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Future of cruise shipping in Baltic Sea region (BSR) nexus: analysis on circular economy

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FUTURE OF CRUISE SHIPPING IN THE BALTIC SEA REGION (BSR) NEXUS - ANALYSIS ON CIRCULAR ECONOMY

By

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Declaration

I certify that all the material in this dissertation that is not my own work has been identified, and that no material is included for which a degree has previously been conferred on me.

The contents of this dissertation reflect my own personal views, and are not necessarily endorsed by the University.

(Signature): .....

(Date): 01 Oct, 2019.

Supervised by: Prof Aykut Olcer & Fabio Ballini

Supervisor's affiliation: .....

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Title of Dissertation: **Future of Cruise Shipping in Baltic Sea Region (BSR) Nexus – Analysis on Circular Economy**

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This dissertation is a study of ever-increasing cruise shipping in Northern Europe of the Baltic Sea Region (BSR). Baltic Sea very recently has become one of the world's busiest waterways with over 39 ports and oil terminals and serves to 9 x north European states. Examination of the traffic on the Baltics' route estimates to be 9% of the world's trade and 11.1% cruise market share in 2014 with worlds' third major cruise tourism region. To ascertain the efficacy of emerging cruise activity, investigation of the trends and facts were assimilated. The manifold human-induced pressures of excess nutrient release, pollution, ammunition dumping and various engineering-based modifications resulted in alarming rate of hypoxic and anoxic water masses.

In the realm of regional environmental degradation and greater cruise calls, the need for alternate energy solutions during port stay (specifically utilising cruise based food and sewage wastes being the potential safe and cheaper waste to energy (WTE) source than fossil fuel) was investigated for the chosen regional case study ports of Copenhagen (Denmark), Helsinki, (Finland) and Tallinn, (Estonia). The available data has been collated and evaluated for concurrent gains at the respective terminal and the region. SWOT analysis tool helped to further crystallise the examination to triangulate the prevalent effort towards environmental measures and Circular Economy (CE) policies by the respective ports, city and at the state level.

Key words: BSR, environmental risk, circular economy (CE) policies, WTE, SWOT analysis.

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LIST OF ABBREVIATIONS

IMO	International Maritime Organisation
EU	European Union
ESPO	European Sea Ports Organisation
EMSA	European Maritime Sea Authority
HELCOM	Baltic Marine Environment Protection Commission also known as Helsinki Commission
ENVI	European Parliament Committee on Environment, Public Health and Food Safety
EPA	European Port Authority
TRAN	Transport and Tourism
BPO	Baltic Ports Organisation
BSAP	Baltic Sea Action Plan
CLIA	Cruise Line International Association
BSR	Baltic Sea Region
CMP	Copenhagen Malmo Port
EEZ	Exclusive Economic Zone
PPRISM	Port Performance Indicator Selection & Measurement
SDM	Self Diagnosis Method
EPIs	Environmental Performance Indicators
EMS	Environmental Management System
SEA	Significant Environmental Aspects
EEDI	Energy Efficiency Design Index
SEEMP	Ship Energy Efficiency Management Plan
MRV	Monitoring Reporting & Verification
PRF	Port Reception Facilities
MARPOL	Maritime Pollution Control
UN SDGs	United Nation Sustainable Development Goals
SWOT	Strength Weaknesses Opportunities & Threats
WTE	Waste to Energy

SSE	Ship to Shore Energy
CE	Circular Economy
SECA	Sulphur Emission Control Area
NECA	Nitrogen Emission Control Area
ECA	European Emission Control Area
PM	Particulate Matter
LNG	Liquified Natural Gas
NOx	Nitrogen Oxide
SOx	Sulphur Oxide
GHG	Green House Gas
OPRC	Oil Pollution Preparedness, Response & Co-operation
BWM	Ballast Water Management
PSSA	Particularly Sensitive Sea Area
APMs	Associated Protective Measures
PBLH	Planetary Boundary Layer Height

CHAPTER 1. INTRODUCTION

Sea has always been a great means of shipping transportation in terms of cargo, and passengers since time memorial. The legacy of the sea continues until today and the world saw the transition of all types of sea transportation growing from small dinghies to mega carriers in terms of bulk, break-bulk, containerisation, ocean liners to most modern day state of the art cruise ships. Sea besides transportation, remains an abundance of resources, i.e. fishing, minerals, entertainment etc. However, the plight of the sea in terms of coastal pollutants, plastics, sewage, black and grey water infiltration, industrial wastes, chemicals, ammunition dumping and all have been instrumental in the degradation of the sea health itself as well as the human residents at the coastal cities. Future of Cruise shipping especially in terms of a special status waterbody, i.e. Baltic Sea Region (BSR), need evaluation in this retrospect as a future healthy means of transportation. Accordingly, the study shall be furthered to evaluate the environmental health and sustainability (safe energy solutions) aspects of the BSR nexus leading cruise terminals. The focus on how these terminals synchronise their relevant infrastructure as supporting factors towards future cruise industry growth in the region.

1.1 Sea and Port as Means of Shipping Transportation

To Stopford Martin, (2009), only sea has the tenacity to serve the humans to undertake more than 90% of a safer and cheaper mean of transportation. To facilitate seafaring, ports played an instrumental role since the inception of shipping. Caldeirinha & Felicio, (2011), thus talk of the port characterising factors to be relevant with visiting vessel. Bichou, K. & Gray, (2005), explain the modern day port concept as Maritime Industrial Development Areas (MIDAs) and Trade and Distribution Maritime Centres (TDMCs), free zones, trading hubs and networks, corridors and gateways etc.

1.2 Origin and Development of the Cruise Industry

With the characterisation of ports, the ever present specialist role of shipping and ports started to get more specific and marginalised into the cargo sector and passenger transportation. The ports to the cruise companies, had to be specialists in their characteristics and facilitation. Therefore, in subsequent paragraphs, the research shall focus on the cruise shipping taking lead from historical perspective.

1.2.1 Evolution and Development of the Modern Day Cruise Industry - Brief Historical Perspective

Technological developments played a great role in the ever-rising popularity of the cruise business that eventually demanded the terminals towards more reforms in terms of terminal facilitation to visiting ship. However, for the sake of a logical progressive overview we shall liquidate the evolution in three phases, 1960-80, 1980-2000 and 2000-till today.

1.2.2 The Early Years of Cruise Shipping (1960-80s)

To start-up with the cruise industry evolution Garin, (2005), explains the cruise industry birth as a form of transformation from the early cruise lines of 19th century, Norwegian, Royal Caribbean and Carnival. Whereas for Brida & Zapata, (2010), the idea of leisure cruising in 1970 did not exist as of present day modern cruise arena. Weaver, (2005), explains, therefore, the early days of cruise market to be a struggling time however, to Polat, (2015), the cruise industry in the 1960's with setting sails through Caribbean region, started to meet a variety of destinations.

1.2.3 The Developing Cruise Tenure (1980-2000)

Brida & Zapata, (2010)**,** sees the 1970s and 1980s era as a chapter of modest growth, the growth (as shown in Table 1 below) during the following decade touched 7.2%million passengers with others increasing from 0.27 to 0.67 %.

	Total (million)	*North American*	*Others*	*North Americans (%)*	*Annual growth rate (%)*
1990	3.774	3.496	0.278	92.63	9.10
1991	4.117	3.834	0.334	93.13	9.09
1992	4.385	4.023	0.362	91.74	6.51
1993	4.728	4.318	0.41	91.33	7.82
1994	4.8	4.314	0.49	89.88	1.52
1995	4.721	4.223	0.5	89.45	–1.65
1996	4.97	4.477	0.49	90.08	5.27
1997	5.38	4.864	0.52	90.41	8.25
1998	5.687	5.243	0.62	92.19	5.71
1999	6.337	5.690	0.65	89.79	11.43
2000	7.214	6.546	0.67	90.74	13.84

Table 1: Annual worldwide growth rate of passengers, Source: (Brida & Zapata, 2010).

It was in the 1990s when the United Kingdom was hit by cruise phenomenal that subsequently was known to the rest of Europe, and from there it took its roots to the Asia-Pacific and rest of the globe, (Spalburg Jo, 2009).

Region	1989	1996	1997	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008
North.America.	3.29	4.61	5.05	5.89	6.88	6.91	7.70	8.23	9.14	9.96	10.38	10.50	
Europe ①	0.53	1.20	1.36	1.79	1.95	2.14	2.39	2.76	2.87	3.19	3.48	4.00	
Sub-total	3.82	5.81	6.41	7.68	8.83	9.04	10.09	10.99	12.00	13.15	13.86	14.50	
Rest of World	0.20	0.44	0.46	0.85	0.78	0.87	0.97	1.05	1.13	1.21	1.29	1.37	
Total	**4.02**	**6.26**	**6.87**	**8.53**	**9.61**	**9.91**	**11.05**	**12.04**	**13.13**	**14.36**	**15.15**	**15.87**	**16.20e**
% N America	81.8	73.6	73.5	69.0	71.6	69.7	69.7	68.4	69.6	69.4	68.5	66.1	

Table 2: International Demand for Cruises - 1989 to 2008 (millions of passengers); (Source: Spalburg Jo, 2009).

Spalburg Jo, (2009), in Table 2 illustrate the trends in cruise shipping as an after effect of economies of scale in shape of ever large cruise ships in the industry that ultimately kept meeting growing passengers and thus bringing cruise industry to European waters from almost negligible in the 1980s to 4 million by 2007.

1.2.4 Prevalent Cruise Industry and Importance of Europe as Evolving Cruise Market of the Future (2000-Today)

To Nelis Alex, (2012), the number of commuters increased manifolds during the last 35 years starting from 1970 – 2004. Cruise market watch, (2018), in Fig 1. below shows

the exponential growth of worldwide cruise industry from 0.2m in 1990 to over 25m by 2020 as an outcome of greater vessel size, economies of scales.

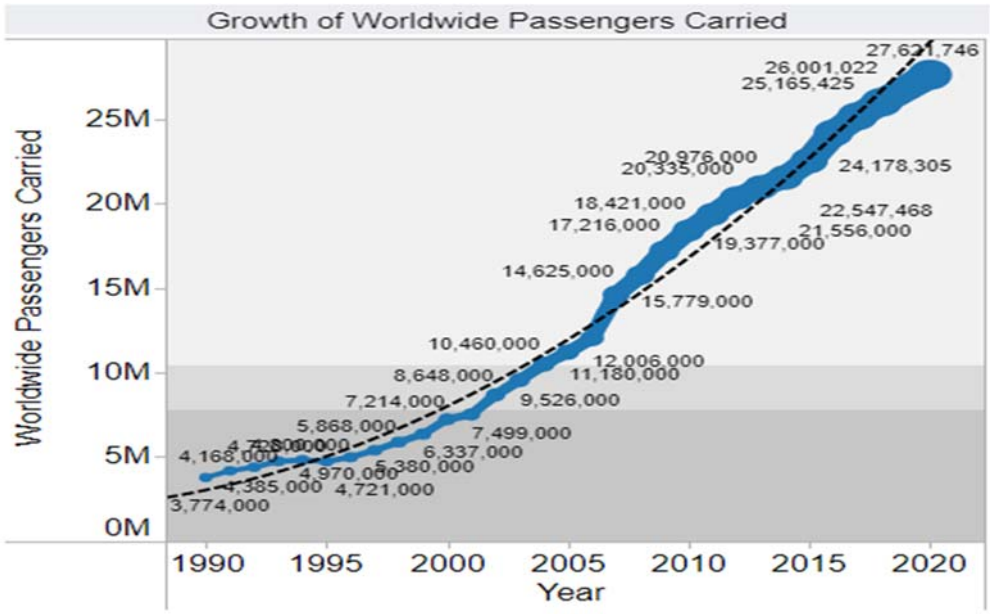


Figure 1. The growth of worldwide passengers, Source: (Cruise market watch.2018)

CLIA, (2018), in Table 3 below see the worldwide cruise market wherein Europe emerged from mere 4million to 6.96 million thus hiking to 71.9% growth, whereas, worldwide demand from 15.9 million travellers to 26.8 million, thus representing 69% overall and 5.4% annual average growth.

	2007	2012	2013	2014	2015	2016③	2017	10-Year Growth
North America	10.45	11.64	11.82	12.21	12.20	12.49	13.12	25.6%
Europe①	4.05	6.23	6.40	6.39	6.58	6.79	6.96	71.9%
Subtotal	**14.50**	**17.87**	**18.22**	**18.60**	**18.78**	**19.28**	**20.08**	38.5%
Rest of the World②	1.37	3.03	3.09	3.74	4.40	5.87	6.67	386.6%
Total	**15.87**	**20.90**	**21.31**	**22.34**	**23.18**	**25.15**	**26.75**	68.5%

Table 3: Ten year growth of Cruise Customers 2007-2017, Source: (CLIA, 2018).

1.3 The Different Cruise Types

The different cruise types are defined by Nilsson Per Åke, (2006), in Table 4 that ranges from river, to special interest and long distance prevalent in the world.

Location/Type	Comment	Supply/Markets
River, canal, lake cruises	Several markets according to location	Small, shallow vessels, often domestic markets
Special interests (sailing education, exploration)	Worldwide markets, highly differentiated	Purpose-built vessels, specialist crews, degree of monopoly through differentiation
Long-distance ocean cruising	Single world market	Large vessels, often relying on "tradition" and luxury, resources acquired internationally
Extended ferry "mini-cruises"	Usually domestic	Joint product with car ferries
Short ocean cruises	World market, heavily dominated by US	Mostly large purpose-built vessels

Table 4: Overview of Cruising Markets; (Source: Nilsson Per Åke, 2006).

1.4 Problem Statement

The Baltics Sea is an enclosed sensitive water body and cruise shipping in the region started relatively recently. However, since the cruise shipping is associated as the source of pollutants (emissions, wastes and passengers) therefore, in the realm of emerging worldwide environmental concerns, BSR stands even more vulnerable owing to its sensitive nature also conferred by the IMO. The new cruise vista BSR, thus demands extra attention and measures in regards to the following:

a. Solid waste (food and sewage) mitigation from an ever increasing number of cruise ships on the route.
b. Black and grey water mitigation.
c. Air emissions protection measures for the overall environmental health of the region.
d. Traffic congestion at the ports of calls.

In this milieu, research envisages an array of problems that may need to be catered and subsequently encountered in the future by the BSR. However, to limit the scope, the study shall only discuss the following in this paper:

a. Are the prevalent environmental measures (Solid, liquid and air) sufficient to cater for the ever increasing numbers of cruise ships in the BSR.

b. What measures are being/or planned to be undertaken by the state'/city/terminal relevant to sustainable circular economy waste to energy solutions.

1.5 Research Objectives

The objectives of the paper shall therefore be as enumerated below:

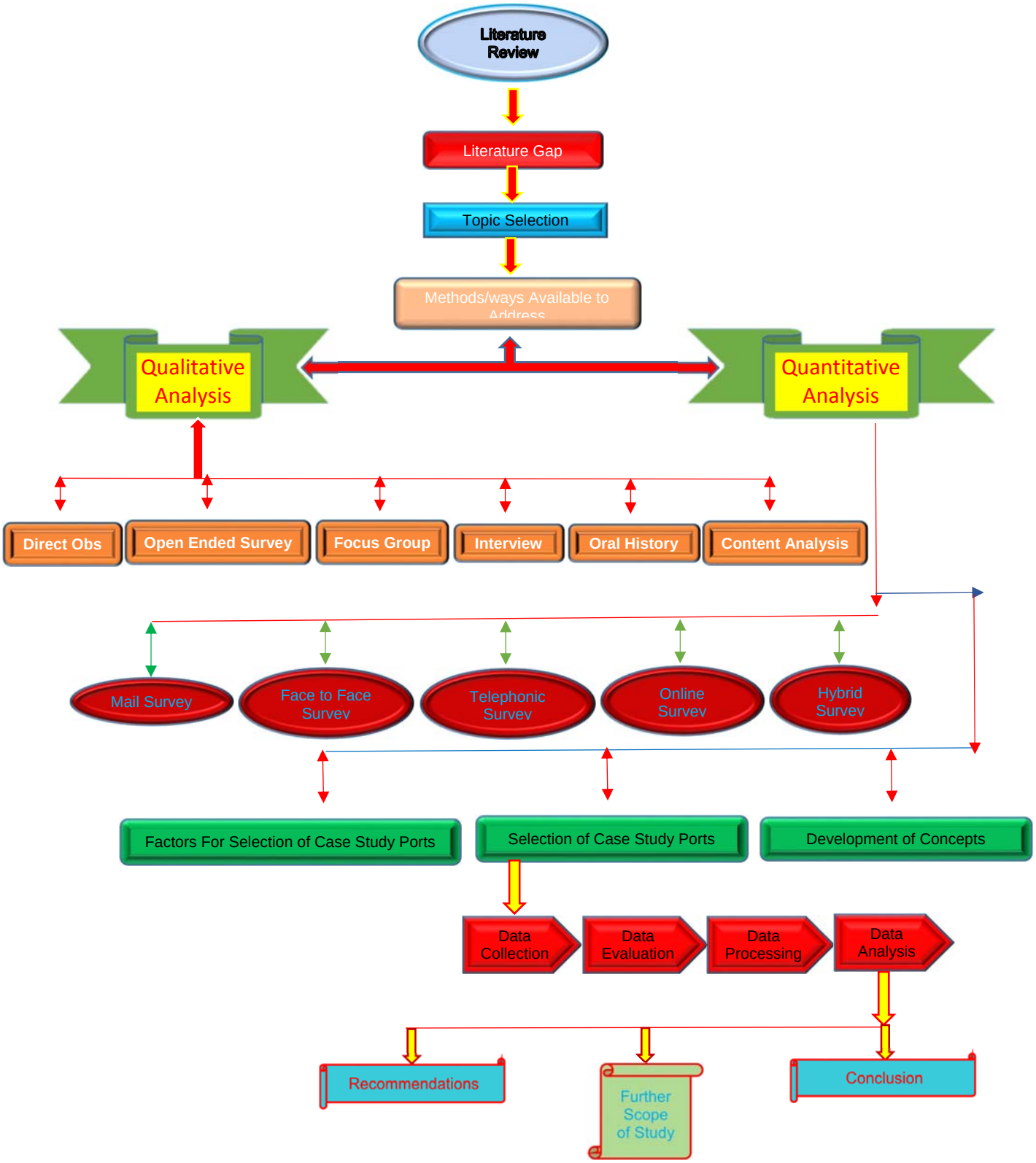
a. To analyse the efficacy of BSR environment in terms of cruise shipping and its future prospects as a cruise transportation means/destination.

b. To identify the Circular Economy (Waste to Energy) potential of leading regional ports of Helsinki, Tallinn and Copenhagen as the way forward towards Goal 7[1] of UN SDGs.

1.6 Research Methodology

The research study mainly hinges upon qualitative and quantitative methods, with some exceptions of hybrid method as well. Various techniques used to accrue outcome are enumerated under the respective model. However, Content Analysis technique being a qualitative method is focussed in the study. To attain valuable outcome extensive Literature Review was worked to accrue pertinent recommendations and future scope.

[1] Affordable and safe energy


Literature Review
Literature Gap
Topic Selection
Methods/ways Available to Address
Qualitative Analysis
Quantitative Analysis
Direct Obs
Open Ended Survey
Focus Group
Interview
Oral History
Content Analysis
Mail Survey
Face to Face Survey
Telephonic Survey
Online Survey
Hybrid Survey
Factors For Selection of Case Study Ports
Selection of Case Study Ports
Development of Concepts
Data Collection
Data Evaluation
Data Processing
Data Analysis
Recommendations
Further Scope of Study
Conclusion

1.7 Research Questions

To meet the objectives of the study, following questions shall endeavoured to be answered:

a. What pragmatic measures are undertaken by the regional organisations and BSR leading cruise destinations towards a healthy, safe sea environment for cruise shipping?

b. What pertinent measures have the ports of Copenhagen, Helsinki and Tallinn initiated in terms of future (waste to energy) CE based energy projects for the visiting cruise shipping so as to meet the UN SDG 7 requirements.

1.8 Assumptions and Limitations

Circular Economy (CE) in terms of implementation on a large scale is relatively a new phenomenon. To shift from linear to CE at the worldwide level shall take time to happen. Also, not much so far has been written on the CE models with perspective of waste to energy solutions exclusively for the port sector. In milieu of limited data on the subject the research shall therefore be pendant upon qualitative method, secondary sources. The questionnaire[2] developed for the stakeholders to conduct quantitative analysis on the subject matter couldn't be used effectively due paucity of time and thus remained limitation of the research.

[2] Questionnaire developed for all the stakeholders attached as Appendix B.

CHAPTER 2. LITERATURE REVIEW

In this chapter the research shall focus on the environmental and circular economy aspects of the Baltic Sea Region (BSR) leading cruise destinations of Copenhagen, Helsinki and Tallinn. The purpose shall be to reveal the cruise industry impact on the visiting destinations' environment. Thus, making a pre-hand call for preventive measures by the stakeholders to be able to contain its presence in the future as well. To unfold the chapter in a logical flow we shall first dilate upon cruise shipping arrival at BSR markets followed by cruising environmental impact, thereon, the chapter while expressing the environment shall necessarily include the Circular Economy (CE) and sustainable efforts being made by the BSR nexus in general and the leading ports of research in particular that is envisaged to give an impression of the future of the cruise industry in the region.

2.1 Inclination of Cruise Shipping to BSR Markets

Liuhto Kari, (2016), documents that for the year 2014 the total cargo volume for Baltic Sea ports plunged to 870 million tonnes, a 3.4% back to back year increase and that Russia's 5 Baltic coastal ports could make 24% of overall Baltic Sea business. Gritsenko Daria, (2016), therefore expresses the BSR importance in the last two decades being the worlds' one of the upcoming busiest traversed routes wherein at any one time around 2000 vessels pass through it. Figure 2 below accounts for the overall increasing activities in the region.

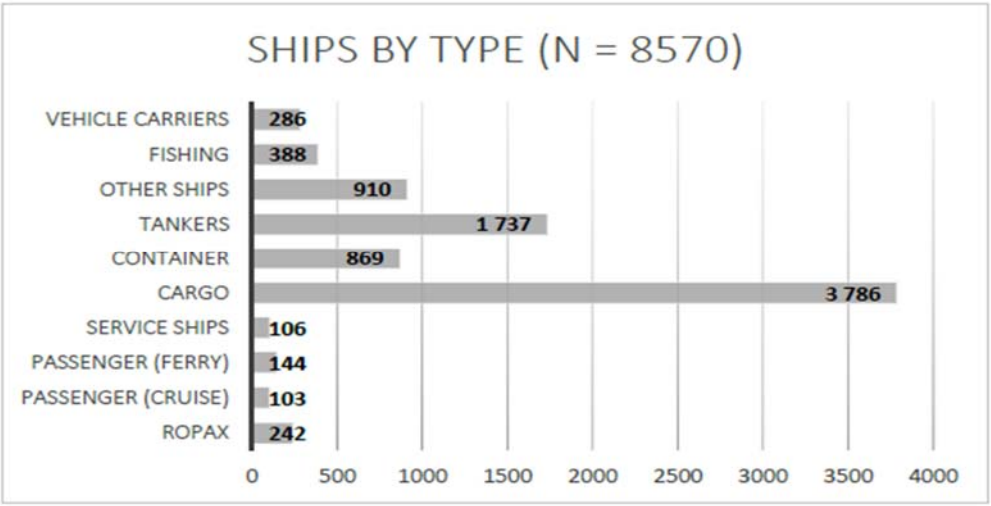


Figure 2: Commercial shipping in the Baltic Sea, by vessel type (2014); (Source: Gritsenko Daria, 2016).

Serry Arnaud, (2015), whereas express Baltic Sea being the largest cruise market in Northern Europe, generating around 4.3 million passengers in 2012. To Cruise Baltic, (2013), BSR is an attractive cruise destination with six capital cities coastal locations within overnight sailing distances. For Nelis Alex, 2012, Esteve-Perez & Garcia-Sanchez, (2015), the rapidly growing popularity resulted as an outfall of increasingly crowded North American destination compelling an altogether new vistas.

Pallis, (2015), calls to understand that BSR ports come in Seasonality itinerary structure in the shipping lines and is thus a periodical market during the months from May-Sep alone. Pallis, (2015), in Table 5. regards the non-Mediterranean European market as the third major region with 11.1% market share in 2014.

Region	2004	2008	2014
Caribbean	40.4%	37.2%	37.3%
Alaska	7.7%	7.6%	4.5%
South America	1.4%	2.9%	3.3%
Europe (No Med)	9.8%	8.3%	11.1%
Mediterranean	12.6%	17.6%	19.9%
Asia	0.5%	1.2%	4.4%
Australasia	0.9%	2.2%	5.9%
Other markets	26.7%	23.0%	13.6%

Table 5: Global Deployment Shares Deployment of Capacity (shares; 2004-2014); (Source: Pallis, 2015).

For Rodrigue & Notteboom, (2013), it was only during 1995 when Northern European cruise ship ports experienced an estimated 2578 visits by cruise liners; Copenhagen was the leading cruise ship destination with 240 visits and Tallinn third with 150 visits. Nilsson Per Åke, (2006), proclaim BSR being rich at the hinterland connectivity whereas to Pallis, (2015), the current situation of the cruise industry in the North Europe in Table 6 includes Kobenhagen categorised as Very Large Cruise Port and Tallinn being Large Cruise destination.

SIZE	USA	MEXICO /CANADA	CARIBBEAN	MEDITTERANEAN SEA	NORTHERN EUROPE
Major Cruise ports	(7) Miami (4.47) Port Everglades (3.94) Port Canaveral (3.86) ------- St. Thomas/St. John (1.98) New York/New Jersey (1.63) Galveston (1.29) San Juan (1.16)	(Mexico: 1) Cozumel (3.40) -------	(4) Nassau/Paradise Island, Bahamas (3.57) The Out Island, Bahamas (2.95). Pointe Blanche, St Martin (2.00) ------- Georgetown, Cayman Islands (1.61)	(8) Barcelona (2.36). Civitavecchia (2.14) --- Venice (1.73) Balearic Islands (1.58) Marseille (1.31) Naples (1.11) Piraeus (1.05) Savona (1.01)	(1) Southampton (1.50)
Very Large Cruise ports	(8) New Orleans; Juneau; Tampa; Ketchikan; Seattle; Skagway; Key West; Los Angeles	(Mexico: 1 / Canada: 1) Ensenada; Metro Vancouver	(9) Grand Turk Cruise Center; Grand Bahama, Falmouth; Port Zante, Bridgetown Oranjestad, Castries; Willemstad, St. John's.	(15) Dubrovnik; Tenerife Ports; Genoa; Kusadasi; Santorini,; Corfu, GR; Livorno; Mykonos; French Riviera Ports; Istanbul; Katakolo, Bari, Palermo; Valletta; Lisbon	(2) Kopenhagen; Hamburg
Large Cruise Ports	(8) Honolulu; Baltimore,; Palm Beach; Jacksonville; Boston; Hilo; San Francisco; Nawiliwili	(Mexico: 4 / Canada: 2) Majahual; Progreso; Cabo San Lucas; Puerto Vallarta; Victoria; Halifax	(5) Montego Bay, Roseau, Ochos Rios, St. George, Pointe à Pitre	(14) La Spezia, Madeira Ports, Tunisian Ports, Málaga, Valencia, Toulon-Var Provence, Messina, Rhodes, Kotor, Gibraltar, Heraklion, Monaco	(12) St. Petersburg; Tallinn; Stockholm; Bergen; Geirangerfjord; Stavanger; Le Havre; Oslo; Amsterdam; Zeebrugge; Flåm; Dover
Medium Cruise ports	9	-	1	> 10	>5
Small Cruise ports	13	25	2	> 100	>100

Table 6: Cruise Ports by Size in Major Cruise Markets (2014); (Source: Pallis, 2015).

Rodrigue and Notteboom (2013), divides shipping destinations into three categories the foremost and important category being a Destination Cruise Port/Home Port/Turnaround Port. Such a port has great economic value for the owned state and has high standards of tourist cultural amenities and concurrent communication (road, rail and air) facilities for passengers and crew alike. Rodrigue and Notteboom (2013), regard ports of St Petersburg, Stockholm and Copenhagen in that category. The second class is Gateway Cruise Port and is termed to be a technical stopover at ports, that does not have much significant facilities for the passengers however still serves as a major destination such as Tallinn and Helsinki. Balanced Cruise Ports stands to be known as the last category that is somewhat a hybrid form of the two and is not the main destination of a cruise itinerary, Gothenburg may fall in this category.

2.2 Literature Gap

Rodrigue & Notteboom, (2013), Garin, (2005) Brida & Zapata, (2010), Weaver, (2005), explains the early days and the cruise evolution from struggling time to a grand self-sustained market. Nelis Alex, (2012) Cruise market watch.(2018) CLIA, (2018), and Rodrigue, J. -P & Notteboom, (2013), discussed about the cruise ship transition from Caribbean and America to the European markets and CLIA, B. (2018), also commented upon being the increase no of cruise ships bed day capacities. Gritsenko Daria, 2016, Nelis Alex, 2012, Liuhto Kari, (2016) Serry Arnaud, (2015) Esteve-Perez & Garcia-Sanchez, (2015)**,** further went on discussing the inclination of the cruise industry towards BSR and have related it with ever growing ship capacity, the economies of scale and the affordability eventually increasing the passengers and thus calling for the cruise shipping to explore more destinations.

Pallis Athanasios A., (2016), in his study made relevant view point on the geographical aspects and the economic growth that cruise shipping avails to a states' economy and overall progression. At the same time Gilbert, Bows, & Starkey, (2010), Johansson.L, Jalkanen. J et al, (2013), (Abbasov Faig, 2019), (Olaniyi Eunice, 2017), have discussed the adverse effects of shipping on the environment and of cruise shipping in particular. The degradation thus needed safe energy solutions. The concept of Circular Economy (CE) though was ever present however, only since last decade and post UNSDG No 7, i.e. clean and efficient energy; the concept got its importance in the context of ports and shipping.

Korhonen, Nuur, Feldmann, & Birkie, (2018), see CE as a new perspective towards the world economy, environment and progress. Kalmykova, Sadagopan, & Rosado, (2018), elaborate the concepts that were established decades ago, such as spaceman economy (Bouldingregard CE as 1966), limits to growth (Meadows, Meadows et al., 1972), steady-state economy (Daly 2005), performance economy (Stahel, 2010), industrial ecology (Frosch and Gallopoulos, 1989) and "cradle-to-cradle"[3] (Stahel and Reday-Mulvey, 1981), being vital among many prevalent. (Geisendorf & Pietrulla, 2018) dilates further the work of (Boulding 1966) that he explained in his book, '*The Economics of the Coming Spaceship Earth' relates* global economy within circular systems that only can guarantee sustained human life on earth and was

[3] CE so far worldwide concepts as Appendice C.

augmented by (Pearce and Turner 1989) through attention to the second law of thermodynamics. A brief description of the different models is attached as Appendice C. Geisendorf & Pietrulla, (2018), while further explaining the CE theory refers to (Georgescu-Roegen, 1986) work wherein the,

'entropy of an isolated system wherein increase over time and, thus, devalue higher order energy or material'.

The CE model got its roots in Europe through Germany with the advent of 'Waste Disposal Act' and the concept of 'Extended Producer Responsibility', the founding pillars of the CE.

Hintjens, Vanelslander, Van der Horst, & Kuipers, (2015), talk about the concept of 'green ports', that are known to have literature wherein sustainable production is seen as a meagre portion to it. It is also pertinent to mention of the disjunct relationship between port authorities' and their projective environmental goals and the concurrent environmental projects and processes managed thereto. However, Ezzat, (2016), discusses the furtherance of the concept into the ports sector that includes a few concrete steps taken by the port of Rotterdam in their vision 2030 by usage of greener industry and logistics concept that essentially includes sustainable energy generation projects of Solar, wind and biofuels to be the vital energy sources. Furtheron, the port of Ningbo in the city of Beilun since 2005; to meet the great energy demands; also intends to hit strategic energy programmes by using a circular economy model that ultimately in 2013 listed Beilun, emerging as a role model circular economy industrial parks. Karimpour Reza, (2017), in his work has mentioned of the Port Authority of Amsterdam with the aim to curtail CO2 by 40% by 2025, the port arena, therefore, has been equipped with big wind turbines to facilitate Ship to Shore Energy (SSE) to visiting ships. Hamburg Port Authority (HPA), whereas in pursuit of cruise emission curtailment introduced CE model of a land-based shore-power-supply infrastructure, using a power barge.

CMP in their futuristic Terminal 4 expansion project shall offer cold ironing to the cruise vessels through city generated energy systems. Karimpour Reza, (2017), in his paper on 'CE Modelling to accelerate the transition of ports into self-sustainable ports' proposed as a case study for the Copenhagen Malmo Port (CMP) the WTE CE concepts as shore to ship energy (SSE) means for cruise shipping, this so far to the scope of my study is known to be only relevant idea. U.S Navy for first time ever is known to term SSE as 'Cold Ironing' wherein to

Kumar, Kumpulainen, & Kauhaniemi, (2019), the USN ships alongside jetty were facilitated more engine hours. To conceptualised the same into pragmatic terms the ships equipped with coal-fired ironclad steam engines were afforded SSE and the ships' engines compulsorily had to be completely cooled down during their entire port stay.

With growing competition to grab market share in the realm of environmental eutrophication of BSR and the requirement of sustainable energy solutions; research on the futuristic cruise activity in the BSR was explicitly found lacking wherein literature gap persists.

2.3 Environmental Aspects of BSR

Gritsenko Daria, (2016), has evaluated shipping to be a major instrument to prevailing local atmospheric issues – and the global environmental issue of climate change. To Gritsenko Daria, (2016), respiratory, allergic, and immune system malfunction are a few of many man-made volatile organic compounds, with hazardous health impacts as the outcome of ship emissions. The Table 7 below shows per year health hazard contributory toxic gases by shipping in the BSR nexus.

Year	NO_x	SO_x	PM	CO_2
2006	327,000	136,800	29,100	15 779,400
2007	350,800	126,700	28,300	16 850,900
2008	357,600	129,900	29,100	17 462,500
2009	336,000	122,300	27,500	16 684,600
2010	346,500	92,600	23,500	17 458,700
2011	377,000	86,500	23,700	19 239,700
2012	369,600	83,700	23,100	19 012,800
2013	323,200	80,200	16,100	15 343,000
2014	322,529	81,845	16,210	16 088,000

Table 7. Air emissions from Baltic shipping, 2006-2014 (tonnes); (Source: Gritsenko Daria, 2016).

Figure 3. Environmental impacts; (Source: Hänninen Jaana, Mäki-Jouppila Tero, & et al, 2016).

The toxic and degrading environmental effects of cruise shipping in a wholesome manner is depicted by Hänninen Jaana, Mäki-Jouppila Tero, & et al, (2016) in Fig 3 above that covers all the facets of a possible environmental damage by a cruise ship.

Svaetichin & Inkinen, (2017), made a study on the concept to minimise the environmental imprint on the leading BSR cruise ports of Helsinki, Stockholm, Tallinn and CMP. The study focussed on the efficacy of waste management system efficiency in the selected cruise ports called for more concrete measures in terms of specialised PRFs and a collaborative discourse for safe and healthy BSR for all types shipping. Kotrikla, Lilas, & Nikitakos, (2017), has gathered very concrete and specific BSR environmental regulations as collective effort by the EU to preserve save the region. The timeline indicative of the important directives pertaining to European waters are below:

a. Directive 2003/96/EC was introduced to levy taxation exemptions on energy products/electricity for the port sector and its associated infrastructures (Article19).

b. Directive 2005/33/EC, adopted in January 2010 calls for the marine fuel sulphur content to be less than 0.1%(m/m) and is considered as the key, if not mandatory driver for adoption of cold ironing for visiting ships for over 2 hours of stay at the port using SSE.

c. Directive 2006/339/EC directs the EU member states for installation of SSE specifically, for the ports reaching the air quality limit values or else the residential areas with public concern for high noise levels.

d. IMO on 1st January (2013), called mandatory EEDI (Energy Efficiency Design Index) for new ships and SEEMP (Ship Energy Efficiency Management Plan) for all ships to reduce the ships CO2. Further steps being a subsidy in LNG (Liquefied Natural Gas) and its facilitation, while offering reduced port charges for ships approaching harbour on slow speed and shore side electricity.

e. EU CE package.

Sweden and Germany to Kotrikla, Lilas, & Nikitakos, (2017), already have a system in place to facilitate rebates on SSE to visiting ships at the ports. Further on, ports and states at their own are seeking emission mitigation initiatives (infrastructure, regulations, and incentives).

Ołdakowski Bogdan, (2016), in conjunction with the port and state held efforts informed us to the new European Union policy that aims to promote European seaports shipping industry by integrating seaports within the entire transportation chain thereby eliminating the negative environmental impacts. Hall, (2010), also conducted a case study on cruise ships visiting BSR ports of Copenhagen (Denmark), Stockholm (Sweden), Tallinn (Estonia), St Petersburg (Russia) and Helsinki (Finland). To the research advantage the extracts of the study explain the dynamics of SSE in different port visits. It was observed that, ships used from their aux engines; 511MW energy being alongside listed ports' berths as shown in Table 8 and emitted 367 tonnes of CO2 that could have been curtailed by 28.5% to 263 tonnes availing SSE. Hall, (2010), also explains (though in the case of Russia and Estonia) that the CO2 emissions using SSEs would be greater in comparison to vessels own aux power supply. However, if ships at Russia and Estonia were exonerated to use SSEs there would have been a reduction of CO2

emissions upto 41% to 217 tonnes. It is therefore concluded that the type of cold-ironing technique also plays a pivotal role in mitigating the environmental damages.

Port	Time (h)	g_{CO_2} ($kWhe^{-1}$)	MWhe consumed	CO_2 from AE (tonnes)	CO_2 from shoreside (tonnes)	Change in CO_2 (%)
Southampton	10	543	70	50.3	38.0	−24.5
Oslo	7	4	49	35.2	0.2	−99.5
Copenhagen	10	605	70	50.3	42.3	−15.9
Stockholm	10	56	70	50.3	3.9	−92.2
Tallinn	9	1341	63	45.3	84.5	86.6
St Petersburg	10	811	70	50.3	56.8	12.9
Helsinki	9	309	63	45.3	19.5	−57.0
Zeebrugge	8	310	56	40.2	17.4	−56.9

Table 8. Reductions in CO2 emissions if shoreside power was implemented in Baltic ports; (Source: Hall, 2010).

Dowling R.K, (2006), and Hänninen Jaana, Mäki-Jouppila Tero, & et al, 2016 however, have dilated upon self-initiated efforts made by the cruise industry towards the health and sustenance at their respective ends[4].

2.4 Various CE Techniques in World

Ports are the kingpin to a states' economic progression. Continuous development and innovative improvements, the world is testimony for those ports to remain prudent and living on the world map.

Carpenter, Lozano, Sammalisto, & Astner, (2018), has outlined a lifecycle stages of any port, (see Figure 4). It is imperative for a port to overcome the Obsolescence stage through rejuvenation and innovative ideas, similarly safe energy solutions is the clarion call for the sustenance of future shipping and ports alike.

a. Growth, a factor that ensures the expansion of facility through investments;
b. Maturity, wherein ports' complete potential is attained;
c. Obsolescence, the times when the modernity and change takes over the status quo business;
d. Dereliction, times when the berths no more see ships alongside; and

[4] Cruise Industry sustenance efforts as Appendice D.

e. Redevelopment, when the complete rejuvenation of port occurs through non-port economic activities.

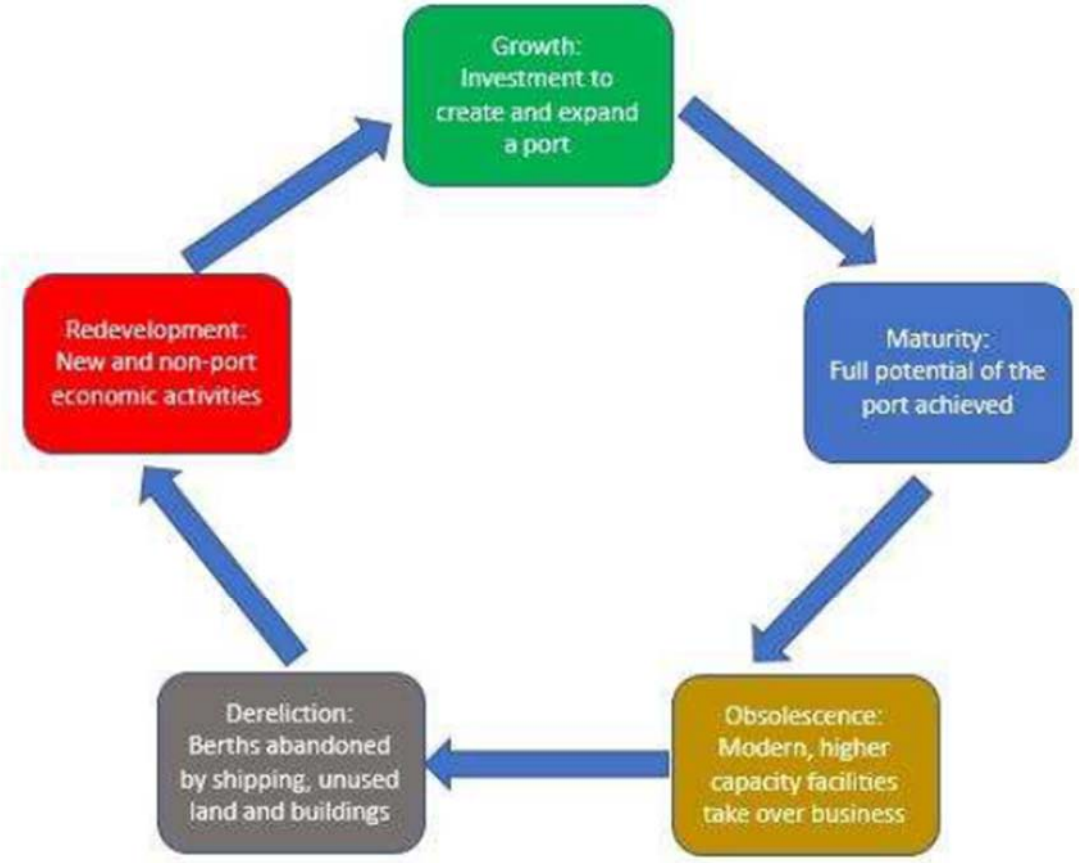


Figure 4. Port Facilities Life-Cycle Concept; (Source: Carpenter, Lozano, Sammalisto, & Astner, 2018).

Stahel, (2016), see Europe to lag a little however, in 2014 Swedish Foundation for Strategic Environmental Research (Mistra) in line with the EU Horizon 2020 programme announced call towards circular economy proposals. The very next year European Commission proposed European Parliament a Circular Economy Package.

However, despite a little old concept it is still not warm welcomed and faces a few impediments as shown in Figure 5. below.

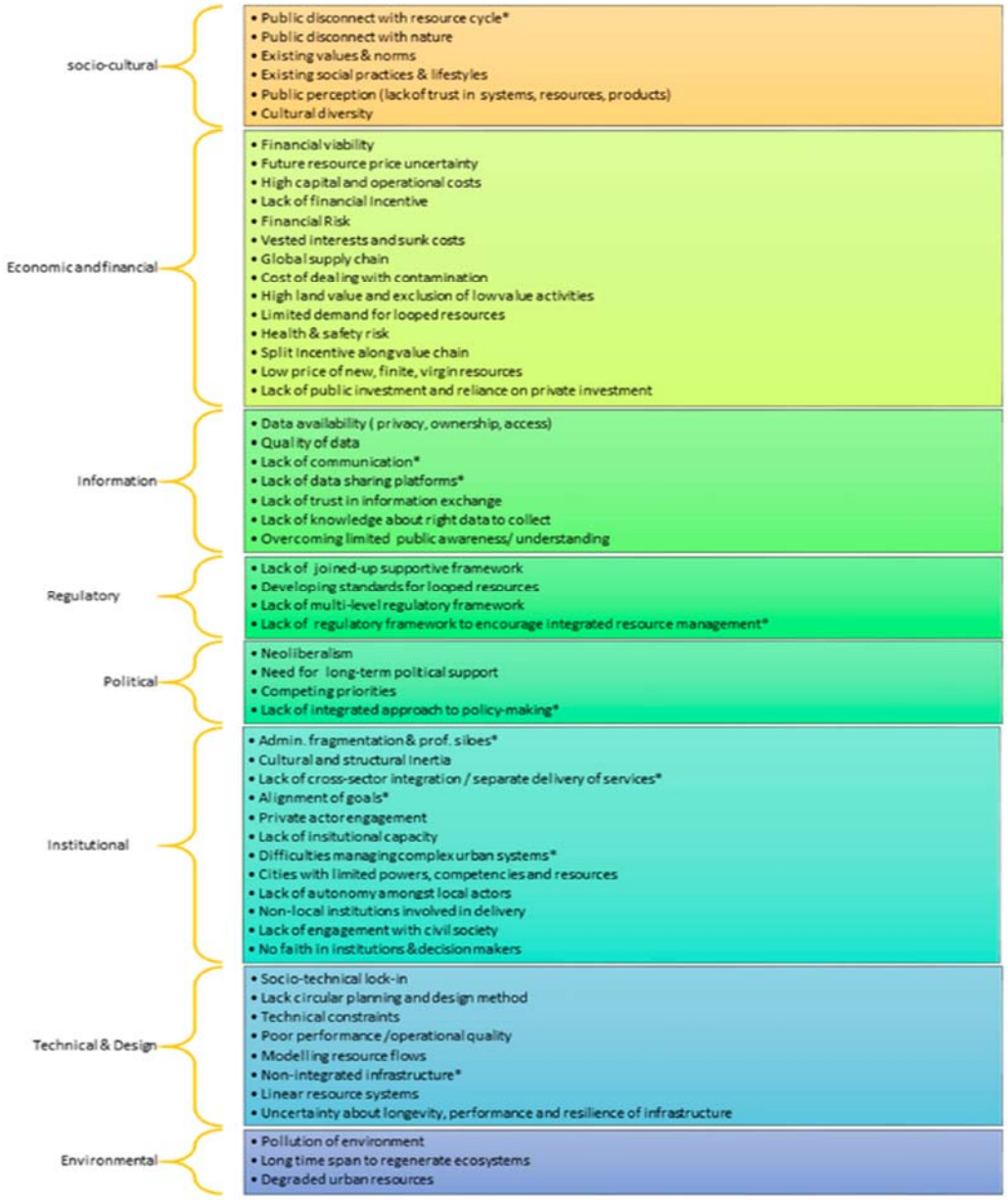


Figure 5. Challenges to looping actions identified by the literature and experts; (Williams, 2019).

Kotrikla, Lilas, & Nikitakos, (2017), talks of both wind and solar energy as the sources for the CE in the Aegean Region being in abundance and cheap. Whereas, Wu & Xia, (2018) has discussed about another option of photovoltaic (PV) panels in the context of hybrid renewable energy system (HRES) that works in the principle of storage components (battery, ultra-capacitor, and so on) to offer stable and sustainable power solutions. The surplus energy in the grid-connected application, may be served to the berthed ships. HRES is capable of supporting hybrid-electric ships and all-electric ships.

Winkel, Weddige, Johnsen, Hoen, & Papaefthimiou, (2016), goes on to discuss solutions made at the shipping company end wherein the ship owners have equipped the ship with SSE equipment onboard their ships. A few of these include NYK Line, Evergreen, Princess Cruise and Holland America Line, China Shipping, Evergreen, Stena Line, Wagenborg, Trans-Atlantic, Trans Lumni, etc. Winkel, Weddige, Johnsen, Hoen, & Papaefthimiou, (2016), also talk about vital challenge of electricity taxation, that ultimately has to compete with the non-taxed ships' fuel.

2.5 Case Study of Port of Copenhagen, Helsinki and Tallinn- Environmental and Circular Economy (WTE) Aspects

Under this heading the research shall focus on assimilating pragmatic measures taken by the respective case study ports. Effort shall be made to accrue pertinent steps introduced by the relevant regional/governmental/municipal and port sector for abatement of environmental degradation while introducing sustainable and safe energy solutions.

2.6 Port Of Helsinki

Port of Helsinki in tandem with City authorities developed Vision for the port that must satisfy the ever growing needs of the future. Helsinki aim to be carbon neutral city by 2035 has enhanced cooperation with businesses in climate change, that shall contribute towards carbon neutral and GHG free Helsinki. 'Climate Partners cooperation network is focussing institutions of higher education, associations and other operators, (CEO Helsinki Port, 2018).

The port and the city under the EU-funded Twin Port 3 project is to properly regulate port bounded traffic eventually gaining the better environmental advantages, (Slotte Andreas, 2018). 1 out of 11 moveable air emission monitoring equipment from Helsinki Region Environmental Services Authority's (HSY) is dedicated within the Port area on alternate years. The air emissions thus monitored are relatively small scale, (Environment Management, 2019). The technology group Wärtsilä's first ever floating Seabin infront of Kaivopuisto, Helsinki, in May 2017 as part of Finland 100 programme and the EU's TEN-T (Trans European Transport Network) Twin-Port project, (port of Helsinki and Tallinn harbours) shall focus on efficient and environmentally sustainable cruise operations, (Twin Ports, 2019).

2.6.1 Port Reforms

In 2018, the port introduced incentive for ships with discounts maximum upto 3% that in 2019 shall reach upto 4% ton vessel charge on the basis of environment friendliness, (based on the vessel's ESI-certificate score). Also, it includes maintaining noise levels below 105 dB (based on confirmed & measured output noise levels while docked), (Rantanen Aino, 2017). The TWIN-PORT 3 projects' (2018-2023) auto-mooring and on-shore power supply solutions shall form part of the environment and safe energy solutions for the port, (Haapasaari Ville & Kalm Valdo, 2018).

The port has developed the facilities to handle approx 90% of waste water from the cruise calls during 2018. No separate charge is levied to discharge waste waters, (Greenest Port Helsinki, 2018). The deepening of the Vuosaari Harbour fairway is also envisaged in line with the environmental solutions of the harbour as it shall facilitate energy-efficient and low-emission vessels, (CEO Helsinki Port, 2018).

Bunkering of vessels on LNG gas is also an effort that entails for the futuristic plans of the Helsinki port and yet another step towards emission friendly shipping, (CEO Helsinki Port, 2018). The noise level measured (from yards or outdoor areas of residential buildings) by port operations shall remain within 55 dB and 50 dB at day and night respectively. Environment Management, (2019), further explains the measures for new noise assessments and noise modelling in close cooperation with city planning. The port has also installed a km long concrete noise barrier whereas Viking Line is also contributing towards the greener port going with shore power system at the Katajanokka quays. Vuosaari harbour has also been equipped with a wastewater pre-processing facility to keep the environment healthy by reducing the release of bad odours into the atmosphere.

Figure 6. The layout of Helsinki Cruise Terminals; (Source: Google, 2019b)

The figure 6. above shows the complete layout of the Helsinki cruise terminal berths that facilitate the cruise business in the city. These are the areas wherein Helsinki port authority is taking measures towards better Baltic Sea. These berths shall and are being used to encourage cruise vessels to discharge the wastewater at harbours. For the same purpose Helsinki port authority introduced vessel waste management charges on vessel size contrary to waste amount vessel is discharging at the harbour. Additionally, the Port in 2016 introduced a 20% discount on solid and oily waste charges provided the vessel discharges her wastewater at the harbour.

Rajamäki Soili, (2017), explains the futuristic aims of the port to be best ship-generated waste management hub as the international cruise traffic and the reception facility is in collaboration with waste management company against a fee package. To further facilitate the visiting ships, the port also offers the services of a dedicated waste management officer, to inform visiting ship's crew of the various possibilities of delivering ship-generated waste of all sorts and of the waste sorting facility in Helsinki. A visiting ship at the port can discharge wastes in following capacities:

a. 20 m3 of mixed waste
b. 20 m3 of recyclable waste
c. 7 m3 of food waste
d. 20 m3 of oily waste
e. An unlimited amount of wastewater, (Rajamäki Soili, 2017).

2.7 Port Of Tallinn

The Port of Tallinn is the busiest port of Gulf of Finland. There are various bilateral projects between Helsinki-Tallinn towards the environment protection and well-being of the habitat. Estonia is an IMO ratified state and since after its membership is known to make concerted effort towards a progressive environment and shipping. The condition layout of terminal is expressed in the Figure 7 below. The figure entails the Kusadasi terminal that shall encompass the most modern changes for the future.

Figure 7.The layout of Tallinn Cruise Terminal; (Source: Google, 2019c)

Tallinn with Vision2030 is set to commission a great range of mega cruise terminals with state of the art facilities of a smart port. The facilities shall make a great contribution towards the healthy commutable Baltic sea for future prospects. Haapasaari Ville & Kalm Valdo, (2018),

explains about the progression Tallinn is continually busy in developing its capacity towards Port sewage reception services for every visiting cruise ship. In addition, there are reforms made at the shipping end, Tallink in this regard shall equip its vessel MS Megastar with rechargeable batteries while she makes her voyage and accordingly facilitates the ship in berthing operations thus helping minimise the environmental sustenance call.

Kiisler Siim, (2017), the Estonian minister for environment assured of the sustainability progression as a resolve towards the social and environmental challenges to shift to circular economy instead of linear take-make-waste production and consumption patterns. Waste was emphasised to be a valuable resource. The Estonian government seems more focussed on blue-green infrastructural reforms that are incumbent towards the sustainable environmental Estonia.

Furthermore, the Trafi (Finnish Transport Safety Agency) has incorporated reforms in a manner wherein Port of Helsinki Ltd offers to international cruise ships with facilitation of waste management services, (Min of Environ Estonia, 2019). Technopolis Group of Estonian Ministry of the Environment in cooperation with HeiVal Consulting and foreign specialists are contemplating the opportunities and threats in relation to switching over to circular economy that Estonia foresights to be finalised by the end of 2020.

SGI, (2016), the report indicates that overall environmental image of Estonia is getting better. The greenhouse-gas emissions are known to be halved in 20 years, and with 2020 vision the GHG emissions are aimed to curtail down to 80% compared to that of 1990 level. INTHERWASTE, (2018), reports encouraging about the Tallinn Waste Management Plan 2017-2021, adopted in 2017. Steps are being taken to recycle or recover waste to the maximum to mitigate the environmental risk by strict effective monitoring and supervision.

2.8 Port of Copenhagen

Copenhagen Malmö Port AB (CMP), is geo-strategically located at the mouth of the Baltic Sea, operates the ports in Copenhagen, Malmö and Visby. Being a full-service port with ultramodern logistics sea, road and rail solutions Copenhagen stands as an exclusive Northern Europe's largest cruise destination with about 45% of turnaround calls. The port has a futuristic vision 2030 to cope up with doubling global freight volumes of approx. 20 billion tonnes.

(CMP, 2013). Until 2014 the cruise business of CMP was handled by quays other than the newly constructed three terminals inaugurated by Her Majesty Queen Margrethe II at the Oceankaj. The terminals constructed worth DKK600 million to meet the ever growing demand of passengers and more visits by shipping lines, (CMP, 2015).

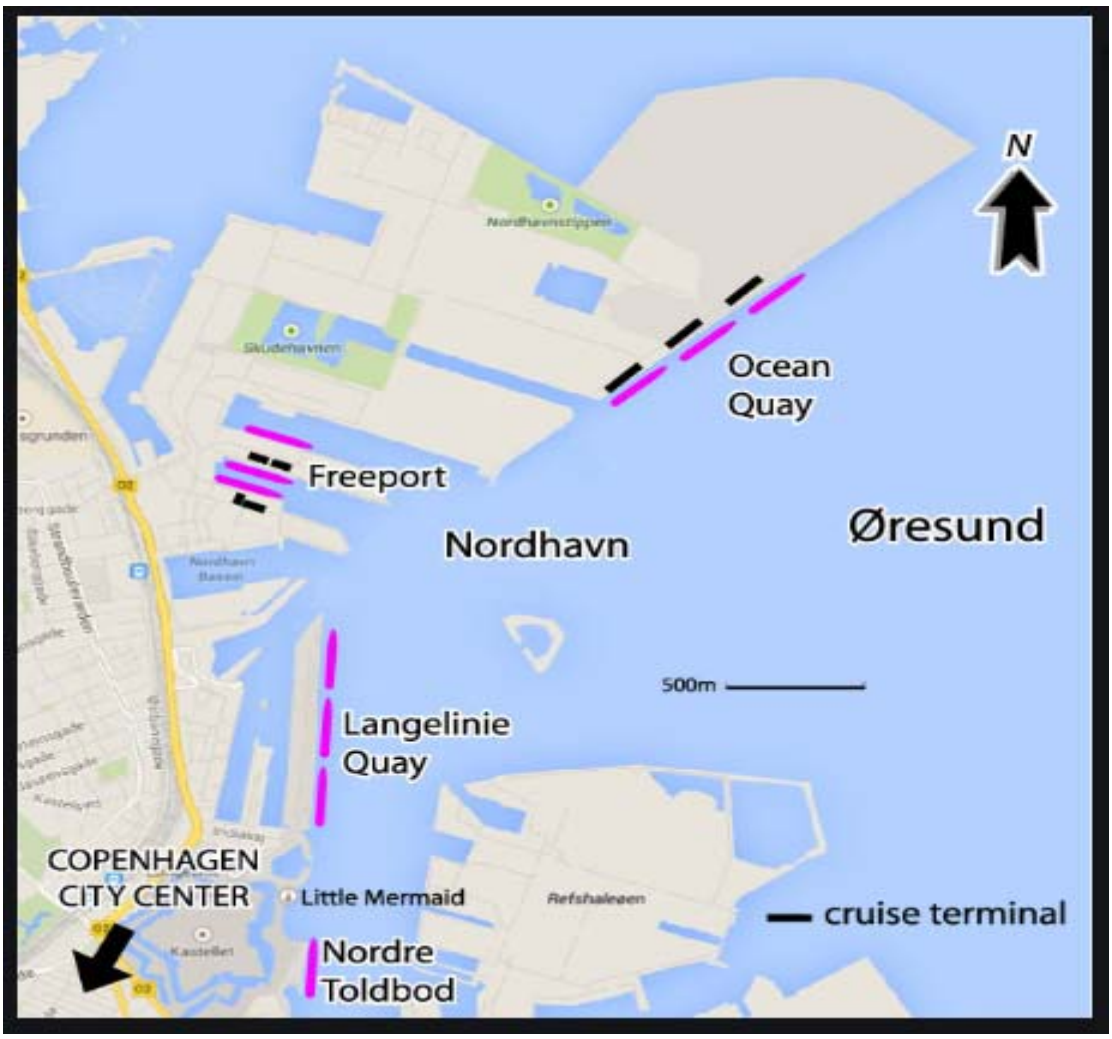


Fig 8. The complete cruise terminals layout at Copenhagen; (Source: Google,2019)

Figure 8. above lays complete canvas view of the cruise terminals. The most modern facility to accommodate larger cruise vessels are accommodated at Terminals 1-3 whereas upcoming Terminal 4 shall exclusively be able to take turnaround cruise calls, all planned on Ocean Quay. The other quays continue to take comparatively smaller vessels.

The Copenhagen had been awarded 5 times since 2004 for "Europe's Leading Cruise Destination" at the World Travel Awards. Whereas, in 2005, the cruise port was also named "World's Leading Cruise Destination", (Cruise ships, 2017).

The port at Copenhagen has plans to phase out fossil fuels for renewable types of energy, however, as such no such plan has been published or is public so far. The various reports that concern the renewable energy from the waste collection don't replicate the future port owned renewable energy solutions. The variety of reports that concern the circularity and environment can be found on CMP website under 'Rules & Regulations'.

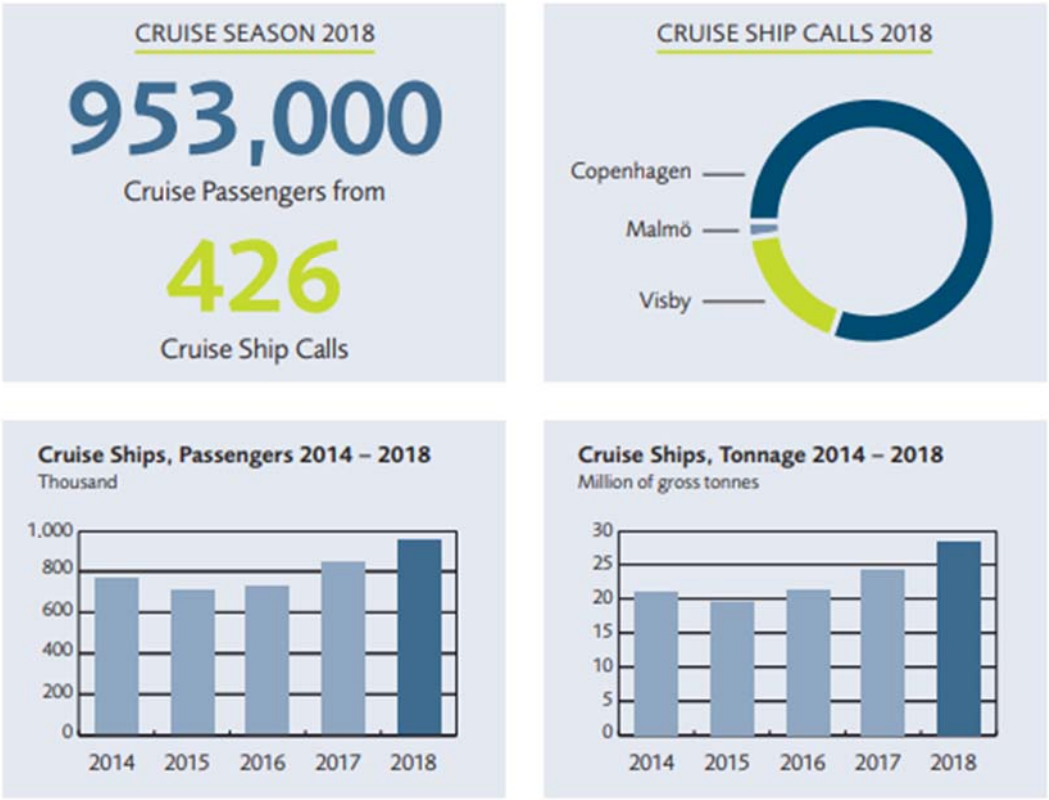


Figure 9. An overview of Copenhagen Cruise market The Annual Report 2018 (CMP) (Source: Åkerlund Mats, 2019).

The Fig 9 above gives a clear depiction of the greater influx of Copenhagen cruise market from 2014-2018, expanding in manifolds in terms of passengers, tonnage and no of cruise ship calls.

Whereas, the Fig 10. below shows the efforts planned to deal with the energy, waste and climate by the CMP in the coming years. Currently, to cater the environment aspects the terminal is equipped to handle waste water from three large cruise ships of capacity upto 900 cbm/hour (300 cbm/hour/ship) whereas, the quay is fitted with power cable tubes for future investments in electrical power from land. To further the environmental calls from the Copenhagen

Municipality and CMP the terminal buildings are roofed with green vegetation in the form of a sedum.

Area	Objectives
Energy	We will reduce our electricity consumption and our heating requirements by an average of 2% per year through efficiency solutions. At the same time, we will increase the proportion of internally generated renewable energy by an average of 5% per annum.
Air	We will be CO_2-neutral by 2025 through changing to fossil-free fuels and fossil-free sources of energy for electricity and heating. The indoor air in our premises will be of good quality and there must be no risk of toxic substances in connection with demolition work.
Water	We will contribute to achieving and ensuring a good biological and chemical status in the classified bodies of water that CMP affects.
Soil	Spillage on permeable areas will be minimised.
Waste	We will follow the so-called waste staircase. Waste generated by CMP will be cut by an average of 4% per annum and the degree of recycling will be 50% (excluding hazardous waste) by 2020. For waste generated by ships, combustible and unsorted waste will be reduced by an average of 2% per annum.
Climate	CMP will develop a clear picture of how the port is affected by changes in the climate. The role of the port in such a situation must be clear.

Figure 10. CMP efforts towards sustainability for year 2018; (Source: Åkerlund Mats, 2019).

Denmark coastal cities however in the wake of 107 cruise ships calls was prone to receive NOX equivalent to half the passenger cars operating in the state. Abbasov Faig, (2019), further explains the damage to the coastal health being very close coast sailing by the ships and long port calls with no SSE facility causes disproportionate air quality.

EPA Denmark, (2019), however, in its report reveals the possibility of futuristic availability of SSE solution. With proper berthing plans at all the Oceankaj terminals inclusive of the upcoming Terminal 4 it is assumed that 34% of cruise ships may be able to use shore power, with upto 70% of port calls and connection time of 252 hours/year. Such an inclusion shall therefore is expected to curtail gaseous emissions at Oceankaj by 14%.

The EPA Denmark, (2019), further reveals the futuristic waste collection at terminal no. 4 are expected to remain sufficient by the present PRF. Whereas, the Danish strategy issued in 2014 on sustainability envelopes goals and initiatives that focus towards the development of innovative and sustainable solutions.

Copenhagen in the wake of more feasible energy solutions intends to plan on long term sustainable solutions, that are equally feasible for financial and environmental friendly cruise shipping business. The future plans CMP, (2018b), of Copenhagen cruise terminal to include SSE solutions that are likely to be mobile, more efficient and cost effective to around 20% of new buildings that shall primarily use LNG (Liquid National Gas). Whereas, in Vision2030 CMP, (2013) sustainable energy solutions entail two facilities for Liquified Natural Gas (LNG), in Northern Harbour.

CMP, (2019), in 2018, Copenhagen Malmö Port (CMP) used the expertise of FORCE Technology to draw up a sustainability report for the industry revealing concerns toward the environmental impact of cruise ships within the immediate surroundings of Langelinie. The report was generated through measurements of 2018 cruise traffic ultrafine particles and nitrogen oxides (NO2), respectively, on Langelinie Allé.

IMPORTANT CONCEPTS FOR THE RESEARCH

2.9 SWOT Analysis Concepts

'SWOT' refers to Strengths, Weaknesses, Opportunities, and Threats. The Strengths and weaknesses being part of the internal factors: i.e. they exist within an organization (or within any company or other setting, that needs to be analysed). The terms Opportunities and threats always deal with the external factors: They always lay outside the testbed either be it organisation or company etc, (UNICEF, 2013).

It also can be seen in Bonnici Tanya, (2015) perspective as a tool wherein, the internal analysis is aimed to identify resources, vital competencies and competitive edges in potentials that inherent to an organization. (see Figure 11).

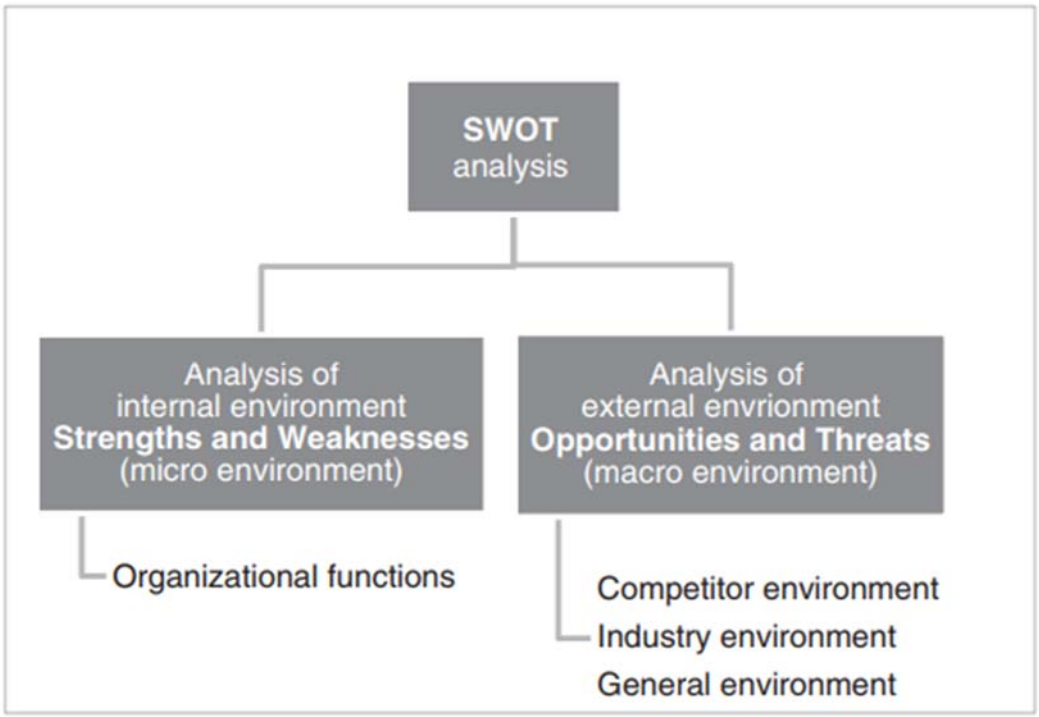


Figure 11. SWOT analysis main components, (Source: Bonnici Tanya, 2015).

GÜREL Emet TAT Merba, (2017), explains that using SWOT Analysis we shall be able to make macro evaluations of the terminals in question possible as it shall enable us to cover the positive and negative aspects of internal and external environment and thus it is also named as Two-by-Two-Matrix, as shown in Table 9.

	Strengths	Weaknesses
Opportunities	Achieve opportunities that greatly match the organization's strengths.	Overcome weaknesses to attain opportunities.
Threats	Use strengths to reduce the organization's vulnerability to threats.	Prevent weaknesses to avoid making the organization more susceptible to threats.

Table 9. Two by Two Matrix (Source: GÜREL Emet TAT Merba, 2017).

2.10 Qualitative Analysis Concept

It can be defined as,

> ‘It is a method of study that values the description and explanation of the phenomena investigated using interviews and observations.1 Initially, such procedures were restricted to anthropology and sociology. However, they gradually have gained ground in other areas of science, as they promote a holistic assessment of the population studied’.

For the topic/subjects wherein the idea of research made is not there and the problem needs to be introduced for the first time, we tend to employ exploratory research and prefer to make qualitative studies that shall help to explain the concept of the research being made, (Juneja Prachi, 2019).

Falcao Denise, Moreno Heitor, & et al, (2017), explain Qualitative research in actual implies systematic and exploratory approach whereas for Crossman Ashley, (2019), the qualitative analysis develops an in-depth sight of the behaviours, interactions, attitudes, social processes and events that composite daily life. The data collected therein should therefore be able to convey reliable description of the meaning, impact, motive, and complexity of the phenomena and behaviours expressing the overall perspective of the exercise, (Falcao Denise, Moreno Heitor, & et al, 2017).

2.11 Planetary Boundary

The extent of ecological pollution thresholds varies in its scales and it generally may be referred to how much pollution is absorbed by the system without transformation; something that our hominid relatives enjoyed over 12,000 years during the Holocene. For Craig, (2019), planetary boundaries, actually reflect what we give to the atmosphere depending upon the type of activities we undertake. For Sawyer & Li, (2013) the Planetary Boundary Layer (PBL) being the lowest troposphere layer, that prevails between some hundred meters to a limited kilometres in depth. For de Arruda Moreira et al., (2018) the PBL Height (PBLH) is the most important parameter as it essentially includes pollutant dispersion, meteorological modelling, weather forecasting and air quality. During the updated research 2014 of the original 2009 version, the scientists identified nine such boundaries, three of these — “the Big Three” — climate change, stratospheric ozone depletion, and ocean acidification, reflect “processes with sharply defined global thresholds” that are “hardwired into the Earth system and cannot be shifted by human

actions," processes that "are capable of sharp shifts from one state to another, with direct implications for the entire planet", (Craig, 2019).

It is of great concern that our planet due to great amount of pollution in the shape of emissions and waste has caused great crossing risk as all three of these boundaries' present status, (Craig, 2019).

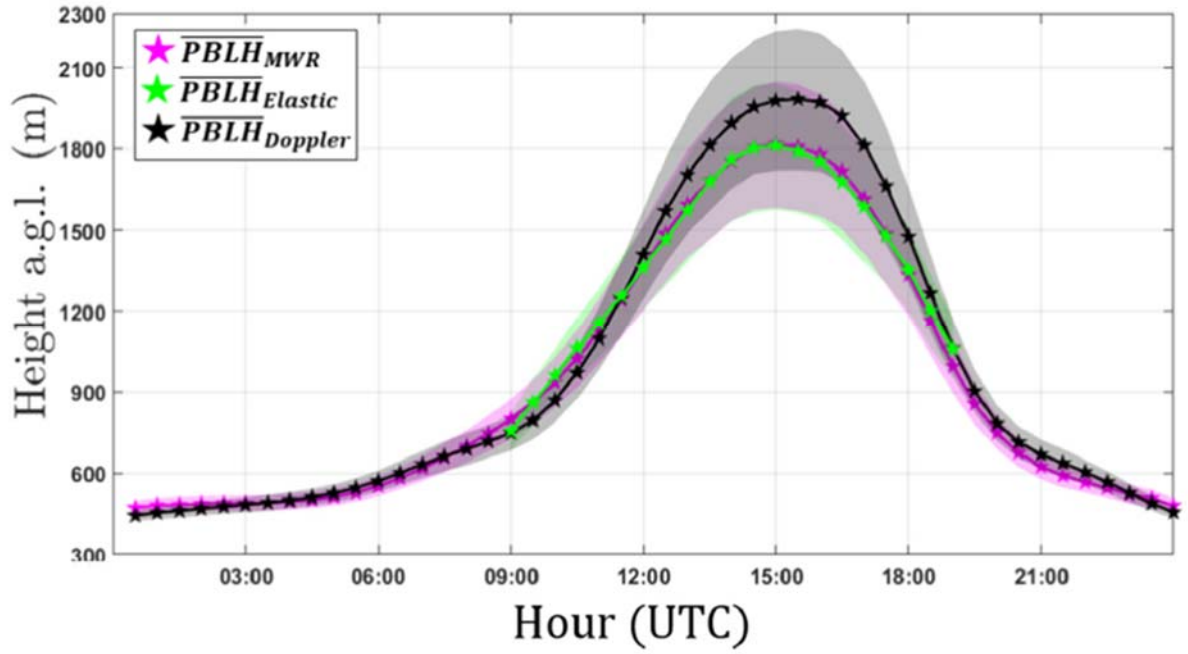


Figure 12. Average values of PBLH provided by MWR (pink stars), EL (green stars) and DL (black stars), (Source: de Arruda Moreira et al., 2018).

The Figure 12 above illustrates the average layer values, the shadows with the coloured stars represent the standard deviation in respective methods, (de Arruda Moreira et al., 2018).

2.12 CE Basic Concepts

Merli, Preziosi, & Acampora, (2018), while linking historical perspective of the CE relates its first ever appearance in Pearce and Turner (1990) study that illustrates the connection between economic activities and its impact on the environment. To Pomázi Ist ván, (2018), Korhonen, Nuur, Feldmann, & Birkie, (2018), CE is not totally a new idea rather it only has been re-emphasised during the last decades as the policy makers and the business community alike are seeking an alternate means towards the prevalent feeble economic condition of the world

resources. The Concept to Merli, Preziosi, & Acampora, (2018), kept progressing through various adaptations, especially by China owing to its green barrier. A think tank on this aspect; Ellen MacArthur Foundation, are contributing towards the progression of the concept and define it as:

> "an industrial system that is restorative or regenerative by intention and design. It replaces the "end-of-life" concept with restoration, shifts towards the use of renewable energy, eliminates the use of toxic chemicals, which impair reuse, and aims for the elimination of waste through the superior design of materials, products, systems, and, within this, business models."
>
> Merli, Preziosi, & Acampora, (2018)

To Stahel, (2016), as depicted in Fig 13 below, the adoption of CE theory and availing resources for the utmost endurance could reduce some nations' emissions by up to 70%; and may enhance their workforces by 4% while reducing the waste.

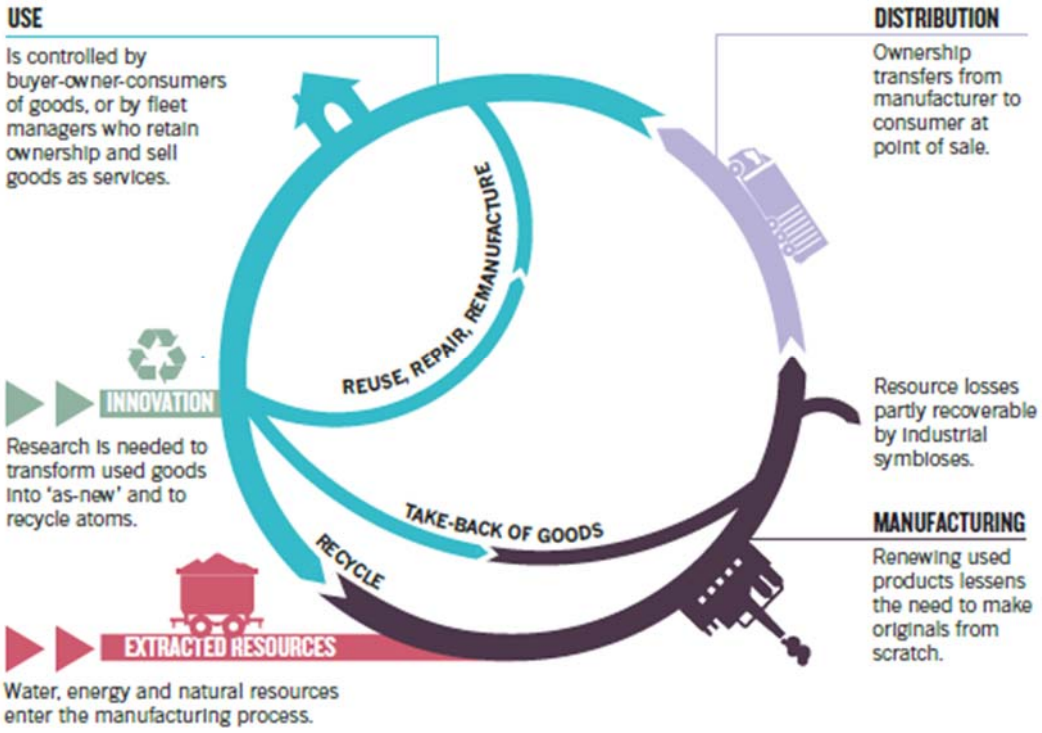


Figure 13. Closing Loops of CE; (Source: Stahel, 2016).

Karimpour, Ballini, & Ölcer, (2019), Ezzat, (2016) explain CE to be 'An industrial system that is restorative or regenerative by intention and design. A model that Ezzat, (2016) define hinges

upon the product remanufacturing using renewable energy, particularly solar power, while exterminating waste being its resource. While Karimpour, Ballini, & Ölcer, (2019), define CE to be;

> 'a system that replaces the end-of-life concept with restoration, shifts towards the use of renewable energy, eliminates the use of toxic chemicals, which impair reuse, and aims for the elimination of waste through the superior design of materials, products, systems, and, within this, business models'.

The concept of linear to circular economy is depicted in Fig. 14 wherein the take-make-dispose theory is encouraged to be a past time story.

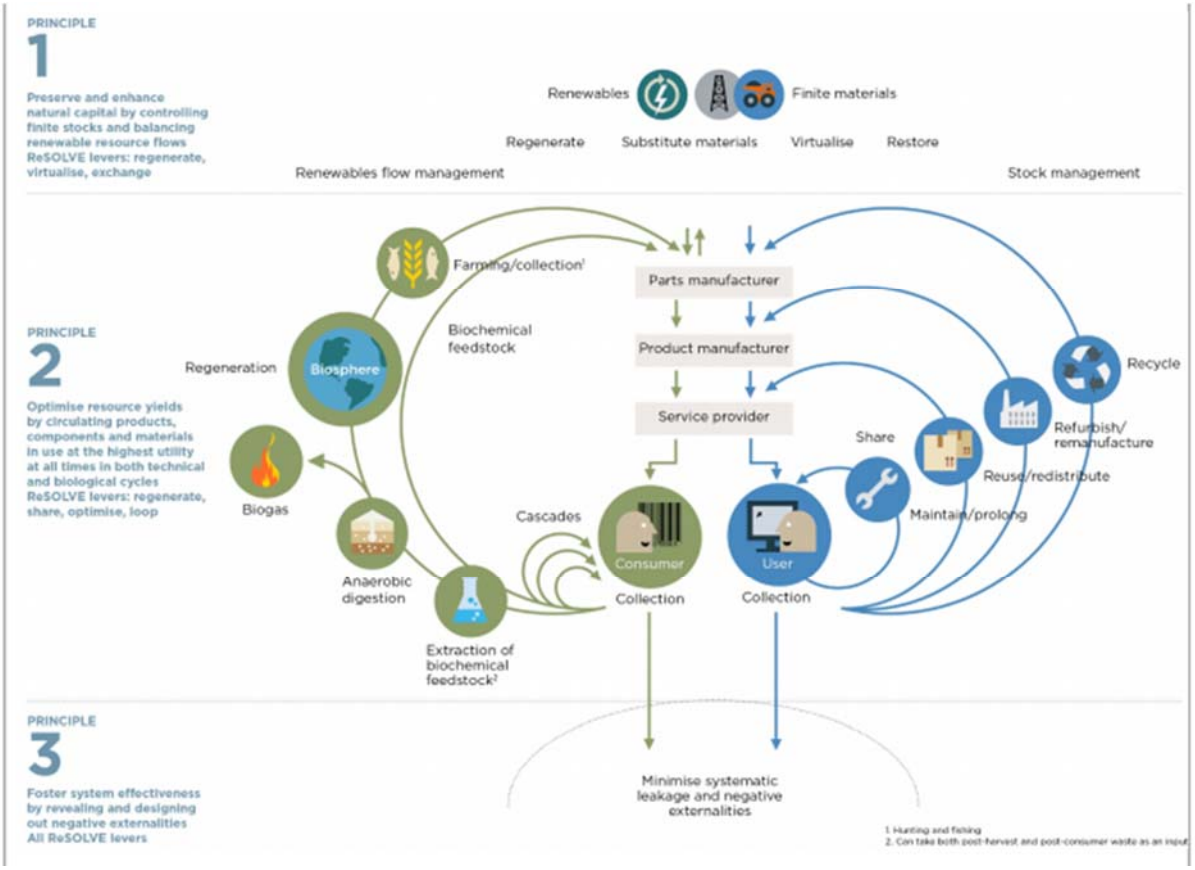


Figure 14. Outline of a circular economy; (Source: Circular Economy, 2018).

There are however 4 fundamental circular economy model principles as shown below; ("Growth within: a circular economy vision for a competitive Europe", 2015; (Ezzat, 2016);

a) Considering the reuse from the design to minimize waste.
b) Using renewable sources of energy and materials.
c) Studying feedback loops within the system to optimize the production system as a whole.
d) Maximizing the usage value of products through sharing them among users and prolonging their life through the reuse, maintenance and repair.

Unlike traditional recycling the CE for Korhonen, Nuur, Feldmann, & Birkie, (2018), is a practical way forward as it shall pivot upon the product, component and material reuse, remanufacturing, refurbishment, repair, cascading and upgrading. It is envisaged that, CE whence completely developed will be able to introduce high value material cycles, cut off low value raw materials, thus introducing sustainable consumption alongside sustainable production.

Figure 15 below depicts an inclusive depiction of the above statement wherein, the inner circles; product reuse, remanufacturing and refurbishment, demand less resources and energy. Korhonen, Nuur, Feldmann, & Birkie, (2018) emphasise that effort should be laid for longer resource value retention within the inner circles. Combustion for energy in CE concepts should always be second to last option, thereby letting the product to retain value, life cycle and quality for longer durations and is also highly energy efficient.

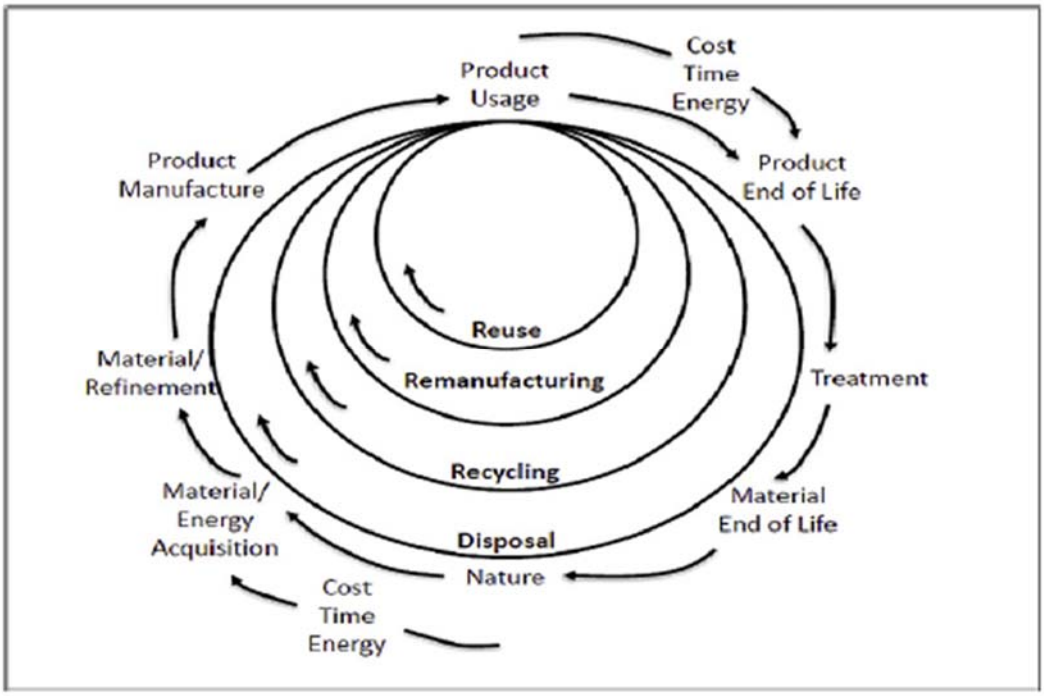


Figure 15. The current concept of circular economy; (Source: Korhonen, Nuur, Feldmann, & Birkie, 2018).

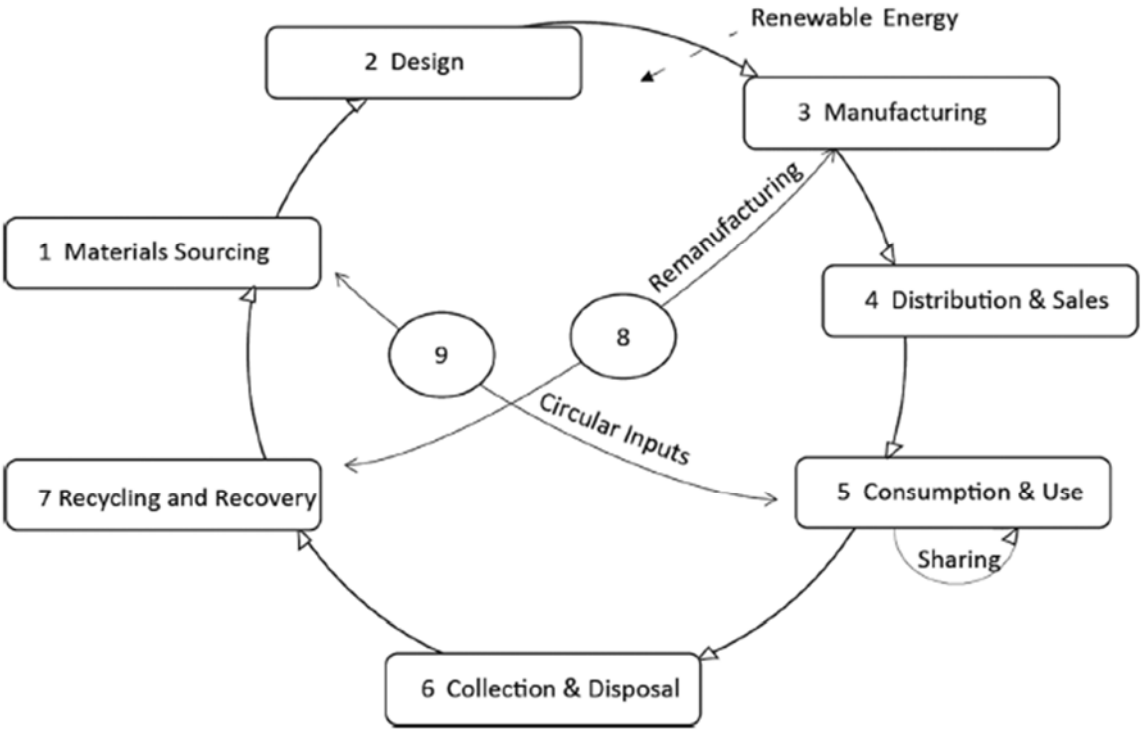


Figure 4. Resource flow chart through circular economy; (Source: Kalmykova, Sadagopan, & Rosado, 2018).

Fig. 16. Above thus depicts the CE concept in a comprehensive manner. The items manufactured are created with flexibility and potential for reuse and recycling, (Kalmykova, Sadagopan, & Rosado, 2018).

CHAPTER 3. BALTIC SEA REGION ENVIRONMENTAL REGULATIONS AND SUSTAINABILITY CONCEPTS

3.1 Baltic Sea Region as Cruise Hub

To Serry Arnaud, (2015), Baltic cruise history remained in doldrums and subjugated to the externalities untoward. The era prior to WW-I was exploited being at two distinct coasts at the Eastern end, with USSR with great demand for Leningrad (St Petersburg) and Sweden/Denmark, however, the war pressures annihilated the cruise tourism from Leningrad. With clouds of WW-II looming on the Russian states the cruise tourism in the Baltics again got restraint to the Sweden/Denmark coasts however, soon after the fall of the Iron Curtain and USSR, St. Petersburg emerged to be one of the leading Baltic Region cruise destinations. Since 2000, the Baltics saw an immense influx of cruise market and the markets reached to 13% more passengers in 2012 in comparison to 2011. Even the global recession couldn't inflate the growing Baltic cruise market and the industry made over 400 round trips and harboured over 70 ships operated by 42 different cruise lines.

For Esteve-Perez & Garcia-Sanchez, (2015), the availability of the most important 3 key stakeholders essential to grow the cruise market of any area/cruise itinerary being;

a. The terminal.
b. The destination city.
c. and the shipping line.

Serry Arnaud, (2015), define for BSR being the most attractive destination of the Northern Europe as it has the 3 essential elements, the most attractive part is its capacity to offer to the tourists easy access to six coasts of important capital cities of the world that too with just an

overnight sailing distance. Beside this BSR is the hub of diverse culture and is rich in history, the destinations are safe and amiable as the residents have good communication skills though English is not the natives' languages. To Esteve-Perez & Garcia-Sanchez, (2015), the size of ships to accommodate passengers upto 6000 have also played a great role in the demand of BSR. For Rodrigue, Jean-Paul & Notteboom, (2013), in 2011 the industry saw 19.1 million passengers contributing towards the international cruise industry rising from mere 7.2 million in 2000, in 2012, Serry Arnaud, (2015), reveal the market share at the Baltic Sea to be around 10.2 %. Baltic Sea thus stood as the largest segment of the Northern Europe market, generating a capacity of around 4.85 million passenger nights in 2012 and around 5.14 million in 2013.

Nelis Alex, (2012), evaluate that with an ever increasing business and with more and more largest cruise ships coming to the industry the reach of the shipping also increased manifolds. Thus given an additional advantage for a more strong growth the Figure 17 below illustrates the main cruise routes of the world with indication of Baltic Sea Regions.

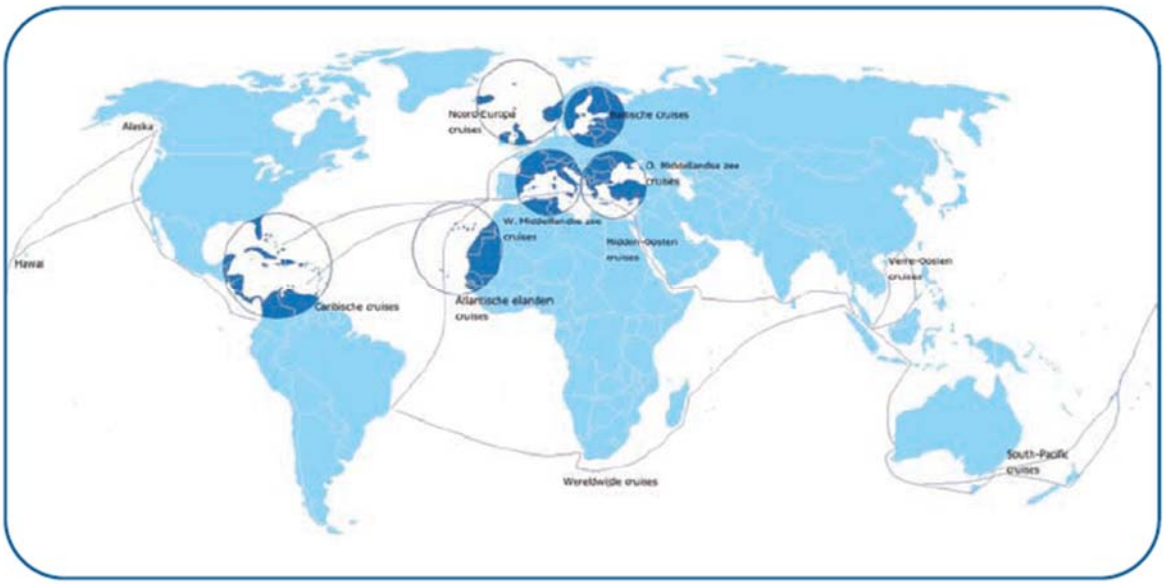


Figure 17. Cruise destinations routes worldwide, (Source: Nelis Alex, 2012).

Pallis, (2015), goes further to express in Table 10 the progressing global cruise market. We can analyse therein the increase of no of beds for the Northern European region from meagre 4.5million passengers in 2003 increasing manifolds to 13.9million in 2013.

Region	2003	2008	2009	2010	2011	2012	2013	10-Year Growth
North America	49.5	56.9	56.8	62.7	62.1	64	63.1	27.4%
Caribbean	35.1	36.9	39.1	46.2	45.5	48	48.1	37.0%
Other North America	14.4	20	17.7	16.5	16.6	16	15	-4.4%
Europe	18.2	35.8	39.6	41.4	49.5	48.7	49.6	172.5%
Northern Europe	4.5	8	10.2	9.7	11.4	13.2	13.9	209.0%
Mediterranean	13.7	27.8	29.4	31.7	38.1	35.5	35.7	160.6%
North America & Europe	67.7	92.7	96.4	104.1	111.6	112.7	112.7	66.5%
Rest of the World	5.3	11.3	13.2	13.8	15.1	20.7	21.8	296.4%
Total	73	104	109.6	117.9	126.7	133.4	134.5	84.2%

Table 10. Global Deployment of Capacity (in millions of bed days; 2003-2013); (Source: Pallis, 2015).

3.2 Environmental Status of Baltic Sea Region (BSR)

Shipping in the past had been making an escape from the environmental pollutant contributor, and, much claim of changing world climate was routed to *'antifouling paints usage, ballast water and fouling as they release non-indigenous species, noise, and emissions of combustion gases and particles to air'*. To Gilbert, Bows, & Starkey, (2010), the industry always was able to escape the Kyoto Protocol; until worldwide deteriorated climate started to damage the health of people living in the port cities, coasts and the hinterlands.

It was later found out that shipping alone contributes great a number of obnoxious gases harmful for human and other living beings. And the main hub for these emissions being the coastal cities, the ports and hinterland. Johansson.L, Jalkanen. J et al, (2013), estimates solely in 2011 the world ports to account '*18 million tonnes of CO2, 0.4 million tonnes of NOx, 0.2 million of SOx and 0.03 million tonnes of PM10'*. For Zandersen et al., (2019), Baltic Sea is an enclosed body of water that makes BSR a very sensitive ecosystem, that is vulnerable to various anthropogenic pressures that include the impacts of prevalent of '*climate change, eutrophication, pollution, overfishing, invasive species, shipping, and habitat destruction'.*

Europe in 2017 struck the great surprise whence the emission reports revealed '*most air polluted region in the world yet being the sulphur emission control areas (SECAs)*'. For nitrogen oxide (NOX) emissions, cruise ships are also of great concern irrespective of the air pollution impact of ongoing land-based "dieselgate" in Europe. (Abbasov Faig, 2019).

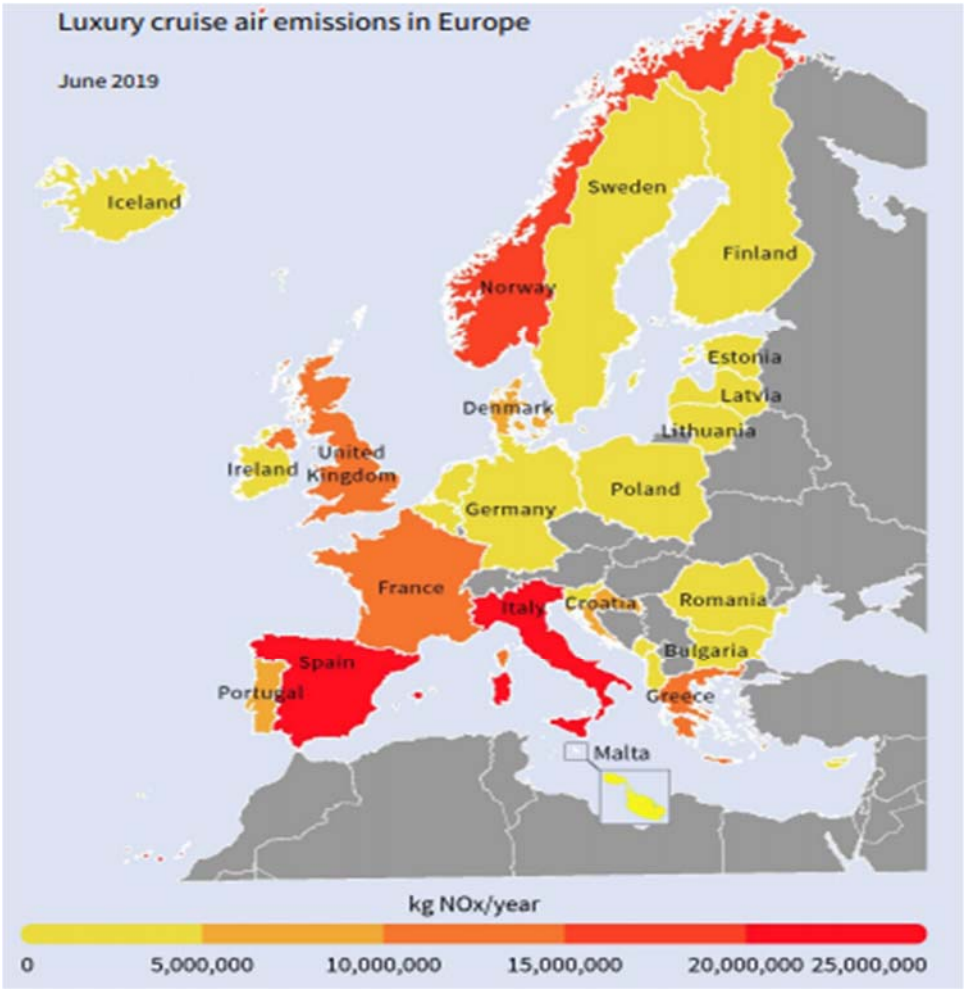


Figure 18. The disposition of NOx in the European cruise line affected coasts in kgs/yr; (Source: Abbasov Faig, 2019).

In Figure 18. above Abbasov Faig, (2019), overlays the NOx affected coasts by the shipping company European Cruise Line, the amount of damage incurred to the coasts on a yearly basis can be seen.

Global cap	SECA
4.50% m/m prior to 1 January 2012	1.50% m/m prior to 1 July 2010
3.50% m/m on and after 1 January 2012	1.00% m/m on and after 1 July 2010
0.50% m/m on and after 1 January 2020 [1]	0.10% m/m on and after 1 January 2015

Table 11. MARPOL Annex VI: ECA regulation of sulphur content in fuel oil; (Source: Gritsenko Daria, 2016).

The Table 11 above shows the implementation of the Sulphur Cap in the world regions wherein it is clearly evident that European states have 0.5% after 2020, (Gritsenko Daria, 2016).

For Brodie, (2014), ESPO after its establishment in 1993, played a vital role in the overall environmental health of the European states' coastal health, from further deterioration. To Gritsenko Daria, (2016), in joining hands with Europe's development revolution created evolution of maritime sector yet, the intensified demand at the maritime domain enveloped the significant pressures on sensitive Baltic region ecosystem. Zandersen et al., (2019), evaluates the damages caused by these pressures in the domains of *'warming temperatures, nutrient pollution, and deoxygenation'* that eventually be transferred to the rest of the world coats not very far than sooner. Though, since the 1990s inception of the Baltic Sea Action Plan (BSAP) was formulated to minimise the damages for a reduced nutrient loads the state of prevailing (phosphorus (P) in particular) is known to raise the targeted level.

Abbasov Faig, (2019), continues to augment in Table 12. the contributors as Cruise ships towards the prevalent poor health of BSR coastal cities of Denmark. The total no of obnoxious gases from cruise shipping includes all the harmful gases esp the SOx, NOx and CO2, inclusive of the particulate matters.

Number of cruise ships	Total SO_x (kt)	Total NO_x (kt)	Total PM (kt)	Total CO_2 (kt)	Total Fuel consumption (kt)
203	62	155	10	10,286	3,267

Table 12. Fuel consumption and air emissions from cruise ships in Europe in 2017*; (Source: Abbasov Faig, 2019).

3.3 Regulatory Framework at EU Countries to Cater Obnoxious Gases

To Liuhto Kari, (2016), the shipping future shall be under the regulatory matters from the world climate change as well as the regional and national environmental bodies. These regulations, seen as barriers to the shipping growth because of complicated demands and assorted additional costs to comply. The main concurrent regulatory amendments in shipping are enumerated in Table 13 below include, but are not limited to the following:

S.No	Regulation	Purpose	Enforcement	Jurisdiction Area
1.	**Sulphur Emission Control Area (SECA)**.Amendment to Annex VI of IMO MARPOL Convention	To regulate sulphur emission limits to ships.	1st January, 2015.	Europe, the Baltic Sea, and most of the North Sea areas.
2.	**Monitoring, Reporting and Verification (MRV);** EU-MRV.	To regulate carbon dioxide (CO2) emissions from ships in EU states.	1st January, 2018.	At all times while at the ports under the jurisdiction of a Member State; BSR.
3.	**Ballast waters;** IMO's Ballast Water Management Convention.	To Control and Management of Ships' Ballast Water and Sediments (BWM).	8th September, 2017.	Effective in all international seas of the world; BSR.
4.	**Discharge of Cargo Hold Washing Waters; Amendment to MARPOL Annex V1.2**	To addon responsibility on shippers for the residues incl of those in wash water are harmful to marine environment (HME).	1st January, 2013.	All international waters of the world; BSR.
5.	**Energy Efficiency Index (EEDI); Amendment to MARPOL Annex VI (MEPC.203(62)).**	Limits the ships' engine power and especially affect ice strengthened ships for ice-infested waters.	1st January, 2013.	Ice strengthened ships for ice-infested waters, BSR.
6.	**Nitrogen Oxide Emission Control Areas (NECA);** Regulation 13 of MARPOL Annex VI.	To regulate all new diesel ships for efficient engine constructions.	1st January, 2016/2021.	Baltic Sea Region.

Table 13. Key regulations for the protection of BSR; (Source: Liuhto Kari, 2016).

3.4 ESPO Waste Management Measures

ESPO since its establishment in 1981 has laid great importance on the European environmental measures. It was in 1996 when ESPO and EcoPorts together started regular monitoring of the European port authorities. In the environmental priorities released by ESPO, we see the influx of priorities in a numerical order. When we see Fig 19, the focus environment is paid the highest priority being Air Emissions at No.1, whereas, the Ship Waste being at No.5, (Reiter, 2014).

Figure 59. Top 10 environmental priorities of European ports for 2018; (Source: Reiter, 2014).

When we consult the Brodie, (2014), environmental report it reveals that Ship waste is regarded as an upper ladder of priority in the 10 list of environmental priorities. It is speculated to be the result of a new EU Directive on Port Reception Facilities for ship wastes. Furtheron, it also reveals that waste reporting has also got the highest priority monitoring by port authorities since 2013 (Figure 20).

Indicators	2013	2016	2017	2018	CHANGE 2013–2018
Waste	67	79	88	84	17%
Energy consumption	65	73	80	80	15%
Water quality	56	70	75	76	20%
Water consumption	58	62	71	72	14%
Noise	52	57	64	68	16%
Air quality	52	65	69	67	15%
Sediment quality	56	63	65	58	2%
Carbon Footprint	48	47	49	47	-1%
Marine ecosystems	35	36	44	40	5%
Soil quality	42	44	48	38	-4%
Terrestrial habitats	38	30	37	38	0%

Figure 20. Percentage of Positive Responses to Environmental Monitoring Indicators; (Source: Brodie, 2014).

3.5 IMO Waste Management Regulations

IMO being a global instrument, encapsulates the regional, national arrangements for areas that require a little more concern and care, due to their oceanographic or ecological condition to be known as 'special areas'. Baltic Sea Region is amongst the areas prescribed to be 'Special Areas'[5]. For these areas there are a set of different regulations and conventions that are required to be followed by the regional states. Few of the Important Maritime Pollution Prevention Conventions are enumerated in Fig 21 as under:

[5] IMO Special Area designation as Appendix E.

a. Convention on the Prevention of Marine Pollution by Dumping of Wastes and Other Matter 1972 (the London Convention).

b. The International Convention for the Safe and Environmentally Sound Recycling of Ships 2009 (the Hong Kong Convention).

c. The International Convention for the Control and Management of Ships' Ballast Water and Sediments 2004 (BWM Convention).

d. International regulation of vessel-based oil spills is most comprehensive, tight, and restrictive when compared to the regulation of other types of pollutants.

e. The International Convention on Civil Liability for Oil Pollution Damage (CLC 1969), often considered to have been initiated due to the Torrey Canyon accident in 1967.

f. The Protocol of 1992 to CLC 1969 changed compensation limits, widened the scope to cover exclusive economic zones (EEZ), and established higher limits of liability.

g. The International Convention on Civil Liability for Bunker Oil Pollution Damage as an instrument analogous to CLC 1969 was adopted in 2001 (and entered into force in 2008).

h. The International Convention on Oil Pollution Preparedness, Response and Co-Operation (OPRC 1990), and amendments to MARPOL regarding the phase-out of single-hull tankers(The sinking of Erika in 1999 set off the EU legislative process, resulted in so-called Erika Packages, and already mentioned Prestige spill in 2002 accelerated phase-out of single-hull tankers in European waters).

Fig 21. Important Maritime Pollution Prevention Conventions; (Gritsenko Daria, 2016).

The setting up of Particularly Sensitive Sea Area (PSSA), IMO ascribes the status to the areas that are sensitive owing ecological or socio-economic or scientific reasons and that particularly need implementation of Associated Protective Measures (APMs). The Great Barrier Reef, Australia, in 1990 being the first followed by the Baltic Sea with (except for Russian waters) being the second to get the status in 2005, (Gritsenko Daria, 2016).

3.6 Waste Management Onboard Cruise Ship at BSR

The Oceans all over the world have been the sole sufferers of human malpractices on industrial, fishing, shipping and coastal ends. Assuming oceans can gulp all the waste humans continued to pour it that has damaged the eco-systems in most sensitive water bodies of the world, (Grip, 2017). IMO MARPOL regulations Annexes cover the requisite terms and references to

minimise pollution from ships. Annex V[6] deals with pollution by garbage from ships. The Appendix, prohibits in details the waste contents to be discharged into the BSR being in the category of plastics and its products, paper and its products in all forms with only exception to overboard due to safety reasons, (Svaetichin & Inkinen, 2017).

The oceans may not have dire consequences of food and other waste dumping owing to their vastness and diversity, however, Baltic Sea being a sensitive ecological entity was not able to withstand even the food waste. ESPO, in order to save the BSR in the longer run, devised policies and conventions to regulate ship board wastes. The EU Directive 2000/59/EC to Brodie, (2014), was a step further to IMO MARPOL Convention 73/78[7] (wherein ports are to have sufficient facilities to embark wastes as per the categorisations). In making regulations ESPO always had been aware of the Baltic sea region ecological sensitivities and the regional conventions, regulations through HELCOM.

IMO foreseeing the changing requirements of waste and its collection came up with an updated version of MARPOL 73/78 in 1999 in the shape of a 'Comprehensive Manual on Port Reception Facilities'. For Brodie, (2014), ESPO in 2000 promulgated strategies to facilitate port administration to prepare ship-generated waste reception plans, that being a little more elaborative and taking a further lead from EU Directive 2000/59. Figure 22 below illustrates the ESPO strategy important contents:

a. Consult with interested parties;
b. Analyse amounts and types of waste generated by ships at the ports;
c. Consider the type and capacity of facilities required;
d. Consider the location and ease of use of the facilities;
e. Ensure that the cost recovery systems for using port reception facilities provide no incentive for ships to discharge their waste into the sea;
f. Ensure that effective publicity is given to the facilities;
g. Submit a written plan to the competent authority;
h. Review the planning process regularly.

Fig 22. Steps desired by ESPO for European Port administrators to handle ships' waste; (Source: Brodie, (2014).

[6] MARPOL ANNEX V as Appendice F.
[7] IMO MARPOL 73/78 Appendice G.

To cover the practical aspects of how the cruise ships are meeting the ships' waste management, Svaetichin & Inkinen, (2017), made a comprehensive research wherein he being wary of the growing worldwide cruise business (reaching to 22 million annual passengers and 55 new ships to join between 2015 and 2020) has defined the roles of both ships and ports in dealing with the waste generated and its disposal. Today, the vessels are required to maintain a garbage record-keeping book that includes all the details of discharge operations, likewise the Port Authority of each port is also obliged to ensure the provision of port reception facilities, without causing undue delay to vessels.

3.7 ESPO Environment Priorities

ESPO gave the environment a top most priority since 2013. EU environmental policy hinges on undermentioned principles, Brodie, (2014b):

a. Public access to information;
b. Public participation;
c. In decision-making and;
d. The "polluter pays" principle.

These principles gave comprehensive guidelines to the EU ports and vision for the future while keeping the public private participation concept intact. The polluter pays horizontal concept marked EU a new approach in European ports and covers activities that aims to prevent and restore environmental damage, (Source: Brodie, 2014b).

3.8 EU CE Package

The CE package[8] containing ten key indicators by the EU is just a monitoring framework to have an eye towards the progress on circular economy aspects within the EU and at the national level.

[8] EU CE package Appendice H.

The CE based Eco-industries and eco-innovation at present is contributing worth a trillion euro. It is envisaged that better eco-design, prevention of waste and reuse can take EU businesses up to €600 billion. It is also envisioned to reduce total annual GHG emissions, (Circular economy, 2018).

CHAPTER 4. WASTE TO ENERGY MANAGEMENT

4.1 EU Ports Waste Policies

The world shipping industry flourished between 1994 - 2008, from 437 to 742 million gross tons, (Franeker, Meijboom, Jong, & Verdaat, 2009). With ever increasing shipping at sea and globalisation coupled with industrialisation the products used by the shipping started to be more non-decomposing and more harmful to the seas contrary to the days prior 1900. The Sotiris Raptis, (2018), Port Reception Facilities (PRF) directive was firstly introduced by EU in 2000 and its revision started in 2015. Therefore, the merger of the MARPOL into EU laws was considered to be an effective tool to meet the lapses on ground.

To Franeker, Meijboom, Jong, & Verdaat, (2009), the directive was intended to facilitate the shipping to hand their waste and cargo residues to ports, whereas, on the same end it obliges the ports to receive the wastes and the directive was issued as Directive 2000/59/EC. Key notes of the same are enumerated as Figure 23 below:

- Obligatory disposal of all ship-generated waste to reception facilities before leaving port. Ship-generated waste includes operational oily residues, sewage, household and cargo-associated waste, but not residues from holds or tanks.
- Indirect financing, to a 'significant' degree, of the delivery of ship-generated waste. Finances for such 'free' waste reception should be derived from a fee system on all ships visiting the port. Delivery of cargo residues remains to be paid fully by the ship
- Ports need to develop and implement a 'harbour waste plan' that guarantees appropriate reception and handling of wastes

Figure 23. Key notes of EU Directive 2000/59/EC, on PRF; (Source: Franeker, Meijboom, Jong, & Verdaat, 2009).

It is therefore endeavoured to present a flow of the EU relevant directives in ensuing paras as a brief oversight on proceedings in this regard that shall lay an emphasis as to How greatly concern is shown by EU states on waste related matters at sea and ports alike:

a. Directive 2000/59/EC[9], 27 November 2000 on Port Reception Facilities (PRF) (Ship-generated waste & Cargo residues).
b. Directive 2009/16/EC on Port State Control.
c. Directive 2010/65/EU on Reporting formalities for ships arrival/departures from EU Ports.
d. COM(2018) 33[10] final 2018/0012(COD), PRF for waste delivery from the ships.
e. DIRECTIVE 2019/883/EU[11] on PRF for waste delivery from the ships.

The European ports according to Sotiris Raptis, (2017), are currently offering green services to vessels; that includes 20% of high voltage OPS services; 22% of LNG bunkering and; 62% as environmental differentiated ships' port charges.

4.2 IMO Ports Waste Policies

The Baltic Sea for Conley, (2012), holds a very special place in terms of water bodies of the world with a great amount of human nutrient influence as it is bounded by 9 states. The activities inflicting damages includes but not limited to sewage dumping, food waste dumping, oil spills, industrial wastes that amounts 20 million tonnes of nitrogen and 2 million tonnes of phosphorus from coastal cities, plastics in large amount, farmers wastes, fishing nets and all, all contributing towards oxygen deprivation 'hypoxic' waters. Such state during the recent decade, is estimated to damage approx 60,000 sq km of the Baltic Sea each year. Hypoxic waters in turn cannot sustain marine life into it. The Fig.24 below illustrates the deadline to be of 2021 for the Baltics ecological system revival through ongoing efforts, Conley, (2012).

[9] Directive 2000/59/EC, Appendice J1.
[10] COM (2018) 33 Appendice J2.
[11] Directive 2019/883/EU Appendice J3.

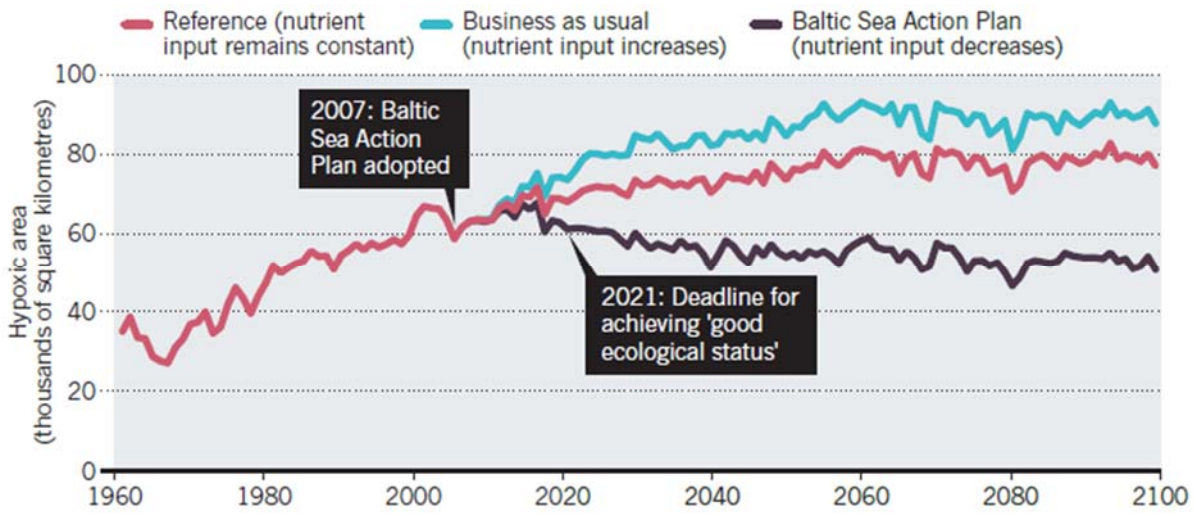


Figure 24. BSR Hypoxic Area; (Source: Conley, 2012).

Breathing Life into the Baltic Model predicts that the action plan to reduce nutrients that flow into the Baltic Sea should be effective at increasing oxygen levels in the water; (Source: Conley, 2012).

The health of the BSR has an indirect economic development impact on the coastal cities/states. Economic activity dependent on the seas cannot flourish if it has been hampered by the overall health of the waterbody. The aftermaths of marine litter for Franeker et al., (2009), is suffered by coastal municipalities in the shape of excessive beach clean ups costs, polluted beaches keep the tourists restraint presence, especially wherein some litter causes to be a health risk for them. Low fisheries catch owing to marine litter that at occasions may ends up discarding of tainted catch.

The International Convention for the Prevention of Pollution from Ships (MARPOL) was introduced for the safety and environmental health of the world sea on 2nd November 1973 at the IMO. Details of convention Annexes are appended as Appendice , however, the excerpts are mentioned in Table 14. below for handy purpose.

MARPOL Annex IV	Wastewater (Sewage)	Sewage systems Standard discharge connections Discharge of sewage Reception facilities
MARPOL Annex V	Waste (Garbage)	Disposal of garbage outside special areas Special requirements for disposal of garbage Disposal of garbage within special areas Reception facilities Port State control on operational requirements Placards, garbage management plans and garbage record-keeping
MARPOL Annex VI	Air Emissions	Ozone-depleting substances Nitrogen oxides (NOx) Sulfur oxides (SOx) Volatile organic compounds Shipboard incineration Reception facilities Fuel oil quality Requirements for platforms and drilling rigs Energy Efficiency Design Index (EEDI) for certain new ships Ship Energy Efficiency Management Plan (SEEMP) for all ships

Table 14. IMO ANNEXES related to sustainability and environment aspects; (Source: Wang, Li, & Xiao, 2019).

The details of special area status of BSR by IMO is also explained in the Figure 25. below. MEPC.200(62) made recent amendments to MARPOL Annex VI by special area definition, sewage discharge regulation and PRF for cruise ships.

Special Areas

In July 2011, MEPC 62 adopted, by resolution MEPC.200(62), the most recent amendment to MARPOL Annex IV, which entered into force on 1 January 2013. The amendment introduced, inter alia, a definition for Special Area as well as relevant requirements for the discharge of sewage from passenger ships in Special Areas and for port reception facilities.

The discharge of sewage from passenger ships within a Special Area is generally be prohibited under the new regulations, except when the ship has in operation an approved sewage treatment plant which has been certified by the Administration (see resolution MEPC.227(64)). The sewage treatment plant installed on a passenger ship intending to discharge sewage effluent in Special Areas should additionally meet the nitrogen and phosphorus removal standard when tested for its Certificate of Type Approval by the Administration (resolution MEPC.227(64), section 4.2).

Currently, the Baltic Sea area is the only Special Area under Annex IV. In accordance with resolution MEPC.275(69), the discharge requirements for Special Areas in regulation 11.3 of MARPOL Annex IV for the Baltic Sea Special Area shall take effect:

.1 on 1 June 2019, for new passenger ships[1];

.2 on 1 June 2021, for existing passenger ships[1] other than those specified in .3; and

.3 on 1 June 2023, for existing passenger ships en route directly to or from a port located outside the special area and to or from a port located east of longitude 28°10' E within the special area that do not make any other port calls within the special area.

Figure 25. BSR Special Area and sewage and PRF facilitation by IMO Annex VI; (Source: Wang, Li, & Xiao, 2019).

4.3 ESPO Ports Waste Policies

The European Sea Ports Organisation (ESPO) was founded in 1993 as an outcome of 1974, the European Commission Port Working Group, ESPO, (2019). The organisation always endeavoured to take the lead from IMO regulations. The framework of the research project ECOPORTS (2002–2005), the Self Diagnosis Method (SDM), for Puig, Wooldridge, &

Darbra, (2014) was yet another step to mitigate the prevalent environmental risk and establishing priority responses. Notwithstanding the most current project being PPRISM (2010–2011), that encourages European ports for monitoring and reporting on selected Environmental Performance Indicators (EPIs).

The PRF Directive was brought on table in 2000 with its revision in 2015, wherein ESPO co-chaired the ESSF PRF working group alongside experts from Belgian, Dutch, Estonian, Finish, German, Greek, Irish, Italian and Swedish ports, SOTIRIS RAPTIS, (2018). Core objective being to tackle sea-based sources of marine litter, upsurge efficacy, lessen managerial burden and copiously enforce 'polluter pays principle', SOTIRIS RAPTIS, (2018).

At ESPO, garbage management and port waste issues have a high profile environmental priorities. Puig, Wooldridge, & Darbra, (2014), also discusses the importance of ship waste as it found a ranking in the Top -10 environmental priorities and is being accorded to relevant Directive and debates relating to facilitation to new types of ship waste with enhanced volumes at the port reception facilities.

Figure 6. Top 10 Environmental Priorities of the Port Sector Over Years; (Source: Brodie, 2014).

Brodie, (2014) at Fig. 26 depicts the priority setting of Waste as a priority in the environmental setting. We can see that the term Garbage/Port waste came to the shipping stakeholders for the first time not before 2004. The factor though not always in the first three top environmental priorities however remained within the top 10 priorities list until today.

4.4 Waste to Energy Theories

The renewable energy topic is not new to the world despite the ever-increasing energy savings and development projects there has been no port specific research, Acciaro Michele, Cusano Maria, & et al, (2014). China in this regard is working more however, EU also has introduced special packages to foster the theory into pragmatic results.

There are different waste-to-energy theories, however, due to paucity of time and limitation on the use of words it shall be endeavoured to present a few that are commonly in use in the market and may be adopted by the ports as energy sources for visiting cruise lines.

Studies on biodegradable show that, '⅓ of the world food produced yearly for human consumption ends up in waste and amounts 1.3 billion tonnes'. Such a huge amount of food waste can be managed for biomethane gas that after necessary upgradation can be fused into natural gas grid stations. The current food waste has the capacity to produce 367 m3 of biogas per dry tonne at approx 65% methane. To Dobraja Kristine, Barisa Aiga, & Marika Rosa, (2015), the inception of the project shall also be able to meet the EU waste and renewable energy targets. Passenger ships, generate waste following their routine messing activities and operations. Food waste being the sole waste stream amounting upto 3.5 kg/day onboard a cruise vessel, (Wilewska-Bien, Granhag, & Andersson, 2018).

If designed for sustainability, FW management can perform a variety of roles in the creation and transition towards sustainable societies, (Kim et al., 2013; Ingrao et al., 2016). A few set of theories that convert waste into energy is summarised by Ingrao Carlo, Messineo Antonio, et, & al, (2018), in their research work wherein they have enumerated a set of different options associated with FW disposal treatment. These are as under:

a. Landfill disposal;
b. Two-stage AD system using Ultrasound pre-treating;
c. Thermophilic acidogenic hydrogenises;
d. Long-term AD of FW stabilised by trace elements;
e. Single stage AD

Ingrao Carlo, Messineo Antonio, et, & al, (2018), further elaborate the efficacy of b,c, and d being more economical and environmentally friendly procedures in comparison to landfilling. Whereas, option b, being the most feasible in cost and better GHG restraints.

4.5 Waste to Energy Management

We need to keep in mind the core aspect of why do we need energy for, thus it shall entail us for the amount of energy that needs to be created depending upon the demand and supply

theory. Acciaro Michele, Cusano Maria, & et al, (2014), refers to energy management as the use that shall have to be expressed clearly for the purpose it needs to be created/generated. The options of the same are as enumerated:

a. Energy required exclusively for port and port related infrastructure and superstructures, that include but not limited to, terminals, administration building, locks, bridges, buoys and lighting etc.

b. Energy generation to be offered to visiting ships for their sustenance at ports without running their own power generation methods, that include, for electricity and all other domestic and operational purposes.

c. Energy requirements for port related and induced activities such as railway operations, refineries, tourism and steel and metal works etc.

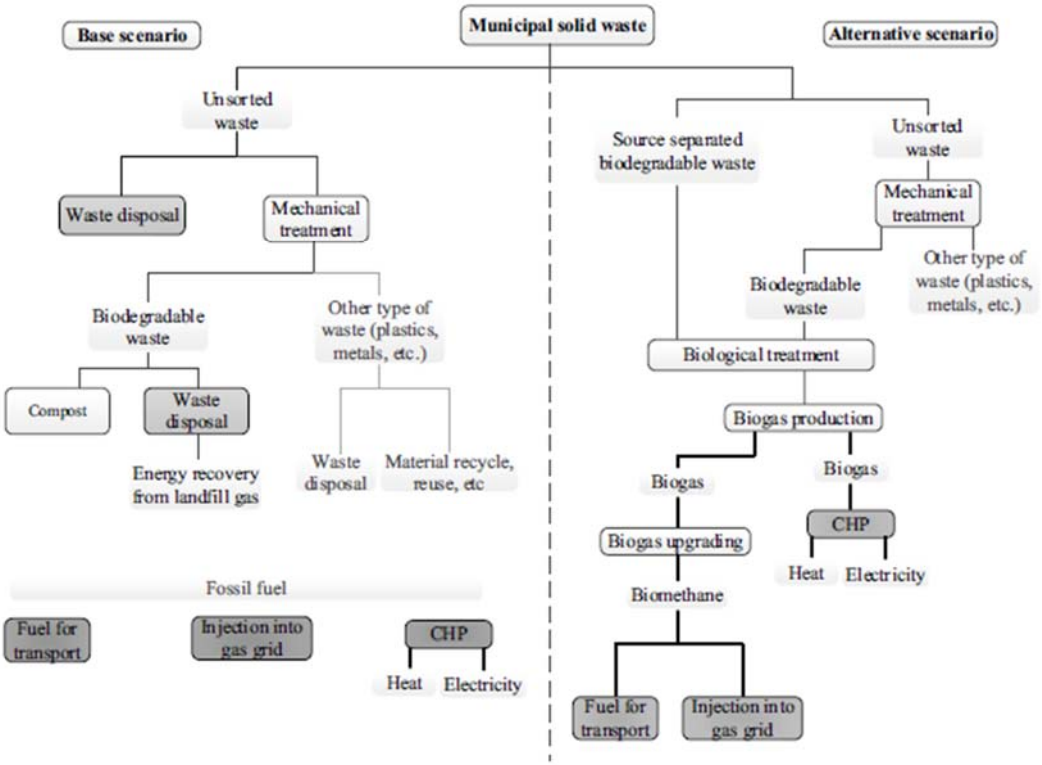


Figure 7. Base and alternative scenariosö; (Source: Dobraja Kristine, Barisa Aiga, & Marika Rosa, 2015).

In Fig. 27 above, we see that Dobraja Kristine, Barisa Aiga, & Marika Rosa, (2015) have formulated a complete management cycle of how the municipal solid waste is transformed from waste to useable biogas energy source that is all ready for use in the shape of heating and electricity sources.

The cruise ships food waste (FW) is a rich source of biogas production, however, the prevalent ports infrastructure to handle waste differs to what facilities are available at the land front of municipality. Waste to Energy models for ports are yet in the research work and that too limited. In the preview of the apprehensive conceptualisation of FW handling at the ports (Wilewska-Bien et al., 2018) in Fig. 28. Below illustrates the available options to deal with the cruise ship FW for beneficial purposes.

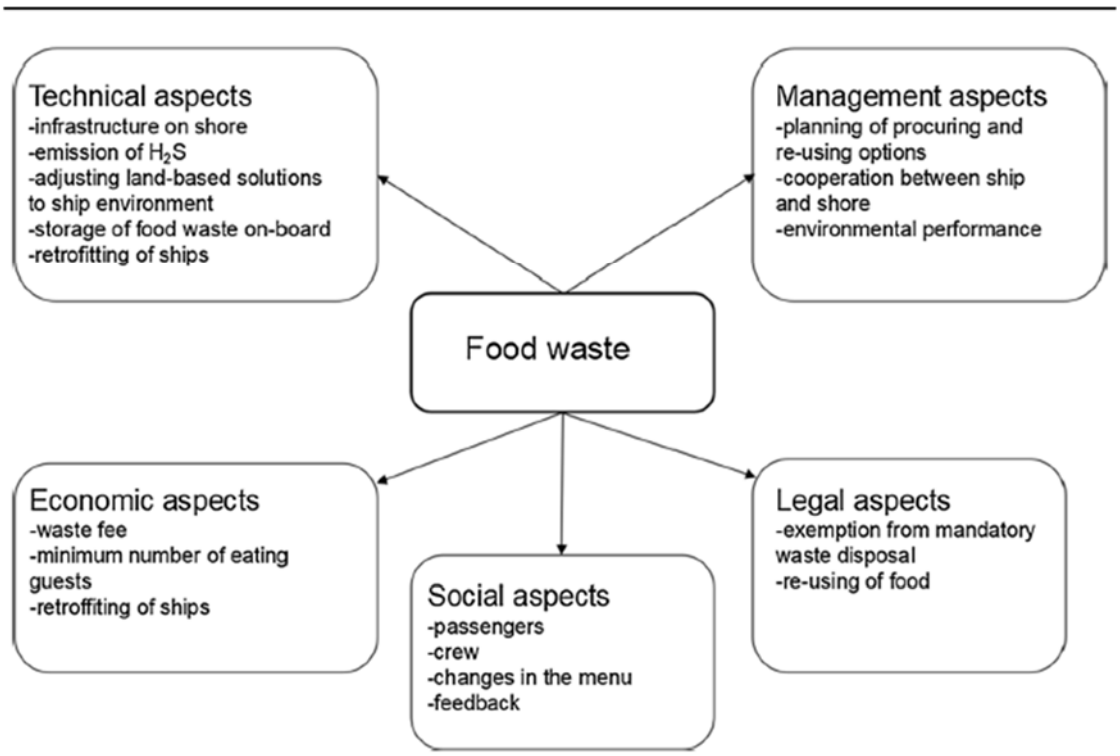


Figure 28. The aspects of the ship-generated food waste management; (Wilewska-Bien et al., 2018).

Sweden, at present is known to have better and advanced waste management facilities at ports with some options pertinent to handle food waste.

CHAPTER 5. CIRCULAR ECONOMY AND ENVIRONMENTAL ASPECTS – CASE STUDY PORTS

5.1 Factors To Choose Following Ports For The Purpose Of The Research

To proceed further onto the analysis of the study, I shall discuss now the reasons to choose Copenhagen, Helsinki and Tallinn as case study ports. When we tend to analyse the reason we come to know that of all the factors that are important for the shipping lines and the passengers to choose a cruise port, the environment didn't get much priority for either of them. Though, it is pertinent to mention that shipping companies and ports at their own after the IMO MARPOL regulations 73/78 and EU/ESPO directives took some measures to move towards sustainability aspects. However, long after the inception of the ESPO Directive 2000/0005 nothing concrete has been made towards the CE aspects for the cruise ports/shipping. Therefore, in making ports selection only a few important factors from the long list of general prevalent perspective have been chosen due to paucity of time and words limitation.

The core factor to the choice of the ports was a mix and match of ports within the different region that could usurp some meaningful results. Importantly, priority was accorded for ports with large cruise and passenger calls and that have great importance in the regional geographical presence. Since, homeport is the most vital port in terms of shipping lines and port municipality alike, therefore, Copenhagen was chosen. Homeport in the cruise industry serves as the main contributor towards the cruise shipping in any region. Likewise Helsinki and Tallinn were chosen to be the most vital port of calls in the Gulf of Finland; North West BSR.

These destinations in the hub of the cruise ports bag the most number of ship calls and passengers and are the most visited and liked ports of the region. Table 15. Below clearly depicts Copenhagen being the top called-on port followed by Tallinn and Helsinki.

Rank '13	Port	Ship calls 2013	Ship calls 2014 (expected)
1	Copenhagen	347	315
2	St. Petersburg	335	309
3	Tallinn	330	315
4	Helsinki	282	269
5	Stockholm	278	277

Table 7. TOP 5 Baltic ports by ship calls; (Source: Thom Dr. Madlen, Busse Frank, & Brauner Thomas, 2014).

5.2 History and Geo-Strategic Importance of Copenhagen Port as Cruise Destination in the BSR

The history of Copenhagen as a port dates back to the 9th century when the Vikings started to use it and gave it the name of Havn (”harbour”). Not much late owing to its geo-strategic location in the narrow Öresund Sound the port emerged as the Traders Harbour (Kaupmannahafn in Old Norse), that emerged as the present day Copenhagen. Today, the port being at the gateway to the Baltic has an immense socio-economic advantage, also because it adds-on to its advantages through a joint venture with the Port of Malmo in Sweden. However, the largest ownership is with the Danish state along with Copenhagen Municipality and Malmö City alongside other private investors, (CMP Vision, 2030).

CMP is the leading northern European cruise ship port and is the ideal home port for cruises in the Baltic Sea and along the western coastline of Norway. Cruise Copenhagen Network was established in 1992 as a collaboration between Wonderful Copenhagen, Visit Denmark, Copenhagen Malmö Port, Copenhagen International Airport, SAS and a long list of private and public organizations that are involved in the cruise industry in Copenhagen. The association's goal is to unite businesses in an effort to further develop and market cruise tourism and strengthen Copenhagen as Northern Europe's gateway, (Various CMP News Journals).

Copenhagen under the CMP flagship has division of shipping activities, wherein Copenhagen deals with the Cruise shipping as turnaround hub and Malmo as the great Ro-Ro hub. The

cruise destination at the Copenhagen comprises of Nordre Toldbod, Langelinie and Ocean Quay. Each quay has different dimensions and capacities, however, Ocean Quay houses the most modern cruise facilities with Three state of the art terminals. With these terminals Copenhagen is visited by millions of passengers every year from over 150 states of the world. Soon after the commissioning of Terminal 4 in 2020 (mainly being constructed for turnaround passengers) the port shall add-on to handle over 5000 passengers at one time under one roof. Such a futuristic step is made to retain the homeport status of the cruise terminal at Copenhagen. Fig. 29. Below shows the location of different cruise docks as an expansion futuristic plan of CMP, (CMP, 2017).

Figure 29. The overview of Copenhagen Cruise Terminals, inclusive of upcoming Terminal 4; (Source: CMP, 2013).

Copenhagen cruise port being at the much expansive transnational areas of Northern and Eastern Europe serves as the heart of the Öresund region, and serves the region with approx 4 million affluent consumers. The cruise destination through its continuous improvements in the infrastructure, service and information received ”Europe’s Leading Cruise Port” award on five occasions between 2005 and 2012, (CMP, 2013).

Rank '13	Port	Passenger visits 2013	Passenger visits 2014 (expected)
1	Copenhagen	800,500	750,000
2	St. Petersburg	523,525	513,885
3	Tallinn	519,319	480,000
4	Stockholm	485,581	500,000
5	Rostock/Warnemünde	483,000	500,000

Table 16. TOP 5 Baltic ports and GCP partner ports by passenger visits; (Source: Thom Dr. Madlen, Busse Frank, & Brauner Thomas, 2014).

Table. 16. Above gives a clear picture of Copenhagen importance as the turnaround port wherein we can see the great influx of passengers in comparison to other ports of the region, thus making it a cruise shipping hub of the BSR nexus.

Between 2000 and 2012, Serry Arnaud, (2015), explains the annual average increased rate of 9.4%. Serry Arnaud, (2015), further expresses the economic aspects of Copenhagen cruise terminal wherein an average passenger expenditure amounts approx 100Euros whereas the crew tends to spend around €25 per call. However, of all the services and plans CMP has for the future there is as yet No circular economy aspect being planned for the port. It is pertinent to highlight that a study on Circular Economy modelling with regards to CMP was conducted in 2017 by a WMU student. Karimpour Reza, (2017), states to be the first to dilate prospects on installation of CE model in the CMP cruise terminal ports, wherein ships' waste is managed by the port authority for onward utility at port-owned biogas plant to generate environment friendly energy solutions.

The port however, serves the visiting ships with the solid waste collection facilities and sewage waste handling facilities through direct shore connector pipes that take the sewage downstream to municipal facilities with flow rates of 3 - 300 m3/h, (Cruise Baltic, 2019).

5.3 History and Geo-Strategic Importance of Helsinki Port as Cruise Destination in the BSR

The history of the port of Helsinki dates back to 1550 with inception at the face of Vantaanjoki River as the commercial and port city by King Gustav Vasa of Sweden in an attempt to compete at Baltic Sea for sea and military transportation. In 1812 Helsinki got the capital status and in

1917 post Finnish independence the port got an ultimate boost in business. In 1921 Helsinki Port Authority was founded and in 1972 the year-round cruise shipping services were introduced through South Harbour and cargo ferry traffic in Sörnäinen, (Helsinki Port, 2019).

The cruise journey as expressed by Helsinki Port, (2019), took momentum from 1975 onwards with advent of different cruise shipping lines and the passenger traffic grew from 1 million in 1975 to over 10 million visitors in 2011. It was in 1975 when the new passenger terminal design commenced for Katajanokka. Today, the Port of Helsinki stands as main Finland port and fifth most famous cruise destination in the BSR, as its geographical location inextricably includes ferries and cruises from Sweden and Estonia alike. In 2018, alone the international passenger alone accounts approx 520,000 visitors that outclassed the 2017 no with over 40,000 passengers with 8.5% lead, (Helsinki Port, 2019).

Helsinki city works international cruising with four harbours: Hernesaari, Lansisatama (Western harbour), Etelasatama (Southern Harbour, including Kanavaterminaali pier) and Katajanokka, with Katajanokka and Etelasatama almost serving passengers at the Market Square, and Hernesaari and Lansisatama being 4.5 and 4 km distant respectively from Market Square. The core attractions to Paananen & Minoia, (2018) for tourists being the historical centre and the Cathedral. More includes museums, cultural centres, and shopping malls.

With the induction of new LHD dock all the cruise shipping shall be contained therein especially for large cruise ships at Hernesaari replacing Melkin Pier, thus shall enable more efficient ship and passenger services, (Helsinki Port, 2019). In Figure 30. below however we see the ever-increasing growth of the Baltic Sea region ports of calls with growing no of Helsinki destined international cruise ship passengers, that alongside the BSR growing numbers also shows the relevant enhanced trends.; (Paananen & Minoia, 2018).

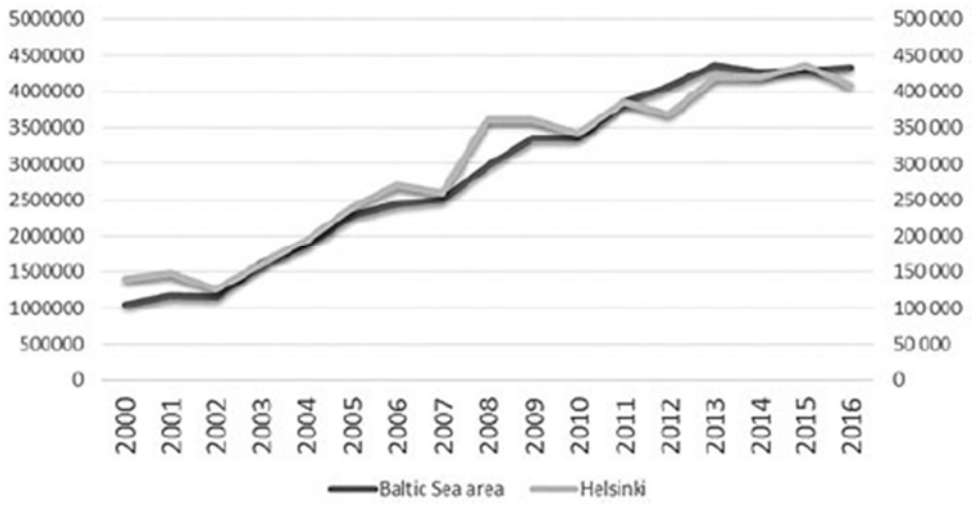


Figure 30. The number of passengers in Helsinki and in the Baltic Sea area in 2000–2016; (Source: Paananen & Minoia, 2018).

Serry Arnaud, (2015), further authenticates Helsinki as an emerging cruise destination calling it to be 'some of the largest ports in the BSR' serviced by cruise liners. In the growing world of most technological advances and attractions cruise buyers expect and tend to fall for the modern and well-functioning units that are generally not too far apart and serve the commuters with all the best services under one-roof of terminal. Lääne Luulea, (2016), therefore have acknowledged this modernisation at the Baltic Sea Region cruise destinations wherein Copenhagen, Helsinki and Tallinn are already making their way through implementation of Vision 2030.

5.4 History and Geo-Strategic Importance of Tallinn Port as Cruise Destination in the BSR

The port of Tallinn is the oldest capital city in the BSR nexus that has seen and carry the burden on the shoulders of thousand and many more years. However, since the research work is passenger related therefore, we may fold it into a few paragraphs by taking lead from 1870 wherein the first passenger steamer Helsingfors commence its sailings from Helsinki-Tallinn-Lubeck routes. The passenger traffic then continued to sail between the Finnish waters across the coasts in BSR with a variety of new additions. In 1989 the passage for Tallinn-Stockholm was opened, and later that year a joint venture of Estonia-Finland began a service of present day, Tallink, vested with transportation of cars and passengers alike and thus laid the

foundation of ferry traffic between the two states. On 10th Oct, 1989 Port of Tallinn, Copenhagen and Rostock initiated the Baltic Port Organisation (BPO) with headquarters in Copenhagen to look-after the shipping ordeals of the BSR states. Historically BSR remained the hub of the world transport activities, today, BSR is the fastest growing business region of the world and Estonia with 3800kms of coast with Port of Tallinn being the largest port authority in BSR is the fifth largest passenger port, (Tallinn Port, 2019).

The Tallinn port is surrounded by six harbours that includes Old city Marina, Muuga, Paldiski, Paljassaare and Saaremaa. The Port of Tallinn estimating the growing edge of the cruise traffic in the region and at the Tallinn harbours formulated a Masterplan 2030 that is envisaged to encapsulate the great socio-economic benefit to the city and the state. In an implementation of the plan it is endeavoured to keep the environment, continued operations, growth and development of the port at the foremost priority, (Tallinn port masterplan 2030).

Tallinn is situated at the mouth of the Gulf of Finland thus making it most important stop over for the Gulf. The current development plans are futuristic and based upon the geo-strategic importance and shipping traffic strength in the Gulf. The Muuga and Paldiski harbours being most important sea route shall be furbished with new berths and terminals coming up at reclaimed lands. The upcoming terminals under the ambit of Masterplan 2030 shall encompass areas of port-city relevant activities alongside urban development areas all combed into a united functional system comprising a human-centered and integrated approach. Such a hub shall facilitate commercial, socio-economic, spatial and environmental aspects availing maximum financial and spatial importance to the sea front, (Tallinn Port, 2017).

To meet the interim solutions the Old harbour D-terminal shall complete its development work by 2023 thus able to meet-up the ever growing cruise traffic. Tallinn already is working on the Smart-Port concept wherein complete traffic management inside the port shall be automated for **pre-check in, check-in and line management** services for vehicular passengers thus attaining little lost time of passengers and pollution friendly environment with little lost time by vehicles in the queue.

Further on, there is a shore-side energy facility to the passenger quays for the liner-vessels berthed for over 6 hours successively. This is envisaged to reduce the time lost by passengers and thus less emissions by ship auxiliary running systems. The facility of automatic mooring

on selected berths is also planned to improve the efficiency and safety. To meet the passenger satisfaction D-Terminal shall be equipped with enhanced parking facilities. To run the terminal year round the arena shall offer multipurpose venues to conduct multifaceted events with roof promenade for public use. The Masterplan 2030 is made with vision to connect city and public realm with the port that shall complement each other by enhanced port functions. To meet this into a pragmatic solution the port area shall comprise of housing and working space for multinationals and shipping firms while the port continues to carry on its other functions, (Tallinn Port, 2017).

The important features of the Smart Port concepts of Tallinn port are enumerated in Fig 31. below:

1. designing the solution based on passengers, not technology;
2. setting the solution's quality criterion to be an improved user experience (using design thinking principles);
3. ensuring usability in various weather and other conditions (day-night, fallen leaves, snow);
4. focussing on creating uniformity and simplicity of service for the end user;
5. ensuring universal functioning –unified check-in system for all various operators;
6. implementing the concept of personal check-in time and resulting time savings and environmental conservation
7. online pre-registration
8. integrating technologies:
   number plate recognition as an identification;
   automatic vehicle dimension check against pre-registration information

Fig 31. Smart Port facilities of Tallinn Port; Source: Tallinn Port, 2017).

CHAPTER 6. ANALYSIS

This chapter shall hinge upon the overall analysis of the study. The important factors of environment and CE with regards to WTE were critically discussed in Literature Review. The findings thus reached have been assimilated in terms of respective cruise terminals' strengths/weaknesses while encompassing into the regional and world support on the matters of great concern.

6.1 Copenhagen Cruise Terminal

To undertake the threadbare analysis of Copenhagen cruise terminal the SWOT analysis matrix as presented below has been used to meet the research objectives.

SWOT ANALYSIS COPENHAGEN CRUISE TERMINAL		
INTERNAL	STRENGTHS	WEAKNESSES
	Geographically located at the best advantageous position in the BSR.	The geographical location demands congruent measures to handle the ever increasing hundredfolds turnaround with increased passenger volume.
	Top notch turnaround cruise terminal of BSR.	More cruise ship visits in the absence of proper traffic management are causing inconvenience to city residents causing long traffic jam thus detrimental to environment and fatigue to the city residents.
	Has IMO/EU & ESPO regulations enforce and complying to SECA, ECA & NECA regulations.	The absence of proper Ship to Shore Energy solutions entail longer auxiliary dependence, thus, more environmental concerns. Food waste utility is not explored at the port premises.
	Energy, electricity, heating planned 2% per year reduction through	ARC facility for the city is not considered for SSE solution to the visiting ports.

	efficiency solutions and shall augment environmental reforms.	
	Oceankaj terminals have environment friendly construction.	The passengers usually don't stay longer at the terminals as they are void of entertainment activities that should hamper the visit to the city.
	Construction of terminals are at the outskirts of the main population area, thus saving the habitants of the noise pollution.	The noise may have improved for the population however, there still need to be lookedup for the natural sea habitat as ships are on their steaming.
	Has direct municipal sewage line with PRF flow rates of 3-300m3 / h.	No Circular Economy model for the cruise terminals or even for the port.
		Sewage liquid waste being handled so far is also drained in municipal drain line with no utility.
		Insufficient PRF thus ships to hire private companies for waste collection.
		Efficiency solutions need to be ascertained.
EXTERNAL	OPPORTUNITIES	THREATS
	Municipality also plans to help reduce GHG emissions by 40% in relation to 1990.	More road transport at the city causing disruption of city traffic thus environmental degradation.
		More turnaround calls with little mitigation techniques don't do parity for the environment vs financial gains.
	Copenhagen environment agency gave headway for Terminal 4 construction.	Reclamation of land for Terminal 4 has its adverse long term affects that shall appear as hypoxic of BSR thus damaging natural habitat.
	The city waste to energy site (ARC) is a great possibility for green energy solutions for cruise ships stay.	Increased no of passengers and ship calls shall cause increased solid, air and noise pollution, more wastes and more PRF facilities.
	City electric and heat supply expected to be 100% by 2035 & of the transport needs by 2050 with Renewable Energy solutions.	Long port calls with meagre SSE facility is detrimental to environmental conditions.

Copenhagen cruise terminal being the turnaround port has immense value in the region in terms of cruise calls and passengers visits. With ever-increasing cruise activity the terminal's plan of upcoming Terminal 4 does matchup to meet the cruise activity in wholesome. However, the environmental aspects are yet seem riding over economic gains. The ships are as yet and in the future shall, continue to run on own auxiliary engines with little to offer on SSE solutions. CE models already working as ARC are considered to be under utility the my so far study made there didn't seem some connection. The external agencies in terms of IMO/EU/ESPO/HELCOM etc. have been showing concerns through formulation of concrete regulations to abate the spiking environmental degradation yet, the need to meet exponential future business needs, activities like reclamation of land, makeshift energy solutions and increased traffic congestions need pragmatic solutions than mere regulations.

6. 2 Helsinki Cruise Terminal

To undertake the threadbare analysis of Helsinki cruise terminal the SWOT analysis matrix as presented below has been used to meet the research objectives.

SWOT ANALYSIS HELSINKI CRUISE TERMINAL		
INTERNAL	STRENGTHS	WEAKNESSES
	Municipality resolve for carbon neutral port by 2035.	The enhanced passenger and ships call traffic causing an imbalance in city traffic and yet need a better solution with ever increasing environment degradation.
	Helsinki is conferred to be best environmental friendly green cruise port of BSR as 90% cruise calls discharge waste water at port.	The ever growing cruise business is beneficial for ports & its infrastructure only if the port and shipping mutual collaboration is met; failing that eventually may compromise on environment standards.
	Port of Helsinki introduced reduced vessel charges discount for environment friendly ships.	The port future energy efficiency programme only workedup with conventional solutions.
	Noise abatement policies are monitored and rewarded upto 4% discounts to shipping companies.	Absence of SSE is a continued noise threat to the sea habitat and the city population.
	Concrete noise barrier at the Vuossari cruise terminal adding eco friendly measures for city population.	

	Ships' waste sorting facility at harbour, (Environ Management, 2019).	Present PRF doesnot seem to meet the emerging cruise calls in the region.
	Waste charges are accordance to ships size thus giving incentives to other smaller vessels & safe BSR, (Environ Management, 2019).	Waste collection through company, thus no CE related opportunities to explore.
	Waste management advisors for proper handling and disposal at all ports of cruising, (Environ Management, 2019).	Levy on taxation of CE energy is not yet regulated thus causing the linear model still viable & progressive
EXTERNAL	OPPORTUNITIES	THREATS
	Twin – Port 3 project aimed to reduce environmental impact with auto-mooring & onshore power supply systems in future developments shall improve the environment of the coastal city.	The Gulf of Finland under anoxic areas, and is not considered a healthy sign for future shipping activity, the SYKE eutrophication of sea report.
	Shore power by Viking lines at Katajanokka quay thus eliminating the use of auxiliary engines, expected to improve the environment condition of the region, (Environ Management, 2019).	High emission levels of NOx, Sox & CO2 per capita & GNP as of May, the deaths caused by PM is approx. 64% and shall only reduce 10% from 2015-2030, (Min of Environ, pg 10, 2019).
	Sewage discharge into BSR by ships enforced, by 2021 (old ships) and 01 Jun 2023 (for new buildings) shall stall the eutrophication process in long run, (Environ Management, 2019).	Ever increasing ship calls and passengers with little hinterland may pose a risk to the city biodiversity.
	Seabin concept for Helsinki by Wartsila may in some manner augment BSR health for future prospects, (Norovirta, 2017).	Expansion & deepening of Vuossari harbour again shall cause damage to sea habitat if not properly managed.
	TEN-T project supports noise modelling of west harbour & automatic docking/undocking shall add values to BSR environment & development of cruise shipping, (Twin Port, 2019).	Ever increasing cruise shipping at the port is a continual threat to the atmosphere until proper and permanent SSE solutions for the entire cruise stay.
	Deepening of Vuossari harbour fairway is also expected to improve upon environment by facilitating energy efficient and low emission vessels.	To attract passengers/business the expansion projects mostly is on reclaimed land thus compromising on the biodiversity of the sea.

Helsinki has taken many initiatives towards the betterment of the environment in the region and city environment aspects. Being an important port of the Finnish Gulf Helsinki receives

90% cruise calls discharge waste water of BSR shipping, Noise abatement to shipping companies is rewarded upto 4% discounts, environment friendly discounts and others, yet, the ships yet at large use their own auxiliary powers alongside berths with future energy efficiency programme only workedup with conventional solutions. Of the many regional and worldwide effort towards the environment saviour Twin – Port 3 project, with auto-mooring & onshore power supply systems, shore power by Viking lines at Katajanokka quay, Seabin concept for Helsinki by Wartsila alongwith a series of regulations by IMO/EU/ESPO/HELCOM the Gulf of Finland is an anoxic areas, high emission levels of NOx, Sox & CO2 per capita & GNP causing approx. 64% deaths by PM and is likely to reduce only 10% from 2015-2030. Expansion & deepening of Vuossari harbour to meet ever increasing ship calls and passengers with little hinterland may pose a risk to the city biodiversity.

6.3 Tallinn Cruise Terminal

To undertake the threadbare analysis of Tallinn cruise terminal the SWOT analysis matrix as presented below has been used to meet the research objectives.

SWOT ANALYSIS TALLINN CRUISE TERMINAL		
INTERNAL	STRENGTHS	WEAKNESSES
	Discounts of up to 80% to ships tonnage fee for Environment ship Index (ESI) for emission free environment.	No interim solution for ships staying <6 hours at the harbour, thus continuous working of auxiliary engines and more emissions.
	Smart Port concept likely to augment the environmental health of the port.	Smart port still has limited lanes that at the peak hours may again be the cause of environmental degradation through traffic congestions.
	Contribution of port measures for environment friendly BSR.	
	Vision 2030 is to facilitate ships berthed for over 6 consecutive hours thus lesser environmental damage.	CE concept at the port premises doesn't exists even in Vision2030.
	Future expansion with complete distripark shall facilitate commercial, socio-economic & environmental aspects.	The expansion is on reclaimed land thus there are great chances of environmental damage.
	Waste management for cruise ships at the port arena.	Port doesn't has waste to energy solutions even in future vision2030.
	Port sewage reception facilities for every ship visiting ship.	
EXTER	OPPORTUNITIES	THREATS

	Collaborated effort in hand by BSR cruise ports & cruise companies for Tallinn green cruise port Action Plan 2030.	Reclamation of land for Muuga & Paldiski harbour expansion project may pose environmental threat to natural habitat.
	Tallinn city council initiation of Tallinn Environment Strategy 2030 that entails substantial use of natural resources.	Traffic congestions despite smart port concept entails environment degradation.
	Tallink shipping shall support the environmental progress by introducing rechargeable batteries onboard ships to facilitate ship berthing on batteries, thus no fuel emissions; less noise generation.	The running of auxiliary engines during complete stay at the port premises shall however remain an ever present source of environment air and noise pollution.

Tallinn port has equally great importance in the Gulf of Finland as of St. Petersburg or Helsinki. Helsinki-Tallinn had been collaborating since decades towards mutual shipping solutions. Tallinn independently (beside joint effort) has introduced measures of upto 80% discounts to ships tonnage fee for Environment Ship Index (ESI), introduced smart Port concept, has plans in Vision 2030 to facilitate ship with over 6 hours berthed SSE facilitation. However, no concrete SSE solution for every visiting vessel irrespective of their stay duration, smart port with limited lanes yet cannot meet the over-whelming passenger needs in peak hours. The port owned CE WTE concept is yet a far call as its not part of ports' Vision2030. For external matters collaborated effort in shape of Tallinn green cruise port Action Plan 2030 and Tallinn Environment Strategy 2030 by city council are in hand besides worldwide regulatory framework for the region. However, like other case study ports, Tallinn future cruise business needs expansion yet again undertaking reclamation projects at Muuga & Paldiski harbour, expansion project, exponential cruise calls, passengers influx and continual running of auxiliary engines during complete stay at the port premises shall however remain an ever present source of environment air and noise pollution in the region.

CHAPTER 7. RECOMMENDATIONS AND CONCLUSION

7.1 Conclusion

The Baltic Sea is the future of cruise shipping. The study was made to qualify and rationalise the statement. During the discourse of research there remained two focal points to focus upon, the environment (being a carrier for the shipping) and the ports (being the facilitator) to make the shipping happen safely, effectively and productively. It was observed that, BSR despite the sensitive aspect of its existence and closely bounded with 9 coastal states has a great demand for economic progression. Ever growing cruise visits and eutrophication thus demands a great amount of parallel progressive measures to be made at the northern European think tanks. The shipping at BSR today is in its survival in the wake of ever growing environmental challenge. Ołdakowski Bogdan, (2016), view environmental regulations in the region to have a great impact on maritime transport and shipping alike. The demand for safe energy practices alternatively call for change towards a better tomorrow, and despite the EU adaptation of CE action plan for 2015-2019 the on ground implementation requires a joint port and shipping effort.

It was found during the course of research that the region has a lot of potential for shipping per se the cruise shipping. Today, BSR stands as the most popular and responded destination of the world. Due to the close proximity of the ports, the intra-European regulations like TEN-T, CMP and Helsinki-Tallinn and similar joint ventures are essential wherein collective brainstorming and progression is transformed into pragmatic headways. The demand to meet the exponential passenger growth and crave for new destinations made the region more dynamic and wanted than ever before. The limitation of seasonality is even fading out as a few cruise companies are making cruises specially for the Christmas season along with cruises to northern polar waters. To meet this hundredfold demand infrastructural developments are

taking place in tandem with the environmental and socio-economic trends. With ever increasing traffic numerous projects are at hand by leading ports of Copenhagen, Tallinn and Helsinki, however, there is still a lot that needs to be done towards the collective call of ports and shipping companies apart from financial gains. The shipping is augmented by the Special area classification of the sea by IMO, subsequently more concern shown by the EU, ESPO, HELCOM, EMSA and such other great organisations that have a great focus on the environmental health of the regional sea. Furthermore, the growing trends and solutions towards Green shipping and ports by various BSR ports is yet another encouraging aspect.

Gritsenko Daria, (2016), analyse BSR (while in the) occupied with a variety of challenging drivers being; the ever increasing passenger growth, the environmental demands and the challenges for alternate safe energy sources to be 'an area of great potential providing strong competition for other marine areas in Europe'.

There is no denying the fact that the efforts in regard to CE solutions utilising cruise ship generated food waste owing its associated implications is likely to take a little more time and acceptance both by the port and shipping stakeholders. Of the varying barriers that are as yet seen to be stumbling block in the adaptation of the WTE projects as within the port sector the economic concern and the will to take the first step is yet lacking.

It was also learnt that the progressive health reforms at the respective coastal cities are not solely made at the world, regional or state level rather with more awareness amongst the regional residents a silent inadvertent demand to the shipping lines is made to undertake positive steps. A great range of regional cruise lines already has committed their passage to save the pristine environment while seeking partnerships with governmental, scientific organizations and even non-governmental organisations. Dowling R.K, (2006), has also estimated that cruise industry with continued piloting pragmatic leadership shall reform as an encouraging example for the destination partners.

7.2 Recommendations

In the wake of study following Recommendations are made for a progressive future of the cruise shipping in the realm of prevalent environment regulations and demand for safe energy Circular Economy systems:

a. Since the self-independent CE WTE solutions are difficult to finance at the upfront but subsequently easy to maintain and run therefore it is recommended that at the macro level (being wary of the fact that almost 80% of the ports today are Landlord type) there deems a great support from the state owned organisations like Maritime Authorities, Ministries for the actualisation of the theory at the ports sector.

b. A lot more cohesion and interoperability is also greatly deemed by seaports and cruise shipping companies at micro level as it may bring about the following collective benefits to the industry:

i. Development of a strategic seaport vision that may further evaluate the best independent safe energy solutions; that may hinge upon WTE models of circular economy.

ii. Tier based awareness skill programmes for all the stakeholders especially the port stevedoring and shipping crew of the potential benefits of leaping towards a smart port.

iii. Setting targets that can amicably outweigh the environmental externalities, offer safe and cheap energy solutions, has socio-economic progression and facilitates adequately the legal aspects.

c. Institutionalisation of the concept in the college and university curriculum so as to aware the future generation of the long term feasible gains of the Circularity over Linearity.

d. Levy advantageous rebate on taxes by governmental organisations to firms and companies working on circularity that shall fade out the linear progression being a little more expensive.

e. To make circularity a trend the cities shall have to adopt to the model at the domestic and commercial level, that include factories, businesses, parks, hotels and all.

f. As Abbasov Faig, (2019), also recommend a zero-emission berth standard for all European ports, such a solution is essentially envisaged for BSR ports along with ban on all types of waste dumping into the sea.

g. Implementation of 10ppm of SECA standards as of the road specifications, Abbasov Faig, (2019).

h. Conversion of cruise ships into the first zero emission propulsion units in the BSR waters, Abbasov Faig, (2019).

7.3 Future Scope of the Study

Circular Economy in its prospects is indeed the future call that shall ensure sustainability in many forms in terms of product usage, environment, longevity or even reusage for human development and progression. It is envisaged that CE measures at the doorstep of the ports shall facilitate the shipping industry manifolds and be a great source of environmental health for the sea and populace alike. The CE models at the ports not only can serve the solutions for safe energy to the visiting ships rather the shipyards, cities and even hinterland may benefit from the same with ever increasing future roles.

The study was made to crystallise the futuristic growth of the region as a potential carrier for shipping. The research remained exclusively qualitative hinging upon the available literature on the subject and due to paucity of time couldn't avail benefits out of the quantitative plan prepared in terms of Questionnaires. However, it remains the untapped aspect that needs to be explored to have a lot more value and authenticity contribution from the stakeholders present on ground with good knowledge of the ever-changing trends and policies towards the subject matter of great concern for the region.

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APPENDIX A

UN SDGs

APPENDIX B1

RESEARCH QUESTIONNAIRE
CRUISE LINES IN BSR

Today, most modern cruise lines have been successful in promoting the ship as a destination in itself. However, the geostrategic position of a cruise terminal is the ultimate determiner of the success of a location in respect of the volume of cruise ship traffic it attracts.

Sequel to aforesaid, the environmental aspects need to be measured and mitigated first:

a. To make the environment safe with least degraded impact.
b. To make the best use of solid wastes as a means of productive gains.

The purpose of the survey is to assimilate information to ascertain the Circular Economy (CE) aspects for the ever expanding Cruise terminal at Copenhagen/Helsinki/Tallinn. The study intends to gather information wrt the following:

1. Is there any impact of the geostrategic location of Terminals on cruise ship traffic.
2. The environmental impact of increased traffic on the terminal & the cities.
3. The potential to convert cruise ship waste into energy for the port, and eventually the hinterland.

GEOGRAPHICAL IMPORTANCE OF COPENHAGEN CRUISE TERMINAL

Q1. In what terms is the geographical location of Copenhagen as turnaround port advantageous to Cruise shipping lines in the region?

a. Easy hinterland access through inland waterways.
b. Accessible historical sights and tourists attractions.
c. Adequate Naval, Commercial and Logistics support.
d. Cruise liners are able to target consumers easily.
e. Others_____

Q2. How well-connected is Copenhagen as a turnaround port in the region?

a. Well connected (Rail, road, sea routes)
b. Adequately connected (Road, Sea routes)
c. Average connection (Road link only)

d. Weak connection (Road link with dilapidated infrastructures)

e. Others_____

Q3. How does geographical location as a factor benefits Copenhagen being famous turnaround cruise port in the region?

a. Easy access to shipping lines being at the mouth of the Baltic Sea.

b. Falls enroute to North sea region.

c. Plies on the busiest sea routes of the world.

d. Has well navigated channel and harbour facilities.

e. Others_____

Q4. Why Copenhagen has importance as a turnaround destination on cruise ship itineraries in the region? Please select only that satisfy your reply in **'Others'** option.

a. Economically viable for cruise lines.

b. Easy availability of services eg/ bunkering, terminal services.

c. The city has a well-established variety of facilities for the tourists.

d. Airport is centrally located and has cheap travel packages for the passengers.

e. Airport is able to handle abundance of passengers at one time without causing inconvenience.

f. City has adequate infrastructure to absorb large influx of passengers at one time.

g. Terminal is well equipped to make fast custom formalities for the passengers that less time is wasted.

j. Terminal has great flexibility towards their customers hassle free movements and the stay.

k. Terminal has suitable transport infrastructure facilities.

l. Transportation does not consume much time in traffic congestions in the city/hinterland transits.

m. Variety of transportation access (train, road & inland water ways) from the terminal gateway is possible for the tourists planned activities at the city and hinterland.

n. None of the above.

p. Others_____

Q5. Why tourists in cruise line perspective must prefer Copenhagen as turnaround port in the Baltic region coastal cities?

a. It gives easy access to city attractions.

b. It gives easy access to hinterland places.

c. Copenhagen as a city stands as more demanded itinerary by passengers.

d. Because of the diverse patterns at the city attractions.

e. None of the above.

f. Others_____

ENVIRONMENT QUESTIONAIRE

Q1. What level of importance (in cruise line perspective) is laid on terminal environmental policies by the port of Copenhagen in the Baltic sea region?

a. Importance laid at the state level by implementation of exclusive environmental policies.

b. Importance is only through city/municipality level policies.

c. Importance is only through at port level policies.

d. All of the above

e. Others_____

Q2. Why does the Environmental health has such a great important factor for the cruise lines at port of call?

a. Cruise lines being part of United Nations Environment Programme (UNEP) environment objectives.

b. Cruise lines being party to European Sea Port Organisation (ESPO) environment objectives.

c. Cruise lines want to prioritise the passengers health.

d. Healthy environment is the demand and priority of the passengers themselves and thus deciding factor towards the choice of the cruise line and the itinerary.

e. All of the above.

f. Others_____

Q3. What air emissions monitoring procedures/devices satisfy the shipping lines being the deciding factor in the choice of Copenhagen as turnaround terminal in the Baltic region?

a. Placement of Fixed Air Emission Monitoring devices at varying places in the port region.

b. Placement of Drones Air Emission monitoring at sea and its approaches to the terminal.

c. Placement of terminal monitored AIS emission monitoring devices onboard the visiting cruise lines.

d. All of the above.

e. None of the above

f. Others_____

Q4. How do the implementation measures at Copenhagen cruise terminal satisfy Shipping lines in the region?

a. Compliant bunker supplies at competitive

b. Compliant bunker supplies at cheaper rates compared to others
c. Rebates and incentives for carbon efficient ships
d. All of the above
e. None of the above
f. Others_____

Q5. What solid and liquid waste monitoring and collection procedures/devices satisfy the shipping lines being the deciding factor to choose Copenhagen as turnaround terminal in the Baltic region?

a. Facilitation of automatic solid waste collection mechanism at the ship waste despatch point that form part as port services with no extra fees.

b. Facilitation of automatic liquid waste collection mechanism at the ship waste despatch node that form part as port services with no extra fees.

c. Facilitation of automatic liquid and solid waste collection mechanisms at the respective ship waste despatch nodes for that ship has to pay extra fees apart from port services.

d. Ship is benefitted in terms of port dues cutting dependent upon the quantified amount of solid and liquid waste collected from the ship.

e. Non-submission of solid and liquid waste at the terminal premises shall entail Fines to ship for non-adherence to environmental control policies/directives from UN, EU and local government.

f. All of the above.
g. None of the above
h. Others_____

Q6. What all major regulations of IMO MEPC.1/Circ.834/Rev.1 in shipping line perspective have been implemented in the Copenhagen terminal?

a. Almost all the constituents with regards to Annex I, IV, V and VI are being implemented.

b. Only Annex VI has been implemented.
c. Only Annex I, IV and VI have been implemented.
d. Only Annex I, V and VI have been implemented.
e. Others_____

CIRCULAR ECONOMY (CE) QUESTIONNAIRE

Q1. How does CE measures affect the shipping company in terms of economic losses?

a. They do not cause economic loss rather is a source of saving for the shipping line.

b. CE has laid an extra burden on the overall operational cost of shipping.

c. The increased cost has been adjusted towards the passenger purchase of ticketing.

d. CE measures is the best solution for cruise industry progress and success in the future.
e. CE measures shall enhance the overall life of ship and yet bring distinction at the port of destination in comparison to other terminals of the world.
f. Others_____

Q2. Why the visiting ships should handover their solid waste to Copenhagen terminal?

a. Because Copenhagen terminal offer waste to energy alternatives for the ships.
b. Because Copenhagen terminal offer waste to port dues concessions.
c. Because Copenhagen terminal offer better waste clearance services free of costs.
d. All of the above.
e. None of the above.
f. Others_____

Q3. Is the Copenhagen terminal able to offer the visiting cruise ships with waste to energy solutions in shape of offshore heating/cooling system using their solid waste as part of CE practices?

a. Such solutions are only in the planning phase at the terminal
b. Such solutions are only in the implementation phase for upcoming terminal 4
c. Already implemented and serving the visiting ships for their duration of stay
d. No such system exists as of now
e. Others_____

Q4. How does the Copenhagen terminal meet the visiting ships' water provisions using CE theories?

a. Recycling the ships' complete liquid waste into non-drinking fresh water provisions.
b. Recycling the ships' complete liquid waste for limited quantity of drinkable fresh water provisions.
c. Such processes are only in the planning phase as of now.
d. No such process exists as of now.
f. Others_____

Q5. When shall the Copenhagen terminal be able to offer energy for the auxiliary services (eg. HPAC, Seawater Pumps, FF Equipment etc) to visiting ships using CE waste to energy management theories?

a. By year 2025.
b. By year 2030.
c. By year 2050.

d. The idea is in planning phase only.
e. The idea doesn't exists.
f. Others_____

Q6. How does the Copenhagen terminal intends to make use of waste to energy (Cold Ironing theory) for environmental friendly (Port & City) atmosphere despite expected increase of cruise shipping at the terminal in future?

a. By provision of (waste to energy) Cold Ironing facilities to visiting ships as part of port dues.
b. Provision of Cold Ironing facilities to visiting ships separate from port dues.
c. Such setup is only in planning phase at terminal level.
d. Such setup has been designed and shall be implemented in Terminal 4.
e. No such provision of Cold Ironing facilities to ships is being offered as of now.
f. None of the above.
g. Others_____

Q7. How does the solid (sewage sludge) collection from the cruise ships benefit Copenhagen terminal to work as waste to energy management plan? Either by sewage flowing in drainage facilities (sewage pipes) or through collection of solid waste from sludge to re-use it for bio-gas?

a. To generate electricity for the visiting ships' lighting requirements only.
b. To generate electricity for the visiting ships' lighting and firefighting pumps requirements.
c. To generate electricity for the visiting ships' lighting, firefighting pumps and other auxiliary requirements.
d. The facility to generate electric power by using sewage sludge for cruise shipping is in planning phase.
e. The facility to generate electric power by using sewage sludge for cruise shipping doesn't exists.
f. Others_____

APPENDIX B2

QUESTIONNAIRE FOR COPENHAGEN, HELSINKI & TALLINN CRUISE TERMINALS

Today, most modern cruise lines have been successful in promoting the ship as a destination in itself. However, the geostrategic position of a cruise terminal is the ultimate determiner of the success of a location in respect of the volume of cruise ship traffic it attracts.

Sequel to aforesaid, the environmental aspects need to be measured and mitigated first:

a. To make the environment safe with least degraded impact.
b. To make the best use of solid wastes as a means of productive gains.

The purpose of the survey is to assimilate information to ascertain the Circular Economy (CE) aspects for the ever expanding Cruise terminal at Copenhagen/Helsinki/Tallinn. The study intends to gather information wrt the following:

1. Is there any impact of the geostrategic location of Terminals on cruise ship traffic.
2. The environmental impact of increased traffic on the terminal & the cities.
3. The potential to convert cruise ship waste into energy for the port, and eventually the hinterland.

GEOGRAPHICAL IMPORTANCE OF COPENHAGEN

Q1. In what terms geographical location of Copenhagen as turnaround port stands advantageous to shipping lines?

a. Easy hinterland access
b. Historical sights and tourists attractions
c. Naval, Commercial and Logistics facilities
d. Cruise lines are able to target consumers
e. Others_____

Q2. What regional hinterland advantages Copenhagen enjoy to facilitate cruise passengers as turnaround port?

a. Well connected (Rail, road, sea routes)
b. Adequately connected (Road, Sea routes)

c. Average connection (Road link only)

d. Weak connection (Road link with dilapidated infrastructures)

e. Others_____

Q3. How place (physical and cultural attributes) as factor benefits Copenhagen as turnaround cruise in the region?

a. Excellent (the terrain is mostly straight and has a variety of culture in the countryside).

b. Better (the terrain is mostly accessible with little diversity in culture)

c. Fair (terrain is hard to access and has strict governmental bylaws)

d. Insufficient (terrain does not have much to tourists entertainment)

e. Others_____

Q4. Why does Copenhagen has an importance as turnaround itinerary for cruise shipping lines?

a. Commercially viable

b. Has more concrete logistic avenues for the shipping lines

c. The city has more well established variety of facilities for the tourists

d. Airport access is centrally located and has cheap commutation packages

e. Airport is able to handle abundance of passengers without causing inconvenience to passengers

f. City has adequate infrastructure to absorb large influx of passengers at one time

g. Terminal is well equipped to make swift custom clearances

j. Terminal has great flexibility towards their customer comfortable hassle free transitions and stay

k. Terminal has suitable transport infrastructure

l. Transportation does not consumes much time in traffic congestions in the city/hinterland transits

m. Variety of transportation access from the terminal gateway is possible

n. All of above

o. None of above

p. Following of above (Pls enlist the relevant alphabet only)

q. Others_____

Q5. Why cruise tourists may prefer Copenhagen as turnaround port?

a. Easy access to hinterland places

b. Has more demanded itinerary by passengers

c. Because of the density, dispersion and pattern of the city attractions

d. Because of the spatial interaction between city links

e. Others_____

ENVIRONMENT QUESTIONNAIRE

Q1. Where does the environmental policies for the Copenhagen terminal comes from?

a. From state levels.
b. Comes from city/municipality level only.
c. Comes from the port level efforts only.
d. All of the above.
e. Others_____

Q2. Why are Environmental health policies a factor of importance for the Copenhagen Terminal?

a. To meet the States' environmental directives.
b. To meet UN Environmental Programme (UNEP) environmental objectives.
c. To meet European Sea Port Organisation (ESPO) environmental objectives.
d. To prioritise the passengers health.
e. The demand and priority of the passengers themselves.
f. All of the above.
g. Others_____

Q3. Which of the following environment identification tools has the port introduced as part of the Environmental Management Systems (EMS) such as the ISO 14001 (ISO, 2015) and the EMAS (European Parliament and the Council of the European Union, 2009) under the ambit of Significant Environmental Aspects (SEA)?

a. Tool for the identification and assessment of Environmental Aspects in Ports (TEAP).
b. Tool for the identification and implementation of Environmental Indicators in Ports (TEIP).
c. Self-Diagnosis Method (SDM).
d. Port Environmental Review System (PERS) Certificate.
e. Others_____

Q4. What emissions monitoring tools satisfy the shipping lines to choose Copenhagen as turnaround destination?

a. Fixed Air Emission Monitoring devices.
b. Drones Air Emission monitoring at sea.
c. AIS monitoring devices onboard ships.
d. Monetary fines for non-adherence to emission control policies/directives.

e. All of the above.
f. None of the above.
g. Others_____

Q5. How does the GHG implementation measures (IMO MARPOL Annex VI) at Copenhagen cruise terminal satisfy Shipping lines?

a. Compliant bunker supplies at competitive.
b. Compliant bunker supplies at cheaper rates compared to others.
c. Rebates and incentives for carbon efficient ships.
d. All of the above.
e. None of the above.
f. Others_____

Q6. What all major regulations of IMO MEPC.1/Circ.834/Rev.1 have been implemented in the Copenhagen terminal?

a. Almost all the constituents with regards to Annex I, IV, V and VI are being implemented.
b. Only Annex VI has been implemented.
c. Only Annex I, IV and VI have been implemented.
d. Only Annex I, V and VI have been implemented.
e. Others_____

CIRCULAR ECONOMY ENERGY TO WASTE MANGEMENT QUESTIONNAIRE

Q1. Does the Copenhagen Cruise terminal in specific has any Circular Economy policies with regards to waste to energy processes?

a. Yes its only at the planning phase
b. Yes it's in the implementation phase
b. No, it doesn't
d. I don't know
e. Others_____

Q2. Why should the visiting ships handover their solid waste to Copenhagen terminal?

a. Terminal offers waste to energy alternatives
b. Terminal offers waste to port dues concessions
c. Terminal offers better waste clearance services
d. To join hands in making Baltic Sea Region (BSR) an environmentally enduring heavens for future shipping.
e. None of the above
f. Others_____

Q3. Is the Copenhagen terminal able to offer the visiting cruise ships waste to energy solutions in shape of offshore heating/cooling system using their solid waste as part of CE practices?

a. Such solutions are only in the planning phase at the terminal
b. Such solutions are only in the implementation phase for upcoming terminal 4
c. Already implemented and serving the visiting ships for their duration of stay
d. No such system exists as of now
e. Others_____

Q4. How does the Copenhagen terminal meet the visiting ships' water provisions using CE theories?

a. Recycling the ships' complete liquid waste into non-drinking fresh water provisions.
b. Recycling the ships' complete liquid waste for limited quantity of drinkable fresh water provisions.
c. Such processes are only in the planning phase as of now.
d. No such process exists as of now.
f. Others_____

Q5. When shall the Copenhagen terminal be able to offer energy for the auxiliary services (eg. HPAC, Seawater Pumps, FF Equipment etc) to visiting ships using CE waste to energy management theories?

a. By year 2025.
b. By year 2030.
c. By year 2050.
d. The idea is in planning phase only.
e. The idea doesn't exists.
f. Others_____

Q6. How does the Copenhagen terminal intends to make use of waste to energy (Cold Ironing theory) for environmental friendly (Port & City) atmosphere despite expected increase of cruise shipping at the terminal in future?

a. By provision of (waste to energy) Cold Ironing facilities to visiting ships as part of port dues.
b. Provision of Cold Ironing facilities to visiting ships separate from port dues.
c. Such setup is only in planning phase at terminal level.
d. Such setup has been designed and shall be implemented in Terminal 4.
e. No such provision of Cold Ironing facilities to ships is being offered as of now.
f. None of the above.
g. Others_____

Q7. How does the solid (sewage sludge) collection from the cruise ships benefit Copenhagen terminal to work as waste to energy management plan? Either by sewage flowing in drainage facilities (sewage pipes) or through collection of solid waste from sludge to re-use it for bio-gas?

a. To generate electricity for the visiting ships' lighting requirements only.

b. To generate electricity for the visiting ships' lighting and firefighting pumps requirements.

c. To generate electricity for the visiting ships' lighting, firefighting pumps and other auxiliary requirements.

d. The facility to generate electric power by using sewage sludge for cruise shipping is in planning phase.

e. The facility to generate electric power by using sewage sludge for cruise shipping doesn't exists.

f. Others_____

APPENDIX B3

QUESTIONNAIRES FOR DENMARK MARITIME AUTHORITY, MUNICIPALITY OF COPENHAGEN (MAYOR), EMERGENCY HEALTH & SECURITY PROVIDERS, LOCAL TRANSPORT HEAD, COPENHAGEN CHAMBER OF COMMERCE (AND ORGANISATIONS OF SIMILAR HIERCHY IN HELSINKI & TALLINN)

It is a known fact that the positive effects of the port spill over to locations beyond the city, while most of the negative effects are concentrated in the port city, and it asks how negative port impacts can be mitigated. 'Ports and cities are historically strongly linked, but the link between port and city growth has become weaker'.
Professional institutions, port authorities, and governments have opted to collaborate more closely to foster regional visions and large-scale planning – that is, planning that takes into account more than the functionality of the port.

The Association Internationale Ville et Ports (AIVP), has held for 25 years annual conferences on port and cities themes. To save the water ways from environmental dismay in the realm of burgeoning cruise activities in the Baltic Sea Region (BSR) Nexus the communities, businessmen, social and governmental bodies direly need to be in cohesion.

Sequel to aforesaid, the following aspects needs priority mitigation:

a. To make the environment safe with least degraded impact.
b. To make the best use of solid wastes as a means of productive gains.

The purpose of the survey therefore shall be to assimilate information to ascertain the Circular Economy (CE) aspects for the ever expanding Cruise business in the BSR. The study intends to gather information wrt the following:

1. Is there any impact of the geostrategic location of Copenhagen/Helsinki/Tallinn cruise terminals on cruise ship traffic.
2. The environmental impact of increased traffic on the terminals & cities.
3. The potential to convert cruise ship waste into energy for the port, and eventually the hinterland.

Q1. How does the Danish state want to see Copenhagen as future Cruise terminal of the region?

a. As future largest cruise port of Northern Europe.

b. As future largest cruise port of Baltic Sea Region only.
c. Danish government has no aspiring goals and has totally left it to the city/municipality domain.
d. The state machinery doesn't directly take decisions for cruise port rather has left it to discretion of city/municipality and act as observatory only.
e. None of the above.
f. Others_____

Q2. How much does EU supports for the development projects of Copenhagen Cruise terminal as Regional Cruise Homeport?

a. EU understands the geostrategic importance of the cruise terminal and offer all out support in shape of grants.
b. EU has nothing to do with the geostrategic importance of the cruise terminal and doesn't offer any monetary support.
c. None of the above
d. Others_____

Q3. What importance does the municipality pay towards the evolution of cruise terminal as future regional turnaround hub?

a. Supports the cruise terminal in the infrastructural developments from city funds.
b. Municipality supports the terminal in allocation of land when needed for expansion projects free of cost.
c. Municipality supports the terminal with development projects payback loans.
d. None of the above.
e. Others_____

Q4. How does local communities (public & business) view cruise tourism in the city?

a. Economically beneficial.
b. Treat presence of cruise ships passengers with fair degree of assistance when required.
c. Not happy in the backdrop of cruising negative effects, that can occur (e.g. air and water pollution, crowd congestion etc).
d. A & B above.
e. Others_____

Q5. What role has the municipality played to develop the cruise terminal infrastructure envisioning Copenhagen port as largest future cruise hub of Northern Europe?

a. There are No such plans in offing at municipality level.

b. Municipality believes that futuristic economic gains from cruise shipping are far less important than health of the city populace.

c. Municipality already has made well devised plans to enhance port capacity as regional Hub as well as the safest Greenport in the Northern European region.

b. B & C above.

c. Others_____

Q6. What safety measures at ports' end ensure happy and safe transit of all passengers?

a. Well devised and well worked up security plans are implemented.

b. State of the art safety and security plans on 24/7 at terminal premises.

d. All of the above.

e. Others_____

Q7. What incentives does cruise shipping lines and their passengers enjoy from municipality and city community during their stay?

a. Free of cost health care facilities by the city municipality.

b. Arrangement of variety of festivals especially during summer time.

c. Development of modern day road and rail infrastructures.

d. All of the above.

e. Others_____

Q8. How does government at all levels, the business sector and the community respond to critical factor engage with the more encompassing oligopolistic power by the cruise lines that being the defining factor in the success or failure of a cruise destination?

a. By engaging with the terminal operators to add more and more cruise lines at the destination.

b. Through Contract terms and conditions with the cruise lines that entails immediate cancellation upon not abiding to terminal rules and regulations.

c. None of the above.

d. Others_____

Q9. Does city has the veto power in the context of proposals for cruise infrastructure development and limit its activities in the good interest of happy Denmark viewing the city services to passengers ratio and environmental degradation?

a. The city has the veto power to deny the expansion projects in the best interest of the city and its populace.

b. The city do not has the veto power to deny the expansion projects in the best interest of the city and its populace.

c. None of the above.

d. Others_____

Q10. What amongst the four stakeholders has Copenhagen municipality laid much emphasis on and why?; i.e cruise line stakeholders, gatekeeper stakeholders, portside stakeholders, and shore-side stakeholders.

a. Cruise line stakeholders as they bring more economic affinity to the city.

b. Gatekeeper stakeholders as they enable the right persons thus ensure safe heaven for all at the city.

c. Portside stakeholders as they are the real men behind the gun in city progress by bringing more shipping thus giving good share to city development projects.

d. Shore-side stakeholders as they make the hinterland and the city attractive for the passengers to visit the city again.

e. A & D above.

f. Others_____

Q11. What incentives does city and its residents enjoy as an outcome from cruise shipping business?

a. Cruise shipping in collaboration with municipality/city work to lift the infrastructure of the city to develop city tourism aspects to meet passenger's needs.

b. Cruise shipping doesn't offer any support for city developments.

c. Cruise shipping only limits its infrastructural support until port premises.

d. Cruise shipping doesn't extend any infrastructural support even at port premises.

e. Others_____

Q12. What incentives does city and its residents enjoy as an outcome from cruise business at Copenhagen terminal?

a. Cruise terminal give some monetary % share to municipality to spend in city development programmes.

b. Cruise terminal give some monetary % share to city transport division to improve and maintain city transport infrastructure.

c. Cruise terminal give some monetary % share to city health care division to improve and maintain city healthcare services.

d. Cruise terminal give some monetary % share to city environmental division to improve and progress city environmental services.

e. None of the above.

APPENDIX C

CE HISTORICAL TERMS

The origin of the stock optimization principle is based on the recognition of the limited nature of Earth's resources and can be traced to several well-established concepts including:

• the 'spaceman' economy, which suggested replacing the conventional open economic system with a cyclical system capable of continuous reproduction of materials, even though it cannot exist without inputs of energy (Boulding 1966);

• the "steady-state economy": "an economy with constant stocks of people and artefacts, maintained at some desired, sufficient levels by low rates of maintenance throughput, that is, by the lowest feasible flows of matter and energy from the first stage of production to the last stage of consumption." (Daly, Herman E. 1992);

• the 'limits to growth': the computer simulation of exponential economic and population growth with finite resource supplies under 3 scenarios, two of them leading to "overshoot and collapse" of the global system, while a third to a "stabilized world."

• the 'industrial ecology' that envisions integration of industrial ecosystems in analogy to biological ecosystems (Frosch and Gallopoulos, 1989), with implementation of such biological imitation as an eco-industrial park where materials are recycled internally and where energy is the only external input (Ayres, 1996)

• the "cradle-to-cradle" concept depicts a closed system of resource flows approached from a product-life cycle perspective, (Kalmykova, Sadagopan, & Rosado, 2018).

APPENDIX D

SHIPPING LINES EFFORTS TO SUSTAIN THE ENVIRONMENTAL HEALTH OF THE SEAS

In addition to international and federal regulation, the cruise industry associations, for example, the International Council of Cruise Lines (ICCL) has set its own voluntary environmental policies for the member cruise lines. ICCL has 16 member cruise lines and includes the majority of the cruise ships travelling in the world today such as Royal Caribbean Cruise Lines, Princess Cruise Lines, Holland America, Carnival Cruise Lines and Celebrity Cruise Lines. In most destinations, ICCL's environmental standards for its cruise lines, assuming they are adhered to, exceed or at least match international and federal legislative requirements (ICCL, 2003). As a result of these industry based regulations, the aforementioned cruise ship companies have agreed to the following environmental practices, (Dowling R.K, 2006):

a. No discharge of black water (treated or untreated sewage) in port;
b. No discharge of grey water (sink or shower water) in port;
c. Discharges of treated black water and grey water conducted when vessels are more than 10 miles (15 km) from port call and proceeding at 6 knots or faster; and,
d. Legal discharges are not conducted when a cruise vessel is within a mile from any surrounding shore.

ICCL's voluntary practices and procedures cover high volume wastes (garbage, grey water, black water, oily residues and bilge water), pollution prevention and the smaller quantities of hazardous waste produced on board.

The ICCL standards for environmental performance were set at a level consistent with the standards outlined in the International Management Code for the Safe Operations of Ships and for Pollution Prevention (ISM Code) and MARPOL's mandated Waste Management Manual (ICCL, 2003). In other words, any violations of the ICCL standards would be considered violations of IMO Conventions and could be punished by the port state. Again, the main concern is not the effectiveness of the standards themselves, but whether the ships are adhering to the practices and procedures with which they have agreed, (Dowling R.K, 2006).

This highlights the importance of monitoring and enforcement issues. Cruise ships must also meet the requirements of classification societies, which are private, third party organizations whose main function is to inspect the ship at regular intervals to

ensure whether its seaworthiness and the ship's structure and machinery are being maintained as required by classification societies' rules, (Dowling R.K, 2006).

Classification societies will also inspect cruise ships for compliance with international safety regulations including Safety of Life at Sea (SOLAS) and MARPOL. Major classification societies include the American Bureau of Shipping, based in the USA; Lloyd's Register of Shipping, in the UK; Det Norske Veritas, in Norway; Bureau Veritas, in France; and Registro Italiano Navale Group, in Italy. Lloyd's Register is the premier classification society for passenger ships, with over 47% of the world passenger fleet currently classified with them, (Dowling R.K, 2006).

Environmentally, classification societies have been known to acknowledge certain cruise ships with 'green certification' or to require compliance with the International Standards Organisation (ISO) 14001 series of environmental management Systems. Port locations have to adapt their policies to accommodate the presence of the cruise ships, and there is considerable variation in the degree to which ports implement and enforce regulations. In some locations such as Canada and in some coastal states in the USA, the federal and state/provincial governments have been divesting policy decisions for the cruise ship industry to both the international and local level. In these locations, the voluntary standards set by the cruise industry are the policy mechanism followed with little monitoring and enforcement efforts. Other locations, such as Alaska and New South Wales, have assumed the primary role in dictating cruise regulations, monitoring and enforcement, yet have come to that decision through different pressures and have had varying degrees of success. In the two comparative case studies presented here, we examine why at the local level, differing approaches to environmental policymaking have arisen, (Dowling R.K, 2006).

Industry Response For Cruise Shipping Sustenance

In June 2001, ICCL and its members adopted a set of practices and procedures entitled Cruise Industry Waste Management Practices and Procedures. These practices primarily build on the regulations of the IMO and the US Environmental Protection Agency (EPA). The major cruise companies and some smaller companies, such as Radisson Seven Seas, have corporate programmes for implementing the ICCL practices and procedures, and, in some cases, exceeding these standards. All of the major lines have programmes that include environmental awareness training for their crews, screening of vendors who handle shoreside offloading of wastes and testing of technologies to minimize or eliminate waste. Each of these programmes is continually evolving to integrate the latest technologies and management practices, (Dowling R.K, 2006).

Cruise ships are like small cities, starting with their own energy and water production, and ending with waste and garbage treatment systems. In between, they manage all

hotel, accommodation, service and entertainment functions. A ship consists of a huge amount of equipment, pipes and ducts, and different kinds of construction, interior and insulation materials, (Hänninen Jaana, Mäki-Jouppila Tero, & et al, 2016).

Cruise ship's lifecycle; (Hänninen Jaana, Mäki-Jouppila Tero, & et al, 2016) Source: Hänninen Jaana, Mäki-Jouppila Tero, & et al, 2016).

Emissions to air can be minimised by many means, starting with selecting cleaner fuels or, alternatively, utilising exhaust gas cleaning and burning process improvements like scrubbers and other purification or filtration methods, catalytic reactors and advanced main engine technologies, and by improving energy efficiency. Such measures will reduce both fuel consumption and emissions. Operational improvements in waste handling and recycling reduce the need for waste incineration, (Hänninen Jaana, Mäki-Jouppila Tero, & et al, 2016).

Emissions and effluents to water are minimised by selecting environmentally friendly hull coatings, and by using advanced wastewater and oily water purification systems, and ballast water treatment systems, (Hänninen Jaana, Mäki-Jouppila Tero, & et al, 2016).

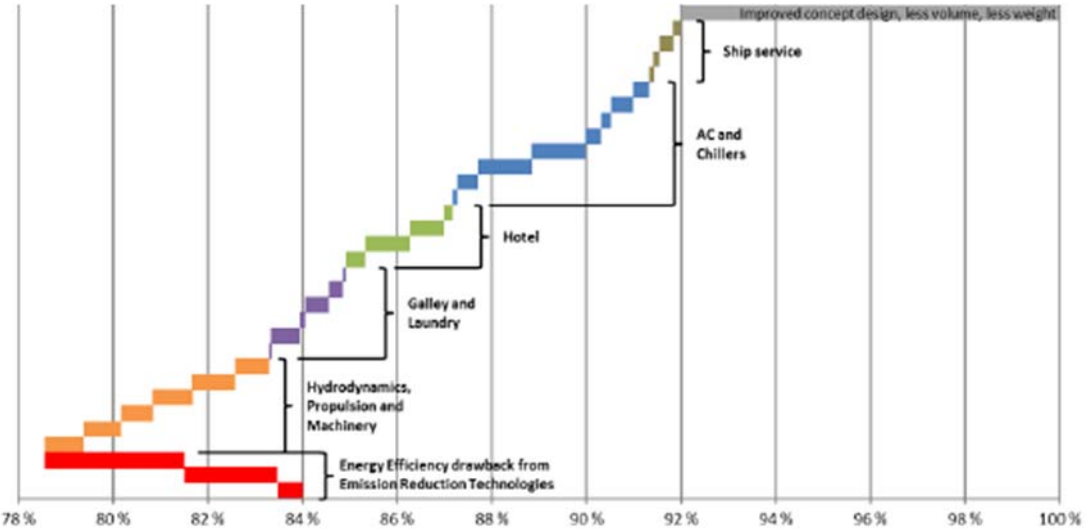
Optimised noise attenuation improves passenger and crew comfort and also reduces external noise under transit and harbour conditions. Good hull form and propulsion design reduce underwater noise characteristics and improve passenger comfort on-board. Wave forming can be minimised by means of advanced hydrodynamic design, which also guarantees low resistance, high propulsion efficiency and excellent seakeeping properties, (Hänninen Jaana, Mäki-Jouppila Tero, & et al, 2016).

Energy efficient cruise ships

Reduced operation costs and environmental legislation are the main drivers of energy efficiency. The ever-tightening maritime environmental legislation forces shipyards and cruise lines as well as system and equipment suppliers to continuously develop

energy efficiency to ensure compliance with the applicable and upcoming regulations. The most recent developments have mainly focused on Waste Heat Recovery (WHR) technologies to increase cruise ships' waste heat recovery rate and the overall utilisation rate of the fuel energy content, (Hänninen Jaana, Mäki-Jouppila Tero, & et al, 2016).

Modern tools for energy efficiency optimisation developed during the past decade, such as modelling and simulation software, bring along possibilities for improving the energy efficiency of ships reliably and effectively. For example, the advanced CFD-modelling software has raised the hydrodynamic design to the next level. Generally, it can be said that the energy efficiency of cruise ships has annually improved by more than 3% for the past 15 years, (Hänninen Jaana, Mäki-Jouppila Tero, & et al, 2016).



Example of the results of continuous and systematic energy efficiency development; (Source: (Hänninen Jaana, Mäki-Jouppila Tero, & et al, 2016).

The cruise lines have also adopted a number of specific practices for different types of hazardous wastes:

a. Carnival Corporation and Royal Caribbean offload photo processing waste onshore and are experimenting with complete digitalization.

b. For dry-cleaning operations, Celebrity Cruises has installed a filtration system that removes the most toxic chemicals from the process.

c. ICCL members are beginning to use alternative printing inks, such as soy-based and non-chlorinated hydrocarbon-based inks in their print shops. Royal Caribbean ships now use water-based instead of chemical based printing plates.

d. Photocopier and laser printer toner cartridges are offloaded for recycling by all Royal Caribbean and Carnival Corporation ships.

e. Excess or expired over-the-counter medicines are offloaded for disposal in an environmentally responsible manner. Carnival donates some older pharmaceuticals to animal shelters, aquariums and animal rehabilitation facilities.

f. Batteries, fluorescent bulbs and mercury lamps are separated from waste and recycled or offloaded as a hazardous waste. Carnival ships, for example, annually recycle nearly 7200 lb (3273 kg) of batteries and 18,000 fluorescent lamp bulbs. P&O Princess collects old batteries from passengers at onboard photo shops, (Dowling R.K, 2006).

The Convention on the Prevention of Marine Pollution by Dumping of Wastes and Other Matter (LDC) of 1972

The subject convention was amended in 1996 to 'prohibit the dumping of any wastes or other matter with the exception of those listed in Annex 1'. These are:

a. Dredged material;
b. Sewage sludge;
c. Fish waste or material resulting from industrial fish-processing operations;
d. Vessels and platforms or other man-made structures at sea;
e. Inert, inorganic geological material;
f. Organic material of natural origin (MARPOL, 1986, (Dowling R.K, 2006).

Response

As with hazardous waste, the ICCL members' waste management practices are very specific as to the management of solid waste. The practices are based on IMO regulations and USA laws such as the Federal Water Pollution Control Act. ICCL member cruise lines have 'zero-discharge' policies, in effect, meaning that they have committed to not discharging certain types of wastes and discharging others only after they have been treated properly. Wastes such as glass, cardboard, aluminium and steel cans are processed on board through crushing, reuse and/or recycling and incineration. Incineration is used primarily for food waste, contaminated cardboard, some plastics, trash and wood. Incinerator ash is periodically tested for toxicity and, if it is determined to be non-hazardous, can be disposed at sea in accordance with international regulations, (Dowling R.K, 2006).

Hazardous ash must be disposed of onshore. Royal Caribbean Cruises Ltd and Carnival Corporation land all ash ashore and test the ash regularly to ensure that

hazardous substances are not present; as their policies are not to incinerate hazardous materials. Most of the major cruise lines have begun to implement shipboard recycling programmes, to reduce the generation of solid waste. Carnival's recycling programme achieves a recycling rate of nearly 65%, which is much higher than most land-based communities. An average of 170,000 lb (77,111 kg) of cardboard, aluminium cans, plastics, glass and steel are recycled each month from Carnival's fleet (Carnival Cruise Line, 2003). Prior to sending waste to a facility, each vendor is checked to ensure that they are in full compliance with local, state and federal environmental regulations. Royal Caribbean's Vision-class ships sort, crush and offload about 450 lb (204 kg) of aluminium cans for recycling per weeklong trip, (Dowling R.K, 2006).

APPENDIX E

IMO SPECIAL AREAS DESIGNATION

Special areas under MARPOL are as follows:

Adoption, entry into force & date of taking effect of Special Areas			
Special Areas	**Adopted #**	**Date of Entry into Force**	**In Effect From**
Annex I: Oil			
Mediterranean Sea	2 Nov 1973	2 Oct 1983	2 Oct 1983
Baltic Sea	2 Nov 1973	2 Oct 1983	2 Oct 1983
Black Sea	2 Nov 1973	2 Oct 1983	2 Oct 1983
Red Sea	2 Nov 1973	2 Oct 1983	*
"Gulfs" area	2 Nov 1973	2 Oct 1983	1 Aug 2008
Gulf of Aden	1 Dec 1987	1 Apr 1989	*
Antarctic area	16 Nov 1990	17 Mar 1992	17 Mar 1992
North West European Waters	25 Sept 1997	1 Feb 1999	1 Aug 1999
Oman area of the Arabian Sea	15 Oct 2004	1 Jan 2007	*
Southern South African waters	13 Oct 2006	1 Mar 2008	1 Aug 2008
Annex II: Noxious Liquid Substances			
Antarctic area	30 Oct 1992	1 Jul 1994	1 Jul 1994
Annex IV: Sewage			
Baltic Sea	15 Jul 2011	1 Jan 2013	**
Annex V: Garbage			
Mediterranean Sea	2 Nov 1973	31 Dec 1988	1 May 2009
Baltic Sea	2 Nov 1973	31 Dec 1988	1 Oct 1989
Black Sea	2 Nov 1973	31 Dec 1988	*
Red Sea	2 Nov 1973	31 Dec 1988	*
"Gulfs" area	2 Nov 1973	31 Dec 1988	1 Aug 2008
North Sea	17 Oct 1989	18 Feb 1991	18 Feb 1991
Antarctic area (south of latitude 60 degrees south)	16 Nov 1990	17 Mar 1992	17 Mar 1992
Wider Caribbean region including the Gulf of Mexico and the Caribbean Sea	4 Jul 1991	4 Apr 1993	1 May 2011
Annex VI: Prevention of air pollution by ships (Emission Control Areas)			
Baltic Sea (SO_x) (NO_x)	26 Sept 1997 7 July 2017	19 May 2005 1 Jan 2019	19 May 2006 1 Jan 2021****
North Sea (SO_x) (NO_x)	22 Jul 2005 7 July 2017	22 Nov 2006 1 Jan 2019	22 Nov 2007 1 Jan 2021****
North American ECA (SO_x and PM) (NO_x)	26 Mar 2010	1 Aug 2011	1 Aug 2012 1 Jan 2016***
United States Caribbean Sea ECA (SO_x and PM) (NOx)	26 Jul 2011	1 Jan 2013	1 Jan 2014 1 Jan 2016***

APPENDIX F

MARPOL ANNEX V

Simplified overview of the discharge provisions of the revised MARPOL Annex V which entered into force on 1 March 2018

DISCLAIMER: Additional requirements may apply.

(Note: The table below is intended as a summary reference. The provisions in MARPOL Annex V and the Polar Code, not the table below, prevail.)

<table>
<tr><th rowspan="2">Garbage type[1]</th><th colspan="2">All ships except platforms[4]</th><th rowspan="2">Regulation 5
Offshore platforms located more than 12 nm from nearest land and ships when alongside or within 500 metres of such platforms[4]</th></tr>
<tr><th>Regulation 4
Outside special areas and Arctic waters
(Distances are from the nearest land)</th><th>Regulation 6
Within special areas and Arctic waters
(Distances are from nearest land, nearest ice-shelf or nearest fast ice)</th></tr>
<tr><td>Food waste comminuted or ground[2]</td><td>≥3 nm, en route and as far as practicable</td><td>≥12 nm, en route and as far as practicable[3]</td><td>Discharge permitted</td></tr>
<tr><td>Food waste not comminuted or ground</td><td>≥12 nm, en route and as far as practicable</td><td>Discharge prohibited</td><td>Discharge prohibited</td></tr>
<tr><td>Cargo residues[5, 6] not contained in washwater</td><td rowspan="2">≥ 12 nm, en route and as far as practicable</td><td>Discharge prohibited</td><td rowspan="2">Discharge prohibited</td></tr>
<tr><td>Cargo residues[5, 6] contained in washwater</td><td>≥ 12 nm, en route and as far as practicable (subject to conditions in regulation 6.1.2 and paragraph 5.2.1.5 of part II-A of the Polar Code)</td></tr>
<tr><td>Cleaning agents and additives[6] contained in cargo hold washwater</td><td rowspan="2">Discharge permitted</td><td>≥ 12 nm, en route and as far as practicable (subject to conditions in regulation 6.1.2 and paragraph 5.2.1.5 of part II-A of the Polar Code)</td><td rowspan="2">Discharge prohibited</td></tr>
<tr><td>Cleaning agents and additives[6] in deck and external surfaces washwater</td><td>Discharge permitted</td></tr>
<tr><td>Animal Carcasses (should be split or otherwise treated to ensure the carcasses will sink immediately)</td><td>Must be en route and as far from the nearest land as possible. Should be >100 nm and maximum water depth</td><td>Discharge prohibited</td><td>Discharge prohibited</td></tr>
<tr><td>All other garbage including plastics, synthetic ropes, fishing gear, plastic garbage bags, incinerator ashes, clinkers, cooking oil, floating dunnage, lining and packing materials, paper, rags, glass, metal, bottles, crockery and similar refuse</td><td>Discharge prohibited</td><td>Discharge prohibited</td><td>Discharge prohibited</td></tr>
</table>

[1] When garbage is mixed with or contaminated by other harmful substances prohibited from discharge or having different discharge requirements, the more stringent requirements shall apply.

[2] Comminuted or ground food wastes must be able to pass through a screen with mesh no larger than 25 mm.

[3] The discharge of introduced avian products in the Antarctic area is not permitted unless incinerated, autoclaved or otherwise treated to be made sterile. In polar waters, discharge shall be made as far as practicable from areas of ice concentration exceeding 1/10; in any case food wastes shall not be discharged onto the ice.

[4] Offshore platforms located 12 nautical miles from nearest land and associated ships include all fixed or floating platforms engaged in exploration or exploitation or associated processing of seabed mineral resources, and all ships alongside or within 500 m of such platforms.

[5] Cargo residues means only those cargo residues that cannot be recovered using commonly available methods for unloading.

[6] These substances must not be harmful to the marine environment.

APPENDIX G

IMO MARPOL 73/78

Annex I Regulations for the Prevention of Pollution by Oil (entered into force 2 October 1983)
Covers prevention of pollution by oil from operational measures as well as from accidental discharges; the 1992 amendments to Annex I made it mandatory for new oil tankers to have double hulls and brought in a phase-in schedule for existing tankers to fit double hulls, which was subsequently revised in 2001 and 2003.

Annex II Regulations for the Control of Pollution by Noxious Liquid Substances in Bulk (entered into force 2 October 1983)
Details the discharge criteria and measures for the control of pollution by noxious liquid substances carried in bulk; some 250 substances were evaluated and included in the list appended to the Convention; the discharge of their residues is allowed only to reception facilities until certain concentrations and conditions (which vary with the category of substances) are complied with.
In any case, no discharge of residues containing noxious substances is permitted within 12 miles of the nearest land.

Annex III Prevention of Pollution by Harmful Substances Carried by Sea in Packaged Form (entered into force 1 July 1992)
Contains general requirements for the issuing of detailed standards on packing, marking, labelling, documentation, stowage, quantity limitations, exceptions and notifications.

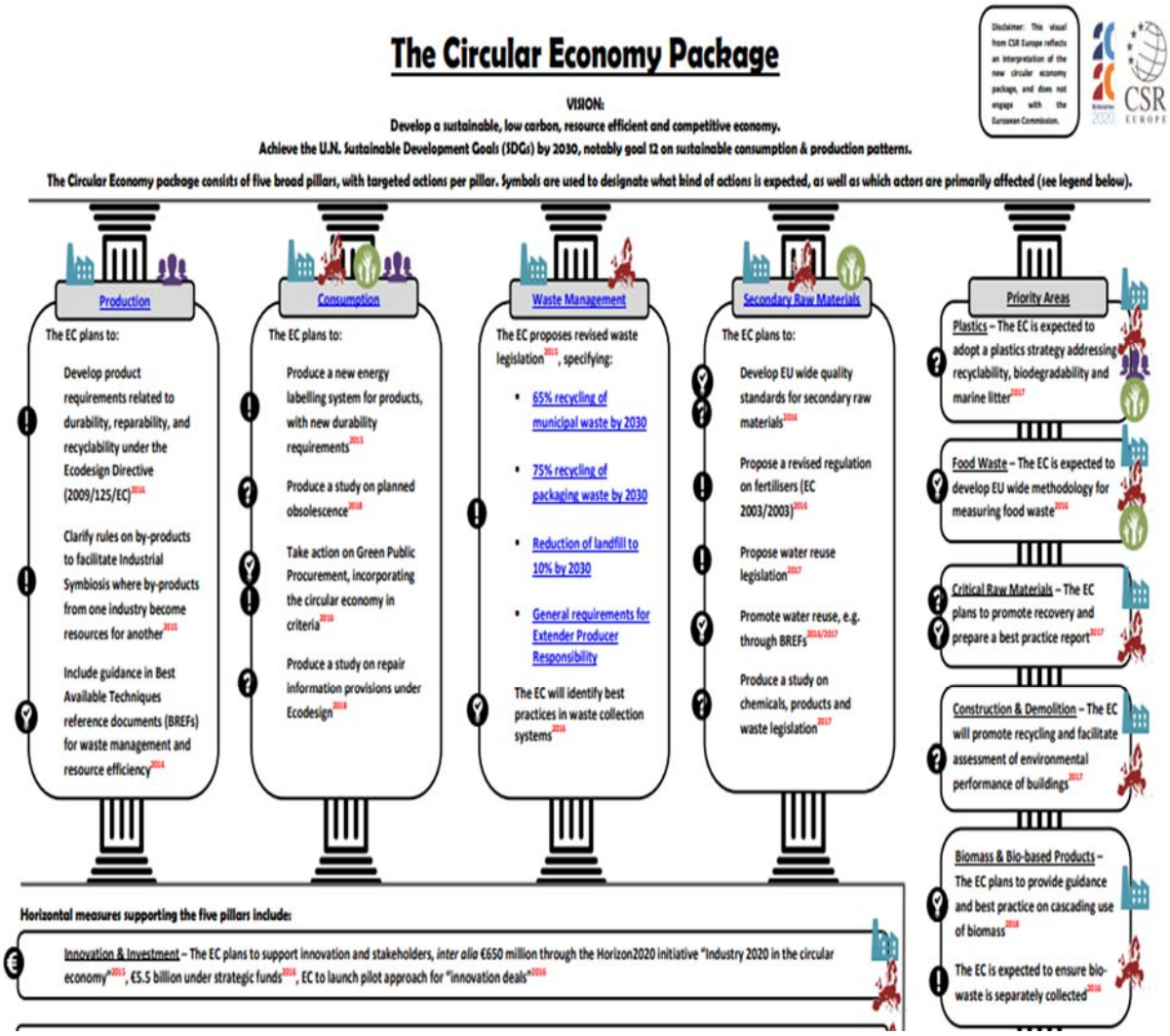
For the purpose of this Annex, "harmful substances" are those substances which are identified as marine pollutants in the International Maritime Dangerous Goods Code (IMDG Code) or which meet the criteria in the Appendix of Annex III.

Annex IV Prevention of Pollution by Sewage from Ships (entered into force 27 September 2003)
Contains requirements to control pollution of the sea by sewage; the discharge of sewage into the sea is prohibited, except when the ship has in operation an approved sewage treatment plant or when the ship is discharging comminuted and disinfected sewage using an approved system at a distance of more than three nautical miles from the nearest land; sewage which is not comminuted or disinfected has to be discharged at a distance of more than 12 nautical miles from the nearest land.

Annex V Prevention of Pollution by Garbage from Ships (entered into force 31 December 1988)
Deals with different types of garbage and specifies the distances from land and the manner in which they may be disposed of; the most important feature of the Annex is the complete ban imposed on the disposal into the sea of all forms of plastics.

Annex VI Prevention of Air Pollution from Ships (entered into force 19 May 2005)
Sets limits on sulphur oxide and nitrogen oxide emissions from ship exhausts and prohibits deliberate emissions of ozone depleting substances; designated emission control areas set more stringent standards for SOx, NOx and particulate matter. A chapter adopted in 2011 covers mandatory technical and operational energy efficiency measures aimed at reducing greenhouse gas emissions from ships.

APPENDIX H


The Circular Economy Package
Disclaimer: This visual from CSR Europe reflects an interpretation of the new circular economy package, and does not engage with the European Commission.
CSR EUROPE
VISION:
Develop a sustainable, low carbon, resource efficient and competitive economy.
Achieve the U.N. Sustainable Development Goals (SDGs) by 2030, notably goal 12 on sustainable consumption & production patterns.
The Circular Economy package consists of five broad pillars, with targeted actions per pillar. Symbols are used to designate what kind of actions is expected, as well as which actors are primarily affected (see legend below).
Production
The EC plans to:
Develop product requirements related to durability, reparability, and recyclability under the Ecodesign Directive (2009/125/EC)2016
Clarify rules on by-products to facilitate Industrial Symbiosis where by-products from one industry become resources for another2015
Include guidance in Best Available Techniques reference documents (BREFs) for waste management and resource efficiency2016
Consumption
The EC plans to:
Produce a new energy labelling system for products, with new durability requirements2015
Produce a study on planned obsolescence2018
Take action on Green Public Procurement, incorporating the circular economy in criteria2016
Produce a study on repair information provisions under Ecodesign2018
Waste Management
The EC proposes revised waste legislation2015, specifying:
65% recycling of municipal waste by 2030
75% recycling of packaging waste by 2030
Reduction of landfill to 10% by 2030
General requirements for Extender Producer Responsibility
The EC will identify best practices in waste collection systems2016
Secondary Raw Materials
The EC plans to:
Develop EU wide quality standards for secondary raw materials2016
Propose a revised regulation on fertilisers (EC 2003/2003)2016
Propose water reuse legislation2017
Promote water reuse, e.g. through BREFs2016/2017
Produce a study on chemicals, products and waste legislation2017
Priority Areas
Plastics – The EC is expected to adopt a plastics strategy addressing recyclability, biodegradability and marine litter2017
Food Waste – The EC is expected to develop EU wide methodology for measuring food waste2016
Critical Raw Materials – The EC plans to promote recovery and prepare a best practice report2017
Construction & Demolition – The EC will promote recycling and facilitate assessment of environmental performance of buildings2017
Biomass & Bio-based Products – The EC plans to provide guidance and best practice on cascading use of biomass2018
The EC is expected to ensure bio-waste is separately collected2016
Horizontal measures supporting the five pillars include:
Innovation & Investment – The EC plans to support innovation and stakeholders, inter alia €650 million through the Horizon2020 initiative "Industry 2020 in the circular economy"2015, €5.5 billion under strategic funds2016, EC to launch pilot approach for "innovation deals"2016

APPENDIX J1

DIRECTIVE 2000/59/EC OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL

of 27 November 2000

on port reception facilities for ship-generated waste and cargo residues

(OJ L 332, 28.12.2000, p. 81)

Article 3

Scope

This Directive shall apply to:

(a) all ships, including fishing vessels and recreational craft, irrespective of their flag, calling at, or operating within, a port of a Member State, with the exception of any warship, naval auxiliary or other ship owned or operated by a State and used, for the time being, only on government non-commercial service; and

(b) all ports of the Member States normally visited by ships falling under the scope of point (a).

Member States shall take measures to ensure that ships which are excluded from the scope of this Directive under point (a) of the preceding paragraph deliver their ship-generated waste and cargo residues in a manner consistent, in so far as is reasonable and practicable, with this Directive.

Article 4

Port reception facilities

1. Member States shall ensure the availability of port reception facilities adequate to meet the needs of the ships normally using the port without causing undue delay to ships.

2. To achieve adequacy, the reception facilities shall be capable of receiving the types and quantities of ship-generated waste and cargo residues from ships normally using that port, taking into account the operational needs of the users of the port, the size and the geographical location of the port, the type of ships calling at that port and the exemptions provided for under Article 9.

3. Member States shall establish procedures, in accordance with those agreed by the International Maritime Organization (IMO), for reporting to the port State alleged inadequacies of port reception facilities.

Article 5

Waste reception and handling plans

1. An appropriate waste reception and handling plan shall be developed and implemented for each port following consultations with the relevant parties, in particular with port users or their representatives, having regard to the requirements of Articles 4, 6, 7, 10 and 12. Detailed requirements for the development of such plans are set out in Annex I.

2. The waste reception and handling plans referred to in paragraph 1 may, where required for reasons of efficiency, be developed in a regional context with the appropriate involvement of each port, provided that the need for, and availability of, reception facilities are specified for each individual port.

3. Member States shall evaluate and approve the waste reception and handling plan, monitor its implementation and ensure its re-approval at least every three years and after significant changes in the operation of the port.

Article 7

Delivery of ship-generated waste

1. The master of a ship calling at a Community port shall, before leaving the port, deliver all ship-generated waste to a port reception facility.

2. Notwithstanding paragraph 1, a ship may proceed to the next port of call without delivering the ship-generated waste, if it follows from the information given in accordance with Article 6 and Annex II, that there is sufficient dedicated storage capacity for all ship-generated waste that has been accumulated and will be accumulated during the intended voyage of the ship until the port of delivery.

If there are good reasons to believe that adequate facilities are not available at the intended port of delivery, or if this port is unknown, and that there is therefore a risk that the waste will be discharged at sea, the Member State shall take all necessary measures to prevent marine pollution, if necessary by requiring the ship to deliver its waste before departure from the port.

3. Paragraph 2 shall apply without prejudice to more stringent delivery requirements for ships adopted in accordance with international law.

Article 8

Fees for ship-generated waste

1. Member States shall ensure that the costs of port reception facilities for ship-generated waste, including the treatment and disposal of the waste, shall be covered through the collection of a fee from ships.

2. The cost recovery systems for using port reception facilities shall provide no incentive for ships to discharge their waste into the sea. To this end the following principles shall apply to ships other than fishing vessels and recreational craft authorised to carry no more than 12 passengers:

(a) all ships calling at a port of a Member State shall contribute significantly to the costs referred to in paragraph 1, irrespective of actual use of the facilities. Arrangements to this effect may include incorporation of the fee in the port dues or a separate standard waste fee. The fees may be differentiated with respect to, *inter alia*, the category, type and size of the ship;

(b) the part of the costs which is not covered by the fee referred to in subparagraph (a), if any, shall be covered on the basis of the types

APPENDIX J2

DIRECTIVE
OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL
ON PORT RECEPTION FACILITIES FOR THE DELIVERY OF WASTE FROM SHIPS, AMENDING DIRECTIVE 2010/65/EU AND REPEALING DIRECTIVE 2000/59/EC

COM (2018) 33 final 2018/0012(COD)

PROVISION OF ADEQUATE PORT RECEPTION FACILITIES

Article 4

Port reception facilities

1. Member States shall ensure the availability of port reception facilities adequate to meet the need of the ships normally using the port without causing undue delay to ships.

2. Member States shall ensure that:

   (a) the port reception facilities have the capacity to receive the types and quantities of waste from ships normally using that port, taking into account:

      (i) the operational needs of the port users;

      (ii) the size and geographical location of that port;

      (iii) the type of ships calling at that port; and

      (iv) the exemptions provided for under Article 9;

   (b) the formalities and practical arrangements relating to the use of the port reception facilities are simple and expeditious to avoid undue delays to ships;

(c) the fees charged for delivery do not create a disincentive for ships to use the port reception facilities; and

(d) the port reception facilities allow for the management of the waste from ships in an environmentally sound manner in accordance with Directive 2008/98/EC and other relevant Union and national waste law.

For the purposes of point (d) of the first subparagraph, the Member States shall ensure separate collection to facilitate reuse and recycling of waste from ships in ports as required under Union waste law, in particular Directive 2006/66/EC of the European Parliament and the Council[1], Directive 2008/98/EC and Directive 2012/19/EU of the European Parliament and of the Council[2]. In order to facilitate this process, port reception facilities may collect the separate waste fractions in accordance with waste categories defined in the MARPOL Convention, taking into account the guidelines thereof.

Point (d) of the first subparagraph shall apply without prejudice to the more stringent requirements imposed by Regulation (EC) No 1069/2009 for the management of catering waste from international transport.

APPENDIX J3

DIRECTIVE (EU) 2019/883 OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL

of 17 April 2019

on port reception facilities for the delivery of waste from ships, amending Directive 2010/65/EU and repealing Directive 2000/59/EC

(Text with EEA relevance)

Provision of adequate port reception facilities

Article 4

Port reception facilities

1. Member States shall ensure the availability of port reception facilities adequate to meet the need of the ships normally using the port without causing undue delay to ships.

2. Member States shall ensure that:

(a) the port reception facilities have the capacity to receive the types and quantities of waste from ships normally using that port, taking into account:

(i) the operational needs of the port users;

(ii) the size and geographical location of that port;

(iii) the type of ships calling at that port; and

(iv) the exemptions provided for under Article 9;

(b) the formalities and practical arrangements relating to the use of the port reception facilities are simple and expeditious to avoid undue delays to ships;

(c) the fees charged for delivery do not create a disincentive for ships to use the port reception facilities; and

(d) the port reception facilities allow for the management of the waste from ships in an environmentally sound manner in accordance with Directive 2008/98/EC and other relevant Union and national waste law.

For the purposes of point (d) of the first subparagraph, the Member States shall ensure separate collection to facilitate reuse and recycling of waste from ships in ports as required under Union waste law, in particular Directive 2006/66/EC of the European Parliament and the Council ([20]), Directive 2008/98/EC and Directive 2012/19/EU of the European Parliament and of the Council ([21]). In order to facilitate this process, port reception facilities may collect the separate waste fractions in accordance with waste categories defined in the MARPOL Convention, taking into account the guidelines thereof.

Point (d) of the first subparagraph shall apply without prejudice to the more stringent requirements imposed by Regulation (EC) No 1069/2009 for the management of catering waste from international transport.

3. Member States, in their capacity as flag States, shall use the IMO forms and procedures to notify the IMO as well as the authorities of the port State of alleged inadequacies of port reception facilities.

Member States, in their capacity as port States, shall investigate all reported cases of alleged inadequacies and use the IMO forms and procedures to notify the IMO and the reporting flag State of the outcome of the investigation.

4. The port authorities concerned or, failing them, the relevant authorities shall ensure that waste delivery or reception operations are carried out with sufficient safety measures to avert risks to persons and the environment at ports covered by this Directive.

5. Member States shall ensure that any party involved in the delivery or reception of waste from ships can claim compensation for damage caused by undue delay.