators*" and how paramount they are in transmitting the necessary knowledge throughout the training. The company also stated that currently "*the trend is to go through a digitalization process, everything related to training is digital*". This is leveraged by PRR (Plano de Recuperação e Resiliência), which is the Portugal's Recovery and Resilience Plan under the EU Recovery and Resilience Facility, with execution date by 2026, aiming to implement a set of reforms and investments destined to support sustained economic growth after the Covid-19 pandemic, in an effort to converge with Europe's goals (Recuperar Portugal, 2023). The crucial objectives of this project include making a move towards digital transition and climatic transition.

According to the literature review, it should be noted that training is key to fostering the Blue Economy, as "*generating a new blue workforce will require a complete review of training and education provision for people of all ages*" (European Commission, 2020).

As mentioned by the Director of the Department of Planning, Training and Certification of company E, equipment such as "*radars, probes, maritime communication equipment,*

Global Maritime Distress and Safety System (GMDSS) simulators" allow this ongoing process to happen.

The Oceano Azul foundation alluded to the fact that they have "*programs with NGOs and schools*". The foundation has "*a program that focuses on working towards raising a blue generation, which involves working with children, as well as working with the government in order to include the ocean in the curriculum of children in a dynamic way*", in an effort to combine education and a sustainable and innovative Blue Economy.

According to Nuno Lourenço, the president of President of +Atlantic CoLAB, nowadays the trends in the Blue Economy are "*Technological development associated to the digitalization of activities, [...] technology associated with the most capital-intensive engineering components*", being "*much associated with the circularity [of the Economy] and decarbonization, meaning solutions that provide decarbonization or circularity in the chain of production*".

The representative and specialist in Marine Science also mentioned that, when it comes to traditional sectors, the trends are as follows:

Aquaculture	"*Biotechnology, digital, communications, sensorization. Basically, technologies that support the chain of production of technological solutions whether offshore or onshore.*"
Fisheries	"*New materials to avoid "bycatch", new monitoring methods, and more sophisticated vessel technologies related to the security, as well as monitoring and minimization of fuel consumption.*"
Training	"*Bringing expertise of what is done on land to the ocean. Everything that is related to more qualified jobs land wise may be reconfigured to the ocean with complementary training.*"

Naval repair and construction	*"New materials, focus on decarbonization and digital methods."*
Marine transportation	*"Investment in new sources of energy, and new propulsion methods. There is an ongoing debate about hybrid energy usage, hydrogen, natural gas, and it conditions the development of new ships."*

These corroborate the answers that were provided by the companies' representatives, and it is possible to infer that each sector is highly differentiated from one another when it comes to the adopted trends.

Moreover, the rising presence of new and improved technologies imposes a higher emphasis on training, both for new and older employees, namely on training and updating.

4.3. Innovation

Innovation is at the genesis of the concept of a Blue Economy. The EU recognises Research and Innovation as a pillar to a sustainable development of the sector and thus places it among the goals in the European Green Deal, stating that the development of the Blue Economy is much facilitated by a *"forward-looking, mission-oriented, and impact-focused research and innovation agenda"* (European Commission, 2022). Innovation is therefore intertwined with sustainability in the idea of a successful development for the Blue Economy, paying special attention to the conservation of the ecosystems and its resources.

The premise makes clear that a picture of the state of the Blue Economy in the Metropolitan Area of Lisbon would be incomplete without inquiring companies about their level of innovation. To better understand our sample's positioning regarding the topic, all firms were asked questions regarding their willingness and ability to innovate, the state of innovation in their specific sector, as well as the obstacles that inhibit this crucial aspect. As for previous areas of interest, we have also extended the same questions to foundations and observers that collaborate with companies in the Blue Economy; their answers provide a precious overview.

Discussing traditional sectors, the association Colab+Atlantic commented that *"usually the companies in the traditional sector of the Blue Economy have limited development capability and are conservative"*. The association partly attributed this lack of innovation momentum to the difficulty of placing a product in these sectors. However, according to the representative from the foundation, aquaculture should be excluded from this paradigm as it is inherently more innovative. Note that this is consistent with the definition of the sector in the literature, which characterises it as a broadening of traditional fishing and makes the use of more innovative practices its distinctive trait. Another exception mentioned was the shipping sector, in which there is potential for a certain degree of innovation. Yet, since it is a tough market to penetrate, newcomers who could introduce novelty to the market may struggle to participate.

The answers from our sample mostly confirm the expert's predictions. Indeed, we see that most companies are reluctant to invest and introduce innovations, although exceptions do exist. Overall, we see that the sector of naval construction and repair appears to be the most conservative in this aspect, with companies A and G mentioning that they could survive without innovation. In particular, company G explained that their field of activity is a niche sector with few competitors, which poses no threat of falling behind when not innovating and thus no incentive to innovate. On the other hand, company A deemed their industry to be competitive but foresee no technological leap in the near future. Interestingly, they added that they find most of the innovation occurring within the sector to come from the competition within the industry, rather than being self-motivated. This is in line with the literature, in which the idea that the intensity of competition is positively correlated with the innovation output as expressed by Sharpe & Currie (2008). Finally, interviewees from companies A and G also disclosed that there is virtually no automation and seemed sceptical about its possible introduction in the future, adding that it is a very intuition-based sector, requiring specific know-how that cannot be easily replaced by robots. The lack of innovation within these companies may indeed be linked with their low level of automation. In fact, the presence of automation may allow companies to focus on expanding know-how. Makowski & Kajikawa (2021), for example, find that higher levels of automation allow time to be allocated to creative problem-solving and management innovation thanks to the resources saved and the time that is made available. According to the authors, this would not only impact human activities and capabilities but also allow the development of further automation technologies.

On the opposite side of the spectrum, company B from the maritime fishing sector emphasised a high degree of competitiveness in its industry that leads the market to be very innovative. The company itself developed their own intranet, an internal portal to manage teamwork, and a repository of documents, but they also use a specific software to aid the management of human resources, including training days, days off and assiduity. Showcasing internal innovative efforts, the company has also developed several apps: a system that can issue permits for the occupation of public dominium ports; another that provides authorities with coordinates of fish captures whenever an endangered species is fished; and finally, one that quantifies the amount of waste brought to land. The most innovative tool developed by the company is an electronic auction system, which is used for the first-sale of the fish caught. Since every auction works in perfect competition, the company has successfully created their own market for their product - one in which consumers ideally all have access to the same products and information at the same time. Finally, the representative for Company B also touched upon the topic of automation, acknowledging that there is great potential in the sector but that it is a "*gradual process*". In particular, and perhaps quite interestingly, the spokesperson highlighted the rejuvenating aspect that automation brings to the sector, substituting physical and routine jobs that bring less value to the activity with automated processes. Moreover, given a greater predisposition to technology from younger generations, the company predicts a decrease in the average age of the workers in the fishing industry.

Company F (maritime fishing) sees innovation as a necessity, having referred to it as a means to maintain the quality of the product, but stated that the company could survive without it. This seems to imply that the space for innovation is restricted as it is only needed to ensure a certain standard for their product that can keep their customers satisfied. In the same sector, company D believes that it is possible to innovate without adopting new technologies. Rather, the representative recognised the role of training schools for innovation and growth as they enable the workforce to work with new technologies, especially fishing masters, who are in charge of governing the fishing vessels and are as such key to successful fishing activities. Albeit viable, the spokesperson admitted that innovation brought by means that are beyond the adoption of new technologies will likely have economic results below their full potential. Moreover, both companies in the maritime fishing sector are characterised by little to no automation, which, according to company D, may hail from the low level of innovation and the traditional nature of the sector.

The spokesperson for company D introduced an interesting topic that will be discussed in further detail in the next section in that it referred to two main sources of innovation: one the one hand, it is self-motivated, with the firm itself putting effort into innovation and implementing measures to foster it; on the other hand, it may be mandated by the competent authorities, primarily the Directorate General for Natural Resources, Security and Maritime Services (DGRM, Direção de Serviços de Inspeção, Monitorização e Controlo das Atividades Marítimas), a government entity with functions that encompass maritime administration, fishing and planning, and sustainability of the sea.

At times, the DGRM may indeed force companies to adopt certain measures or the use of specific materials, such as the use of an electronic fishing journal, namely data collection instruments that consists of all declaratory acts of fishing activities and operations under the exclusive responsibility of the crew member who is in charge of command functions of the vessel (DGRM, 2023).

The testimony from company D already alludes to the argument that innovation standards in the traditional sectors should perhaps be imposed or strongly pushed by the regulators. In this regard, the Oceano Azul Foundation believes the government can create plenty of stimuli to develop marine biotechnology, in particular, and that Portugal has the potential to place itself as an international leader in the sector, adding that the country possesses a great deal of know-how in R&D centres that could potentially scale up the sector.

Nonetheless, there are difficulties transferring the knowledge to the industry and support is required on this level. The spokesperson explained that the research teams must be aware of what the market gaps are, understand them, and study the market, so as to develop technologies for which there is demand. In order to achieve this, the transfer of knowledge must be backed with the help of proper capital support, as well as regular check-ups with the R&D developers for the purpose of adjusting certain details in their research, if needed. This prevents incompatibilities between the market and the research team and allows the idea to be carried on with, while minimising divergences. This is why initiatives that connect investors with start-ups can help boost the sector and help ideas move forward. For example, Dealroom.com is a recent digital platform for people who want to invest or create start-ups in the Blue Economy,

According to company E (training), efforts to innovate in the Blue Economy evolve from pressure within the sector as a result of an expectation to meet the patterns of innovation and

technological level in other sectors and to be capacitated to reach the Blue Economy's targets, such as the mitigation of the impacts of climate change, while ensuring a future characterised by technological developments. In particular, they trust that new start-ups have the potential to upgrade the Blue Economy as they are often born out of innovative ideas and enabled by state-of-the-art technologies. For this reason, they acknowledge the crucial role of start-up accelerators and incubators who support new ventures in their early stages until take-off, as well as platforms that can connect potential investors with promising entrepreneurs.

The spokesperson of company H (aquaculture) pointed out that there is always room to adopt new innovative measures, mentioning among others the need for an improved traceability of their product and for further optimisation of production processes, all the while guaranteeing the best quality of the final product and maximising its sustainability. For example, while still far from the objective, the company aims to increase the use of automation in their business.

This innovation-oriented outlook is the result of both internal and external pressures; in fact, even if the spokesperson described it as niche, not only does the company operate in a market that is quite competitive, but they also wish to expand internationally and therefore have to be ready to face a broader set of competitors. For this reason, for example, the firm invested in a project with a university that facilitates the integration of students in the company, be it for market studies or within the scope of a thesis. This partnership between the corporate world and the academic world creates a symbiotic relationship between the companies and the students in which both sides benefit from the exchange of know-how.

Aquaculture is a sector that shows great promise in terms of innovation. This is perhaps much related to the fact that the sector is growing in Portugal as it is elsewhere in order to meet the increasing demand for fish and seafood (Boyd et al., 2022). Despite the promising future of the sector, companies in the sector still struggle to reach their full potential. The spokesperson for company H (aquaculture) outlined two challenges specifically: funding and the difficulty in producing technologies as some technologies must be imported. The firm has yet much to prove to its stakeholders in order to position themselves in the market and more generally investors are still slow to recognise aquaculture as a fundamental industry in the Blue Economy. As of now, the sector faces a trade-off regarding investment and perceived benefit that is based on experimentation, causing pressure for the firm to secure investments from stakeholders and for innovation to not only satisfy the stakeholders' expectations but

also to help provide a quality product. Similar issues were also pinpointed by company C (inland waterway passenger transport), whose spokesperson further highlighted how high initial financing requirements may discourage investors with slow payback periods and a general difficulty in converting large investments into profit. As far as their motivation goes, the representative of company C claimed that the efforts to innovate come from the company itself and are not driven by competition. Yet, the interviewee also alluded to the need to adopt technologies from external markets, which could potentially imply that the company is more of a follower rather than a leader when it comes to introducing novelties in the market. Nonetheless, the company seems to have a clear strategy when it comes to investment in development, stating that companies should rely on processes rather than people; that is, the priority should be to retain skills and knowledge within the company rather than confining it to specific employees: doing so would create a dependency and may provoke a loss of knowledge if these workers decide to leave. Accordingly, the firm's focus on process optimization instead of human capital is evidenced by their heavy reliance on automation, especially when it comes to the administrative parts of the business. Similarly, unlike before, commanding of ships is mostly automatic as well these days.

Summarising, innovation seems to be scarce and does not appear to be a primary concern for most companies in our sample, although some notable exceptions exist, especially among firms that face harsher competition. Note that this finding nicely accords with Sharpe (2008), who indeed suggested that competition is the primary engine for technological modernisation within sectors. By contrast, firms that claim to strive to innovate by their own volition or in response to policy requirements are typically characterised by lower levels of innovation and technology, adapting to the minimum necessary. Moreover, several companies have recognized a role in fostering innovation of education and training, and therefore of the schools and institutions providing dedicated programs, as well as accelerators and incubators for start-ups. The latter are particularly relevant as they bridge one of the shortcomings of the market infrastructures of the Blue Economy, financing, that might be causing innovation to slow down.

Other reasons include holding on to the traditional aspect of the activity, which may bring lack of proactivity and a missing sense of urgency towards innovation: this is in agreement with Markard et al. (2012), who expresses the idea that in general terms there is a tendency for actors and institutions not to deviate from previously established methods and retain the

same used technologies. In this context, it would be intriguing to study whether this is the case in the specific region of Portugal. Closely related, Company B from the maritime fishing sector adopted a high degree of automation and stated that this has been leading to a rejuvenation of their workforce. Yet, the age of workers may also be a cause of the increasing adoption of automation as younger workers may be more versed with new technologies and more open to innovation. Conversely, older workers may be more conservative and resist new methods and processes. This is surely an interesting causation to study in further research.

Finally, experts noted that complex and innovative duties require more know-how and education (Nerhus, 2014). Hence, the existence of excessive routine tasks might be a barrier to the adoption of innovation measures as there is no time to allocate to scientific and personal development, to tasks that demand a focus on know-how, and to specialise cognitive competencies. Automation can help reduce menial tasks and allow companies to invest in their human capital. The relationship between automation and the presence of innovation is our final suggestion as an avenue for future study.

4.4. Sustainability

Sustainability is inherently tied to the Blue Economy, so much so that it is a term that has entered the very definition of the sector. Recall for example that the World Bank describes it as "*the sustainable use of ocean resources for economic growth, improved livelihoods, and jobs while preserving the health of the ocean ecosystem*". The literature has further highlighted how economic growth must be supported by healthy and resilient oceans, urging that economic growth objectives be aligned with sustainability guidelines.

Accordingly, the topic of sustainability occupies a central role in this thesis and has been of special relevance while conducting the interviews. In general, however, while most companies agree that sustainability is important and should play a big role within their businesses, only a few seem to have taken actual steps towards this goal.

Companies working in the sector of vessel repair, maintenance and construction (A, G), explained that sustainability is not a priority in their activity, while admitting that there are changes that could be made to improve the footprint of their business. Company A justified their inaction in this direction by expressing concerns about the price sensitivity of their clients. Company G also agreed that there are avenues to make their typically very polluting

industry greener, quoting for example the usage of biodegradable materials, such as antifouling, which bear less severe impacts on the contamination of the water. The company is also in the process of investing in retention basins for heavy particles that prevent chemicals from leaving the basin. For these companies, the role of sustainability within their activity mostly revolves around minimising the damages that their activity might cause rather than leading the sector towards sustainable practices.

Two fishing firms also described a marginal role for sustainability for their businesses, with Company D not practising dragnet fishing and hence not polluting the Ocean with fishing nets, and Company F only stressing the importance of respecting established fishing quotas. In stark contrast, however, Company B, which also operates in maritime fishing, shared a completely different perspective. Being a public company and having a role in the execution of the first sale of fish to buyers, the company is subject to strict sustainability requirements imposed by regulators that apply to most public administration and public companies in the sector. Yet, the company reported that they do not merely comply with the regulation and in fact overachieve the imposed targets as a result of their proactivity when it comes to sustainability.

Recall that Company B developed a harbour management system to optimise water and energy consumption by reducing emissions and minimising waste. However, a perhaps more original contribution to establishing sustainable practices on their side consists in an app that allows fishermen to quickly communicate with the authorities whenever they catch endangered species; in particular, the app collects the coordinates of the fish capture and shares this information with the Instituto Português do Mar e da Atmosfera (IPMA).

Finally, the company also developed an app to record the amount of waste brought to land, an important initiative to keep track of the waste that the activity causes. In the spokesperson's words, it consists of a "*point based system that as a reward reduces the electricity bill of the vessels. In case they cannot catch the marine litter, it allows them to take pictures with coordinates, so that larger vessels may collect the waste*". By doing this, the company prizes ethical and sustainable behaviour, as oftentimes the lack of awareness may bring carelessness throughout workers of traditional sectors, in particular a lack of knowledge about the consequences of polluting the means of production, in this case the sea.

To explain their commitment, Company B notes that it is not only possible to harmonise the well-being of the Oceans with profits but that it is essential in the fishing sector, defending

that it is imperative that economic, social, and environmental sustainability exist, as everyone benefits from the well-being of the Ocean. This ensures the quality of the product and the means of production, according to the representative.

Such a belief that profits and sustainability can not only coexist but can actually reinforce each other is shared by the Oceano Azul Foundation as well, having said that a balanced model can only be achieved if the conservation of resources and biomass plays a crucial part in the activity. According to the foundation the economy is more profitable, efficient, and effective when it respects conservation, and this composes the base for a profitable and sustainable economic model. Such clarity about the goal of the Blue Economy does not imply that the path is free of hurdles, however, and the foundation is well aware of that. For example, while confident about the positive contribution of sustainability reports, which can attract investors, she recognizes that these may create concern in larger corporations. Specifically, in the interview, the spokesperson shared that corporations and bigger firms are more likely to struggle than start-ups when they incorporate environmental concerns into their business plans. Unlike new ventures that inherently grasp the need for innovation and often design strategies that seamlessly integrate sustainability with their business goals from the outset, larger corporations typically already have very well-established business models; these need to be adapted to higher sustainability standards and require a higher degree of innovation for the company to remain competitive. The foundation's spokesperson concluded by admitting that economic returns will always be sought for by the market, even if it means sustainability may be neglected: if given a choice, companies would always have a strong preference for the best outcome in terms of profit. In short, when profits are at stake, sustainability is restricted if not neglected altogether.

CoLAB + Atlantic take on a more cautious stance, affirming that profits do not necessarily benefit from the adoption of a balanced model but that it is indeed possible to harmonise the occurring activity and the well-being of the Oceans. The association developed further by explaining that any activity that can minimise or mitigate environmental impacts on the sea and simultaneously generate social as well as economic well-being is viable and sustainable. Anything that is unable to intertwine these two aspects is unadvisable. The representative also suggested we invert the tendency of evaluating the impacts that corporations have in a binary way, and instead take into consideration the impact of the

carbon footprint and determine whether it is transient or not. In other words, this means that we should evaluate impacts with a special focus on the long-term effects.

Company H (aquaculture) sides with this view and further highlights how sustainability is a matter of balance between economic activity and the impact that derives from it but also between financial cost and benefits. The company produces low trophic level species that do not demand feed, and do not require any sort of pharmaceuticals, often associated with regular fishing. They explained that their product has the advantage of sequestering carbon, accumulating it in their shell, in a process that allows for the capture of CO_2 from the environment. The referred specifications carry high social and environmental responsibility as they bring benefits to the environment and align with the company's goal of producing the largest quantity of protein possible while having the least impact on the environment.

Company C (maritime transportation) has a sustainability policy in place. The spokesperson affirmed that effort is being made towards a more sustainable Blue Economy, but she claimed that there is a degree of uncertainty about whether this commitment is merely a result of the imposed regulations as of late, or due to ulterior motives, such as the company's goodwill or to satisfy stakeholders. Nevertheless, she believes that it is possible to harmonise profits with the well-being of the Oceans, bearing in mind the current state of technological development available for the company as well as its financial constraints. Moreover, the spokesperson believes that the presence of sustainability measures generally depends heavily on the specific sector and how the health of the Oceans impacts the product that is being delivered to the end consumer.

In the sector of training, company E talked about the importance of sustainability for companies in the maritime sector. The company does training about the need to preserve resources and recognizes the increasing concern about environmental preservation, highlighting that there is room for sustainable fishing but that proper training is necessary. Certain actions, such as digitalisation, leading to paper reduction, as well as a change of attitudes as a result of awareness initiatives and training are only a few steps being taken as part of the current period of change towards a more sustainable future that the company is undergoing. In fact, one of the company's main objectives is to reduce energy consumption by 30% and keep progressing towards energetic efficiency, a desire shared also by company C (maritime transportation) and company B (maritime fishing).

Summarising, efforts towards sustainability appear to be generally self-motivated. However, most examples provided seem linked to increased efficiency as well, suggesting that sustainability is still tied if not subordinated to some economic return. This is further confirmed by several companies claiming that the measures they implement are also intended to ensure a higher quality for their final product. Several interesting elements that could hinder the adoption of stricter sustainability standards have been mentioned. For example, concerns about the price sensitivity of clients were referred to as the primary obstacle to this in the naval construction and repair sector and the fishing sector. Additionally, business models that care for the environment without compromising profits may appear too complex and uncertain to companies that belong to more traditional sectors and hence they may stray from adopting changes due to fear of the impact on the profits. Finally, even though sustainability appears to come as a result of imposed regulation in sectors like maritime fishing (companies D and F), the lack of regulations that make it compulsory for companies to quickly adapt and strive to improve could perhaps be another reason for the absence of an urgent character placed on the adoption of sustainability policies or measures.

As a highlight from the interviews on the topic, recall that company B (maritime fishing) developed an app that records the amount of waste brought to land by vessels and prizes participants through a point-based system as well as an app that allows fishermen to notify IPMA in case there are captures of endangered species. These two apps are practical examples of citizen monitoring, a concept that is of growing interest for the literature. Such initiatives empower citizens or, as in this case, workers of the industry to take part in better ocean data collection and monitoring (Auad & Fath, 2022). This is surely an interesting concept that needs careful consideration in that the promotion of actions from the non-scientific community can cause a positive impact on the scientific development, conservation, and constant monitoring of the Blue Economy. In doing so, these initiatives may become a pillar in the upgrading of the Blue Economy.

4.5. Regulation

The need to protect, preserve, and conserve the Oceans and the Seas is closely linked with innovation. Regulators play an important role in ensuring that the future of the Blue Economy intertwines these aspects as they mandate the guidelines and norms that should be followed by

the players across all sectors. The impact of regulation on the choices and decisions of companies in the industries, its actions reflecting the strategy of Portugal and the EU (DGPM, 2021), and its role as a motivator for change are only some of the reasons why this topic must be approached in this study.

As previously mentioned, the DGRM is the main regulating entity for inspection, monitoring and control of maritime activities. It is a common denominator among the companies in the Blue Economy and has indeed been mentioned several times during the interviews for this project as well, which emphasises its central importance on all matters related to the Ocean and to marine services and products.

Companies in the naval repair and construction sector (A, G) placed more emphasis on the reinforcement of the regulatory policies rather than the policies themselves. The representatives of these companies highlighted that regulation mostly reflects through the act of surveying, which consists of the inspection and oversight of marine vessels by specialists, including the acts of supervising the maintenance and construction of ships, as well as keeping an eye on the registration of vessels and other supplementary legislation based supervisory acts (DGRM, 2023). As claimed by the spokesperson of company A, the most relevant role that surveyors have is to enquire on the quality of the work to make sure the ship is apt to safely sail. He revealed that they also provide advice on welding, as well as legislative support on anything related to naval repair and construction. Furthermore, the surveyors are up to date on the technological developments and provide information and assistance on anything related to this matter. From another angle, Company G (maritime fishing) indicated that the role of regulators comes down mostly to the level of information that must be provided, and seemed to hint at the fact that DGRM does not in any way strangle the industry.

The obligation to report to DGRM was referenced by company C (maritime transport), D (maritime fishing) and H (aquaculture) as well. The latter developed further, saying that the regulator plays a part in overseeing the lifecycle of the product, its production conditions, and its quality. In addition to its role as supervisor, company F from the maritime fishing sector considers that DGRM performs an important role in establishing guidelines for companies.

Another entity that company F has mentioned was the Economic and Food Safety Authority (ASAE), a specialised national authority which enforces the legislation, inspects, monitors, and assesses the risk related to the sale of products and services legally established

and ensures consumer health and safety and, in this particular case, its role is crucial in overseeing the fish capture to make sure it is in compliance with consumer safety guidelines. (ASAE, 2014).

Company B (maritime fishing) believes that the level of regulation does not negatively impact innovation. In fact, the company believes that there is close proximity between the regulators and the agents of the sector. According to the spokesperson of the company this closeness allows for the legislation to be shaped in agreement with the market needs, in the direction of performance improvement of the activity, both innovation-wise and in the direction of lessening the environmental impacts. The representative recognizes that this is not a common practice among all sectors but highlights that the regulating entities partner with the company due to its public nature, as it provides a public service.

The association CoLAB+ATLANTIC believes that the existence of accelerators and corporate incubators, as well as the diffusion of a strong start-up culture help upgrade the Blue Economy. The representative drew special attention to development programs involving public policy that positively impact entrepreneurship in the Blue Economy, and one of these is DGPM's Blue Fund, a national fund which finances varied science and technology-based projects, including ocean research, renewable energy and protection, conservation and monitoring of the maritime environment (DGPM, 2021). In short, the purpose of this fund is to maximise the Blue Economy's potential and to implement SDG 14, a set of goals established by the United Nations that aim to boost conservation and sustainability efforts in the Ocean and all marine resources. In terms of regulating entities, the spokesperson for the association believes that DGRM facilitates easy and quick access to licences that make it possible to take part in research activities.

Company E (training) mentioned the role of regulating entities positively, making a reference to the national strategy for the sea elaborated by DGPM, which aims to use scientific knowledge towards protecting the Ocean, while empowering traditional and economic sectors of the Blue Economy through sustainable management (DGPM, 2021).

CoLAB+ATLANTIC's representative highlighted that sometimes the biggest barrier is the lack of financing as well as the possible need for insurance. Currently, financing in the Blue Economy is much aided by the help of governance and EU supported initiatives and funds. However, it is still a challenge to attract private and public funding as the returns for a sustainable Blue Economy might not be as financially enticing as other sectors, despite the

fact this is a sector with immense growth potential (DGPM, 2021). The sectors that constitute the Blue Economy may often carry a high risk, especially when compared to other sectors. Hence, insurance is a crucial part of the Blue Economy that is concerning to possible investors and may impact financing.

Regulators are generally proactive in not being a burden to innovation, but they generally do not seem to propel new advancements. Perhaps there is a lack of incentives to more conscious actions on behalf of corporations. In this sense, it would be interesting for further research to build a set of incentives that would be interesting to push companies to adopt more informed and mindful actions, and further study firms' responses.

5. Conclusion

This thesis characterised the traditional sectors of the Blue Economy in the Metropolitan Area of Lisbon through interviews with a set of companies in the field. Doing so, it was possible to gain deep insights of how the industry reacts to pressing themes such as the growing need for new technologies and innovation, as well as the essential role of sustainability in today's economy. An inductive method was used, which allowed for the presence of much curiosity as a main driver, as when the interviews were being conducted there was plenty of room for off-script topics. This means that using a pre-established set of questions was only the starting point for a full portrait of the several sectors that composed the sample.

The interviews uncovered interesting heterogeneity throughout the sectors and companies, which made it so that each case had to be analysed individually. In general, however, it could be inferred that innovation is moderate in quantity and quality, but certain companies are much more open to innovation and sustainability. It was interesting to understand the link between the kind of corporation and their willingness to change, as well as what motivates these differences.

Although again depending on the specific sector and firm, companies generally seem to be concerned about the impact of innovation in their activity and to foster it to some extent. New technologies are a way to measure the way innovation propagates, and it seems that there is a concern in being up to date to market standards when it comes to adopting new technologies. This is reflected through the assimilation of technologies such as new software, apps, information technology systems, and AI tools. There are also technologies that are linked with sustainability that have the potential to scaling up the sector, such as consumption monitoring devices linked with higher energetic efficiency, or the adoption of digitalization.

Companies have stated that they are adopting sustainability measures. However, it would be interesting to study the relationship between the adoption of sustainability measures and regulation that forces those same changes. The regulator's proactivity is necessary when it comes to establishing the right conditions for the market to develop, as clear and contemporary measures are necessary to foment the Blue Economy.

The Ocean Azul foundation mentioned that the role of the government as a creator of stimuli for upgrading the Blue Economy should be maximised. It is difficult to isolate the government from the nation's economy. Hence, it is important to note that although the

corporate fabric itself is the biggest driver of the market, the government should play an active role in policy making that positively impacts the sector.

Hopefully some of the generated hypotheses will be given further continuity as the Blue Economy has extensive potential, keeping in mind that Portugal's vast marine resources constitute economic richness that should be further explored.

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Appendix

QUESTION SET 1: STATE OF TECHNOLOGY

"What are the technological trends in your industry? What technologies is your company adopting?"

Company A	*"Some technologies we use are billing software and Autocad."* *"Welding machines are the main equipment in the industry. The technology has not been developed much over the past 50 years, but the machines have become lighter and easier to carry, making its use simpler."*
Company B	*"[...] apps designed for fishermen and shipowners [...] that allow for the smart recognition of fish. We also rely on first sale fishing systems, smart scales, cloud technologies [...]. The machine may aid in the recognition of the species, but the final word belongs to the operator, as the machine may cause doubts despite having a high degree of confidence." "[...] emerging technologies, especially Microsoft, C#, and hard coding. [...] there is a need for a well-grounded skeleton. [...] Since 2019, we have renovated our computer equipment and invested in research poles in universities to push the development of new technologies."* *"[...] bet on renewable energies, especially photovoltaic plants."*
Company C	*"The technological trends in our industry are consumption monitoring systems, radars, telecommunication systems, such as machine alarms, a set of alarms that record and evaluate breakdowns and accidents [...] to understand and guide interventions, registration of ship velocity, consumption registration, performance comparison between crews, fuel consumption records [...] the optimization of consumptions is a fundamental aspect of the activity."* *"GPS and monitoring systems, information systems. There is a system that allows for the registration of all the equipment and its interventions, as well as software that reinforce maintenance management, accounting software, which is SAP, financial management and human resource management software, and performance evaluation, career development, and training management software."* *"Optimization of systems is an adopted trend."* *"Systems related to the optimization of fuel are relevant."* *"There is a lack of update of the tendencies- monitoring and optimization are essential."*

Company D	"Right now we have wooden ships, but we are participating in grants that will allow us to acquire Fiberglass Reinforced vessels. We also use radars, GPS Systems and probes that exist nowadays." [...] VHF radars"
Company E	"When it comes to training, we use e-learning platforms, navigation simulators, machinery simulators [...]" "We have workshops with plenty of mechanical equipment- motors, maritime machinery, security equipment, electricity workshops, basic electricity equipment, simulation panels[..]"radars, probes, maritime communication equipment, GMDSS simulators"
Company F	"There is not a lot of innovation. At factory level, we are adopting better software. [...] not a lot of evolution in terms of software." "We use Sonar systems, probes."
Company G	"Machines of metallic construction, glassfiber. [...] We envision the construction of steel vessels. [...] IT Software" "[...] There is no recent technology that can be highlighted."
Company H	"Technology related to aquaculture in terms of filtering systems, water quality monitoring systems following certain quality parameters, and technology related to laboratory techniques." "Software that estimates the productive capacity of bivalve molluscs according to their size and life cycle."

QUESTION SET 2: NEW TECHNOLOGIES AND INNOVATION

"Do you think that companies in the Blue Economy in general and/or in your specific sector would be able to survive without adapting to new technologies?"

Company A	"There is no innovation in the sector, the ships have had the same technology for the past 40 years, there will hardly be a technological leap."

Company B	*"There is a lot of room to use new technologies. Despite the fact a lot of people don't have higher education, there is a growth in the number of people with higher education in the industry, sometimes they conciliate [fishing] with other activities. The younger generations have a bigger aptitude to use new technologies."* *"[...]The electronic auction system has been used for over 30 years."* *"[...] Everything is in a database."* *"[...] In the fishing sectors, due to the type of activity, there are technologies currently under development to better serve users, such as apps to emit permits for the occupation of public dominium- ports [...]."* *"[...] App that registers the garbage brought to land".* *"[...] Remote water and electricity control that allows reduction of consumption."* *"[...] Installation of photovoltaic panels in the ports to reduce consumption and manage invoices better."* *"On an internal level, we have an intranet, platforms for document management and team work to be done, there is a repository of documents."* *"All of the Human Resources management system, including days off and assiduity is made through digital tools".* *"The sector is not resistant to new technologies, even if we only think of the production, commercialization and transformation parts they are not resistant".*

Company C	*"We are implementing a new ticketing system through a website and a mobile app. We are reviewing our access gates, currently in the 2nd phase of the trials of the mobile app and the website before the launch. New technologies allow for the optimization of the operational activity of the company, dematerialization of the process, for example eliminating paper invoices."* *"[...]payment through via verde (i.e., a system that allows for the automatic payment of tools and tickets via a device that is placed on the vehicle and works through monthly subscription), a tendency that is growing."* *"After the adoption of new technologies, we are able to serve more clients."* *"This is a sector that does not evolve quickly, the purchase of ships limits innovation because they are long term decade acquisitions. The investments in ships cannot be produced at a larger scale".* *"Small equipment is expensive, and the Capex is large."* *"Large investments don't reflect quick enough, and the payback is slow."* *"The companies in our sector are not resistant to the adoption of new technologies, but they are also not at the vanguard of the usage of new technologies."* *"The conservation of the information is essential so that we do not depend on people but instead of processes. It is important to retain the information within the company."*
Company D	*"The materials have a high cost; we have 7 vessels."* *"[...] we use ancient machinery."* *"[...] we are trying to innovate when it comes to the machines, probes, and radars."* *"Training schools are very important when there is innovation."* *"[...]there is a need for training of our fishing masters, it is important for innovation and growth".* *"[...] it is possible to innovate without adopting new technologies, but the results are below their full potential."*

Company E	*"[...] we are acquiring new management and preventive maintenance of the training equipment [...] STCW training [...] the trend is to go through a digitalization process, everything related to training is digital, and we are also making the financial management part of our activity digital."* *"[...]According to the PRR we are optimising our processes, making technological investments, purchasing technological equipment and navigators, welding equipment [...]investing in infrastructure, network and information systems [...] Centralising our 12 poles through cloud systems."*
Company F	*"We have to innovate and maintain the quality in order to provide a good service to the client."* *"[...] energy counter with higher power."* *"[...] Companies can survive without adapting to new technologies."*
Company G	*"At the moment we are not adopting new technologies, but we are adapting to the changes that arise."* *"We could survive without adapting to new technologies."*
Company H	*"New technologies are very important [...] allow the reduction of fouling organisms in open sea or that are affecting the implemented structures, technology that predicts booms of toxic algae, which shuts down open ocean production and precludes the distribution of production."* *"The trade-off regarding investment and perceived benefit is based on experimentation."* *"[...] project with a university that works around integrating students in the company in academic contexts, for example market studies, and oftentimes in the scope of a thesis [...] patency between the corporate world and the academic world, in the sense that it benefits both the company and the students, involving exchange of know-how."* *"There are challenges when adopting new technologies, such as funding, producing and adapting technologies as, for example, some technologies must be imported [...]. Eventually there may be some lack of support when it comes to adopting new technologies."*

	"There is always room to adopt innovation measures, for example for better traceability of the product, better sustainability and quality of the product, or guaranteeing the optimization process."

QUESTION SET 2: NEW TECHNOLOGIES AND INNOVATION

"Is automation common in your industry?"

Company A	*"There is a very low level of automation in the sector, as intuition is key for each ship due to how different they can be from one another, there are also places in the ships with difficult access as well as steel alloys that require careful handling."*
Company B	*"There is a possibly high degree of automation in the industry. It is a gradual process, and it allows for the substitution of physical and routine jobs that bring less value to the activity. This process has decreased the average age of the workers in the fishing industry."*
Company C	*"Automation has a big role in the industry especially when it comes to the administrative part of the business."* *"The commanding of the ships is mostly automatic these days, unlike before."*
Company D	*"No degree of automation."*
Company E	*"No degree of automation."*
Company F	*"No degree of automation."*
Company G	*"No degree of automation."*
Company H	*"For now, there is still not a high degree of automation, but it is one of our goals."*

QUESTION SET 2: NEW TECHNOLOGIES AND INNOVATION

"Do you consider there is pressure in the sector to innovate? What originates this pressure? Does it come from external or internal factors, namely your own company, direct or indirect competition?"

Company A	*"It is a competitive sector, there are 12 competitors in the Metropolitan Area of Lisbon".* *"[...] The prices are not competitive yet. [...] high prices."* *"[...] The innovation comes mostly from the competition within the industry, especially when we talk about naval construction."*
Company B	*"There is a need to innovate in general- to adapt to the reality of the world, and the challenges imposed by the business partners."* *"[...] It is a very competitive industry, each auction works in perfect competition, the market leans towards the perfect competition, there is stiff competition between different agents of the market. It is a natural sort of competition, the fishermen themselves are competitive, and they unload about 3000 different vessels each year."*
Company C	*"It is a relatively traditional industry. There is not much pressure to innovate in Portugal and innovation is often imported."* *"[...] The pressure in the sector to innovate comes mostly from within the company itself."*
Company D	*"There are mainly 2 types of innovation: 1) The DGRM forces us to adopt certain measurements or materials; 2) We feel that it is important to innovate, and we do it of our own volition."*
Company E	*"I would say some years ago the pressure was mostly internal, but nowadays there is a lot of will on behalf of the sector to be aligned with innovation and technologically capacitated to meet the Blue Economy's targets" "[...] at the moment there is blue-up school, start-ups and accelerators."* *"Forum Oceano [...] deal room is a digital platform for people who want to invest or create start-ups in the Blue Economy, there are companies created there as well as investors [...] (deal- room) is a business platform that joins start-ups that were created with the objective of developing their business."*

Company F	"In terms of boats we are trying to adopt less noisy motors."
Company G	"There are not many resources to update vessels with different technologies." "[...] It is a competitive industry price wise [...] we have a niche."
Company H	"Innovation in our sector is the result of both external and internal factors. [...]we must create competitive infrastructure, and we must provide a quality product." "There is plenty of investment made on an experimentation basis that takes time to lead to a result." "There is internal pressure to secure the investment that is made by the stakeholders, innovate and provide a quality product." "There is also external pressure, especially outside of Portugal, given our sector is a niche sector. When wanting to compete with the biggest players of this sort of sector, technological evolution is crucial."

QUESTION SET 3: SUSTAINABILITY

"What is the value placed on sustainability within your company? "What sustainability measures does your own company adopt and do you think there is room to adopt more? If none, do you think there is room to adopt them?"

Company A	"There is room to adapt sustainability measures, but the clients are very price sensitive." "Sustainability is not key in the sector, but there are changes that can be made, such as an update on the vehicle fleet towards more sustainable vehicles."

Company B	*"There is a need to innovate in general- to adapt to the reality of the world, and the challenges imposed by the business partners."* *"[...] It is a very competitive industry, each auction works in perfect competition, the market leans towards the perfect competition, there is stiff competition between different agents of the market. It is a natural sort of competition, the fishermen themselves are competitive, and they unload about 3000 different vessels each year".* *"There are sustainability measures imposed by the regulators- these targets apply mostly to public administration and public companies in the sector, but they are mainly focused on the office buildings".* *"We overachieve our imposed targets, which is a result of the proactivity that we have as a company when it comes to sustainability."* *"In Nazaré we have developed a harbour management system that monitors the consumption of water and electricity, supporting good practices in harbour management and their sustainability[...]with the goal of reducing emissions, providing electric power to vessels when they are parked, production through renewable energies, provision of electric vehicles and residual water treatment."* *"We are developing an app that records the amount of waste that vessels bring back to land [...] point based system that as a reward reduces the electricity bill of the vessels. In case they cannot catch the marine litter, it allows them to take pictures with coordinates, so that larger vessels may collect the waste [...] there is an investment on the remote control of consumptions".* *"We have developed an app that the fishermen can use when they capture endangered species which provides the coordinates of the fish capture, it allows for the IPMA (Portuguese Institute of the Sea and the Atmosphere) to gather the information."*
Company C	*"Sustainability has a big role in the company [...] we have certifications such as ISO14001 and a sustainability policy implemented."* *"Sustainability has a certain degree of importance in the companies in the Blue Economy. However, it depends on the sector and how the health of the Oceans will impact the product that is delivered to the end consumer directly.*

	An effort is being made, but perhaps as a response to the regulations that have been imposed as of late."
Company D	*"Sustainability does not have a big role in the activity of the company."* *"[…] it is difficult to implement and control measures."* *"We do not practise dragnet fishing, and hence do not pollute the ocean with fishing nets."*
Company E	*"We do trainings about the necessity to preserve resources. There is increasing concern about the environment." "Internally we are in a period of change towards sustainability, from the digitalization, leading to paper consumption reduction, to the changes of attitudes."* *"Requalifying our poles- our objective is to reduce the energy consumption by 30%, towards energetic efficiency."*
Company F	*"Sustainability does not play a big part in our activity."*
Company G	*"This industry is a polluting industry, but the usage of biodegradable materials, especially when it comes to antifouling, has less impact on the contamination of the water […] Retention basins for heavy particles so that they stay in the basin […] investing 400.000.00 EUR in a treatment plant."*
Company H	*"Sustainability is fundamental in our company. We are producing low trophic level species that do not demand feed and do not require any sort of pharmaceuticals, which is associated with regular fishing."* *"Our product also has the advantage of sequestering carbon, and they accumulate carbon in their shell, so they do CO_2 capture. This benefits the environment."* *"Our product has a high social and environmental responsibility, in the sense that our goal is to produce the largest quantity of protein possible while having the least impact on the environment.* *It is a product that, for its sustainability level, is highly differentiated from a regular protein product."*

QUESTION SET 3: SUSTAINABILITY

"Is it possible to harmonise profits with the well-being of the environment and the oceans, given the current state of the technology in your company as well as its financial situation?"

Company A	*"Yes, however, as this is a seasonal industry, it is necessary to cover up for the weaker months business wise."*
Company B	*"It is not only possible but essential to harmonise profits with the well-being of the Oceans. There must be economic, social, and environmental sustainability and everyone benefits from the well-being of the Oceans. It ensures the quality of the product and the means of production."*
Company C	*"It is possible to harmonise profits with the well-being of the Oceans, bearing in mind the current state of technologies available for the company and the financial constraints."*
Company D	*"It is possible, we make sure not to let trawl pieces into the Ocean."*
Company E	*"It is possible. Our trainings are mostly free, and we pay a food and transport allowance to the trainees. Our business is not for profit as we are a public entity. Our mission is to train and qualify people for the sector.* *"Our training is either free of charge or a symbolic value. The profit is diluted in the budget."* *"There is room for sustainable fishing."*
Company F	*"We must pay attention to the established fishing quotas, especially sardine, and we must practise sustainable fishing."*
Company G	*"It is possible in the future on every level. […] we made the transition from a stacker that was fossil fuel based to a fully electric stacker."*
Company H	*"Sustainability is intrinsically connected with the impact that is created by the activity. It is a matter of balance, associated with a cost-balance ratio."*

QUESTION SET 4: REGULATION

"Are regulators involved with innovation in your sector and, if so, how? Are there any sustainability standards or practices directly or indirectly imposed by the regulator? Are they stringent?"

Company A	"In our industry we have surveyors, who enquire whether the work is well done so the ship may safely sail. [...] They provide welding advice, a set of regulations and legislation to perform this kind of labour [naval repair and construction], the legislation is constantly updated, and they are always on top of the technological developments."
Company B	"There is plenty of regulation regarding the fishermen activity. The level of regulation does not deter innovation. There is proximity between the regulators of the sector, and it allows the legislation to be altered whenever it may improve the performance of the activity. [...] Unlike other sectors, the regulating entities work in partnership with the company, as they provide a public service. There is close coordination between regulators and companies in the sector."
Company C	"The regulators have very little impact on innovation". "The regulators impose a high level of information to the companies."
Company D	"DGRM forces us to adopt measures to have a better control over our activity."
Company E	"DGPM has elaborated a national strategy for the sea. There are instruments linked with policies of the European Union- digitalisation policies, decarbonization and circularization, that forced the existence of mechanisms of innovation to meet certain demands." "Public entities that would otherwise be less innovative are being pulled by force of national and European Union policies to meet established goals."
Company F	"ASAE has a monitoring role, and DGRM has a surveying role, as well as establishing guidelines."
Company G	DGRM is the regulator. Everything that is legislation based is related to DGRM, as well as when it comes to the information we have to provide." "[...] Repair and the assembly process of ship production."
Company H	"On an activity level, it's mostly about reporting, namely what is happening, under what conditions is it being produced in, and the quality of production. If we want to expand activity and diversify the species we work with, then other sorts of regulations are demanded from regulating institutions."

QUESTION SET 1: STATE OF TECHNOLOGY

"What are the technological trends in the Blue Economy and what technologies is your entity adopting?"

"What is the importance of new technologies in the future?"

"Do you support investment in new technologies?"

Oceano Azul Foundation (I)	*"At the moment one of the most developed sectors in the Blue Bioeconomy is the algae sector, according to the EU report (2022). The use of bioresources has implications in the food sector, pharmaceutical, skin care and nutraceutical."* *"Oceano Azul Foundation works together with Calouste Gulbenkian Foundation, which promotes the Blue Bio Value programme, blue biotechnology startups and R&D projects accelerator, with solutions that tackle the world's main challenges in the areas of food and feed, well-being, environmental solutions and bioindustry."* *"In the Blue Bio Value Acceleration, we work with international startups, connecting them with a wide networking of experts and investors in the sector, helping them improve their pitch skills and to improve some aspects of their business model."* *"We also work throughout the Ideation programme, where R&D projects on a national sphere, with research centres in Portugal connect to Business Mentors to help these projects throughout their transformation into marketable and competitive business ideas. This serves as leverage to researchers who sometimes have a hard time commercialising scientific projects, as there is plenty of potential in Portugal."* *"As we are a conservation-based foundation, we believe at the end of the day if we must choose between economic returns and Sustainability, the market dictates that economic returns must be elected."* *"Bioeconomy is the way to guarantee that economy and conservation go together, as we are supporting a sector that develops solutions, products or services that depend on healthy marine bioresources."* *"It is important to commit to the advances in biotechnology, and the decarbonization of the economy."*

	"We must understand that we must transition from the current extractive business model to the renewable business model, and biotechnology may help us achieve this goal."
Oceano Azul Foundation (II)	*"By using bioresources, we are not only enhancing our dependency on something that is renewable, but also supporting the circular economy, which is sustained on using residuals such as waste and co-products of the fishing industry. As an example, we work with a start-up that retrieves collagen from fishing by-products and uses them in the creation of dog biscuits. It is also possible to use collagen for skincare products. It is important for a sustainable future to use these potentially wasted products."* *"We support the investment in new technologies by working with start-ups and accelerators."* *"Oftentimes in aquaculture to feed fish, we use algae, which are used to create new proteins."* *"Nowadays, algae booms are an issue that arises from climate change, we try to find innovative start-ups that can somehow solve this problem and use them in a non-harmful way."* *"Oceano Azul Foundation works in 3 areas:* *Blue natural capital- this connects conservation and economy. We work with start-ups as well as in the field of conservation in the facilitation of the creation of marine protected areas. We are supporting the enlargement of a MPA in the Azores, as well as area MPA in Algarve, Cascais, Mafra and Sintra. This way, we are able to directly support conservation and the bioeconomy.* *Blue network- We provide advisory to embassies and the government. We advise on how we can adjust governance to the conservation needs, while still supporting the growth of the Economy.* *Blue Generation- We work with the civil society, having programs with NGOs and schools. We have a program that focuses on working towards raising a blue generation, which*

	involves working with children, as well as working with the government in order to include the Ocean in the curriculum of children in a dynamic way."
CoLAB+ATLANTIC	*"Technological development associated with the digitalization of activities, [...] technology associated with the most capital-intensive engineering components. Nowadays the trends are much associated with the circularity [of the economy] and decarbonization, meaning solutions that provide decarbonization or circularity in the chain of production."* *"New technologies are especially important in IT and communications, [...] new materials."* *"When it comes to traditional sectors, the trends are as follows":* *For aquaculture: "Clearly biotechnology, digital, communications, sensorization. Basically, technologies that support the chain of production of technological solutions whether offshore or onshore."* *For fisheries: "New materials to avoid "bycatch", new monitoring methods and more sophisticated vessel technologies related to the security, as well as monitoring and minimization of fuel consumption."* *For the training sector: "Bringing expertise of what is done on land to the Ocean. Everything that is related to more qualified jobs land wise may be reconfigured to the Ocean with complementary training."* *Naval repair and construction: "New materials, focus on decarbonization and digital methods."* *Marine transportation: "Investment in new sources of energy, and new propulsion methods. There is an ongoing debate about hybrid energy usage, hydrogen, natural gas, and it conditions the development of new ships."* *"[...] we do some work associated with artificial intelligence, hydrodynamic models, satellite images, remote detection and*

	applying computer vision logic, namely automatic detection of dead fish and biometry of captive animals.”

QUESTION SET 2: NEW TECHNOLOGIES AND INNOVATION

“Do you consider that companies in the Blue Economy are resistant to the adoption of new technologies?”

Oceano Azul Foundation	*“I don't believe the companies are resistant, especially in Portugal. There is plenty of stimulus on behalf of the government itself in the development of biotechnology, and in the positioning of Portugal as an international leader in this industry.*
	Portugal does not have a very large quantity of biomass and bioresources, but we have great variety, and this means we have an amazing environment to do research for new biotech solutions. The country possesses plenty of know-how in R&D centres that have the potential to scale up the sector.”
CoLAB+ATLANTIC	*“Usually, the companies in the traditional sector of the Blue Economy have limited development capability and are conservative. It is an emerging market, and it is hard. It is not easy to place a product in those sectors, and aquaculture is a sector where it is easier to see innovation happening, besides shipping. Even though shipping is a capital-intensive industry it is not easy to penetrate the market."*

QUESTION SET 2: NEW TECHNOLOGIES AND INNOVATION

“Do you believe there is a high degree of automation in the Blue Economy?”

Oceano Azul Foundation	*“The growth of the Blue Economy implies there will be a growth in available jobs, so despite the fact routine jobs may be affected by automation, there will also be new and innovative jobs arising from this growth.”*

CoLAB+ATLANTIC	*"It depends on the sector. There are certain sectors in which it is more common for there to be automatic pipelines for the data and information management that not only involve the capability to retrieve data in situ or through remote ways, but also to aggregate them, transmit them, receive them, process them, there is an entire management pipeline."* *"In terms of manufacturing there is plenty of automation, and especially when we talk about, for example, the treatment of the whole chain of fish, from the production to the transformation and the validation."* *"There are less technologically sophisticated sectors in which a path is still being traced. Technology based solutions that are aligned with automation objectives in fishing and management control of fishing are becoming more frequent nowadays."* *"The fishing logbook is electronic, and the control of fishing is through information management systems. Everything that is related to the production in onshore aquaculture systems is abundant in automation."*

QUESTION SET 2: NEW TECHNOLOGIES AND INNOVATION

"Do you consider there is pressure in the Blue Economy to innovate? What originates this pressure? Does it come from external or internal factors, namely the company itself, direct or indirect competition?"

Oceano Azul Foundation	*"There are a lot of stimuli to innovation. Biotechnology is a very niche sector, with areas that take a while to be developed. The focal point lies in the stimulus to innovate, and not in the pressure to do so.* *In Portugal there is room to create new technologies and innovate."* *"On a national level we possess a great level of know-how, but there are some difficulties transferring the knowledge to the industry, and support is required on this level. Research teams must understand what the market gaps are and how they can develop technologies for which there is demand. The transfer of knowledge and technology must be backed, and this is not only*

	made with capital support, but also with regular check-ups with the R&D developers to help them adjust the details in their research to avoid business inconveniences at the end. For example, if a R&D project has the need to use a serum with an unsustainable cost, during the time of the research they can start looking for a substitute, this anticipates future constraints when looking for investment."
CoLAB+ATLANTIC	*"In the traditional sectors of the Blue Economy there is not a lot of propensity to innovate, in the most emerging sectors there is."*

QUESTION SET 3: SUSTAINABILITY

"What is the value placed on sustainability within your entity?"

Oceano Azul Foundation	*"Sustainability is at the genesis of our foundation, given we are a foundation based on conservation. We try to provide all the support that is possible to companies and start-ups so they can develop on sustainable economic models.* *Sustainability reports attract investors but create concern in larger corporations. A start-up knows it must be innovative to the point that it already respects sustainability metrics and creates upfront strategies that align sustainability with their business objectives.* *Oftentimes larger corporations already have very well-established business models and need to implement sustainability strategies, which should be innovative, otherwise they will not be competitive. In this case there might be some pressure placed on the companies, as there are tough metrics that must be achieved by 2030. It takes some time to change what companies are doing, and companies will want to be ahead of these goals."*
CoLAB+ATLANTIC	*"It is transversal to everything we do. The idea is that we evaluate the impact of the anthroposphere on the Ocean."* *"Everything we do and support in terms of activities is according to sustainability values. The Blue Economy is*

	supposed to be socially, economically, and environmentally sustainable at its core.
	We always try to support a conservation standpoint, having a rational usage of the maritime space and coastal areas."

QUESTION SET 3: SUSTAINABILITY

"Is it possible to harmonise profits with the well-being of the environment and the Oceans?"

Oceano Azul Foundation	*"Yes, it is. And if we look at an economic model that is profitable, we can see that the Economy is more profitable, efficient, and effective when it respects conservation. A balanced model, in which respect for the conservation of resources and biomass plays a crucial part, is the solution."*
CoLAB+ATLANTIC	*"It is possible to harmonise the activity of the company with the well-being of the environment and the Oceans, perhaps not profit.*
	Any activity that can minimise or mitigate the impacts of the maritime means and can generate social well-being and positive economic results is viable. Anything else is not advisable."
	"We evaluate the impacts in a binary way, and we should evaluate the impact of the carbon footprint to check if it is transient or permanent."

QUESTION SET 4: REGULATION

"Are regulators involved with innovation in the Blue Economy and, if so, how? Are there any sustainability standards or practices directly or indirectly imposed by the regulator? What is the role of public policies in innovation?"

Oceano Azul Foundation	*"We support the creation of marine protected areas as well as sustainable fishing. In sustainable fishing all the regulating entities have an important role in not only making appropriate regulation but overseeing that it is being followed. Implementation of regulation must involve cooperation between several parts. The fishermen must be involved in the process, as well as the regulating entities and the government.* *Cooperative efforts help guarantee that the implemented rules are followed, as well as guaranteeing there are visible results. Regulation also plays a part in marine protected areas.* *In terms of public policies, it is essential that there is support on behalf of the government to achieve sustainable fishing. At the moment what is being done is based on establishing fishing quotas. This can cause rapid mass fisheries as soon as the fishing season begins for a certain species of fish, which leads to a price decrease, followed by quota unavailability, as the quota is reached too soon.* *There must be efficient measures on behalf of the government for a better management of the quantities of fishing."*
CoLAB+ATLANTIC	*"In terms of public policies, there are support and development programs that positively affect entrepreneurship in the Blue Economy. Some of these are DGPM's Fundo Azul, accelerators, and corporate incubators.* *In terms of regulators, DGRM has been facilitating easy and quick access to licences that allow experimental activities for research purposes."* *"The public sector allows the development of technology and innovation. But sometimes the biggest barrier is the lack of financing as well as insurance."*