ONE OCEAN FOUNDATION

Ocean Disclosure Initiative

SHIPBUILDING AND REPAIRS INDUSTRY REVIEW

SDA Bocconi SCHOOL OF MANAGEMENT
SUSTAINABILITY LAB

McKinsey & Company

CSIC
Consejo Superior de Investigaciones Científicas

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About One Ocean Foundation

This research is an initiative of the One Ocean Foundation as part of its Ocean Disclosure Initiative project.

The mission of the Foundation is to accelerate solutions to ocean issues by inspiring international leaders, institutions, companies and people, promoting a blue economy and enhancing ocean knowledge through ocean literacy. The Foundation intends to develop a leading platform, bringing together and strengthening the voices speaking out on behalf of the ocean around the world.

The distinctive feature of the One Ocean Foundation is its scientific scope and, at the same time, its strong educational drive, with the aim of increasing awareness and establishing constructive relationships between all stakeholders engaged in marine preservation at different levels.

Thanks to its extensive network of partners, the One Ocean Foundation is engaged in numerous unique, innovative, and high–value projects related to its mission of ocean protection in three main areas: education, environmental research, and the blue economy.

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About the Ocean Disclosure Initiative

The Ocean Disclosure Initiative project is part of the multi-year research “Business for Ocean Sustainability” promoted by the One Ocean Foundation (OOF) in collaboration with SDA Bocconi School of Management Sustainability Lab, McKinsey & Company, and CSIC (Consejo Superior de Investigaciones Científicas) and aimed at building knowledge about the relationship between business activities and the ocean.

The project commenced in 2019 to investigate the role of companies in addressing ocean challenges, focusing on the pressures on marine ecosystems, levels of awareness within the business community and the main responses (technological and organisational) implemented.

The Ocean Disclosure Initiative aims to be a science-based framework and methodology with the objective of supporting businesses from all industries in acting on ocean-related issues, promoting prevention and/or mitigation responses, and favouring disclosure and reporting.

Introduction to the Shipbuilding and Repairs industry

The shipbuilding and repairs industry (SBR) is vital for the global economy, as it is closely connected to and facilitates other key sectors such as transportation, security, energy, and tourism. The industry can be categorised into two areas: shipbuilding facilities where new vessels are constructed, and repair facilities where the focus is on maintenance and repair activities. These include floating and dry docks, shipbuilding piers and anchorages.

Shipbuilding facilities are mostly associated with the production of larger vessels for various sectors such as cargo or passenger transportation, offshore energy, and military, to name but a few. They also undertake the construction of cruise ships, mega-yachts, ferries, and dredgers.[1]

Repair facilities, on the other hand, offer services and products related to the construction, conversion, and maintenance of vessels, which can be performed at sea or in port.[2] However, significant repair operations require ship (repair) yards or dry docks.

Typical shipbuilding activities may include:

— Handling of raw materials
— Fabrication and surface treatment of steel components
— Assembly of (pre-)fabricated parts into blocks
— Erection of ship structures through the fitting and welding of blocks
— Outfitting of ships with electronic equipment
— Preparation and installation of various (pre-)fabricated parts that are not structural.

Parallel maintenance and repair activities typically include:

— Surface cleaning and treatment operations
— Oil transfer operations
— Servicing of machinery and other equipment

1. European Commission (N.D) “Shipbuilding sector” [online]. Available at: https://single-market-econmy.ec.europa.eu/sectors/maritime-industries/shipbuilding-sector_en
2. Ibidem

The industry has experienced significant growth in recent years, with the global market size reaching USD 40,980 million in 2022.[3] This growth is expected to continue, with projections indicating it will expand to USD 56,500 million by 2028.[4] China holds the largest shipbuilding market share, accounting for approximately 40%, followed by South Korea with 35%.[5] The growth of the SBR industry is attributed to the increasing demand for sustainable ships and shipping services, and to a widespread increase in seaborne trade.[6]

SHIPBUILDING ACTIVITIES HAVE THE POTENTIAL TO IMPACT THE OCEAN IN ALL THE PHASES OF A SHIP'S LIFE CYCLE

Shipbuilding activities have the potential to impact the ocean in all phases of a ship's life cycle, including construction, maintenance, and repair. Furthermore, although the SBR sector is not responsible for the environmental impact of ships during operation and end of life (dismantling and recycling), the sector plays a crucial role in improving also the shipping and port sectors' overall environmental performance.[7] Indeed, unsustainable practices during ship construction, such as the use of toxic anti-fouling paints, pollutants and other potentially hazardous materials, can exacerbate environmental challenges during subsequent maintenance and dismantling phases.

With growing awareness of the industry's negative environmental impact, the SBR sector has initiated efforts to reduce the marine environmental footprint. Triggered by this increased awareness of the pressures exerted on the marine ecosystems, the current international debate is pushing the industry to manufacture greener ships. The International Maritime Organisation (IMO) has, in fact, established that ship CO_2 emissions should be reduced by 40% by 2030 compared to 2008;[8] while the target for 2050 is a 70% reduction. Additionally, the IMO introduced the Energy Efficiency Design Index (EEDI) in 2013, which sets the energy efficiency standard for new ships. Meeting this requirement is a significant challenge for shipbuilders and operators, as all ships built after 2025 must be at least 30% more fuel-efficient.[9] To achieve this, more sustainable shipbuilding processes characterised by less energy consumption are now top priorities in the construction of new vessels. This involves more environmentally friendly shipbuilding practices and progressive supplier solutions for nearly all systems on board.

MORE SUSTAINABLE SHIPBUILDING PROCESSES CHARACTERISED BY LESS ENERGY CONSUMPTION ARE NOW TOP PRIORITIES IN THE CONSTRUCTION OF NEW VESSELS

3. Market Watch (2023) "Shipbuilding Market Research- 2030" [online]. Available at: https://www.marketwatch.com/press-release/shipbuilding-market-research-2030-2023-06-17
4. Ibidem
5. Ibidem
6. Magmaweld (N.D) "Shipbuilding Industry" [online]. Available at: https://www.magmaweld.com/shipbuilding-industry-ua-9
7. OECD (2010) "Environmental and climate change issues in the shipbuilding industry" [online]. Available at: https://www.oecd.org/sti/ind/46370308.pdf
8. Vakili, S., et al. (2023) "The road to zero emission shipbuilding industry: a systematic and transdisciplinary approach to modern multi-energy shipyards" [online]. Available at: https://doi.org/10.1016/j.ecmx.2023.100365
9. Sofar Ocean (N.D) "Decarbonizing the shipping industry: the role of the IMO" [online]. Available at: https://www.sofarocean.com/posts/decarbonizing-the-shipping-industry-the-role-of-the-imo

The scientific review conducted within the framework of the Ocean Disclosure Initiative project has unveiled the most significant pressures potentially exerted by the shipbuilding and repairs industry on the marine environment, which include:

— Emissions of pollutants from ship construction
— Contaminants released from shipbuilding activities
— Introduction of energy from construction and ship repairs
— Marine litter from discarded materials

FIGURE 1: Review of direct and indirect pressures of the shipbuilding and repairs industry*

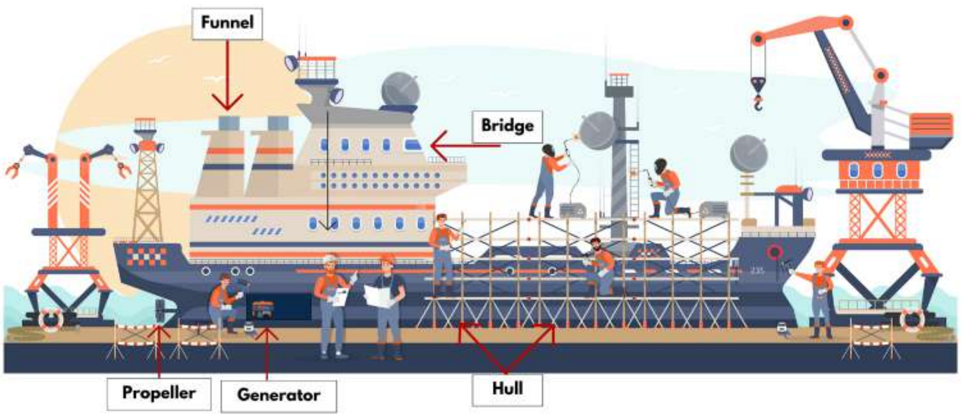
Source: Ocean Disclosure Initiative, One Ocean Foundation, 2021

*Pressures exerted on the eleven Good Environmental Status descriptors (GES) of EU marine waters, listed in the figure as identified in the Marine Strategy Framework Directive of the European Union. https://ec.europa.eu/environment/marine/good-environmental-status/index_en.htm

The main pressures exerted by the the Shipbuilding and Repairs industry

The shipbuilding and repairs sector struggles to adopt a "life cycle" approach to minimise the impact of ships throughout their lifespan, and is therefore associated with significant environmental challenges. Ships are built to last for a long time, up to 30 years or more, and their environmental impacts neither start nor end when the ship leaves the shipyard where it was built.[10] Throughout their operational lives and up until their final dismantling, ships will continue to have an impact, a holistic approach is therefore essential when considering potential solutions for shipbuilding activities.[11] The life-cycle approach is significant from a business perspective because it allows companies to identify cost-effective or profit-generating ways to improve their environmental performance.[12]

FIGURE 2: General parts of the ship



Source: Authors' elaboration from Shutterstock illustration

10. OECD (2010) “Environmental and climate change issues in the shipbuilding industry” [online]. Available at: https://www.oecd.org/sti/ind/46370308.pdf
11. Vakili, S., et al. (2023) “The road to zero emission shipbuilding industry: a systematic and transdisciplinary approach to modern multi-energy shipyards” [online]. Available at: https://doi.org/10.1016/j.ecmx.2023.100365
12. Bockin, D. (2022) “Business model life cycle assessment: a method for analysing the environmental performance of business” [online]. Available at: https://www.sciencedirect.com/science/article/pii/S2352550922001026

The following section explores the industry's potential pressures on the marine environment and outlines some of the best practices to be adopted. Additionally, it covers the innovative measures taken to improve ship design and construction in smart shipyards, aiming to increase efficiency and reduce environmental harm.

Air emissions from the production of ships

The ship building and repair sector is a contributor to air pollution. In particular, as of 2023, shipbuilding and repair activities accounted for approximately 2.89% of global GHG emissions. By 2050, this percentage is projected to increase by 50% compared to 2018 levels.[13]

SHIPBUILDING AND REPAIR ACTIVITIES ACCOUNT FOR 2.89% OF GLOBAL GHG EMISSIONS, BY 2050, THIS PERCENTAGE IS PROJECTED TO INCREASE BY 50%

Smaller vessels can be produced in roofed work areas, but larger vessels are worked in open areas, floating dry docks, or marine railways. The main sources of air pollution come from the release of volatile organic compounds from paints and solvents. Additionally, air heating devices, called "thermogens", which use fossil fuels as their energy source, emit NOx, CO, and particulate matter (PM) that are typically released into the surrounding air. Lastly, shipyards' dependence on electricity generated from fossil fuels contributes to their overall emissions.

The release of these pollutants is connected to two serious issues affecting the ocean: ocean acidification and water eutrophication. Ocean acidification occurs when the pH of the ocean decreases due to the absorption of carbon dioxide from the atmosphere over a prolonged period. Eutrophication happens when a body of water becomes overloaded with nutrients that lead to the excessive growth of algae, ultimately leading to oxygen depletion and the formation of dead zones.

Best practices. Shipyards are engaged in identifying key areas to reduce emissions, including the use of energy from renewable sources, such as offshore wind or wave power, due to the proximity of yards to the ocean. More generally, another good practice is replacing old equipment and using digitalised technology to improve energy efficiency and reduce air emissions from operations.[14]

13. Vakili, S., et al. (2023) "The road to zero emission shipbuilding industry: a systematic and transdisciplinary approach to modern multi-energy shipyards" [online]. Available at: https://doi.org/10.1016/j.ecmx.2023.100365
14. Ibidem

Introduction of contaminants

The pressures potentially exerted by SBR on the marine environment also extend to both seawater and seabed contamination, including the introduction of contaminants in marine sediments in nearby waters.

Studies conducted in Norway have revealed that some of the most prevalent contaminants found near shipyards include lead, mercury, copper, TBT, PCB, PAH, and other chlorinated organic components.[15] In particular, oil spills can contaminate the surrounding waters due to runoff water carrying accumulated oils and debris from the dock area.[16]

THE MAIN SOURCE OF SEAWATER CONTAMINATION DUE TO SHIPBUILDING ACTIVITIES COMES FROM THE PAINTS USED FOR THE BOTTOMS OF VESSELS

The main sources of contamination of seawater in proximity to shipbuilding facilities come from the paints used for the bottoms of vessels that are in direct contact with water. To paint these parts of the vessels, "anti-fouling" paints are commonly used. These contain chemicals that inhibit the attachment of fouling organisms to hulls. The active ingredients commonly found in anti-fouling paints are metal-based, such as cuprous (copper) oxide or tributyltin (TBT).[17] Such components are harmful to many types of marine life as well as fouling organisms.

As a consequence of using these toxic anti-fouling paints during shipbuilding, chemicals can enter seawater during maintenance and ship dismantling processes. This occurs through the release of anti-fouling paint chips, cleaning agents and solvents. Because of its toxicity, TBT is banned globally but remains a hazardous substance on the hull of older vessels and is a concern during the maintenance and servicing of hulls in shipyards.[18]

15. Vakili, S., et al. (2023) “The road to zero emission shipbuilding industry: a systematic and transdisciplinary approach to modern multi-energy shipyards” [online]. Available at: https://doi.org/10.1016/j.ecmx.2023.100365
16 European Bank (N.D) “Sub-sectoral environmental and social guidelines” [online]. Available at: https://www.ebrd.com/downloads/policies/environmental/transport/shipbuilding.pdf
17. Ibidem
18. Ibidem

Heavy metals cannot be eliminated and may gather in water to create deposits. Certain sea creatures, such as shells, can store heavy metals in their bodies at higher levels than in the surrounding water.[19] Moreover, metals found in anti-fouling paint can contribute to seawater eutrophication, which results in increased plant growth, changes in the balance of organisms, and water quality deterioration.

Furthermore, significant volumes of wastewater are generated in shipyards, particularly during ship manufacture and repair activities. Production processes including blasting, welding, painting, machining, and metalworking, as well as repair processes such as hull washing and painting processes like paint removal, contribute substantially to this wastewater generation. Furthermore, open-area processes involved in ship repair and maintenance contribute to stormwater runoff, further adding to the overall increase in wastewater production.[20]

Best practices. There are options for anti-fouling coatings that do not rely on toxic compounds to prevent the buildup of marine organisms on hulls. These alternatives, such as Teflon and silicone-based slippery coatings, focus on surface properties to discourage attachment.[21] The naval industry is also researching a novel polymer coating that inhibits the adhesive bonds that marine organisms use to attach to hulls. Using lower solvent or solvent-free coatings can also reduce emissions of harmful pollutants. Some alternative options include water-based coatings, high-solids paints, and powder coatings. Using these materials prevents the release of these toxic substances during maintenance or dismantling operations.

Alternatives to sandblasting to remove machine coatings from ship hulls include high-pressure water blasting and blasting with wet grit that has been chemically treated to bind heavy metals and isolate them from aquatic life,[22] thereby decreasing the amount of chemicals marine species ingest.

19. Rachmat, A., et al. (2021) “Strategy for shipyard industrial waste management in controlling water and air pollution in ship repair” [online]. Available at: https://iopscience.iop.org/article/10.1088/1755-1315/716/1/012009/pdf
20. Celebi, Ugur & Vardar, Nurten & Akanlar, Tolga. (2011). The importance of wastewater treatment in shipbuilding industry. International Journal of Global Warming. [online]. Available at https://www.researchgate.net/publication/258333531_The_importance_of_wastewater_treatment_in_shipbuilding_industry/citation/download
21. Northwest Industry (1997) “Pollution prevention at shipyards” [online]. Available at: https://p2infohouse.org/ref/07/06643/rt_rept.pdf
22. Ibidem

The utilisation of nanotechnology-based coatings on glass surfaces and superstructures enables a reduction in water consumption for cleaning purposes. The implementation of long-lasting self-cleaning paints, with a durability of up to five years, further promotes sustainability efforts within the industry.

Another solution to avoid biofouling is applying a bubble stream system which introduces micro air bubbles into the water. This creates a protective barrier around a boat's hull that prevents marine microorganisms from attaching.[23] This natural method effectively solves the fouling problem without pollution. Additionally, the system enhances water oxygenation, improving pH levels and benefiting the marine environment.[24]

Overall, it is necessary to adopt efficient water treatment systems for purification within the shipyard. These systems can effectively gather all wastewater, including rainwater, usually employing high-quality filters to ensure the release of purified water into the internal waters of ports.

Marine litter

If not handled properly, shipbuilding activities and demolition can contribute to waste pollution. While recycling ships is an eco-friendly way to dispose of them, it is important to take appropriate steps to ensure the safe disposal of waste, safeguarding both the environment and workers. Currently, more than 70% of obsolete ships end up in South Asia, where they are broken under precarious conditions in a practice known as "beaching". [25] End-of-life vessels can contaminate water with hazardous materials, heavy metals and microplastics,[26] which have the potential to starve marine life, hinder growth, disrupt hormones and damage digestion, impacting the entire food chain.[27]

MORE THAN 70% OF OBSOLETE SHIPS END UP IN SOUTH ASIA, WHERE THEY ARE BROKEN UNDER PRECARIOUS CONDITIONS

23. Hopkins GA, Scott N, Cahill P. (2023) "Application of bubble streams to control biofouling on marine infrastructure-pontoon-scale implementation" [online]. Available at: https://www.ncbi.nlm.nih.gov/pmc/articles/PMC10493092/
24. Pantecnica- Engineered Solutions (2022) "Sistemi antivibranti e di tenuta per fluidi R&D & Innovation-Blue Technologies" [online]. Available at: https://www.pantecnica.it/wp-content/uploads/2021/04/Pantecnica-BubbleBoat®-Aprile-2021.pdf
25. NGO Shipbreaking platform (N.D) "The problem" [online]. Available at: https://shipbreakingplatform.org/our-work/the-problem/
26. Hill Dickinson (2021) "Decarbonisation and shipping: ship recycling- a changing landscape" [online]. Available at: https://www.hilldickinson.com/insights/articles/decarbonisation-and-shipping-ship-recycling-changing-landscape
27. UN Environment Programme (2019) "Fashion's tiny secret" [online]. Available at https://www.unenvironment.org/news-and-stories/story/fashions-tiny-hidden-secret

Best practices. Several international conventions and regulations control the impacts of shipbreaking and recycling, such as the 1989 United Nations Environmental Programme, the 2009 Hong Kong Convention and the European Union Ship Recycling Regulation. Despite this, there are significant challenges surrounding recycling, mainly due to the lack of traceability in the supply chain. Shipowners often sell their ships to brokers in developing countries where there are fewer environmental regulations in place. The Ship Recycling Transparency Initiative was created as a way to combat this issue, enabling shipowners to share data on ship recycling policies and to demonstrate a commitment to transparency and responsible ship recycling practices.[28] This allows all stakeholders to make smart and informed decisions and provide accountability.

Another solution to the waste problem in shipping is to design ships with a focus on reducing hazardous materials, and planning for efficient dismantling at the end-of-life stage.

Introduction of energy

The shipbuilding process involves several activities that have the potential to introduce energy to marine ecosystems in the forms of light and noise.

The introduction of artificial light can result from construction and repair activities on vessels, which may require artificial lighting and have the potential to affect biodiversity and disturb fauna in the surrounding areas, especially those species that rely on natural light for hunting. Underwater noise can come from two main sources, the first being the construction process, which involves the use of pneumatic hammers, gouging tools, and chipping machines that generate significant noise levels in shipyards.[29] Marine animals can be exposed to these sounds if repairs or construction are carried out in the water, as is often the case for larger ships.

THE INTRODUCTION OF LIGHT AND NOISE DUE TO SHIPBUILDING PROCESSES COULD DISTURB MARINE FAUNA AND ALTER THE PHYSICAL AND ACOUSTIC BEHAVIOUR OF ANIMALS

28. Hill Dickinson (2021) “Decarbonisation and shipping: ship recycling- a changing landscape” [online]. Available at: https://www.hilldickinson.com/insights/articles/decarbonisation-and-shipping-ship-recycling-changing-landscape
29. Ibidem

The other source of noise pollution is linked to the design of the engine or propellers, which produce loud noise. The rotation of a propeller and vortex cavitation can generate over 180 dB of underwater radiated noise, which can be heard by animals even from thousands of kilometres away.[30]

These sounds can alter their physical and acoustic behaviour, including hearing loss, stress, and alterations in communication and echolocation sounds.[31] This is especially true for marine mammals, whose communication and navigation frequencies can overlap with ship noise. These disturbances can lead to behavioural changes that may ultimately result in the animal's death.

Best practices. To manage and reduce the impact of underwater noise and light pollution on marine life, effective measures include improved ship design, operation, maintenance, and the use of new technologies.

Specifically for noise pollution, recent studies suggest that seawater-lubricated propellers can decrease propeller noise compared to oil-based lubricants. The navy and fisheries prefer these lubricants as they have been found to scare fewer fish away.[32] In addition, injecting water filtered through a 5μm membrane[33] around the propeller blades can further reduce propeller noise and cavitation on a seawater-lubricated propeller shaft.

Another potential method for enhancing propeller design is to modify the materials used in their construction. Rather than relying on metal, 3D printing techniques can be employed to create hollow, lightweight blades that produce fewer vibrations and less noise.[34]

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30. Wheater, P. (2023) “Quieting the propeller and cutting underwater noise” [online]. Available at: https://www.rivieramm.com/news-content-hub/news-content-hub/quieting-the-propeller-and-cutting-underwater-noise-74799#:~:text=(source%3A%20Thordon)-,The%20propeller%20is%20responsible%20for%20about%2085%25%20of%20a%20ship's,%2C%20avoid%20danger%2C%20and%20survive.
31. Erbe, C., et al. (2019) “The effects of ship noise on marine mammals—a review” [online]. Available at: https://doi.org/10.3389/fmars.2019.00606
32. Wheater, P. (2023) “Quieting the propeller and cutting underwater noise” [online]. Available at: https://www.rivieramm.com/news-content-hub/news-content-hub/quieting-the-propeller-and-cutting-underwater-noise-74799#:~:text=(source%3A%20Thordon)-,The%20propeller%20is%20responsible%20for%20about%2085%25%20of%20a%20ship's,%2C%20avoid%20danger%2C%20and%20survive.
33. Ibidem
34. Ceurstemont, S. (2023) “New materials to make ships more sustainable and less noisy for marine life” [online]. Available at: https://ec.europa.eu/research-and-innovation/en/horizon-magazine/new-materials-make-ships-more-sustainable-and-less-noisy-marine-life

Additional considerations

Construction activities associated with shipbuilding and repairs could exert pressure on seabed integrity.[35]

These kinds of activities may result in resuspension of sediments, leading to the potential risk of seawater cloudiness. This, in turn, has the potential to adversely impact fragile marine habitats like coral reefs, and could also influence the feeding behaviours of diverse species.

Activities to repair ships could also contribute to the issue of introduction of non-indigenous species (NIS) into the marine environment, particularly during movements of vessels to repair facilities. The primary route for these species is through the release of ballast water, crucial for maintaining ship stability during loading and unloading, especially tankers and container vessels; however, discharges of untreated waters represent a significant threat to marine biodiversity. Furthermore, the introduction of NIS is also caused by biofouling, i.e. the unwanted accumulation of microorganisms, plants, algae, or small animals on surfaces such as ship and submarine hulls.

Under suitable environmental conditions and thanks to a high level of resilience and adaptability, non-indigenous species may turn into "invasive species" and proliferate in the marine environment with significant ecological impact on biodiversity, including i) alteration of presence and abundance of native populations, ii) effects on food web interactions, iii) competition for food, space and mates, and eventually, iv) replacement of native species.

To reduce and control the risks of spreading invasive species, ship owners and operators must adhere to international regulations and adopt specific management plans, including procedures and guidelines for managing ballast waters and biofouling. An example is the International Convention for the Control and Management of Ships' Ballast Water and Sediments (BWM Convention) adopted by the IMO.

35. For additional consideration on the pressures exerted by the construction industry please refer to: One Ocean Foundation (2023), Construction and Building Materials Industry Review. [online]. Available at: https://www.1ocean.org/resources

Innovation in Shipbuilding and Repairs

THE PRESSURES EXERTED BY THE SHIPBUILDING SECTOR CAN BE MINIMISED BY USING MORE SUSTAINABLE MATERIALS AND APPLYING INNOVATIONS IN DESIGN

From a design standpoint, engineers can reduce the environmental impact of shipbuilding by incorporating ecological considerations into design and engineering processes, using more sustainable materials and embracing hydrogen or hybrid-electric engines, thereby minimising the impact of building and re-purposing activities. Incorporating new building materials, such as fibre-reinforced plastic (FRP) instead of steel, is a great alternative to reduce the weight of ships and decrease fuel consumption.[36] Other materials also include advanced composites, aluminium alloys, and bio-based polymers.

Using composite materials can also extend the lifetime of a ship, thereby reducing the resources required for construction. Steel ships are often damaged by corrosion, eventually leading to irreparable damage. This is not the case when non-metallic materials are used. In addition, vessels made from composite materials can be better recycled at the end of their life, making them a more sustainable option. Under certain circumstances, composite materials can also be used to repair damaged steel ships, thereby extending their lifespan.[37] Another solution involves optimising the ship's hull lines to increase the ship's speed, save fuel and improve efficiency.[38] However, despite these advantages, composite materials pose challenges due to their higher costs, complexities in repairs, and limited expertise in shipyards. While promising, their broader use in heavy-duty cargo ships is subject to practical and cost-related considerations within the industry.

Innovative engine designs are being developed for ships, boats, and yachts. These designs come in two models: fully electric or hybrid. Hybrid models combine traditional and electric propulsion systems, utilising diesel generators and electric motors powered by advanced lithium-ion batteries.[39] These new motor designs offer environmental benefits by reducing emissions and producing lower noise and vibration, which benefits marine species.

36. For additional consideration on the pressures exerted by the construction industry please refer to: One Ocean Foundation (2023), Construction and Building Materials Industry Review. [online]. Available at: https://www.1ocean.org/resources
37. Ibidem
38. BrightHub Engineering (N.D) “Green ship design for ship building” [online]. Available at: https://www.brighthubengineering.com/naval-architecture/62859-what-is-a-green-ship/?utm_content=cmp-true
39. Benetti 150 (N.D) “Our eco-Yachting philosophy” [online]. Available at: https://www.benettiyachts.it/hybrid-sustainability/

Smart Shipyard

In order to improve the sustainability of vessel production, it is important to make changes to the shipyard system. This involves designing shipyards to improve the scheduling and execution of operations, streamline the information flow required for construction, and automate processes to speed up production and assembly. By doing so, production costs can be reduced while improving the quality of the ships, leading to more efficient management of resources and less waste. Moreover, this will help reduce the time required for shipbuilding, which in turn will minimise the noise and air pollution caused during manufacturing.

Connecting the digital twins of ships being designed with the digital twin of the shipyard can lead to innovation. By creating a 3D model of a ship and simulating its passage through a virtual shipyard, production processes can be tested and optimised, leading to cost reduction and increased efficiency, prior to building costly physical ships or production facilities.[40] Additionally, artificial intelligence can help automate and standardise business processes, optimise planning and operations within the shipyard and supply chain, and introduce smart innovations for production methods and execution.

BY USING DIGITAL TWINS OF SHIPS AND SHIPYARDS, SHIPBUILDING COMPANIES COULD REDUCE PRODUCTION COSTS AND INCREASE EFFICIENCY

In essence, shipyards can play a pivotal role in influencing customer behaviour towards more sustainable marine practices. By educating customers on emerging solutions aimed at minimising carbon footprint and conserving energy and natural resources, shipyards can contribute significantly to fostering a greener marine industry.

40. Ogewell, V. (2022) "Creating a smart digital shipyard" [online]. Available at: https://www.engineering.com/story/creating-a-smart-digital-shipyard https://www.engineering.com/story/creating-a-smart-digital-shipyard

The importance of disclosing the business pressures on the ocean

The industry-specific edition of the Ocean Disclosure Initiative tool dedicated to the shipbuilding and repairs sector, developed by One Ocean Foundation in collaboration with its partners, reflects the main pressures exerted by this sector. The objective is to support companies in becoming aware of their potential impacts on marine ecosystems, assessing the related risks, and disclosing key information and strategic responses on the significant issues related to shipbuilding and repairs activities.

As identified in our research and reflected in the industry-specific tool, these pressures include i) emissions of GHGs and air pollutants from ship construction; ii) contaminants released from shipbuilding activities; iii) introduction of energy from construction and ship repairs and iv) marine litter from discarded materials.

The importance of the Ocean Disclosure Initiative lies in the fact that, for the first time, companies, scientific and financial communities, and civil society can rely on a common language to measure, address, and mitigate the most relevant pressures that humanity exerts on the marine environment, sector by sector, with significant advantages for the health of the ocean.

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