



Environmental Sustainability in the Cruise Industry

Anna Maria Kotrikla^{1*}

Evangelia Chortatsiani¹

¹University of the Aegean, Department of Shipping,
Trade and Transport, 2a Korai Street,
Chios, 82132, Greece

* Corresponding Author

Received: 21 September 2022 / Accepted: 19 November 2022 / Published: 20 December 2022
© 2022 Anna Maria Kotrikla and Evangelia Chortatsiani

Doi: 10.56345/ijrdv9n4s212

Abstract

Cruise shipping is currently one of the fastest growing segments in the tourism sector and creates a significant environmental impact. The aims of this study are a) to investigate what are the main environmental issues faced by the cruise ships and which measures are taken or foreseen to address the problems, b) to explore the passengers' attitudes towards environmental protection and the companies' drivers to adopt pro-environmental measures. Data were collected by reviewing the sustainability reports of the main cruise companies and by interviewing three environmental officers that work at the industry. The results showed that there is a trend in employing LNG to address climate change and air pollution. The energy efficiency is further improved with measures such as shore-side electricity, gas-turbines, waste-heat recovery, air lubrication etc. A substantial percentage of ships is equipped with EGCS to address SO₂ and PM emissions. Campaigns to reduce single use plastics and saving water and the use of Advanced Wastewater System are also measures to reduce the environmental footprint of cruise shipping. The passengers are informed about the rules and regulations and generally comply with them. According to EO's opinion, they probably would not pay more for a cruise to support a green program. Also, the companies adopt pro-environmental measures to fully comply with regulations but also to protect the local environment (i.e. flora, fauna), the health of the locals and the local economy.

Keywords: climate change, air pollution, plastics, green cruising

1. Introduction

Cruise shipping is currently one of the fastest growing segments in the tourism sector. In 2009, the global ocean cruise industry carried roughly 17,8 million passengers. As of 2019, this figure peaked at 29,7 million (Statista, n.d.). Cruise ships operate in all the oceans of the planet, often in sensitive marine ecosystems. They tend to concentrate their activities in specific coastal areas, creating a significant cumulative impact at the local scale (Kotrikla et al, 2021).

The sustainability of the cruise industry (and other economic activities) was challenged lately due to Covid-19 pandemic. Cruise operations were paused in March 2020 and there was the challenge of safely returning thousands of guests and repatriating crew members. However, the pandemic sooner or later will come to an end. On the opposite, the big environmental issues of our times (i.e. climate change, biodiversity loss) will be still there, waiting for sustainable solutions.

In this framework, this study explores the environmental sustainability of the cruise industry. The aim is to find out what are the main environmental issues faced by the cruise ships and which measures are taken or foreseen to address the problems. In addition, an attempt was made to explore passengers' attitudes towards the anti-pollution efforts onboard a cruise ship and to investigate the factors leading to the adoption of pro-environmental measures by the cruise companies.

2. Materials and Methods

The 2020 Sustainability Reports of the four biggest cruise companies (Table 1) were reviewed to find out the main environmental issues and the solutions in use or in perspective. The topics searched were energy efficiency and climate change, air pollutant emissions, waste management/circular economy and wastewater management. These topics were selected for one or more of the following reasons: a) They occur in the sustainability reports, b) They include main waste streams of the cruise ships, c) They address important environmental issues of our times.

This information was cross-referenced through semi-structured interviews with senior Environmental Officers (EOs) working in cruise ships, conducted in March 2022. The questionnaires were sent by e-mail to 5 EOs and 3 of them agreed to participate. EOs were asked mainly open questions to identify the anti-pollution operations and technologies on board their ship. In addition, their valuable opinion based on their experience (3.5-10 years) was asked on the passengers' attitudes towards environmental protection in the ships and the anticipated factors that lead the cruise companies to adopt pro-environmental measures.

3. Results and Discussions

3.1 Important environmental issues and the response of the cruise industry

The cruise line market is oligopolistic in its ownership (Pallis, 2022) since four main cruise lines account for 83% of the market in terms of ship's capacity (Table 1). The issue of sustainability appears to be important for the cruise industry. The leading cruise line companies routinely post online sustainability reports with environmental goals and performance (CLIA, n.d.). They did not stop even during the extremely difficult Covid-19 period. The following discussion is based on the sustainability reports of the companies (Carnival, 2021; MSC, 2021; NCLH, 2021; RCG, 2021), and it is cross-referenced by the responses of the EOs.

Regarding energy efficiency and climate change, all companies state their commitment to decarbonization and carbon neutrality. Since there is not any single innovative fuel or technology to lead to decarbonisation, the solution is to combine several approaches. To this end, liquefied natural gas (LNG) is currently the fuel of choice. Carnival Corporation has already 4 ships on LNG, in operation by 2020 and will add 7 more ships by 2025, representing 20% of its total capacity. Royal Caribbean has decided to introduce fuel cells and liquid natural gas in some of the 13 ships now in planning or under construction. MSC Cruises has its first LNG powered ship operational by 2022 whereas two further ships are confirmed to enter service in 2023 and 2024.

One hurdle to overcome with LNG is the potential for escaped unburned methane, or 'methane slip'. The overall CO₂ reduction of LNG is estimated around 8–20% compared to HFO and MDO (Balcombe et al, 2019) and therefore cannot be used in isolation to meet the targets in GHG emissions, but it must be combined with measures such as slow steaming, wind assistance, or blending with bio-LNG (Balcombe et al, 2019).

The cruise ships, while at berth, could connect their electric power generators to the grid, a process called shore side electricity or cold ironing. By this way the emissions of all the pollutants (CO₂, SO₂, PM, NO_x, CO) at the port are reduced. The overall reductions depend on the energy mixture that the port relies on. There are limited ports with shore power today, but gradually more of them develop such plans. Carnival Corporation has equipped 40% of the fleet with shore-power capabilities and aspires to increase it to 60% by 2030. Royal Caribbean Group has equipped 4 (out of 60) ships with shore power connectivity. Thirty-five percent of Norwegian Cruise Line's ships and one ship for Regent Seven Seas Cruises are equipped with cold ironing capabilities. In addition, 100% of ships on order are equipped with cold-ironing capabilities.

Additional measures to increase energy efficiency of the ships are reported. RCG (2021) uses gas-turbine engines which burn cleaner fuels. Waste heat recovery, a process that recovers heat from the engines and transfers to freshwater piping is used (RCG, 2021; NCLH, 2021). Air Lubrication, a system that creates air bubbles distributed across the ship's hull, which results in reduced resistance as the ship sails is also applied in one ship of NCLH and discussed by RCG. Hull

design and optimization is described by RCG, MSC and NCLH whereas NCLH reports the application of low friction silicone hull coating to 100% of the fleet. Air conditions and ventilation units are optimized as well as led lighting upgrades are applied (RCG, 2021; NCLH, 2021). A variety of innovative technologies and fuels such as batteries, fuel cells, hydrogen, methanol, ammonia, and biofuels are studied in research or demonstration programs to estimate their potential to future cruise vessels.

Digital resources are increasingly applied to improve energy efficiency. MSC (2021) reports a data analysis digital process that collects extensive amounts of data using onboard automation systems and sensors, allowing a very precise status report on the energy profile of the ship. NCLH employs voyage planning and optimization, looking for options where the vessels can travel at lower speeds, considering time at sea and efficient port selection, analyzing weather forecasts, currents, and wave conditions to save fuel.

Cruise companies invest in land applications to offset their carbon emissions (RCG, 2021; NCLH, 2021). For example, RCG invested in a wind farm in Kansas, that generates approximately 242,000 tons of CO₂ offsets, or an expected 12% of the company's global emissions each year (RCG, 2021).

Global emissions of greenhouse gases are still on the rise, and it is expected that average global temperatures will climb. This will bring all kinds of risks, including more frequent extreme weather events and coastal erosion from rising sea levels. NCLH (2021) will undertake carbon risk scenario planning to estimate both physical and financial risks and develop adaptation strategies.

The emission of toxic air pollutants by ships (SO₂, NO_x, PM) is addressed by MARPOL Annex VI (2020 sulphur cap and NO_x emission limits). LNG is an excellent fuel for SO₂ and PM (but also for NO_x) emission reduction. Other effective solutions for SO₂ removal include the use of MGO or the use of Exhaust Gas Cleaning Systems (EGCS) (scrubbers) that additionally reduce PM. Carnival has equipped 80% of their fleet with scrubbers, Royal Caribbean Group 70%, MSC 53% and NCLH 46%. The remaining vessels have completed all fuel modifications to run on compliant fuel. For the decrease of NO_x emissions, selective catalytic reduction (SCR) is reported in several cases. For example, Celebrity has already equipped 3 ships and all future ships are also designed with SCR systems to reduce NO_x to greater than 90%.

The complex logistics of supplying and managing the necessary goods onboard should follow the principles of circular economy in the supply chain. The products should preferably be local, of multiple uses and recyclable. There is an effort to reduce non-essential, single-use items including plastic cups, lids, cutlery, straws, toothpicks, and many others. Carnival plans to achieve 50% reduction in single-use plastic items by the end of 2021. They partner with primary vendors to reduce upstream packaging volumes and aspire to reuse near 100% of packaging material by 2050. In RCG follow similar policies, having removed 60% of their single use plastics from their supply chain. In MSC they work to eliminate millions of single-use plastic items from their ship operations in partnership with their suppliers. Due to Covid-19 however, several single-use items that contain plastic were introduced including personal protective equipment and packed lunches to crew in quarantine and to guests for shore excursions.

There are usually two options for water on-board: desalination of seawater by heating or by reverse osmosis and bunkering of fresh water from local sources. RCG produces 90% of freshwater on board via desalination or reverse osmosis. NCLH states approximately 83% of fresh water used onboard across the fleet in 2020, was self-produced from seawater. This is particularly important in countries where fresh water is limited so it is reserved for local needs.

Efforts to reduce water consumption are reported by installing water flow reducers or flow meters on areas which typically have higher consumption rates (NCLH) or use AC condensate for machinery systems, laundry, and deck washing (RCG, NCLH). In RCG they have reduced the average guest daily water consumption to 66 gallons (250 L) per day. In the USA, each person uses about 80-100 gallons of water per day, for indoor home uses.

Regarding the management of wastewater (black water), all the cruise ships are equipped with a marine sanitation device to comply with Annex IV of MARPOL for the Prevention of the Pollution by Sewage from Ships. On top of this, all companies state that they have installed Advanced Wastewater System for part or all their capacity.

Table 1. Specifics of the main cruise lines¹

Cruise line	Nationality	Founded	Brands	Number of ships	Market share 2020 (%)
Carnival Corporation & plc	USA	1972	AIDA Cruises, Carnival Cruise Line, Costa Cruises, P&O Cruises, P&O Cruises Australia, Cunard Line, Princess Cruises, Holland America Line, Seabourn	>100	39.0
RCG - Royal Caribbean Group	USA	1977	Royal Caribbean International, Celebrity Cruises, Silver Sea, TUI Cruises (50%), Hapag Lloyd Cruises (50%)	60	24.0
MSC Cruises	Italy	1989	-	17	11.5
NCLH - Norwegian Cruise Line Holdings	USA	1966	Norwegian Cruise Line, Oceania Cruises, Regent Seven Seas Cruises	28	8.3

¹Pallis, 2022

The advanced systems include tertiary treatment to further reduce organics, turbidity, nitrogen, phosphorus, metals, and pathogens and the effluent is suitable to be reused for irrigation (e.g., food crops, golf courses), for recreational purposes (e.g., lakes, estuaries) etc. In RCG 87% of their capacity is equipped with Advanced Wastewater Purification systems. In MSC Cruises, 61% of the wastewater volume is treated by advanced, tertiary system and in NCLH, 100% of their ships are equipped with advanced wastewater treatment systems.

3.2 Exploring the views and attitudes of passengers on environmental issues

According to the Environmental Officers' view, passengers are fully aware about environmental protection rules onboard. "Once per cruise", guests get informed about environmental standards and certain presentations take place by the Environmental Officers. In addition, posters, and TV announcements on board and also in their cabins inform them about the rules and regulations. On all open decks there are placards with MARPOL's ANNEX V and all bins are labelled for the correct segregation in glass/ aluminum and paper/ plastic.

A critical point is the extent to which passengers comply with rules for waste management on-board. According to the Environmental Officers consideration, those passengers who are knowledgeable and fully aware about environmental standards, do comply with rules and regulations. Moreover, crew members assist passengers on recycling waste material and advice to put into different waste bins and the passengers follow the separation instructions. Moreover, crew members advice and encourage passengers to attend energy and water savings programs and lectures given by Environmental Officers, ensuring in that way "diffusion of knowledge" on these issues. Generally, the whole environment on board and the culture of people who work on board, cultivate the need for handling waste material, recycling and generally passengers' compliance with certain rules and regulations.

In particular, this research investigates significant factors affecting passengers' compliance for waste management on-board based on Environmental Officers views. Educational background, mentality and culture of passengers and demographics (ie. nationality, age and gender), are the most significant variables affecting passengers' compliance for waste management on-board.

Moreover, this research investigates whether the existence of a green cruise program becomes a critical reason for passengers' selection of a particular cruise. According to the Environmental Officers views, people started becoming more environmentally conscious, especially young generations. Although a green cruise program could be an extra asset for the passengers to select a particular cruise, however, this wouldn't be a critical reason. A significant number of passengers will not pay more for a cruise to support a green program. Only those passengers who are already environmentally conscious, may prefer to pay "a little bit more" for a cruise which is compatible with their educational level, mentality, or culture. Cruise lines should work together with crew to motivate the guests/ passengers on this critical issue.

Although cruise companies adopt pro-environmental measures to fully comply with MARPOL and other regulations, definitely, there are additional reasons for adopting pro-environmental rules on-board. Those reasons could be the need for protecting the local environment (i.e. flora, fauna), protecting the health of the locals, avoiding nuisance to the local economy (i.e. tourism, fishing), or even attracting passengers.

Although this is an in-depth investigation which adds theoretical and practical value about environmental protection onboard, sample limitation remains a critical issue. The small number of EO participants into this qualitative investigation,

arises generalization issues. Moreover, passengers' views regarding environmental protection onboard, have been collected by senior Environmental Officers and not directly by passengers. Therefore, judgments might be shaped by their personal opinions making this type of investigation to suffer from subjectivity. The above imposes the need for conducting research directly to passengers to collect accurate and objective data, enhancing thus, our understanding on their perceptions.

4. Conclusions

Climate change is the most important global environmental problem of our times that threatens the ecosystems and people's livelihoods and communities. There is no one single solution to decarbonise shipping. LNG is currently the fuel of choice of the cruise industry, following the trend in shipping and land applications. However, its price and availability are volatile, following geopolitical events. In addition, methane is still a carbonaceous fuel and adding the methane slip, the potential of CO₂ reduction is only 8-20%. Therefore, it must be combined with other measures. The adaptation to the financial and physical risks due to climate change is an important issue addressed by NCLH. The emissions of toxic air pollutants (SO₂ and PM) are efficiently address with cleaner fuels and EGCS. There is significant effort to reduce single use plastics and water consumption onboard. The principles of circular economy should guide the relevant programs. There is a trend towards the installation of tertiary systems for wastewater management.

Although this research focuses on ways of handling wastes on-board and passengers' awareness and compliance into this, further investigation needs to be conducted to associate environmental rules and ways of handling waste material "on-board" with environmental rules "out of board" for the benefit of the local economies, tourism but also for ensuring/ or achieving environmental and economic sustainability.

It is even more worth investigating, whether the adoption of rules and compliance about handling wastes on board is the result of imposed regulations by "people on board " or by stakeholders' interests or actually a "voluntary compliance" as a way of practicing social responsibility.

To conclude, as one of the EO replied "a fantastic guest experience relies on a clean and healthy marine environment and the well-being of the destinations the cruise companies' visit. The cruise companies have the responsibility to protect these places, to ensure the future of the business and because it is the right thing to do".

References

- Balcombe, P., Brierley, J., Lewis, C., Skatvedt, L., Speirs, J., Hawkes, A., & Staffell, I. (2019). How to decarbonise international shipping: Options for fuels, technologies and policies. *Energy conversion and management*, 182, 72-88.
- Carnival (2021). Sustainable from Ship to Shore, 2020 Sustainability Report, Carnival Corporation and plc, available at <https://carnivalsustainability.com/>
- CLIA (n.d.). Environmental Stewardship, available at <https://cruising.org/en-gb/about-the-industry/policy-priorities/environmental-stewardship>
- Kotrikla, A. M., Zavantias, A., & Kaloupi, M. (2021). Waste generation and management onboard a cruise ship: A case study. *Ocean & Coastal Management*, 212, 105850, <https://doi.org/10.1016/j.ocecoaman.2021.105850>.
- MSC (2021). Navigating Through the Pandemic Cruises Sustainability Report 2020, available at <https://www.msccruises.com/en-gb/About-MS/News/2020-Sustainability-Report.aspx>
- NCLH (2021). 2020 Environmental, Social and Governance (ESG) Report, Norwegian Cruise Line Holdings, available at <https://www.nclhld.com/sustainability/reporting-and-downloads>
- Pallis A., (2022). Ports and Cruise Shipping, in Notteboom T., Pallis A. and Rodrigue J.P. (2022) Port Economics, Management and Policy, New York: Routledge, 690 pages, available at <https://porteconomicsmanagement.org/pemp/contents/part1/ports-and-cruise-shipping/>
- RCG (2021). 2020 Sea Sustainability, Royal Caribbean Group, available at <https://sustainability.rclcorporate.com/reporting/>
- Statista (n.d.), Leisure Travel, available at <https://www.statista.com/markets/420/topic/493/leisure-travel/#overview> assessed on March 2021.