Digital Technologies for Sustainable Waste Management On-Board Ships: An Analysis of Best Practices From the Cruise Industry

Assunta Di Vaio, Rohail Hassan, Gabriella D'Amore, and Alberto Dello Strologo

***Abstract*—This article aims to investigate the role of digital technologies for sustainable waste management in the cruise industry to meet the United Nations (UN) 2030 Agenda. These issues are analyzed through the sustainability disclosure of the major cruise corporations. Under the lens of the corporate social responsibility framework and legitimacy theory, this study construed sustainability reports of four major cruise corporations published from 2015 to 2019 and their website pages by using the Leximancer text-mining software to map the underlying main research topics with the visual concepts range and manual content analysis. The results highlight the increasing commitment of cruise corporations to reduce the environmental impact by meeting sustainable development goals (SDGs) included in the UN 2030 Agenda by investing in digital technologies on-board ships. Using a double level of sustainability reporting analysis, this study, compared to previous studies, seeks to determine best practices on operational processes on-board ships regarding waste issues, including the digital technologies as an enabler to sustainability, especially SDGs. This study opens the way to scholars about waste processes and financial investment in technology issues, as well as the role played by the regulatory framework. In addition, this study highlights the insufficiency of the theory of legitimacy alone to identify best practices related to broader waste issues. Likewise, the practitioners find in this study a key roadmap about the need to involve crew and cruisers in the waste digital process thanks sharing of programs to define the waste practices. Practitioners also find the address to the factors that will make them aware of the current weakness of nonfinancial disclosure in sustainability reporting. To the best of the authors' knowledge, this study represents the first time an empirical analysis conducted through sustainability reporting and other non-financial documents allows to identify "best practices" adopted on-board cruise ships to meet sustainability goals in digital waste management. Moreover, the use of two levels of analysis, by Leximancer and manual content analysis about the text documents companies make available to stakeholders, allows for identifying the high-level concepts and key ideas without bias, well as being able to define the perimeter of good practices linked to the orientation of cruise corporations toward new technologies.**

***Index Terms*—Corporate social responsibility (CSR) disclosure, cruise corporations, cruise waste practices, legitimacy theory, sustainability reporting, sustainable development goals (SDGs).**

I. Introduction

IN THE last three decades, the cruise segment has been one of the fastest growing in the tourism industry [1], [2], although it suffered an estimated loss between mid-March and September 2020 of $77 billion in economic activity, 518 000 jobs, and $23 billion in wages [3]. Several scholars have widely acknowledged the environmental, economic, and social relevance of this growth [4], [5], [6]. Research on sustainability in the cruise industry has increasingly addressed on-board waste management to reduce the impact of cruise ships [7], [8], [9], [10]. Specifically, the terrestrial environmental impact of cruise ships is also due to ship waste disposal [11]. It has also been estimated that cruise ships are responsible for 25% of all the waste generated by merchant's vessels, with the production of about 3.5 kg/passenger day [12]. Although MARPOL 73/78 [13] still allows for disposal at sea of several types of treated waste at a defined offshore distance, there is a need to encourage the adoption of green practices and the use of technologies to achieve a more sustainable approach to shipboard waste management [14].

The United Nations (UN) 2030 Agenda in 2015 indicated global priorities to achieve and establish an action program for the planet according to a collaborative approach within 2030 by recognizing the importance of the cruise industry in contributing to the achievement of sustainable development goals (SDGs) [15], [16]. Likewise, some scholars confirmed the relevance of business in achieving sustainability, chiefly in developing business models by adopting digital technologies [1], [2], [3], [4], [5]. Several actions regarding climate protection, such as cutting the greenhouse gas (GHG) emissions by 50% by 2030, represent challenges for cruise corporations, but also a clear pressure to "renewed commitment" toward sustainability [17], [18]. Climate engagement and growth of sustainable awareness are the main issues to address in achieving SDGs,

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which can be substantiated in operational practices described to waste management on-board ships. Hence, on the one hand, the commitment to climate protection and conscience about sustainability represents an evident pressure for cruise corporations. On the other hand, digital technologies are seen as enabling factors in an environment that is increasingly aware of the issues of sustainability. Therefore, in this game between stakeholders toward sustainability, companies need to be constantly legitimized regarding their behaviors, in particular on the waste management process and the enabling technologies toward sustainable processes, i.e., sustainable waste management on-board ships [3], [2], [3], [4], [5], [6], [7], [8], [9]. If, on the one side, the commitment to climate protection and conscience about sustainability represents an evident pressure for cruise corporations; on the other side, digital technologies are seen as enabling factors in an environment that is increasingly aware of the issues of sustainability. In this game between stakeholders toward sustainability, companies need to be constantly legitimized regarding their behaviors, mainly on the waste management process and the enabling technologies toward sustainable processes, i.e., sustainable waste management on-board ships. In this perspective, cruise corporations have rushed to "tell" their commitment to the climate and, more generally, to environmental, social, and economic sustainability [1], [2], [3], [4], [5]. Thus, sustainability reporting becomes a marginal tool in the relationship between the cruise corporations and the other stakeholders to a key tool for obtaining legitimacy regarding one's reputation linked to being involved in protecting the environment [19].

Corporate social responsibility (CSR) disclosure to stakeholders about sustainable waste management practices increases cruise corporations' trustworthiness [20]. Halkos and Nomikos [19] focused on the study of Nielsen and Thomsen [21] about CSR practices to highlight that the firms aim to legitimacy implement practices fitting with stakeholders' needs. Several frameworks are proposed to present the nonfinancial disclosure of firms. Halkos and Nomikos [19] introduced United National Global Compact, International Standards Organization 26000, and Global Reporting Initiative (GRI) to establish principles related to the transparency of nonmandatory reporting. However, although great strides have been made, guidelines on sustainability disclosure have not yet been fully enacted. A still-weak disclosure regulatory framework does not facilitate the potential that sustainability reporting can assume for a wide audience in recognizing CSR, expressly when digital technologies can be the enabling factor for the pursuit of sustainability and the goals included in the UN 2030 Agenda. Although the need to manage the impact of waste processes on the environment and the social dimensions of sustainability has been widely recognized [7], [8], [9], [10], along with the close relationship between digitalization and sustainability [22], [23], these issues are still underinvestigated in the cruise management literature. Likewise, little attention has yet been paid to how the contribution of business organizations to SDGs can be translated into best practices [24].

Based on the issues introduced here, under the lens of CSR framework and legitimacy theory, this study analyzes the enabling role of digital technologies for sustainable waste management in the cruise industry toward the UN 2030 Agenda. This study seeks to reply following research questions (RQs):

(RQ1): What are the waste management practices adopted by major cruise corporations?

(RQ2): Which technologies have been adopted in the waste management practices by major cruise corporations to meet the UN 2030 Agenda?

The research design starts with an in-depth review of the literature on the CSR framework supported by the legitimacy theory, as well as the role played by digital technologies in the operational processes on-board cruise ships for waste management process in the sustainability perspective. The next step of the design consists of the content analysis of sustainability reports published from 2015 to 2019 by four major cruise corporations, as well as their website pages, using an automated-Leximancer software and a manual content analysis. The results evidence a clear awareness of cruise corporations' necessity to invest in digital and green technologies to reduce the environmental impact of their activities while meeting SDGs. The investments are mainly intended to reduce GHG emissions, replace plastic products with biodegradable alternatives, and change from carbon-fueled to liquid natural gas (LNG) ships. However, the real impact of sustainable initiatives and investments in digitalization and new technologies on economic, environmental, and social performance does not emerge clearly from the sustainability reporting of the sample.

This study contributes to academic research and practice in several ways. First, it extends the cruise literature evidencing the role of digital technologies and green practices in the waste management processes as drivers to reduce the negative effects on the environmental and social pillars. Through the analysis of sustainability reporting about the digital technologies adoption in the waste management processes on-board cruise ships, this study highlights interesting issues jointed to waste processes to get sustainable practices, e.g., the financial investment in digital technologies. Additionally, this study highlights that although legitimacy theory is an of the most common theories supporting CSR disclosure, it is not enough to understand innovation processes. Likewise, this study can help the practitioners with several issues. In more detail, the conceptual map about sustainable waste practices disclosure through sustainability reporting and websites becomes the enabling factor in getting the legitimacy of stakeholders. Moreover, the need to adopt programs to involve cruisers in waste processes becomes the first solution to educate on sustainable behavior on-board ships. To the best of the authors' knowledge, this study represents the first time an empirical analysis conducted through sustainability reporting and other nonfinancial documents allows to identify "best practices" adopted on-board cruise ships to meet sustainability goals in digital waste management. Moreover, the use of two levels of analysis, by Leximancer and manual content analysis about the text documents companies make available to stakeholders allows for identifying the high-level concepts and key ideas without bias, well as being able to define the perimeter

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of good practices linked to the orientation of cruise corporations toward new technologies.

The rest of this article is organized as follows. Section II introduces the theoretical background. Section III describes the research design and methodology. Section IV analyzes the findings. Section V presents the discussion of results and academics and managerial implications of the study. Section VI concludes this article.

II. Theoretical Background

A. CSR Disclosure, Practices, and Sustainability Reporting

CSR is a multidimensional concept to describe the business's willingness to integrate societal and environmental problems into their core business strategy to mitigate their potential negative impact on society and the environment. Some scholars discussed environmental management (EM), introducing the concept of EM practices as the pillar of sustainability management; this means activities and resources management for preserving the natural environment; therefore, all initiatives of EM influence the interest of firms in involving their own CSR activities to preserve natural environment [25], [26]. Hence, the practices and the initiatives under the lens of the CSR framework assume obligations and commitment for business organizations to behave according to predefined patterns toward the action included in the sustainability plan. Thus, the practices enable the enhancement of CSR legitimacy [25]. Legitimacy theory suggests that when there is a discrepancy between corporate actions and societal expectations, management employs disclosure media (e.g., sustainability reporting) to mitigate public concerns highlighting that the corporation is finally meeting community and societal expectations [27]. CSR disclosure can be used to determine the extent to which social responsibility meets stakeholders' expectations and "hypothesize on the reasons for the patterns found" [2]. After all, legitimacy results in stakeholders' perception of the actions and behaviors of companies toward social beliefs and current regulatory frameworks [28]. The growing public awareness of sustainability issues has increasingly pushed cruise companies to adopt sustainable practices and disclose the outcomes through their sustainability reporting and websites [5], [6], [7], [8], [9], [10], [11], [12], [13], [14], [15], [16], [17], [18], [19], [20], [21], [22], [23], [24], [25], [26], [27], [28], [29], [30]. Thus, cruise companies provide information about economic, environmental, and social issues, especially activities and initiatives implemented in the organizations, trying to state their ability to create value for themselves and society [31], [32].

Some scholars [33], [34], [35] highlighted that since 2015 business organizations started to include the SDGs in their corporate sustainability strategies, as well as in their corporate reporting to evidence their commitment toward UN 2030 Agenda. Nevertheless, sustainability reporting will likely help firms define their sustainability strategy to integrate their principles into their business practices [36]. Likewise, some scholars discussed the positive impact of sustainability disclosure on corporate performance [37], [38]. According to this new approach to the sustainability goals, GRI, and UN Global Compact (2018) have suggested a guideline for facilitating firms to measure sustainability performance, as well as to clarify the sustainability reporting actions and initiatives adopted by the firms toward SDGs [34].

However, there is skepticism about the real effectiveness of the actions declared by business organizations, mainly undertaken to achieve the SDGs [39], [40]. Scholars have doubts about sustainability reports' reliability, comparability, and content [41], [42]. Firms might use sustainability disclosure as a managerial tool for promoting their brand and services and define these tools as "window dressing" [35]. Previous studies found that cruise companies tend to overreport immaterial questions and underreport material issues, disclosing more management than performance data without meeting stakeholders' needs [43], [44]. Although sustainability reporting is still broadly discussed regarding the quality of disclosure, as well as the transparency and accountability of the practices related to the actions and initiatives adopted by the firms, its role in the business–stakeholders relationship cannot be overlooked, and it is essential for business organizations that wish to be legitimized in their environment [45].

B. Sustainability in the Cruise Industry Through Waste Management On-Board Ships

The cruise industry is currently acknowledged as one of the most polluting industries, producing approximately 4000 ton of gray water, 800 ton of black water, and 80 ton of solid waste and slime [46]. This searches for green solutions for fast and effective waste management systems on-board an urgent issue to be afforded by sustainable cruising [22]. Cruise ship-generated waste issue has attracted greater attention after the changes to Annex V of MARPOL Convention 73/78, operative starting from March 2018, that distinguished wastes harmful to the marine environment (HME) and nonharmful (non-HME). Cruise ships are floating cities producing several types of wastes and polluting substances that require different treatment methods and appropriate technologies before being discharged into the sea or disposed of on shore to reduce the economic, environmental, and social impact of cruise ship activities [2]. This entails not only the necessity to minimize the volume of waste produced on-board but also to create a waste management system between on-board and on-shore to avoid ships being discouraged from delivering their waste to ports [47].

The first stage of the solid waste management cycle involves waste separation by trained crew members. Recyclable materials like plastics, glass, metal, and paper/cardboard are separated and pressed together, forming large bales that will be disposed of on shore. Instead, food waste is considered biodegradable and nonharmful, and current regulations still allow the sea-disposal at 12 nautical miles from the coast [13]. The food waste separation on-board is not strictly governed, so each maritime company decides how far beyond the minimum requirements to go [48]. The space on cruise ships is limited, and it should be optimized and its weight to reduce fuel and energy consumption, so modern ships are equipped with on-board incinerators. However, waste incineration is not a zero-impact solution since the resulting ashes, gas emissions, and associated compounds need to be adequately managed to reduce air and water pollution. On the

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other side, ships can reduce the solid waste generated by different strategies, e.g., purchasing in bulk, encouraging suppliers to efficient packaging, reusing packaging when possible, and using more environmentally friendly packaging materials [49]. Butt [50] evidenced that the pressure on the environment determined by cruise waste, especially on ports, requires, the cruise ships, a strict waste reduction program, and the implementation of adequate waste management facilities. Mohee et al. [51] evidenced that the waste generated by ships is regarding not only the port area but also the cities that receive the solid waste from ships, suggesting the adoption of specific solid waste management plans for ports and an environmental policy to reinforce the commitment between cities governments and port authorities. Hence, the effectiveness of the waste management cycle will strongly depend on the facilities available onshore and the waste management regulation in the cities [52]. Thus, the prevention of ship-source pollution is reliant on the provision of adequate port reception facilities for the discharge of wastes [53], and that sustainability challenge may not be won if all the parties will not collaborate [4]. Under the CSR framework, cruise companies' commitment to the waste management processes on-board is joined to their environmental consciousness and awareness, which define the different waste practices [47]. Hence, the cruise industry, as well as more general, the tourism industry, to be compliant with sustainability oblige needs to be involved and committed to CSR activities, especially waste activities, to allow CSR framework to be the lifeblood of corporate strategy to improve the CSR legitimacy [25].

C. Digitalization of Waste Management Processes and Environment Practices On-Board Cruise Ships

In the 21st century, introducing digital technologies within any business process has become a prerequisite for companies to compete in the market and improve their economic and financial performance [54]. However, the adoption of digital technologies such as big data, the Internet of Things, artificial intelligence, and business processes alone is not enough for a digital transformation of the business. Likewise, the integration of digital technologies introduced in the single modules of processes identifies the "digitalization" [55]; hence, digital technologies are progressively playing a significant role in enhancing sustainability [23], [24], [25], [26], [27], [28], [29], [30], [31], [32], [33], [34], [35], [36], [37], [38], [39], [40], [41], [42], [43], [44], [45], [46], [47], [48], [49], [50], [51], [52], [53], [54], [55], [56].

Some scholars highlighted a positive relationship between digital technologies, circular economy, and SDGs [57], [58], [59]. Gallo et al. [60] identified the relationship between digitalization in waste management on-board ships to get sustainability; specifically, the authors highlighted four best practices. First, for waste from plastic, the practice is the grinding and treatment for future use of 3-D printers, gadgets, and the production of items; second, for waste from paper, the practice is the increasing of digitalization in the information sharing implies the decreasing of paper; third, for waste from glass the solution is the replacement with dispenser and reusable bottles; and finally, for waste from packaging the practice is to reduce the packaging activities. Hence, digital technologies can support cruise corporations by addressing environmental and social sustainability goals, reducing emissions and waste production and its reuse in multiple efficient ways to reduce the environmental impact of the giants of the ocean improving resource efficiency [57], [58], [59], [60], [61].

Wang et al. [61] created an algorithm to help the cruise industry identify the best scale for waste disposal, thereby reducing cost. Technology innovations offer greater possibilities for managing ships' entire waste chains, from on-board production to final disposal [62]. Barone et al. [63] highlighted how using specific technologies to recover energy from waste combustion could reduce the costs of ships and their environmental impact. Finally, Vujičić et al. [64] evidenced the possible contribution of "distributed ledger technology," better known as blockchain technology, for the monitoring, recording, and measuring of wastewater overboard discharge as well as preventing any possibility of illegal actions and falsification of documents.

As increasingly shown in the recent literature [22], digitalization and green technologies can support any phase of the shipping waste management cycle, encouraging the operators to adopt new sustainable business models to meet the UN 2030 Agenda. Furthermore, in the long period, digitalization positively affects companies' reputations and profits [65], [66]. Hence, it should also understand the cost of engineering processes to achieve disposing of waste practices as best practices. In this direction, it is relevant to establish strategic partnerships between cruise corporations and stakeholders, especially the cruise community on-shore [67]. Even in competitive markets, like the cruise industry, where business profitability and growth strategies prevail, companies can increase their sustainability by reducing negative externalities and stakeholder pressures, thanks to technological innovation.

III. Research Design and Methodology

A. Content Analysis

A systematic content analysis of cruise corporations' major disclosure sources was undertaken. It seeks to identify the main environmental practices of waste management on-board ships adopted by cruise corporations and the related digital technologies enabling SDGs. Content analysis is one of the most widely used methodologies in the study of corporate communications, particularly in sustainability disclosure [68]. Content analysis allows us to investigate the overall content of the communication [69] and count the number of words or sentences focusing on a specific topic. Content analysis is a research method employed to systematically review sustainability reports published by maritime organizations (i.e., usually named "CSR" or "sustainability reports") and enable the authors to analyze and assess, from a qualitative side (i.e., labeling/coding), their content [70]. Both automated and manual content analysis were used in the present study; findings obtained were crossed with other sources, e.g., annual reports and articles, to increase the overall analysis validity and reliability.

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As a matter of fact, Leximancer software was used to analyze the sustainability reports published by the Carnival Corporation, Royal Caribbean Group (RCG), Mediterranean Shipping Company (MSC) Cruise, and Norwegian Cruise Line (NCL) from 2015 to 2019 and their website pages. Leximancer software (ver. 5.0) was used to carry out an automated content analysis of the documents collected, which uses a high level of proximity values for text natural language processing analysis to identify concepts in the text data and to map themes [71]. The Bayesian theory could analyze the texts using an unsupervised method to classify the word frequency as concepts and their associations [71]. "Fragmented pieces of evidence" in a data set "can be employed to predict what is happening in a system," according to Watson et al. [72, p. 1233]. Leximancer outputs in visual demonstrations and themes can be color-coded, with brightness indicating the importance of themes, according to Angus et al. [73]. If the concepts are closely mapped, they have a clear semantic relationship [74]. The interactive concept-mapping function in Leximancer software aids researchers in interpreting the conceptual structure. The visual map depicts how concepts are linked and offer a conceptual overview of the data. We used Leximancer to evaluate the entire data set and map out the data's overall semantic landscape. This allowed us to obtain a conceptual map to create a cluster of concepts from the most commonly occurring concepts in the texts and the key themes of documents [75]. For this study's specific purposes, Leximancer provided a mechanism for generating and identifying themes, including those that might have been otherwise missed or overlooked as data had been manually coded. Using the themes derived by the software, data have been engaged directly to explore further and interpret the text meanings [76]. Since Leximancer software does not allow the analysis of the sentences' textual logic (the meaning of the sentences), we also conducted a manual content analysis of sustainability reports to analyze the practices and new technologies implemented explicitly for waste management processes to meet SDGs. The keywords selected for defining disclosure items in our research were: "waste," "food," "wastewater treatment," "plastic," "circular economy," "digitalization," "technolog∗," "sustainable development goal∗," "SDG∗," "SDG12," "sustainable initiatives," "social initiatives," and "environmental initiatives." We analyzed pairs before coming together to compare the results and work on the discussion. All the sentences, including these keywords, were analyzed to understand the technologies and practices adopted to improve social and environmental sustainability waste management processes, highlighting all the specific SDGs. All the technologies and initiatives implemented for each SDG are synthetically reported in Table V. These include all the most advanced technologies and sustainable initiatives implemented by the companies until now to meet the SDGs. This allows us to understand the current implementation of technologies for waste. Findings have been confirmed by other data sources [3] and used to validate and strengthen the reliability of this study.

B. Sampling

We selected four major groups in the industry—Carnival Corporation, RCG, MSC Cruise, and NCL—representing about 80% of global passengers and revenue income [77]. Carnival Corporation, founded in 1972, is one of the largest leisure travel companies. The group's fleet consists of around 100 ships, visiting over 700 ports worldwide, totaling 254 000 lower berths (http://www.carnivalcorp.com). RCG, founded in 1997, represents the second largest group in the industry. It manages 60 ships overall, with an aggregate capacity of about 135,520 berths, offering cruises all over the globe (https://www.royalcaribbeangroup.com). MSC Cruise is a subsidiary of MSC Group, which is an independent group with two specific divisions, MSC cargo, and MSC passengers. The latter includes cruise (MSC Cruise) and passenger ferries and high-speed vessels (Società Navigazione Alta Velocità and Grandi Navi Veloci). MSC Crociere S.p.A. manages a fleet of 19 cruise ships (https://www.msccruises.com). NCL, founded in 1966, is a leading global cruise company with a portfolio of three world cruise brands. The group's fleet consists of 28 cruise ships (http://www.nclhltd.com).

C. Data Collection

Data collection and analysis were conducted in four steps. First, a systematic online search collected official nonfinancial documents and sustainability reports published by the investigated cruise corporations from 2015 to 2019. Second, an in-depth analysis of the companies' websites was performed to outline the content and type of information provided on sustainable performance, particularly waste management, to determine whether their business models and practices meet the SDGs, particularly SDG12. Third, between 2015 and 2019, we performed an automated content review and collected data from 18 sustainability reports, including 37 website pages related to waste management, published by the four sampled corporations.

Fourth to identify the waste management reporting, a focus group with four experts in waste management was organized to determine the link between the new technologies used in waste management in the cruise industry to meet SDGs. The expert group identified the following keywords: waste; environmental; sustainability; and technology. These keywords were used to search the Carnival Corporation, RCG, MSC Group, and NCL websites. In addition, concepts in Leximancer are collections of keywords that generally travel together throughout the text. Keywords are weighted so that the presence of each word in a sentence provides an appropriate contribution to the accumulated evidence for the presence of a concept. Leximancer allows for more specific queries involving concepts and the raw terms (keywords) within the source documents. We chose reports focused on new waste management technologies. A content study demonstrates how concepts in emerging technology for waste management have evolved for sustainable business models from 2015 to 2019. Table I summarizes the year-by-year distribution of selected sustainability reports, indicating that 2015 was not incredibly prolific. The sustainability reports percentage refers to the number of reports classified under the research subject in this study from 2015 to 2019.

For this study, a total of 18 sustainability and 37 website pages were listed. As in Watson et al.'s research [72], we used the Leximancer text-mining program to better map the themes

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TABLE I
SUSTAINABILITY REPORTS OF CARNIVAL CORPORATION, RCG, MSC GROUP, AND NCL

Years	Cruise Corporations	Number of Sustainability Reports	Percentage of Reports
2015	Carnival Corporation, RCG, MSC Group and NCL	2	11.11
2016		4	22.22
2017		4	22.22
2018		4	22.22
2019		4	22.22
Total		18	100.00
Number of Website pages		37	-

and concepts, using the visual concepts set to understand the targeted data. We conducted the Leximancer analysis for all the companies together and each company analysis. In addition, we conducted a separate analysis for the website pages reported in the sections below.

Then, we conducted the manual content analysis on the sampled cruise companies' sustainability reports published in 2019, which allowed us to understand the status of the technologies implemented. The second level of analysis has been conducted exclusively on sustainability reporting published in 2019. During 2015–2018, a cruise corporation of our sample, that is MSC cruise, published sustainability reporting related to the shipping and cruise business in a single document. The role of digital technologies has been very detailed for the shipping business and more residual for cruises; hence while this issue does not have significant relevance to getting and analyzing the concept maps, it can create a bias in manual mapping and analysis of practices. The choice of 2019, the last year of the selected period range, does not affect the whole analysis. This is because the high investments in digital technologies do not undergo substantial changes in terms of practice disclosure from one year to another.



Fig. 1. Thematic map of sustainability reports of Carnival Corporation, RCG, MSC Group, and NCL during the period 2015–2019.

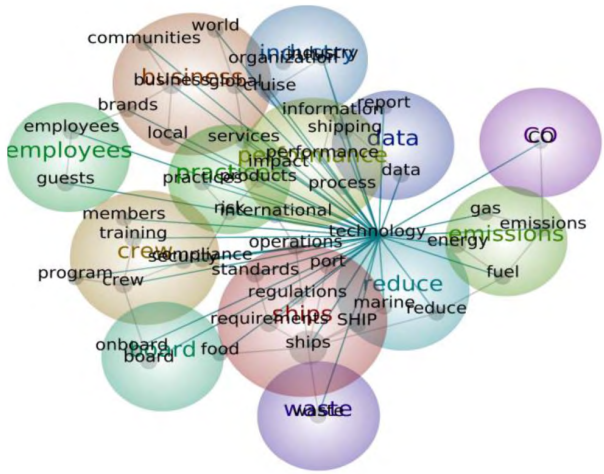


Fig. 2. Concepts map of sustainability reports of Carnival Corporation, RCG, MSC Group, and NCL during the period 2015–2019.

IV. FINDINGS

A. Theme and Concepts

Leximancer was used to build a cluster of concepts from the most commonly occurring concepts in the texts and the key themes of the sustainability studies [75]. From the 18 sustainability reports, Leximancer produced 48 concepts and 13 themes. The nine themes are ships, sustainability, environmental, emissions, performance, reduction, waste, technology, and CO (see Table II and Figs. 1 and 2). We omitted generic terms (e.g., analysis, method, findings, analyzed, document, suggest, and shows) and common function words (e.g., not or and) because they are widely used in reports and add value to the concepts chart.

We also combined the majority of singular and plural terms, such as value/values and use/uses, since these meanings are semantically similar. Notably, the most common concepts are themes that are connected to a community. The number of hits and connectivity for each theme indicates the number of text excerpts relevant to concepts, and connectivity indicates each theme's relative significance [78], [79]. We analyzed the conceptual map for a detailed view of the relationships among the key themes [80] that the reports emphasized, namely, ships, environmental, emissions, sustainability, regulations, waste, and performance, after analyzing and evaluating the created concepts and themes (see Table III). The ship theme is linked to concepts such as ships, requirements, regulations, standards, and operations port [42]. The idea of waste is related to concepts such as employees and the public [81]. The connectivity rating indicates the themes' relevance (the most important is the top theme at 100%). Since it is connected to emissions, fuel, oil, and gas, our research's most prominent theme is the ship, with the most relevant term related to emission issues.

B. Concepts Linked to New Technologies and Waste Management

As per the Leximancer review, the three main themes (ships, technology, and emission) created many concepts. Although not explicitly emerging as a trend, several studies examined environmental concerns in the cruise industry [82], [83]. Nonetheless, the semantic review indicates emerging technologies play an increasingly important role in waste management (see Tables

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TABLE II
THEMES AND CONCEPTS IN SUSTAINABILITY REPORTS OF CARNIVAL CORPORATION, RCG, MSC GROUP, AND NCL

All companies with Concepts 0% and Theme size 33%				*All companies with Concepts 100% and Theme size 33%*			
Theme	**Hits**	**Connectivity**	**Concepts**	**Theme**	**Hits**	**Connectivity**	**Concepts**
Ships	2645	2480	ships	**Ships**	7270	32162	ships, requirements, regulations, standards, operations, SHIP, port
Sustainability	1676	2243	sustainability, regulations	**Business**	3714	18215	business, cruise, communities, global, local, world, brands
Environmental	1639	1904	environmental	**Crew**	2266	12978	crew, training, compliance, security, members, program
Emissions	1075	1143	emissions	**Performance**	2181	11190	performance, international, information, impact, shipping, process
Performance	536	1016	performance	**Emissions**	1643	8746	emissions, fuel, energy, gas
Reduce	440	677	reduce	**Practices**	1195	7183	practices, services, risk, products
Waste	578	586	waste	**Employees**	1442	5364	employees, guests
Technology	278	404	technology	**Board**	1087	4400	board, on-board, food
CO	314	230	CO	**Reduce**	1028	4363	reduce, marine, technology
				Industry	875	3271	industry, organization
				Data	726	3263	data, report
				Waste	578	1779	waste
				CO	314	531	CO

TABLE III
MOST FREQUENT CONCEPTS

Concept	**Count**	**Likelihood (%)**	**Concept**	**Count**	**Likelihood (%)**	**Concept**	**Count**	**Likelihood (%)**	**Concept**	**Count**	**Likelihood (%)**
Ships	2645	100	**Reduce**	440	17	**Gas**	20	6	**Gas**	20	6
Favorable	1819	69	**Co**	320	14	**Impact**	22	6	**Impact**	22	6
Environmental	1639	62	**Technology**	278	11	**Industry**	32	6	**Industry**	32	6
Emissions	1124	46	**Unfavorable**	288	11	**Shipping**	20	6	**Shipping**	20	6
Sustainability	1164	44	**Fuel**	46	8	**Global**	32	5	**Global**	32	5
Regulations	598	23	**Training**	46	7	**International**	24	5	**International**	24	5
Waste	578	22	**Cruise**	52	6	**Port**	26	5	**Port**	26	5
Performance	536	20	**Food**	20	6	**Practices**	25	5	**Practices**	25	5

TABLE IV
THEMES AND CONCEPTS IN SUSTAINABILITY REPORTS OF INDIVIDUAL COMPANY

1) Carnival Corporation with Concepts 100% and Theme size 33%				**2) RCG with Concepts 75% and Theme size 33%**			
Theme	**Hits**	**Connectivity**	**Concepts**	**Theme**	**Hits**	**Connectivity**	**Concepts**
Environmental	2500	22143	environmental, safety, health, security, program, training, performance, compliance, practices, information	**Sustainable**	584	5321	sustainable, sustainability, WWF, conservation, work, global, ensure, partnership, support, business, health, safety
Ships	3048	16344	ships, Carnival Corporation, operations, port, marine	**Guests**	674	4682	guests, communities, destinations, employees, practices, local, destination, operations, environment
Requirements	1741	11046	requirements, management, regulations, standards, board, international, data, reporting	**Ships**	521	3136	ships, management, environmental, including company
Cruise	1548	10721	cruise, COMMITMENT, COMMUNITY, industry, global, world	**RCL**	435	2887	RCL, cruise, year, on-board, food
Business	1689	8794	business, brands, guests, organization, experience	**Emissions**	369	2735	emissions, data, energy, information, GHG
Sustainability	1293	6851	SUSTAINABILITY, impact, local, maritime, WKH	**Water**	186	1694	water, ship
Use	997	5045	use, emissions, gas, vessels				
Employees	780	4277	employees, crew, members				
Water	904	4227	water, waste, systems				
Fuel	303	963	fuel				
LNG	205	820	LNG				
Process	131	462	process				
3) MSC with Concepts 100% and Theme size 33%				**4) NCL with Concepts 100% and Theme size 33%**			
Theme	**Hits**	**Connectivity**	**Concepts**	**Theme**	**Hits**	**Connectivity**	**Concepts**
MSC	1142	11830	MSC, shipping, environmental, use, systems, sea	**Ships**	325	3253	ships, ship, fuel, provide, year, operating, technology, technology, management
Safety	671	10030	safety, ensure, management, standards, training, crew, health	**Cruise**	230	2870	cruise, crew, guests, including future, global, destinations, ability
Ships	650	9189	ships, vessels, cargo, efficiency, performance, ship, fleet, reduce	**Environmental**	390	2807	environmental, NORWEGIAN, program, reduce, impact, operations, fleet, training, company
Global	645	7838	global, world, countries, trade, services, sustainable, sector, economic	**Water**	250	1670	water, board, WATER
Business	730	7810	business, development, local, social, support, people, activities, challenges	**Use**	159	1091	use, emissions, vessels
Employees	280	3582	employees, work	**Environment**	53	942	environment
				Waste	93	766	waste, plastic
				Energy	92	641	energy, on-board

III and IV). The environmental concept was listed 1639 times in research linked to other concepts, with a 62% likelihood (i.e., referring to events that have a fair chance of occurring), giving it the third-highest occurrence and likelihood values behind pollution and results. Table IV presents the individual semantic analysis of companies and thematic maps of the sustainability reports of all the selected companies presented in Table I. We can observe that all the companies have common themes and concepts. Fig. 2 shows the concept analysis of the sustainability reports, and Fig. 3 introduces the concept analysis of the website pages.

C. New Technologies, Digitalization, and Sustainable Initiatives Adopted by Cruise Companies

The manual content analysis of sustainability reports evidenced an increasing awareness of the cruise corporations to their sustainable reputation and image. In their reports, they declare to be strongly committed to the UN 2030 Agenda and the reports published in the last years make explicit reference to the new technologies and sustainable initiatives undertaken to improve SDGs. The sustainability director of Carnival Corporation declared, "Our entire management team, including our Boards of Directors, is committed to addressing climate change and our path to decarbonization" [84, p. 8]. She also listed several technologies they would implement on their ships in "alignment with the UN 2030 Agenda." That decarbonization appeared to be a crucial issue looking at the words of the Executive Chairman of MSC, that state "Our ultimate goal is to build zero-emissions ships," but it was also evident how this goal could be hard to be achieved: "This is why, while we work on the development of new technologies that will allow this, we have decided to bridge the technology gap by compensating for our ships' emissions through investing in carbon offsetting projects." [85, p. 4]. NCL,

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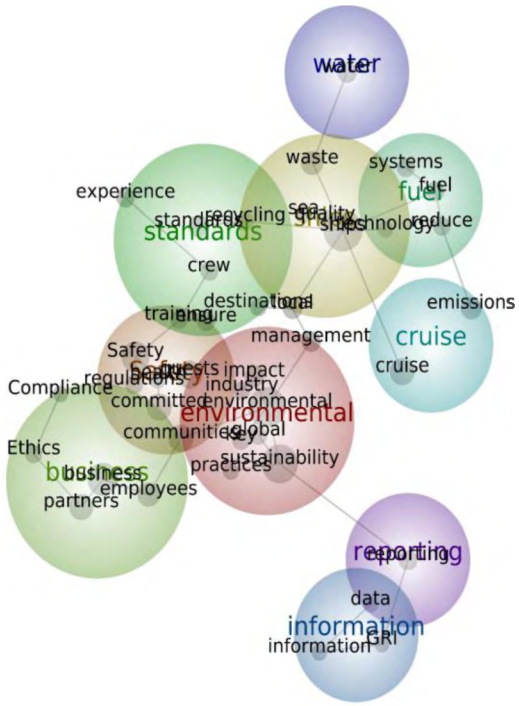


Fig. 3. Concepts map of sustainability reports of website pages.

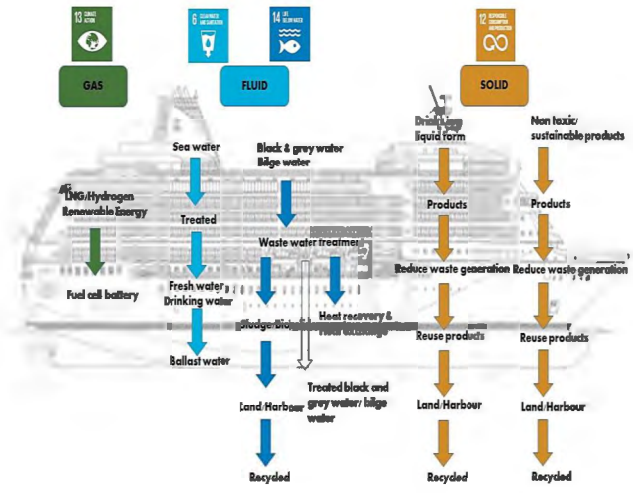


Fig. 4. Technologies used by cruise corporations to manage waste on board.

unlike the other companies, did not make any specific reference to SDGs. Still, their awareness about the use of technology for reducing the impact of their vessels was yet evident: "Our Company is committed to reducing on-board waste, both from food and wastewater, through innovative technologies, staff training and implementing stringent recycling programs" [86, p. 49]. "One innovative technology our ships use to decrease exhaust emissions is an Exhaust Gas Cleaning System (EGCS)" [86, p. 44]. As evidenced by Fig. 4, cruise corporations are progressively adopting multiple practices and equipping their ships with advanced digital technologies to manage the several types of cruise waste produced (i.e., gas, fluid, and solid). Cruise ships cannot utilize energy grids, and renewable energy sources such as solar and wind power are insufficient to meet their energy needs. The cruise industry has developed technologies and operational practices to minimize garbage disposal and environmental consequences. The cruise industry is aggressively pursuing this technology and requesting port authorities to make the necessary infrastructure improvements.

Table V shreds of evidence connections between SDGs and technologies. Extending digital and technological innovations to every ship is likely to allow improving environmental sustainability for sustainable cruising.

In greater detail, cruise companies replaced all nonessential single-use items and plastics, like straws, cups, lids, stir sticks, cocktail picks, toothpicks, butter foils, and plastic shopping bags with sustainable alternatives to meet SDG12 requirements. Following a circular economy strategy, they were investing in the search for materials that can break down rapidly and establishing partnerships with companies operating in the recycling industry and charitable associations to donate items on the ships, like pillows, mattresses, or sheets that are still in excellent condition to be reused, improving their environmental status and social sustainability. Furthermore, the Carnival Corporation established partnerships with local charitable associations to donate surplus food, thus enhancing its social sustainability. To reduce the impact of food waste on marine and coastal ecosystems (SDG14), Carnival Corporation and NCL equipped their fleets with food bio-digesters. This green technology uses an anaerobic digestion process and efficiently breaks down food particles. However, the current technology still does not entirely avoid landfill disposal and incineration, even in small amounts.

To reduce water pollution with the purpose of meeting SDG14 requirements, all the cruise corporations have installed advanced wastewater purification and ballast water treatment systems to clean wastewater by mechanical filtration ultraviolet light and chemical treatment before it is returned to the sea. NCL and RCG ships are also equipped with oily water separators technology, which automatically stops discharging if the bilge water does not meet established requirements. To reduce water consumption and meet SDG6, all companies are progressively adopting freshwater production plants turning seawater into drinking water through desalination and reverse osmosis technology and advanced wastewater treatment system. All the companies in 2019 self-produced more than 80% of their fresh water, and up to 90% in the case of RCG. Freshwater on RCG ships is also produced thanks to evaporators that use heat sources, such as exhaust gas boilers, oil-fired boilers, or waste heat recovered from the main engine's high-temperature cooling system.

All the cruise corporations highlight themselves as being particularly sensitive to the need to reduce gas emissions and improve energy efficiency, equipping their ships with advanced technological solutions to meet SDG3 and SDG13. Finally, cruise companies have equipped their ships with an EGCS, which significantly reduces the sulfate compounds and particulate matter, including exhaust black carbon resulting from engines, by 98%. The Carnival Corporation, RCG, and the

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TABLE V
TECHNOLOGIES AND SUSTAINABLE INITIATIVES IMPLEMENTED BY ALL CORPORATIONS TO MEET SDGS

SDGs	Interlinkages	Technologies and Sustainable Initiatives	Cruise Corporations			
SDG13	SDG3	Exhaust Gas Cleaning System (EGCS)	CARNIVAL	RCL	MSC (2)	NCL
SDG13	SDG3	Selective Catalytic Reduction System (SCRS)	CARNIVAL	RCL	MSC	NCL
SDG13	SDG3	Waste Heat Recovery (WHR)	CARNIVAL	RCL	MSC	NCL
SDG13	SDG3	Smart HVAC			MSC	
SDG13	SDG12	Software That Supports Trim Stabilizer to Reduce Fuel Consumption			MSC	
SDG13	SDG12	Liquid Natural Gas (LNG)	CARNIVAL	RCL*	MSC*	
SDG13	SDG12	Fuel-Cell Technology	CARNIVAL		MSC*	
SDG13	SDG12	Battery Technology	CARNIVAL		MSC*	
SDG13	SDG3	Ready For Ship to Shore Power /Cold Ironing	CARNIVAL	RCL	MSC	NCL
SDG6		Self-Production of Freshwater on Board Via Desalination or Reverse Osmosis	CARNIVAL	RCL	MSC	NCL
SDG6		Reduction Of Average Guest Daily Water Consumption on Board	CARNIVAL	RCL		
SDG6		Condensation From Air Conditioning Units Collected and Used in Laundry Areas		RCL		
SDG14		Advanced Wastewater Purification Systems (AWPS)	CARNIVAL	RCL	MSC	NCL
SDG14		Ballast Water Treatment Purification	CARNIVAL	RCL	MSC	NCL
SDG14		Oily Water Separators (OWS)		RCL		NCL
SDG12		Reduction Of All Non-Essential Single-Use Items and Plastics	CARNIVAL	RCL	MSC	NCL
SDG12		Food Waste Bio-Digester	CARNIVAL			NCL
SDG12	SDG2	Food Donation To Poor	CARNIVAL			
SDG12	SDG2	Donation of Items from Ships Can Help Support Communities While Also Mitigating Waste	CARNIVAL		MSC	NCL
SDG11	SDG2	Donations to Communities, Especially Those Involved In Environmental Disasters	CARNIVAL		MSC	NCL

MSC Group also implemented a selective catalytic reduction system to reduce the nitrogen oxides (NOx) from their ships' exhaust by up to 90% by transforming it into harmless nitrogen and water. Also, to reduce the emissions in ports, all the sampled corporations have equipped their ships with the cold ironing/shore power technology (CISPT), which allows them to switch off their engines when they are stationary on the quay powering the ships with electricity supplied from the land. However, the current limit of these technologies is that there are still only a few ports with these facilities.

To meet SDG13, all the corporations have equipped their ships with waste heat recovery technologies that allow them to recover heat from the engines and transfer it to freshwater piping, thus using a free energy source to improve water production and save fuel. In addition, the MSC Group is equipping its new ships with smart heating, ventilation, and air conditioning systems that self-adjust according to the weather and how many people are on-board, and heat recovery loops to redistribute heat and cold from the laundry room and machinery spaces to warm up the swimming pools and other parts of the ship. The MSC Group declares to be particularly committed to reducing fuel consumption, rethinking the new ships' overall structure, deck space, and weight distribution to achieve optimal hydrodynamics and aerodynamics, as well as to maximize energy and fuel efficiency, along with coating their hulls with special paint that slows the growth of marine organisms, reducing drag and improving energy efficiency. In the same vein, the MSC Group has also adopted the digital innovation of a trim stabilizer, a software application that monitors the ship's stability to support the deck officers in optimizing the vessel's trim. RCG uses tens of thousands of centralized data points to reduce its fuel usage by 4%. Finally, the search for investments in alternative fuels seems to be the next challenge for cruise corporations to meet SDG13. The Carnival Corporation, RCG, and the MSC Group also declare themselves strongly committed to replacing their carbon-fueled ships with LNG ships that reduce carbon emissions by as much as 20% compared with the same ship using conventional fossil fuels. However, this technology is currently used only in two Carnival Corporation ships, whereas the first MSC Group ship fueled with LNG will enter into service in 2022. MSC Group and Carnival Corporation are also investing and testing other advanced technologies, such as fuel battery cells, lithium-ion battery storage, and solid oxide fuel cell technology.

V. DISCUSSION

The analysis of cruise corporations' sustainability reports highlighted their awareness of sustainable development and new technologies' crucial role in meeting SDGs, with environmental and social objectives prevailing in their corporate values. Regarding the RQ1, this study outlines the waste management practices currently adopted by cruise ships, thus evidencing their complexity due to the several types of waste produced on board, most of which require incineration processes or landfill disposal.

Regarding the technologies adopted by cruise corporations to meet SDGs (which RQ2 is clearly focusing on), findings highlight that rising investments should be addressed to technologies likely to prevent and treat all kinds of waste, especially to reduce GHG emissions, through the use of syngas generators installed on modern ships and thanks to the transformation of waste into exploitable fuel. The creation of digital twinships, instead, may allow to focus on the optimum targets for all the machinery and equipment and provide the deck and engine officers with the support and advice they need, which might contribute to the reduction of fuel consumption. The analysis of sustainability reports evidenced a rising awareness of cruise companies to SDG13, probably due to the growing institutional pressure on achieving the Net-zero target by 2030. However, ships still release large quantities of nitrogen oxide (NOx) and sulfur oxides (SOx) into the air, especially during the docking, mooring, and unmooring phases [87]. Previous studies [22] highlighted the urgent need for investments in the ship–port interface segment otherwise equipping all fleets with CISPT technology or battery cell risks useless or ineffective. Despite the strong commitment to the achievement of the UN 2030 Agenda declared by cruise companies, the effective contribution of the technologies adopted in the direction of environmental and social sustainability goals could not be effectively measured, thus finally reducing the reliability of the information provided [30], [31], [32], [33], [34], [35], [36], [37], [38], [39], [40], [41], [42], [43], [44]. Though the outcomes achieved from waste practices are not yet fully measurable, this study evidences that cruise corporations are replying to the growing pressure

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of external stakeholders by releasing more information about the actions and initiatives, including digital technologies, to meet sustainability goals. To strengthen the reliability of the information provided, Carnival Corporation and RCL adopted the GRI disclosure framework that facilitates the stakeholders in understanding and benchmarking corporate responsibility performance.

Our study ranks among the studies analyzing sustainability disclosure in the cruise industry. Specifically, Geerts and Dooms [88] discussed the corporate social actions of five major cruise companies to improve their CSR through a content analysis of sustainability reports finding the high interest of corporations regarding the environment, ethics, and social issues. Di Vaio et al. [5] provided an analysis, through nonfinancial disclosure, on sustainability initiatives for achieving the SDGs in the maritime industry, highlighting some shortcomings in the corporate reporting system regarding the measures in the relationship between initiatives and SDGs. Di Vaio et al. [1] find that cruise corporations' behavior is toward sustainability initiatives meeting SDGs, mainly for corporate social performance. Also, Li et al. [11] took care to understand the CSR of cruise companies through la disclosure. The authors found CSR scores and indicator disclosures are mostly management indicators and many measures about the negative effects of practices have been neglected. Thus, CSR legitimacy is still at an early stage for the cruise industry's social and environmental effect responsibilities. Although these previous studies investigate major cruise players' initiatives, practices, and actions using the content analysis methodology; our study helps extend the questions analyzed by leveraging a factor enabling sustainability practices, such as digital technologies. Specifically, our study thanks to the double level of content analysis, first conceptualizes and then describes the waste practices on board ships supported by digital technologies. Furthermore, our study clarifies the relationship between waste practices and obtaining SDGs by trying to define possible on-board best practices that corporations declare through reporting to obtain CSR legitimacy.

Therefore, cruise corporations should differentiate themselves by going beyond compliance, building a reputation, and gaining competitive advantages [57]. Under the legitimacy theory lens, digitalization and innovation should enable sustainability practices in the waste management; therefore, the cruise companies could increase set measurable aims, "using novel approaches to report on their progress" [89, p. 7]. Linking technological innovation to the three sustainability pillars through a circular economy can benefit companies' sustainability and resilience to external shocks, like pandemic events [90], by gaining legitimacy. Finally, each organization should define its strategy to integrate technologies into its internal processes to improve its sustainability and contribute to the UN 2030 Agenda, enhancing its reputation and legitimacy.

A. Theoretical Implications

The academic implications of this study focused on identifying "best practices" through nonfinancial disclosure derived from the double level of disclosure analysis, under the lens of legitimacy theory. This study, by providing a concept exploration of the waste management process, digital technologies adoption, UN 2030 Agenda issues disclosed by the major cruise companies, and then an analysis of the practices, open the way to investigate the other problems through sustainability reporting. The first is the relationship between operational processes and financial investment in digital technology; the second is between issues and the regulatory framework. This allows us to understand the adoption of a single theoretical lens is not enough to understand best practices through corporate legitimacy tools, which is sustainability reporting. Hence, this study highlights legitimacy theory as the most commonly used theory for the analysis of CSR disclosure, but other theories should integrate it. For instance, diffusion of innovation to "explain how, why, and at what rate new ideas and technology spread," stakeholders theory to include in the analysis the interests of the other players of the maritime supply chain, and institutional theory, to also include the regulatory framework.

B. Managerial Implications

From a practical perspective, this study is valuable for cruise corporations required to implement sustainable practices to meet SDGs. Likewise, the implications for practice aim to get an effect on "present actions," and the theoretical framework and results allow to reply to the managerial knowledge needs [91]. The adoption of digital technologies on-board cruise ships for waste management processes can improve the cruisers behavior in meeting sustainability goals. This means the managers should also adopt a series of programs to address the behavior of cruisers on-board cruise ships in their relationship with waste issues. For example, to provide on-board cruise ships not only digital brochures that illustrate the phases of waste disposal or recycling but also try to organize events of short duration during the journey to share information on the use of digital technologies in individual processes, as well as share and develop "best practices" on the issues discussed. Cruise corporations should involve crew and cruisers more directly in waste management projects by organizing programs to raise awareness of waste reduction and reuse through informed use of technology. These may be just some of the practices cruise corporations should adopt on every ship in their fleet. The practices should then be clearly communicated in sustainability reporting, highlighting not only the technical aspects of the process but also the crew's involvement and especially of the cruise passengers. Likewise, sustainability is more a matter of conscience and responsibility of corporate practices, but also of consumer behavior, which is the cruiser. At the same time, this study underlines the further efforts required to enhance the credibility, reliability, and accountability of the information released by assessing specific performance measures and providing external assurance.

C. Avenues for Future Research and Recommendations

Despite the conclusion that cruise companies tend to explicitly declare their commitment to adopting sustainable practices to

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meet the UN 2030 Agenda, additional resources are still required to enhance their sustainability, equipping all their fleets with new technologies that have so far been tested only on a few ships. Furthermore, solid waste cycle management needs further efforts toward sustainability. In this sense, ports need to be equipped to recycle the waste disposed of by cruise companies, which could establish agreements with recycling companies on the territory to close the loop. Also, the investments in "green technologies" to reduce GHG emissions made by cruise ships risk being ineffective for achieving a zero-emissions Europe by 2050 or the UN 2030 Agenda if port infrastructures and the logistics organization on the ground are not adapted.

Furthermore, to enhance their sustainability reports' reliability, quality, and verifiability, they should disclose more quantitative information and data on the effects of their sustainability initiatives. For example, their operations' environmental, social, and economic impact on the cities they visit, and the number of substances that the ships continue to release into the air and oceans are not reported. This information would enhance their sustainability disclosure's quality, meaningfulness, and reliability. GRI standards certification, in this sense, significantly enhances the meaningfulness, reliability, and truthfulness of the Carnival Corporation and RCG sustainability reporting, especially compared to the other companies.

D. Limitations of the Study

This study does not allow assessing the quality of companies' information in their sustainability reports. Hence, essential information is either incomplete or even missing, so the information presented here cannot be considered to correspond to concrete reality entirely. Thus, the sustainability disclosure should be integrated with information and data collected from the community and cruisers through a survey field study, exploring what the cruise companies do and how well they disclose it in the general public's opinion. Further research could include cross-sectoral, multicountry surveys and new items identified from the literature on the issues discussed here.

VI. Concluding Remarks

This study sheds light on the use of digital technologies and green practices to meet environmental and social sustainability in the cruise industry, but how far these are effective and how these contribute to the achievement of the SDGs remain yet unclear. Although cruise companies in their sustainability reporting and websites highlight the large investments in technologies undertaken to reduce the environmental impacts of their activities, the analysis does not allow to identify the stakeholders' engagement, especially in the engineering issues of waste management processes, as well as the measures of relationship between waste practices and getting SDGs. In more detail, cruise corporations emphasize their commitment to sustainability by investing in the search for digital technologies that, in some cases, have been implemented on a few ships of the entire fleet to alleviate the strict regulatory pressure toward environmental compliance. To be really effective, a deep digital transformation process should involve the strategies, processes, activities, infrastructures, and relationships among all the players involved in the maritime ecosystem, hence using the logic of stakeholders' engagement to achieve CSR legitimacy.

The impact of their operations on social sustainability, as well as the details about waste practices and social effects, is given little space in their disclosure, as shown in Table IV. This is due to the low pressure of regulation on the social dimension, linked to a general commitment to the UN 2030 Agenda declared in 2017 by the CLIA without further binding regulations.

This seems to confirm the doubts that some scholars highlight on the reliability of the information voluntarily disclosed by companies since they tend to disclose their sustainable initiatives mostly for their legitimization in meeting the community's needs. The external assurance and certification may enhance the reliability of the information since it allows the verification of sustainability disclosures, thereby reducing the risk of undetected mistakes and the influence of corporate management on its social and environmental accounting [45]. The introduction of an IFRS standard for sustainability reporting, announced in November 2021, might improve consistently the meaningfulness, reliability, verifiability, and comparability of information disclosed. In this case, the most significant analysis should be carried out on sustainability reporting starting from 2022.

Cruise corporations have increased their attention toward environmental sustainability, and they tend to disclose their sustainable actions and behaviors to respond to the growing pressures from their wider stakeholders. This study allows us to understand the strategic role of digital technology as enabling factor for SDGs in the practices, such as waste practices, and whose implementation requires stakeholders' engagement also in the engineering issues of processes, as well as the relevance of sustainability disclosure for environmental and social issues getting wider CSR legitimacy.

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