Navigating towards sustainable vessels: state of the industry and its relationship to SDGs

Navegando hacia embarcaciones sostenibles:
estado de la industria y su relación con los ODS

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Abstract

It is a fact that the maritime industry is betting on sustainability and decarbonization in its value chain. This implies designing and building sustainable vessels, which requires focusing not only on technical aspects of functionality and quality, but also on solutions that reduce the environmental impacts of the product throughout its life cycle while generating a positive social impact. This paper answers the question: What are the sustainable technology solutions - products and services - that, aligned with the SDG agenda, are being adopted by global shipyards today? The study follows a mixed methodology with a quantitative descriptive approach and qualitative approach using the content analysis technique by reviewing the sustainability reports available for public consultation of global shipbuilding companies as of 2021. (1) the average number of SDGs to which the industry claims to contribute is provided: 3, 7, 8, 9, 12, 13, 14 y 17. The industry is contributing through innovation projects focused on the design and construction of intelligent, efficient and sustainable vessels, including platforms for the offshore wind power market, zero-emission hydrogen-powered ships, technologies to reduce waste, technologies for automation and energy efficiency, and solutions for social benefit in communities, among others. This study has practical implications for emerging markets wishing to venture into sustainability issues as it provides a global perspective, trends and portfolio of solutions being adopted in the industry.

Key words: Shipyards, Shipbuilding, Sustainable vessels, Sustainable Development Goals -SDGs, Sustainability.

Resumen

Es un hecho que la industria marítima le está apostando a la sostenibilidad y la descarbonización en su cadena de valor. Eso implica, diseñar y construir embarcaciones sostenibles lo cual requiere enfocarse no solo en aspectos técnicos de funcionalidad y calidad, sino también en soluciones mediante las cuales se reducen los impactos ambientales del producto a lo largo de su ciclo de vida generando paralelamente un impacto social positivo. Este documento responde a la pregunta ¿Cuáles son las soluciones tecnológicas -productos y servicios- sostenibles que, alineadas con la agenda de los ODS, están adoptando hoy los astilleros globales?. El estudio sigue una metodología mixta con un enfoque cuantitativo de tipo descriptivo y el enfoque cualitativo utilizando la técnica de análisis de contenido revisando los informes de sostenibilidad disponibles para consulta pública de empresas globales de construcción naval a fecha de 2021. (1) se facilita el promedio de ODS en los que la industria declara que aporta así: 3, 7, 8, 9, 12, 13, 14 y 17. Se observa como la industria está contribuyendo a través de proyectos de innovación enfocados en el diseño y construcción de embarcaciones inteligentes, eficientes y sostenibles, incursionando desde plataformas para el mercado de la eólica marina, buques propulsados por hidrógeno cero emisiones, tecnologías para la disminución de los residuos, tecnologías para la automatización y la eficiencia energética, soluciones de beneficio social en las comunidades, entre otros. Este estudio tiene implicaciones prácticas en mercados emergentes que deseen incursionar en los temas de sostenibilidad pues proporciona una perspectiva global, tendencias y portafolio de soluciones que se están adoptando en la industria.

Palabras claves: Astilleros, Construcción naval, Embarcaciones sostenibles, Objetivos de Desarrollo Sostenible -ODS, Sostenibilidad.

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Introduction

The maritime sector faces more pressure to improve its sustainability and transparency practices, which requires its management to evolve in a more holistic and interrelated manner towards the dimensions of sustainability (integrating Environmental, Social and Governance risks). The players in this sector can be divided into main groups: maritime transport owners, design companies, shipyards, equipment suppliers and others *(Strandhagen et al., 2020)*. The shipbuilding industry is a largely globalized sector *(Para-González et al, 2020)*, its activities comprise the construction, repair and maintenance of vessels and naval apparatus. This industry is a typical example with a complex global supply *(Cerezo-Narvaez et al., 2021)* and chain structure in which components are supplied by manufacturers from different countries and then semi-finished and finished products are returned to customers around the world.

One of the challenges in sustainability, involves analyzing value chain processes with holistic life cycle thinking *(Könnölä et al., 2020)*, in particular, ship design where operational profitability is prioritized over improved environmental performance *(Strandhagen et al., 2020)*. An evolution towards the eco-design philosophy *(Könnölä et al., 2020)* has been proposed, which is materialized through technological innovations that reduce environmental impacts as well as responsible acquisition of materials and proper waste management.

Therefore, it is important to address the vision of sustainability in solutions -products and services- generating investments towards projects with innovative sustainable technologies and towards the use of cleaner fuels; in parallel, in operations reducing negative environmental impacts, without neglecting the associated social and governance risks. Today, Sustainable Development Goals (SDGs) are the most complete reference to address all of the above in the corporate strategy of organizations, given their comprehensive focus on the planet, people, prosperity, stability and partnerships. This paper aims at answering the following research questions: What are the technology solutions - sustainable products and services - that, aligned with the SDG agenda, are being adopted by global shipyards today? Which SDGs are being prioritized?

Research development

Research on sustainability for this industry according to the literature review can be grouped into four themes: oriented to promoting a green supply chain and green transportation; corporate social responsibility practices; incorporation of technologies and industry 4.0 and promotion of blue economy (See Fig. 1).

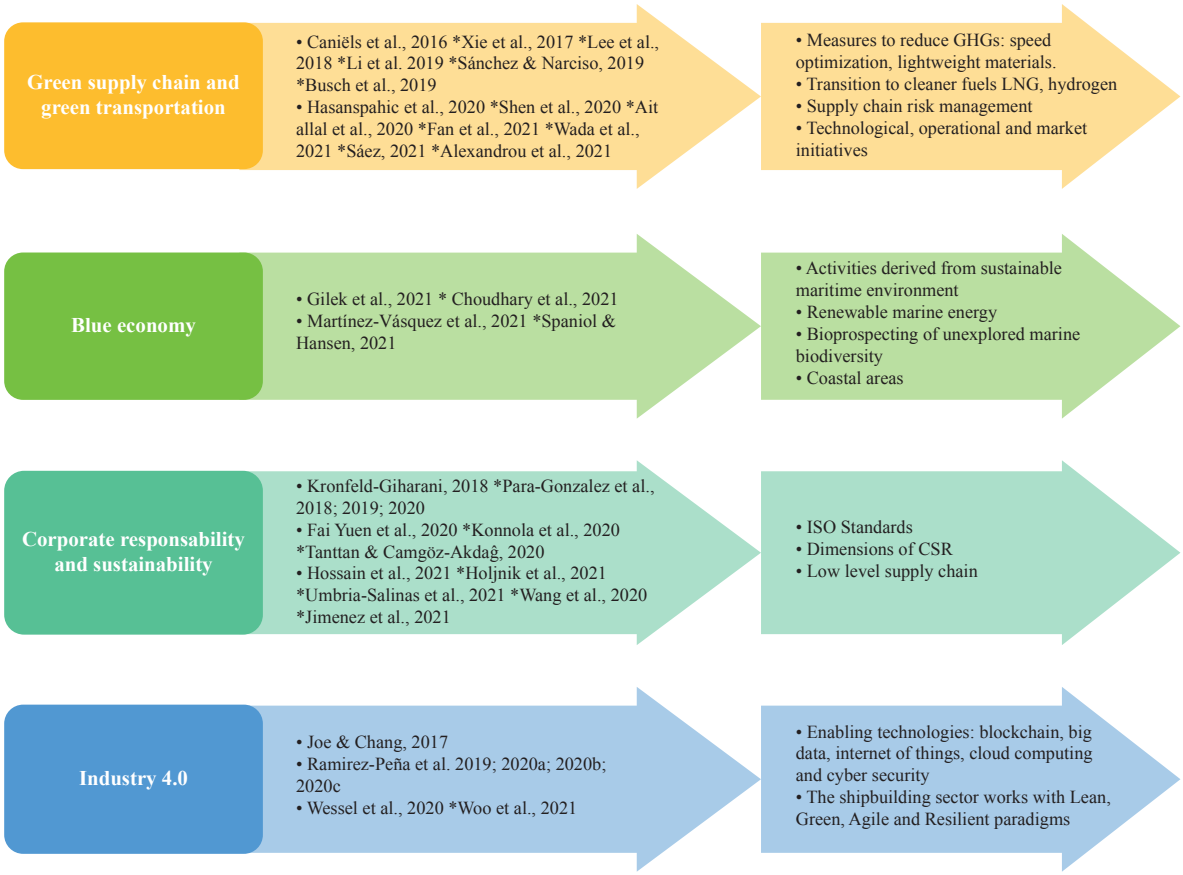
Sustainable vessels

Climate change is one of the most important global risks according to the latest World Economic Forum -WEF report, some of the current measures implemented by maritime transport to address this risk include reducing ship speed, transitioning to liquefied natural gas (LNG) fuel and/or biofuels and promoting the Energy Efficiency Design Index (EEDI) regulation.

But the most important and urgent measure is the introduction of zero-emission ships to achieve these goals *(Wada et al., 2021)*. The Getting to Zero Coalition initiative materializes and accelerates the decarbonization of maritime transport with the development and deployment of commercially viable zero-emission deep-water vessels by 2030, including the development of new marine fuels, derived from abundant untapped renewable resources (https://www.globalmaritimeforum.org/getting-to-zero-coalition).

Technological measures to reduce emissions in maritime transport *(Wada et al., 2021)* include changes in ship construction and the application of new technologies in shipping, such as: changes and innovations in hull design, power and propulsion systems, use of alternative fuels and energy sources, use of exhaust gas reduction and cleaning technologies, catalytic reduction systems (SCR) and scrubbers.

Fig. 1. Sustainability issues in the literature review for industry.



Today we see a deployment of collaborative projects in the global maritime industry, initiatives such as green corridors -zero emission maritime trade routes between ports- along with a transition strategy, are key elements in addressing sustainability challenges. Therefore, a continuous innovation process in the organizations that are part of the naval defense is fundamental, otherwise they can quickly become obsolete and compromise their ability to carry out their fundamental mission: to protect their country *(Cerezo-Narváez et al., 2021)*. A proactive stance towards environmental challenges by shipyards is critical and engaging in green innovations can generate business opportunities (Saether et al., 2021) which implies a long-term strategic focus on sustainability.

The research by Jokinen et al. (2022). conducted an image analysis of "The World's Most Sustainable Ships" in the future, identifying issues such as (1) life cycle thinking, which involves the entire supply chain being committed to the circular economy; (2) collaboration, economic realities and radical innovations -including Industry 4.0 technologies- which involves building a culture of trust in the value chain and establishing appropriate channels for radical ideas and problem solving with different stakeholders.

In ship maintenance and repair, efficient operational measures must also be implemented to reduce waste generated and GHGs emitted *(Ait allal et al., 2020)*. Solid and liquid wastes should be minimized through efficient management of the use of abrasive materials, solvents and other cleaning products. This waste must go through a recycling process by separation of oily water. A log should be kept to track the discharge of various ship maintenance and repair waste. Install a treatment plant for the treatment of surface water and rainwater that is dredged with the different waste existing in the dock.

The recycling of vessels is another of the issues identified in sustainability that must be addressed, being consistent with the life cycle thinking which must also be contemplated from the design *(Ocampo & Pereira, 2019)*; it consists of the dismantling of the structure and components of the vessel, there steel and other materials are recovered in good condition, the treatment of hazardous materials and safety conditions is carried out which generates certain economic, social and environmental impacts on the sites where they are carried out, hence the importance of doing this in certified shipyards *(Jokinen et al., 2022)*.

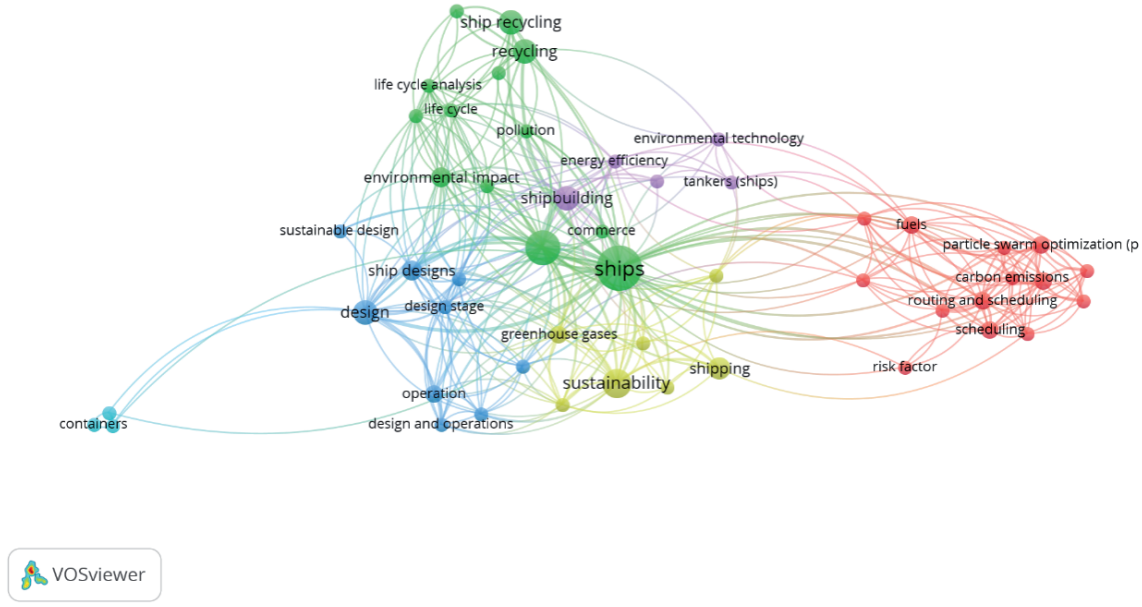
Industry and SDGs

Table 1. Role of the maritime industry in achieving SDGs.

SDG	SDG	Description
1	Poverty reduction	Ensure that maritime transport is safe, clean and creates prosperity and sustainable growth in a green and blue economy.
2	Zero hunger	Ensure efficient and cost-effective supply chains for global food distribution; safeguard an important source of nutrition, address illegal fishing.
3	Good health and well-being	Contribute to the reduction of maritime transport-related pollution in oceans, ports and coastal regions.
4	Quality education	Safety, security and environmental protection at sea depend on the education and training of seafarers.
5	Gender equality	Support gender equality and empower women in the maritime sector through a comprehensive and targeted program.
6	Clean water and sanitation	Minimize dumping and disposal of waste at sea, which is a key component of the overall waste management cycle.
7	Clean and affordable energy	Promote funding, research and development of clean energy technologies for the maritime sector.
8	Decent work and economic growth	Shipping is an important source of labor, especially in developing countries. Issues related to the health and welfare of seafarers.
9	Industry, innovation and infrastructure	More efficient shipping, working in partnership with the port sector, will be an important driver toward global stability and sustainable development.
10	Reduced inequalities	Improve capacity in countries that lack the know-how and resources to operate a safe maritime transport and efficient industry.
11	Sustainable cities and communities	They depend on a secure supply chain, helping improve maritime security and protect the global logistics infrastructure.
12	Responsible consumption and production	Reduce the generation of waste, both operational waste from ships and discharges at sea.
13	Climate action	Emissions control and solutions to minimize the contribution of maritime transport to air pollution and its impact on climate change.
14	Life below water	Responsible for global measures to improve international maritime transport safety and security, and prevent pollution from ships.
15	Life on land	Responsible for port security and is part of global efforts to stop illegal wildlife trafficking.
16	Peace, justice and strong institutions	Promotes effective institutions to ensure the safe, secure, and environmentally protective flow of maritime trade.
17	Partnerships for the goals	Partnership agreements with leading global and environmental organizations for the development of joint projects.

Source: Wang et al., 2020, p.14.

Fig. 2. Concurrence of keywords in literature review.



Methodology

The literature was reviewed in a high impact database which showed the growing trend and orientation of research associated with sustainability in the industry and sustainable vessels (see Fig. 2). This study also followed a mixed methodology, with a descriptive quantitative approach and using the content analysis technique, reviewing the sustainability management reports of 25 global shipbuilding companies (2020-2021) which are a powerful tool to explain whether SDGs are really important for the private sector and how companies effectively contribute to them *(Costa et al., 2022)*. Illustrative case studies were used to showcase leading practices of the organizations; only publicly available data are explicitly discussed in the document. We reviewed which SDGs are declared as prioritized by the organizations.

Results

For this research, 25 companies from 17 countries were selected, including holding companies (groups of companies), which allows for a global approximation. Companies today have a microsite on their website focused on sustainability referred to as: sustainability, corporate social responsibility, commitment, management and sustainable development, SDG or ESG. They have a non-financial management report referred to as: sustainability report, annual report, integrated report, CSR report, annual report or ESG report. They report on Sustainable Development Goals in their reports. All SDGs were prioritized by companies in the industry. In some cases, alignment with corporate strategy, prioritization and concrete indicators can be observed. In some cases, although their relationship with SDGs is not explicitly stated, a relationship can be established in the material issues of sustainability or corporate responsibility. The number of prioritized SDGs varies, with an average of 8. The minimum is 4 and the maximum is 17.

As can be seen in Fig. 3, SDGs being prioritized are those corresponding to the planet, *i.e.*, seeking to reduce environmental impacts (7, 12, 13, 14) through innovation (9) without neglecting the fact that this industry is intensive in skilled labor and contributes to the economic growth of the countries in which it operates (8).

Fig. 3. Prioritization of SDGs by global shipyards.

Table 2. Sustainable technology solutions from global shipyards.

Companies	SDG	Solutions
[1,2]	7, 13	Platforms for the offshore wind market (fixed and floating structures, installations), vessels for offshore wind farms and offshore aquaculture.
[2]	7, 13	Zeus -Zero Emission Ultimate Ship- the first prototype ship powered by hydrogen -fuel cells-. Zero Coaster intends to develop a new class of zero-emission bulk carrier for coastal shipping.
[2]	6, 14	State-of-the-art ballast water treatment and systems based on plankton pre-filtration and subsequent sterilization with ultraviolet rays.
[2, 3, 4, 11]	7, 13	Use of alternative fuels (Liquefied Natural Gas, Ammonia, Methanol, Liquid Hydrogen) Microbial Fuel Cells (MFCs) Change, the first hydrogen fuel cell-powered passenger ship with engine in the US. Lithium batteries First application of NRS® (Nitrogen Refrigerant System) in two LNG-FSUs. Wind assisted propulsion systems.
[2,4]	7, 12, 13 14	Safe and environmentally friendly LIMPIDH2O® technology: internationally patented technology for recirculation dredging provides the best way to achieve outstanding levels of environmental protection in special interventions and marine, lake or river works. Technology at ports when docked: the dockside electrification system that allows electricity to be supplied to the ship directly from shore, so that the ship's engines can be shut down while docked.
[2]	7, 13	FUCELL project operation of a power generation plant for marine applications, consisting of a hydrogen production plant, compression plant, storage and distribution to feed a fuel cell system combined with a super capacitor system. Fuel cell and hydrogen technology transferred to future vessels.
[2, 3, 4]	7, 13	Software tool to support decision making and monitor energy performance. SmartShip Solutions, Air Lubrication System (ALS): An energy saving device to reduce friction and drag when working on a hull by sending air to the bottom surface, applied to a methane tanker. SG system (shaft generator): power generation system by using the rotating shaft power of the ship's propulsion motor shaft in operation as a clean source of energy.
[2]	14	PIAQUO - mitigate problems related to underwater noise and reduce its impact on the marine environment ecosystem by optimizing propellers and developing a real-time self-assessment model;
[2]	12	The technological solutions adopted for the treatment of solid waste shall be implemented by converters, which allow for the drying and sterilization of waste and the consequent reduction of volume and weight and the subsequent automatic vacuum storage, increasing retention on board. The modern converters adopted allow a volume reduction of 70% and a weight reduction of 30%. Graywater and wastewater are collected in appropriate physical and chemical treatment units that macerate suspended solids and reduce Total Suspended Solids (TSS), Biochemical Oxygen Demand (BOD) and Chemical Oxygen Demand (COD) contents through aerobic processes. The process also includes disinfection by UV systems.

[2]	12	Voluntary certifications such as Green Passport provide, upon delivery of the vessel, the inventory of materials to be monitored during the life cycle of the vessel and is used to ensure that the vessel is scrapped in a safe and environmentally friendly manner.
[3]	12, 14	Technologies to deal with marine debris. During the COP26 'Go With The Flow' project, which encouraged engineers to participate in a challenge to design and build a prototype river cleaning vessel.
[3, 4]		Expand the types of vessels that feature new clean technologies, such as ALS, DS4 platforms and high manganese steel applied tanks.

The technological solutions - products and services - offered and declared in their sustainability reports by shipbuilding companies based on research, development and innovation to address sustainability challenges, mainly in environmental matters, were reviewed.

Conclusions

The shipbuilding industry is navigating towards sustainability, starting with innovation through the design and construction of smart, efficient and sustainable vessels; as well as innovative technological solutions and practices to address sustainability needs and challenges in its operations and during the use of the vessel by customers. In this regard, great challenges are evident from the design of products -vessels, equipment and naval by-products-, which requires research, development and innovation that can be carried out in alliances with universities, leading research centers and by accessing external resources, given the large investments required.

There is also an explicit commitment to the global sustainability agenda, as technological development is aimed at reducing polluting emissions and fuel efficiency, increasing energy efficiency, complying with international regulations that are increasing every day and providing quality and efficiency in the products and services offered. In short, the aim is to evolve towards vessels that are hyper-connected, energy self-sufficient, lighter with green or hybrid propulsion systems and capable of recycling up to 90% of the waste generated.

As can be seen, the shipbuilding industry is working on its portfolio of eco-friendly products and services, on the decarbonization of transportation and on making its shipyards more socially and environmentally responsible.

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