

# **“A STUDY OF GREEN PORT INITIATIVES IN INDIA”**

Project Report Submitted in Partial Fulfillment for the Award of the

degree Of

**MASTER OF BUSINESS ADMINISTRATION (MBA)**

**IN**

**PORT AND SHIPPING MANAGEMENT**

submitted by

**SHON JACOB**

**Reg. No. 2103304020**

Under the Guidance Of

**Dr. Lekha Ravi**

**Assistant Professor**



**School of Maritime Management**

**INDIAN MARITIME UNIVERSITY**

(A Central University, Government of India)

**MAY 2023**

## DECLARATION

I, **SHON JACOB** (Reg. No. 2103304020), Student of School of Maritime Management, Indian Maritime University –Chennai Campus, Hereby Declare that this Project Report Titled **A STUDY OF GREEN PORT INITIATIVES IN INDIA** Submitted in Partial Fulfilment of the Requirement for the Degree of Master of Business Administration in Port and Shipping Management is My Original Work Carried Under the Guidance of My Project Guide. It Has Not Formed the Basis for the award of Any Degree/Diploma of Any University/Institution. the Information Submitted is True and Original to the Best of My Knowledge.

  
**SHON JACOB**

(Reg. No. 2103304020)

**Date: May 2023**

**Place: Chennai**

**CERTIFICATE**  
**SCHOOL OF MARITIME MANAGEMENT**  
**INDIAN MARITIME UNIVERSITY, CHENNAI.**

This is to Certify that the Project Report Entitled "A STUDY OF GREEN PORT INITIATIVES IN INDIA Submitted to the School of Maritime Management, Indian Maritime University, Chennai Campus., In Partial Fulfilment for the Award of the Degree of Master of Business Administration in Port & Shipping Management, is a Record of Work Carried Out Entirely by SHON JACOB, Reg. No. 2103304020.



**Dr. LEKHA RAVI**  
**Assistant Professor**  
**PROJECT GUIDE**



**Dr. B. Swaminathan**  
**ASSOCIATE PROFESSOR**  
**HEAD OF THE DEPARTMENT**



External Examiner:  
Place: Chennai  
Date: May 2023

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## **ABSTRACT**

The aim of this study endeavor seeks to examine the efficacy and execution of environmentally friendly port initiatives in India. With the goal to minimize the environmental damage and advance environmentally friendly growth, Indian ports have implemented a number of plans, regulations, as well as procedures. It is critical to consider the detrimental effect that the booming international trade has on the Indian port industry, which is flourishing at the expense of the coastline.

The study seeks to investigate the ecological impacts of an expanding port industry in India and evaluates the efficiency of actions taken to reduce the increasing pollution brought on by port activities. The study has provided a comparison of the environmental impact of major ports and minor ports. the study has gathered secondary data from professional and separate groups of port sector participants throughout of the nation's most active ports It was found that maritime activities significantly harmed the environment in terms of water contamination, waste water destruction, dangerous pollutants, as well as even more.

The study has conducted a comparison and discovered differences in the rate of achievement of profitable operations among significant as well as minor ports with regard with the effectiveness of remedial actions to make up for such harm. The study additionally highlights the difficulties Indian ports encounter in putting green initiatives into reality, including an absence of financing, inadequate facilities, as well as an absence of knowledge between participants. The study suggests the creation of solid legislative frameworks, cooperation with the private sector, and the offering of technical and financial assistance to address these issues. Last but not least, the study's significant and minor ports have been placed according to how well they're doing in terms of ecological sustainability and negative environmental effects.

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## **EXECUTIVE SUMMARY**

This study seeks to investigate the efficiency and execution of green port efforts in India, with an emphasis on reducing adverse ecological impacts and fostering equitable growth. The study uses, integrating a review of the literature and the gathering of secondary information from informal conversations with the port participants. According to the results, Indian ports have taken major progress towards putting green initiatives into practice. Governments and port authorities have put into effect a number of policies to lower carbon dioxide emissions, save power, and promote sources of renewable energy. In addition to promoting clean modes of transport and sustainable port operations, these initiatives also include the setting up of solar power systems, LED lighting, as well as energy-efficient devices.

The study additionally emphasizes the difficulties Indian ports encounter in putting environmentally friendly goals into practice, including an absence of financing, inadequate facilities, and an absence of knowledge between participants. According to the research, legislators and port management should give priority environmentally friendly efforts, make investments in sources of clean energy and technologies that conserve energy, and promote awareness among stakeholders while conducting operational discussion with stakeholders and involvement. The findings of this study offer insightful information for politicians, port officials, and business professionals across India as well as developing nations who want to put green port initiatives into practice to support sustainable growth and lessen the negative environmental effects. The findings and suggestions of the research can help with the creation of strong policy frameworks, strategic alliances with the private sector, as well as the distribution of resources and technical assistance. According to the study's findings, green port efforts are essential for fostering equitable growth and reduction of the negative effects of port activities in the nation on the natural world. In order to guarantee the effective execution of environmentally friendly port efforts, the study highlights the requirement for ongoing investments in clean energy and energy-efficient equipment, along with involvement of stakeholders and promotion of awareness. The study's conclusions and suggestions can help develop practical plans for encouraging sustainable port activities in the nation of India along with other nations that are developing.

## **CHAPTER-I**

### **INTRODUCTION**

#### **1.1 ABOUT THE PORT SECTOR:**

The physical structure of port is essential to the prosperity of every country. India possesses around 7,500 kilometres long coastline. Ports manage almost 90% of the nation's international trade in terms of quantity and seventy per cent in terms of value. Iron ore, coal, crude petroleum, and other basic commodities are all imported via the marine route. India's coastline is home to 205 minor ports and 12 major ports. A port may be described as a waterfront or a location with the capacity to shelter multiple ships and vessels (the transfer of passengers or goods) and to permit ongoing or infrequent shipments.

In India, ports are classed as Major or Non-Minor. The national government owns and manages major ports, whereas the states control and handle non-major ports. India has 12 massive ports as well as 205 minor and medium ports that have been recognised.

#### **MAJOR PORTS:**

- Major Ports are governed within the Indian Ports Act of 1908 & the Major Port Trust Act of 1963 and fall within the Union Territory List in the Indian Government.
- A group of Governors that the Indian government established oversees every significant port. They are responsible for port leadership, preparation, and operation.

#### **NON-MAJOR PORTS**

- non-Major ports are administered at the national government by the port's management division or the State Maritime Board of Directors, if one was established, as was the situation in Maharashtra, Gujarat, and Tamil Nadu.
- State Maritime Boards focus on recruiting investors by issuing concessions agreements, giving rewards, having exclusive rights, & insuring the purchase of land.

- Their duties are comparable to that of port respects and additionally include the ability to establish tariffs.

## CARGO CAPACITY AT MAJOR PORT

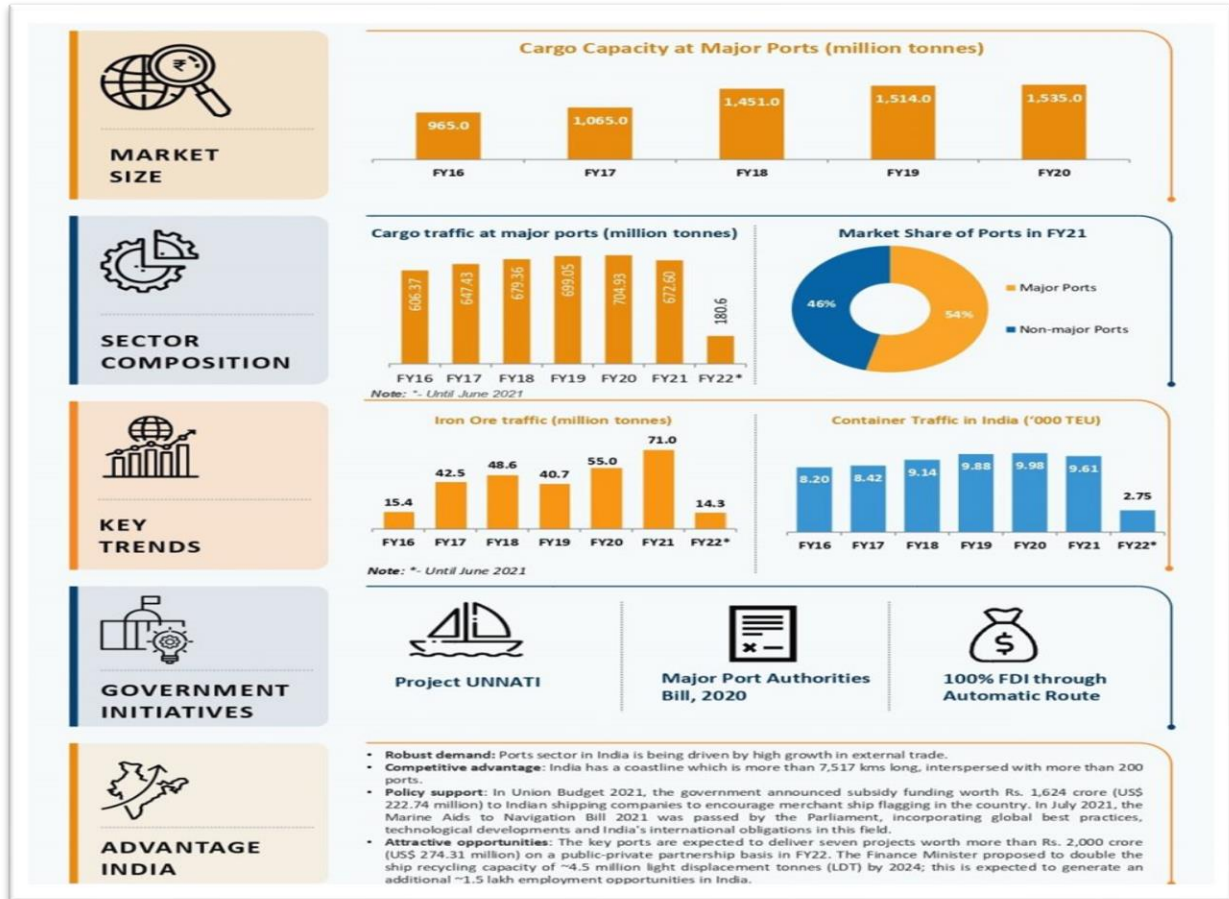


Fig 1.1 (Source: Sustainable port-hinterland intermodal development: Opportunities and challenges for China and India)

### 1.1.2 THE RECENT PERFORMANCE OF INDIA'S PORT SECTOR

- More than eighty per cent of the nation's trans-shipment materials employs establishments at locations in Singapore, Colombo, Sri Lanka, and Klang, Malaysia, which together handle nearly 25 percent of the country's maritime trade.
- The transfer of goods expenses cost the Indian port sector Rs fifteen billion rupees every year. India can thus fully utilise its tremendous potential for port utilisation.

**Comparative impact of port-led development on economies of India and China**



		India 	China 	China/India	
Size	Land mass (mn sq km)	3.3	9.6	3X	
	GDP (USD trillion)	1.9	9.2	5X	
Port-led development	Energy	Cost of energy (cents/kWh)	19	11	-42%
		Electricity production (bn kWh)	1,000	5,000	5X
		Petchem crackers (number)	07	46	7X
	Materials	Steel production (mn tonne)	87	823	10X
		Cement production (mn tonne)	280	2,480	9X
	Discrete Mfg	Container traffic (mn TEUs)	11	174	16X
		Merchandise export (USD bn)	317	2,343	7X
Services	Mobile subscribers (mn)	1,000	1,290	1X	
	Internet subscribers (mn)	354	659	2X	

Fig 1.2(Source: Sustainable port-hinterland intermodal development: Opportunities and challenges for China and India)

### 1.1.3 ISSUES AND CHALLENGES IN INDIA'S PORT CONNECTIVITY

**Long turnaround efforts instances:** Indian ports experience lengthy processing times for the vessels. For instance, the typical transport turnaround time in Singapore is under a single day. Yet, it takes more than two full days in India.

**Port traffic jams:** A major issue is congestion in ports caused by a large number of containers, a lack of storage facilities, and insufficient operations. For instance, the port of Nhava Sheva is an example.

**Sub-optimal Transfer Modal Mix:** This is caused by an absence of the necessary facilities for evacuating from both significant and lesser ports.

**Restricted Hinterland Linkages:** The lack of adequate countryside interaction via transportation, highway, motorways, coastline transport, as well as waterways inside the country results in incompetence. As a result, moving goods and paying for shipping become more expensive.

**Protracted examination as well as investigation:** Despite India's swiftly paperless and digitalizing immigration activities, goods and various other maritime activities go on to be subject to protracted assessments as well as review.

**Insufficient technological advances along with facilities:** The Non-Major Ports lack sufficient docking facilities, the dock numbers, or duration for appropriate landing for these vessels. The majority of non-major ports lack the necessary supplies and handling equipment that would enable an instantaneous turnaround. Insufficient machinery for managing heavy loads Lacking suitable amenities, systems for information technology, and assistance with navigation.

**Problems alongside Regulations:** Major and non-major locations are subject to distinct laws. The system of regulation is also strict. Because local carriers continue to hold a monopoly on this route, multilingual-flagged arteries aren't allowed to transport shipment between Indian ports. Property purchase as well as ecological approvals

**Problems regarding the PPP:** The vast majority of port PPPs place severe limits on what entrepreneurs are able to do, typically with regard to of what kinds of goods they are permitted to handle. In the past, other issues involved the lack of an arbitration process and tariffs enforcement.

**Sustainability:** Because of lax enforcement of ecological regulations and norms, accidental leaks or spills to the unloading and loading of cargo as well as oil pollution are frequent during port operations. The ballast discharge as well as fluid lost throughout vessel disinfecting pose a danger to the health of marine ecosystems. The dredging impacts regional water efficiency and the fishing industry by increasing the formation of sediments which is an issue for the ecosystem.

**Social effects of port growth:** The vast majority of connection initiatives and growth lead to movement (for example, in the cases of Gujarat's Mundra and Andhra Pradesh's Gangavaram Port). Limitations on access to places of fishing near ports is another significant issue raised by fishermen.

**Human Resources as well as Employment Problems:** Primary issues include inadequate instruction, declining workforce effectiveness, along with resistance towards change.

**Pollution Rivalry:** Researchers have expressed their worries about the growth of several ports managing identical goods in close range as it could result in locations battling over identical goods arrival.

## **1.2 ENVIRONMENTAL IMPACT OF SEA TRANSPORT**

Using over eighty percent of worldwide markets in terms of the amount and seventy percent in terms of cost, the sea travelling is a significant mode of transportation (UNCTAD, 2017). The ports function as entry points for international supply chains, boosting the economy globally. despite the fact that the maritime sector is frequently regarded as being one for the smallest culprits in terms of the damage it causes to the environment, due to the amount of transporting or port movement, it still presents serious risks.

However, due to variations in political and financial places and conditions, the issues and opportunities faced by industrialized, emerging, and emerging savings vary. It is necessary to take into account that normal focus in every situation. The equitable growth and green growth of ports along with additional activities that generate value are the primary objectives of the International Association for Waterborne Transport Infrastructure (PIANC, 2014). It offers recommendations on proactive steps and strategies for achieving equitable growth and subsequent activities and supports an adjustment in thought towards a strategy for the future.

Given the significance of the natural world for long-term growth, the Indian government has launched "Project Green Ports," which seeks to turn some of the nation's main ports to more environmentally friendly and cleaner ones. The "Swachh Bharat Abhiyaan" and "Green Ports Initiatives" are both components of the scheme, according to the Govt. of India (2016). Twelve measures are included in this endeavor and will be carried out on a regular basis to achieve all the goals. These tasks entail: creating processing plants, treatment centres, and garbage collection plants; creating green energy manufacturing initiatives at the ports; enhancing Oil Spill Response (OSR) facilities; managing and forbidding the release of waste through the oceans. getting the required machinery for tracking of environmental degradation. obtaining dirt removing as well as reducing structure.

## **1.3 RESEARCH QUESTION:**

Is it feasible for ports in India to find an equilibrium between efficiency and sustainability? Is it feasible to reconcile the execution of environmentally friendly efforts alongside the requirement of ports to keep operating profitably? The study investigates if a sustainable approach may be implemented for Indian port activities without having an adverse impact on their efficiency and bottom line.

## 1.4 OBJECTIVE:

- To study the Port operations in India and functions from the environment perspective.
- To understand and identify how the Indian ports affect the environment.
- To study the measures of waste management and resource usage at Ports.
- Identify parameters for sustainable practices at the Port.

## 1.5 RESEARCH METHODOLOGY:

The following phases will be included in the methodology used for the investigation of green port efforts in India:

**Literature review:** To determine the legal and policy structures regulating green ports in India, technological advances and standards of excellence implemented in Indian ports, and the social, environmental, and economic effects of green port initiatives, a thorough review of the relevant literature, such as research papers, mentions, and policy papers, is going to be carried out.

**Case examinations:** To gain insight into certain green ports in India and assess the success of their green initiatives, case investigations are going to be done. Location examinations, conversations with port workers and customers, and an examination of pertinent data are all part of the case study.

**Gathering information as well as evaluation:** Utilising suitable secondary data, information regarding the economic, social, and environmental impacts of green port initiatives may be assembled. The study's main goals are to pinpoint the main forces promoting long-term prosperity in Indian ports and gauge how well green port efforts are working towards achieving environmental goals.

**Primary data from Professional referrals:** For knowledge and opinions on the present situation of green port programmes in India and potential implications of subsequent changes, expert discussions alongside customers, such as port authorities, representatives from the industry, and environmental specialists, will be held executed.

**Recommendations:** In accordance with the results of the research, suggestions will be made for improving Indian ports' ecological sustainability and encouraging the implementation of

standards of excellence while advancements. Aiming at legislators, port executives, and all other participants who participate in green port attempts, suggestions were made.

## **1.6 LIMITATIONS OF THE STUDY:**

**Limited scope:** The study may only focus on a specific region or city, limiting the generalizability of the findings to other areas.

**Data availability:** The availability of data on Green Port initiatives in India may be limited, making it difficult to obtain a comprehensive understanding of the subject.

**Reliability of data:** The quality of data available on Green Port initiatives may vary, affecting the accuracy and reliability of the findings.

**Lack of comparative analysis:** The study may not compare Green Port initiatives in India with similar initiatives in other countries, limiting the insights that can be gained.

**Timeframe:** The study may only focus on a specific timeframe, making it difficult to understand the long-term impacts of Green Port initiatives in India.

**Incomplete coverage:** The study may not cover all the relevant stakeholders, such as port authorities, private sector, or civil society organizations, leading to a partial understanding of the subject.

## **1.7 CHAPTER SCHEME**

### **First Chapter**

First chapter is an introduction about the industry and research already has been done on the related field is mentioned along with the objectives, research methodology, limitation. It will make readers familiar how the study is being conducted.

### **Second Chapter**

Second chapter is all about review of literature, consists of articles from different journal available in respect of green port.

### **Third Chapter**

Third chapter talks about the analysis of the study, having comparison with port of Antwerp and Indian port, including some case study and data.

#### **Fourth Chapter**

Fourth chapter consists of data interpretation of available information for the project study.

#### **Fifth Chapter**

Fifth chapter consists of data findings and conclusion for the project study.

## **CHAPTER – II**

### **REVIEW OF LITERATURE & CONCEPTS USED**

#### **INTRODUCTION**

##### **2.1 GENERAL CONCEPT USED**

Ports are important to global trade and the growth of the economy, but they also cause substantial waste and damage to the environment. The Sustainable Ports Responsibility is a programme aimed at promoting ecological sustainability and lowering port harm to the environment. The government's Ministry of Shipping in India launched the Sustainable Ports Action in 2015 to deal with sustainability issues in the nation's ports. The examination of the existing research will look at the advancements and obstacles of the nation's Green Ports initiatives.

##### **The Nation's Green Ports Approach**

In the nation of India, the Sustainable Ports Action is an extensive initiative aimed at improving the green credentials of the nation's ports. The Government of India's Ministry of Shipping introduced the programme in 2015, and the Indian Ports Association (IPA) is in charge of its execution. The initiative is divided into four major components: (1) managing the environment, (2) reducing pollution, (3) energy savings, and (4) ecological sustainability.

##### **Ecological Administration**

The Sustainable Ports Initiative's sustainable development part seeks at enhancing the general environmental record of Indian ports. It involves creating sustainability management plans, carrying out audits of the environment, and putting in place systems for managing the environment. The effort also hopes to encourage sustainable procedures, such as the consumption of environmentally friendly goods as well as a decrease of junk generation.

##### **The contamination Reduction**

The environmentally friendly Ports Initiative's pollution prevention component emphasises decreasing pollution-related to ports, such as land, water, and air pollution. The initiative's goals include lowering greenhouse gases from vessels and connection-related tasks, improving

garbage disposal processes, and preventing spills of oil as well as other mishaps. To minimise emissions, the campaign additionally promotes the use of environmentally friendly inventions like coastal power and vehicles with lower emissions.

### **Conservation of energy**

The Sustainable Ports Initiative's sustainable energy part intends at decreasing port usage of energy along with encourage the utilisation of sources of clean energy. The programme promotes the adoption of energy-saving devices like LED lighting and effective goods handling devices, as well as sources of clean energy like solar and wind power. The attempt additionally fosters systems for energy management and the selection of green forms of conveyance.

### **Renewable energy**

The Sustainable Ports Initiative's renewable energy element targets at fostering long-term growth in ports as well as nearby areas. It entails the creation of green construction projects the promotion of environmentally friendly tourism, and also the assistance of neighbourhood organisations. The drive likewise seeks to endorse environmentally friendly forms of transportation, including public transit and other forms of mobility.

### **Progression plus Obstacles**

The Sustainable Ports Choice has achieved major advances towards enhancing the green credentials of Indian ports. As of the year 2021, 14 ports had received programme certification, and 26 ports provided sustainable development plans. The work has also culminated in the creation of ecologically conscious facilities and the implementation of energy-saving technologies.

Even so, the Sustainable Ports Approach encounters a number of obstacles. a few the biggest obstacles are an absence of ecological knowledge and comprehension between port all parties involved, which includes port authorities, shipping firms, and other those involved. This may end up in a lack of dedication and collaboration in putting green policies in place.

A further problem is the shortage of funding and the necessary resources to carry out the Healthy Ports Innovation. A lot Indian ports currently under economic strain, so enacting green initiatives may necessitate substantial expenditures. The absence of rewards and

encouragement for ports to implement environmentally friendly practises may serve as an impediment.

## **2.2 LITERATURE REVIEW**

**The paper "Green Ports: Challenges and Opportunities" was indeed presented at the Maritime Transport and Connectivity Conference in 2021. The authors of the paper are Mireia Valverde and Rosa M. Arnau, who are both affiliated with the Polytechnic University of Valencia in Spain.** Valverde is a research professor at the Institute of Transportation and Territorial Development, while Arnau is a professor of operations research and statistics at the same institution. In order to achieve sustainable development in the port industry, green ports must be developed. Green ports can lessen its negative effects in the natural world, increase their financial productivity, and encourage social accountability. To accomplish these objectives, it is essential to use technological advances, sources of clean energy, and feasible exercises.

By lowering consumption of energy and operating costs, environmentally friendly and smart ports can improve their competitiveness and draw in greater maritime companies. Utilising electronic devices may raise earnings and boost supply-chain effectiveness by decreasing interruptions. By lowering pollution in the water and air, clever as well as environmentally friendly ports additionally assist save the planet. A happier planet may result from the power of port machinery, the application of green power, and better waste management. By implementing ethical procedures and participating in outreach to communities' initiatives, environmentally friendly intelligent ports can encourage social accountability. Utilisation of digital technology could enhance port procedures' transparency and responsibility, fostering greater confidence among consumers.

The analysis of the literature on green ports in the country emphasises the significance of putting green policies in place to lessen the harm that ports due to the ecosystem. The Sagarmala Programme, the National Electric Mobility Mission Plan, and the Green Port Initiative have just a few of the numerous schemes the Indian government has put into place to support green ports in the country as a whole. Rules governing the use for technologies that are energy-efficient, and efficient disposal of waste are crucial determines to guarantee that ports work sustainably. Prioritising social duty will help ports be excellent corporate citizens.

**"Smart Port Development,"** which was produced by a team of experts and researchers from the United Nations Economic and Social Commission for Asia and the Pacific (ESCAP). Unlike a journal paper, this report does not have specific authors since it was a collaborative effort

Many benefits, such as improved efficiency in operation, preservation of the environment, and profitability, could be gained by the port industry from the creation of innovative ports within the Asia-Pacific area. The use of automation, AI, as well as the Internet of Things (IoT) are a few examples of technological advances that can be used in ports to increase productivity, reduce expenses, and enhance the quality of life. To guarantee an organised and cohesive strategy, intelligent port growth additionally calls for cooperation among port officials, maritime companies, logistics services, technological advances suppliers, along with communities at large.

Through encouraging the application of clean power, lowering pollutants, and enhancing the handling of waste, green and intelligent ports across the nation had a chance to lessen the adverse impacts of maritime operations in the surroundings. Smart methods and technologies may raise performance, boost functionality, as well as rise security for employees in ports. Furthermore, eco-friendly while innovative ports may be more enticing to patrons and shareholders, increasing their level of competitiveness and benefiting those who live nearby by lowering contamination, enhancing safety for everyone, as well as fostering growth in the economy.

By fostering creativity and ingenuity in shipping operations, elected officials, port leaders, and various other customers will fully understand the potential benefits of technologically advanced ports in the Asia-Pacific area. For the sake of the roll out of innovative equipment and procedures in ports to be prosperous, cooperation and partnerships among different players have essential. Additionally, implementing effective and ecologic technologies can improve the in general viability and efficiency of port activities in India and elsewhere in the globe.

**"Seaport: Challenges and Issues in India,"** which was authored by N. Raghavendra and published by the Indian Institute of Materials Management.

During furtherance of highlighting the requirement over an additional incorporated and worked strategy for the growth of ports, this work aims to shed light on the difficulties and problems that shipping hubs across the nation face. The investigation determines a number of difficulties

seaports within India confront, such as facilities limitations, legal restrictions, ecological responsibility, and rivalries with nearby nations. In order to increase the efficiency and economic viability of ocean ports in India, the piece highlights the requirement over planned preparation, participation from the private sector, technological advances, as well as creativity. A synopsis of literature on seaport problems and obstacles in the country discovered a number of significant problems involving structures limitations, ineffective activities, and ecological worries. The growth of sea ports throughout India has been hampered by an absence of sufficient projects including road and rail interaction, berth ability, managing tools, along with warehouses. a while turnaround times over vessels, lengthy waiting periods over merchandise, and elevated transaction expenses have all been the consequences of ineffective procedures. The viability of port facilities across the nation has additionally been impacted by ecological problems like soil, water, and air pollution. In general, the research points out the necessity for a structured alongside comprehensive strategy for port growth in India. The effectiveness and affordability of maritime hubs across the nation can be significantly increased with the help of private industry, technological devices, particularly inventiveness.

**"Challenges Towards Sustainable Port Development in India" by Gaurav Ailawadi, submitted to the World Maritime University in 2019. Author: The author of the dissertation is Gaurav Ailawadi.**

The primary objective of this thesis is to advance comprehension of the difficulties Indian ports confront as they make their journey to equitable growth. It offers an in-depth examination of published work on the subject of environmentally conscious growth of ports, outlining its characteristics, motivators, as well as difficulties. The review of literature also emphasises the importance of an expanded and cohesive strategy for the growth of ports which considers consideration variables such as the surroundings, society, as well as the financial system. In moving with equitable growth, Indian ports visage a number of significant obstacles, which are identified in the coursework. Important natural, regulating, interpersonal, and economic obstacles are a few of such. In order to guarantee long-term sustainability, proactive steps must be taken to address ecological issues like contamination, shoreline erosion, and warming temperatures. The dispersed and complicated legislative framework in India makes equitable growth difficult. Employment freedoms, safety and health, and involvement in the community are additional social issues that Indian ports must address. It may be difficult to make investments significantly in technology, facilities, and personnel to achieve long-term expansion of ports given the constrained resources available and multiple needs. It offers

suggestions to boost Indian ports' the achievement of sustainability objectives The requirement to feed an improved organised and holistic method for the development of ports, cooperation among stakeholders, as well as an opportunity over innovative technology to promote feasible shipping operations are a few of such. It emphasises the necessity of a proactive in order forward-thinking strategy for viable growth of ports that requires into consideration potential difficulties and trends. The study offers useful advice for port administrations, decision-makers, and various other participants to improve the sustainability achievements of Indian ports.

**"Port Strategy for Sustainable Development"** that was published by MDPI Books in 2021. This book features multiple chapters written by different authors, each addressing various aspects of sustainable port development.

Authors: The book has multiple authors, each contributing to different chapters. The authors include experts from academia, industry, and government agencies, with backgrounds in fields such as environmental science, engineering, economics, and law.

The objective of this work on viable growth of ports is to give readers an in-depth understanding of the concept by illustrating its motivations, difficulties, as well as possible remedies. It aims to provide customers, including port officials and politicians, with helpful insights into the intricate processes present with environmentally friendly expansion of ports.

A comprehensive overview of the research on environmentally friendly growth of ports is included in the publication, which analyses many studies and articles from various areas of the globe. It draws attention to a number of important results, such as the severe ecological issues that ports encounter, which includes pollution of the environment, loss of habitat, and warming temperatures. To guarantee profitable operations while minimising adverse outcomes, such difficulties call for proactive approaches. Ports significantly affect the surrounding areas, such as job possibilities, safety, and the standard of existence, according to the work's other key finding. Therefore, involvement of stakeholders and guaranteeing environmentally friendly port growth have essential.

Financial challenges arise because sustainable growth of ports also necessitates substantial expenditures in human resources, technological advances, and facilities. Thus, it is crucial to determine and execute methods of funding equitable growth.

The work also discusses rules and regulatory concerns, emphasising the complicated and dispersed rules and regulations for ports that is governed by numerous agencies and laws. Thus, a clear as well as synchronised regulatory structure needs to exist for advising environmentally friendly development of ports.

**"Green Ports in Theory and Practice,"** which was conducted by **Rickard Bergqvist and Jason Monios**. This review delves into the theoretical and practical aspects of green ports by analysing a wide range of literature on the topic, including academic articles, reports, and case studies. The main objective of this review is to provide readers with an overview of the major issues and challenges involved in developing and implementing green ports.

Ports, which significantly affect the surrounding areas, such as job possibilities, safety, and the standard of existence, according to the work's other key finding. Therefore, involvement of stakeholders and guaranteeing environmentally friendly port growth have essential.

Economic difficulties arise because viable growth of ports also necessitates substantial expenditures in human resources, technological advances, and facilities. Thus, it is crucial to determine and carry out methods of funding equitable growth.

The work also discusses rules and regulatory concerns, emphasising the complicated and dispersed rules and regulations for ports that is governed by numerous agencies and laws. Thus, a clear as well as organised regulatory structure needs to exist for advising environmentally friendly growth of ports.

They note several examples of significant difficulties in developing and implementing green ports all over the course of the study. To overcome these barriers, sustainable development efforts in ports must be driven by strong management, efficient administration, and constant open monitoring of sustainability. The contributors also stress the significance of creativity in creating feasible procedures, such as the application of novel company structures and technological advancements.

In general, the assessment of the research provides insightful analysis into the complex problems relating to ecological responsibility in the shipping sector and offers helpful recommendations for politicians, port officials, and various other participants looking to advance environmentally friendly practises in ports.

**"Pollution Prevention at Ports: Clearing the Air,"** which was written by Bailey and Solomon in 2004. The paper examines the environmental effects of ports and provides a list of proactive steps which may be taken to lessen contamination in port areas. The contributors start by talking about how ports impact the natural world, pointing out that they're having a big impact in the wellness of those living nearby as well as the cleanliness of the water and the air they breathe. Considering the expanding significance of commerce worldwide and the significance of ports in global supply chains, they highlight the necessity for tackling the negative environmental effects of ports.

The authors go on to discuss the primary causes of contamination at ports, emphasising vessels, vehicles, and transporting cargo machinery. They go over the various pollution types that can arise from those sources, such as particles and organic solvents, that can have an effect beyond the port's immediate area. The section also looks at the statutes regarding port emissions, pointing out that national as well as global laws have been put in place to deal with the problem. Although the writers are aware for the difficulties in implementing and enforcing these laws, they also understand their importance in promoting sustainable development in the shipping sector.

The work concludes with a discussion of the steps that may be implemented to prevent contamination in connection areas, including increasing the energy utilisation of vessels and connection machinery, using low-sulphur fuels, and lowering truck emissions. The authors stress the value of stakeholder participation in promoting greener practises in port regions and an opportunity for ports to work with other supply chain stakeholders to meet common objectives regarding sustainability.

**"Green Performance Criteria for Sustainable Ports in Asia,"** which was written by Lirn, Wu, and Chen in 2013. A thorough examination of the green benchmarks for environmentally friendly ports in the Asian continent is given in this review of the literature. The idea of "sustainable" ports," "the present state of sustainability efforts in Asian ports," "one of the creations of environmentally friendly performance criteria," as well as "the difficulties and possibilities connected to their execution" are the four main topics on which the contributors concentrate during the investigation.

Their findings stress the significance of encouraging conservation in the port industry and lessening the negative effects of carrying on the surroundings. Whereas that is no agreed-upon a description of a "sustainable" port," they point out that it typically refers to a type of port

which requires measures to reduce its ecological footprint and advertise viable protocols. They highlight the noteworthy advancements which are being produced recently regarding the implementation of green initiatives in Asian countries. The study's authors address the creation of low-impact standards of performance for environmentally friendly ports in Asia and demonstrate the significance of creating a thorough set of standards that can be used to assess the natural environment of ports in an in keeping and accessible way. Someone also draws attention to certain difficulties in putting green initiatives to good use in the maritime sector, including the costly nature of adopting cutting-edge technologies and the requirement for participation from stakeholders.

They conclude by highlighting the significant benefits of implementing environmentally friendly programmes in Asian ports, such as the chance to lower costs, boost productivity, and support sustainable economic growth. They emphasise how crucial stakeholder participation and cooperation are to advancing efforts towards sustainability and accomplishing common sustainable development objectives.

**The article "Port Sustainability and Performance: A Systematic Literature Review" by Lim, Pettit, Abouarghoub, and Beresford (2019)** This inventory of the scientific literature provides an in-depth examination of over one hundred papers on shipping efficiency and the environment. The idea and the assessment of port long-term viability various variables that affect port ecological responsibility, the plans and follows related to environmental sustainability in ports, as well as the effects sustainability has on the operation of ports are the four primary areas into which the authors organised the work.

The contributors to the volumes talk about the difficulties in establishing and evaluating sustainability in ports, pointing out the lack of a common definition and the requirement for an extensive comprehensive framework to assess sustainability. The relevance of cooperation and partnership among port stakeholders is emphasised, as they also look at the socioeconomic, environmental, and social variables that affect port ecological sustainability. The analysis shows a variety that are sustainable adheres to and programmes in ports, such as ecological design principles, environmentally friendly transport options, and green port actions. Despite the fact there seems to be a lot of progress lately, the authors point out that further structured and thorough approaches for ecological sustainability are required. In order to promote

ecological responsibility in ports, they additionally emphasise the significance of involvement of stakeholders and the function of electronic devices.

The authors then look at how environmental sustainability affects port efficiency, noting that it can result in better financial results, less of an impact on the environment, and greater impact on society and the economy. They do, nevertheless, additionally understand the disadvantages, difficulties, and demand for additional study related to environmental efforts.

**The article "A Notional Research on Implementing Green Port Strategy at the New Mangalore Port Trust" aims to identify and analyse the challenges and opportunities for implementing green port strategies at the New Mangalore Port Trust (NMPT) in India.**

The authors conduct a literature review to identify the key concepts and strategies for green ports, as well as the challenges and opportunities associated with their implementation.

The content of the piece gives an in-depth account of environmentally conscious port methods and discusses how they might be used within the NMPT in the nation of India. They list the primary barriers and possibilities to enacting green initiatives inside the port, including the lack of adequate facilities and legal hurdles, but they also highlight the prospective advantages of putting money into clean energy sources as well as involving stakeholders.

A variety of initiatives that encourage ecological sustainability and lessen the ecological impact are included in the hypothetical green port strategy that is being proposed for the NMPT, including environmentally friendly activities, power from renewable sources, less waste, and reuse and recycling. In order to promote environmental sustainability customs, the authors stress the demand for a thorough comprehensive strategy for addressing long-term viability in the port industry. They also stress the value of involvement of stakeholders. As a whole, the piece of writing is a useful tool to stay port administrators, decision-makers, and all other parties involved in advancing conservation in the maritime industry. The contributors supply an in-depth examination of the body of knowledge on port efficiency and sustainability in addition to a focused case investigation of the power source NMPT, providing useful insights into the possibilities as well as the challenges of putting environmentally friendly approaches into effect in the setting of ports. The piece adds to the increasing amount of work on environmentally friendly port operations by demonstrating the possible advantages of environmentally friendly port tactics and offering advice on how to put them into execution. It also provides valuable insights for upcoming studies in this area.

## **2.3 CONCLUSION**

An entire programme designed to encourage ecological responsibility and lessen ports' adverse ecological impacts is called the "Green Ports Initiative" in the nation of India. Although the effort has substantially enhanced the green credentials of Indian ports, there are still a number of obstacles to overcome. The obstacles consist of port the interests of stakeholder's inadequate knowledge and comprehension of ecological problems as well as an absence of resources and money for putting green policies into action. The Green Ports Action in India will need to overcome such barriers if it is to be a success in encouraging sustainable growth in the nation's ports.

## **CHAPTER -III**

### **PORT OPERATIONS IN INDIA AND FUNCTIONS FROM THE ENVIRONMENT PERSPECTIVE**

#### **3.1 INTRODUCTION:**

The delivery of products and services throughout borders both nationally and globally is made possible by ports, which are important points in the highway system. Nevertheless, ports may have significant adverse effects on the natural world in addition also constitute major contributors of contamination. As a way to make certain that those ports work ethically while remaining in compliance with regulatory requirements, it is essential to analyses the harmful effects of port activities and tasks in India.

For example, fine particulates along with other substances can be released during the transportation and holding of shipment at ports, which adds to air contamination. Furthermore, ports may produce a great deal of garbage, including dangerous, sturdy, while bodily fluids, that may have a ripple effect on the aquatic the standard in their vicinity.

Furthermore, ports may help destroy wetland ecosystem and the mangrove forests, two ecosystems in nature that could have permanent negative effects on the planet. Making sure that maritime activities are environmentally friendly and have no serious side effects on the natural world will rely in analyzing the consequences to find regions over enhancement.

In order to ensure that those ports work environmentally friendly with a minimal adverse ecological effect, it is imperative to investigate the way they operate and function from the viewpoint of the environment. It might be possible to enhance the long-term viability of such ports as well as lessen their negative ecological effects by using the primary knowledge which will result from an examination for the negative environmental effects of the port operations and duties in India.

India's ports are important entry points for international trade and play a significant role in the development and growth of the nation's economy. Yet, port activities may have significant adverse effects on the natural world, resulting in noise contamination, water and air contamination, as well as a higher risk of incidents and leaks. In order to recognize possible hazards, it is crucial to study the running of Indian ports to a sustainability viewpoint.

### **3.2 PORT OPERATIONS IN INDIA FROM THE ENVIRONMENT PERSPECTIVE**

In India, ports are important for the development of the economy because they act as entry points for trade and business. India has a 7,517-kilometer-long shoreline, with 187 non-major ports and 13 major ports propagated out along it. The ports sector has experienced substantial expansion in the past few years, yet there remain a number of issues and obstacles that must be resolved if growth and expansion are to continue.

Infrastructure deficiencies are one of the major issues that India's port industry must deal with. A lot of the ports are not equipped with contemporary infrastructure, such as deep draught berths, mechanisation, and contemporary cargo handling tools. Due to these shortcomings, Indian ports are less on par relative to other ports within the vicinity, resulting in a while processing time as well as more expensive prices.

The inadequate integration into the different types of conveyance is a further issue. The main mode of delivery in India is by highway, which causes traffic jams and puts off in the flow of cargo between and to ports. For a quicker and more effective movement of goods, a multipurpose transport network that incorporates multiple forms of shipping, including highways, trains, and rivers and lakes, is required.

Safety concerns are a big problem in the shipping business. The natural world is significantly impacted by port activities like excavation, transport congestion, while cargo handling on the oceans. To reduce its negative effects on the natural world, India's port sector must make investments in green technologies as well embrace ecologically sound business practises.

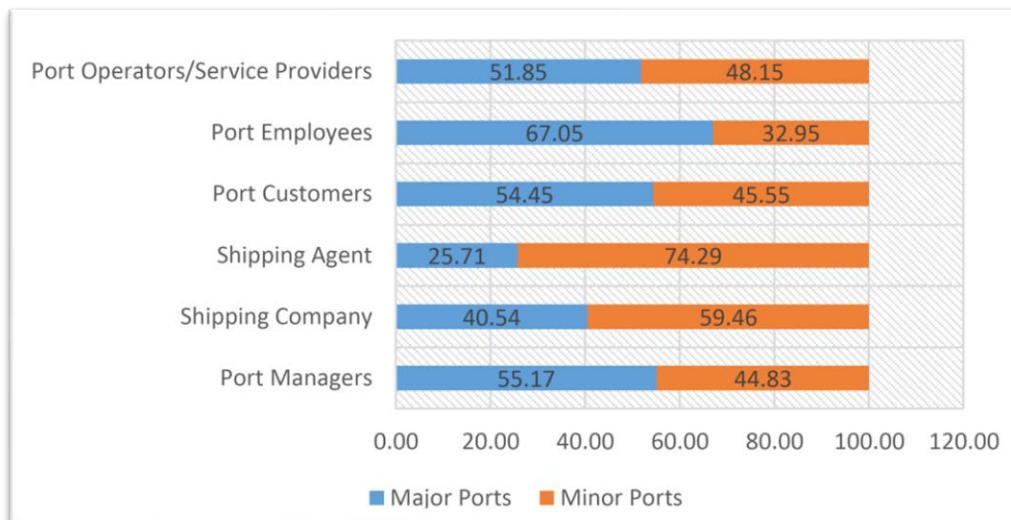
Another issue the Indian port business faces is complying with regulations. There are many organisations that regulate port activities in India, which adds to the complexity of the rules and regulations for the maritime sector. It is common for this level of detail to cause execution of projects postpones followed by unclear choice-making.

India's port sector additionally has to contend with rivalry with additional ports in the vicinity. Ports in nations like China and Singapore have made substantial investments in contemporary facilities and innovations, resulting in them being quicker as well as economical compared to ports in India.

India's connection sector possesses a lot of room for further growth and enhancement. fortunately, in order for the port sector to experience steady expansion, it has to tackle a number of problems and obstacles, including insufficient amenities, a lack of different transport styles, environmental concerns, compliance with regulations, and rivalry from rival ports to the vicinity. Indian ports can increase their market share and establish themselves as significant players in the worldwide ports industry by implementing environmentally friendly practices and making investments in modern facilities and innovations.

### 3.2.1 FINDINGS OF A STUDY ON THE IMPACT OF INDIAN PORTS ON ENVIRONMENT<sup>1</sup>

#### RESPONDENTS PROFILE



(Result of a study done in 2016-17) Fig 3.1 (Source: Measuring impact of Indian ports on environment and effectiveness of remedial measures towards environmental pollution<sup>2</sup>)

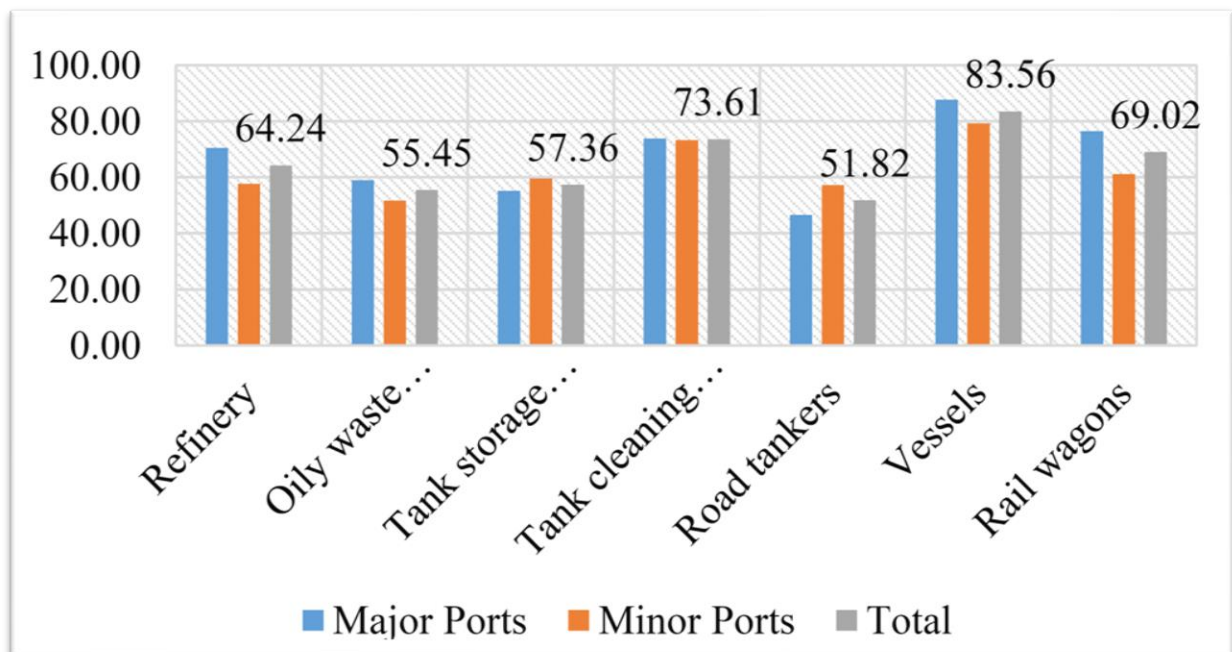
<sup>1</sup> URL

[https://www.researchgate.net/publication/335060357\\_Measuring\\_impact\\_of\\_Indian\\_ports\\_on\\_environment\\_and\\_effectiveness\\_of\\_remedial\\_measures\\_towards\\_environmental\\_pollution](https://www.researchgate.net/publication/335060357_Measuring_impact_of_Indian_ports_on_environment_and_effectiveness_of_remedial_measures_towards_environmental_pollution)

<sup>2</sup>Measuring impact of Indian ports on environment and effectiveness of remedial measures towards environmental pollution

The characteristics of those participating in the present research to major ports <sup>3</sup>and participants to smaller ports. 523 people in all, broken down into six public groups (port managers, the port staff members, port clients, transporting representatives, maritime businesses, and port supervisors), made up the entire number of those polled. The majority of those who participated within this group (67.05%) who worked in ports had been to the larger ports. In contrast, the majority of those who responded from shipping brokers and maritime businesses (74.29% and 59.46%, respectively) were to minor ports. Almost identical amounts of people to the major permits responded under the headings of port administrators, connection clients, and port leaders (51.85%, 54.45%, and 55.17%, respectively).

### 3.2.2 FACILITIES FOR OILY WASTE



(Result of a study done in 2016-17) Fig 3.2 (Source: Measuring impact of Indian ports on environment and effectiveness of remedial measures towards environmental pollution)

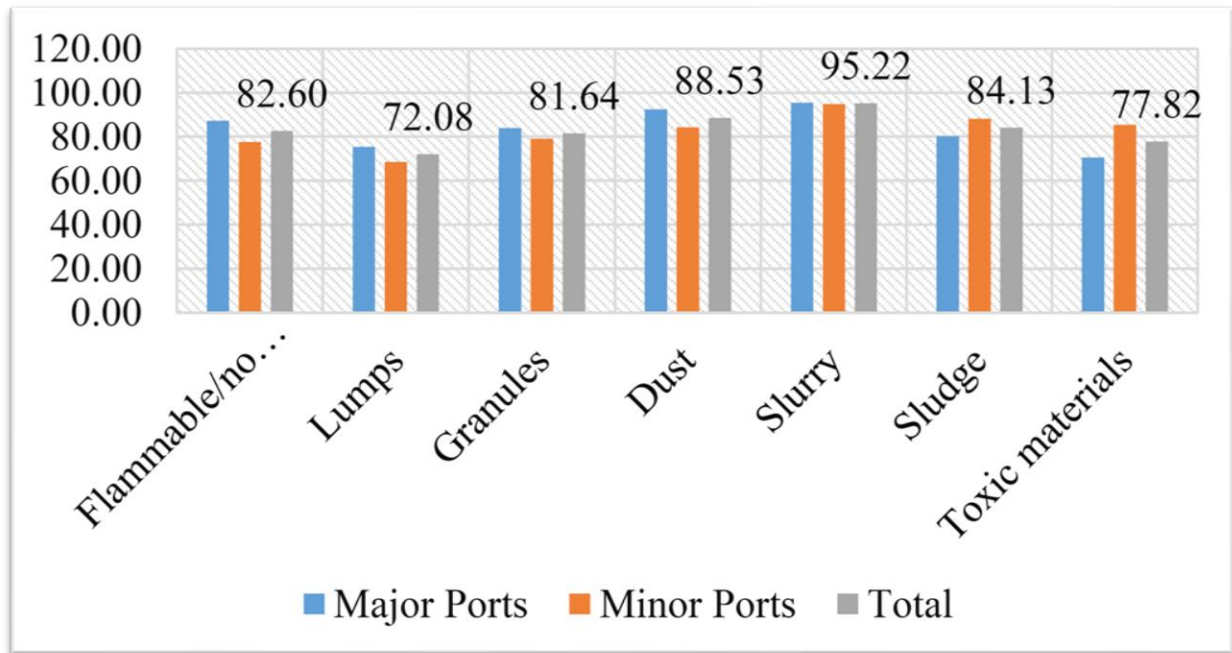
Both major and small ports have port infrastructure for handling of greasy garbage. At major ports, oil refineries as well as train waggons were far more readily available compared to a smaller port. At significant ports, waste oil clean-up arteries were also more often observed. nevertheless, those with smaller ports <sup>4</sup>performed better when it came to transferring oil. While

<sup>3</sup> Measuring impact of Indian ports on environment and effectiveness of remedial measures towards environmental pollution

<sup>4</sup> Measuring impact of Indian ports on environment and effectiveness of remedial measures towards environmental pollution

roadway vessels proved to be below mid-point at major ports, the reservoir terminals for storage and washing facilities carried out identically at major and minor ports. Large ports had somewhat superior communication with the sector to handle oily waste products, but just one out of every two smaller ports did.

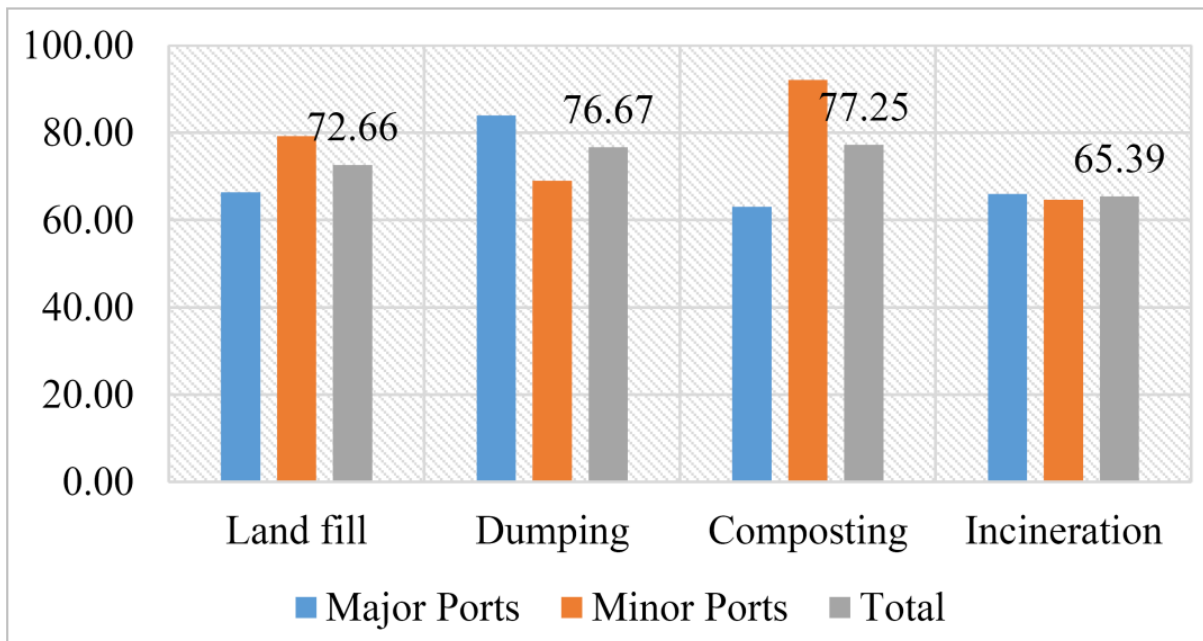
### 3.2.3 TYPES OF SOLID WASTES IN PORT PREMISES



(Result of a study done in 2016-17) Fig 3.3 (Source: Measuring impact of Indian ports on environment and effectiveness of remedial measures towards environmental pollution)

identifies the different types of solid substances at substantial and small ports. The main recyclable material at both kinds of ports had been a liquid. Significant average amounts of dirt, mud, and explosive and incombustible substances were additionally observed. Very levels of particles in the air are produced close to the regions in which maritime operations remain suspended as a consequence of escapee dust carried by the wind during the process of loading and unloading. Toxic substances had the smallest value at significant ports, whereas Bulgies enjoyed the smallest appreciate that insignificant interfaces.

### 3.2.4 METHODS USED FOR DISPOSAL OF SOLID WASTES IN PORT PREMISES



(Result of a study done in 2016-17) Fig 3.4 (Source: Measuring impact of Indian ports on environment and effectiveness of remedial measures towards environmental pollution)

It demonstrates that in significant ports, throwing had been the primary means of disposing of garbage, whereas in smaller harbours, recycling was a more popular green practise. In addition, additional methods like burning and garbage dumps were employed, in burning getting most common. Among small harbours, garbage dumps play an important part when it comes to ecological overloaded. Major shipping ports are unable to investigate garbage dumps alternatives owing because of the lack of land available in densely populated urban areas. The majority of the nation's major ports are severely constrained by their ability to handle just cargo traffic, whereas minor ports have more space, which may help to explain why landfill usage is more prevalent in small ports than the larger ones. dealing with

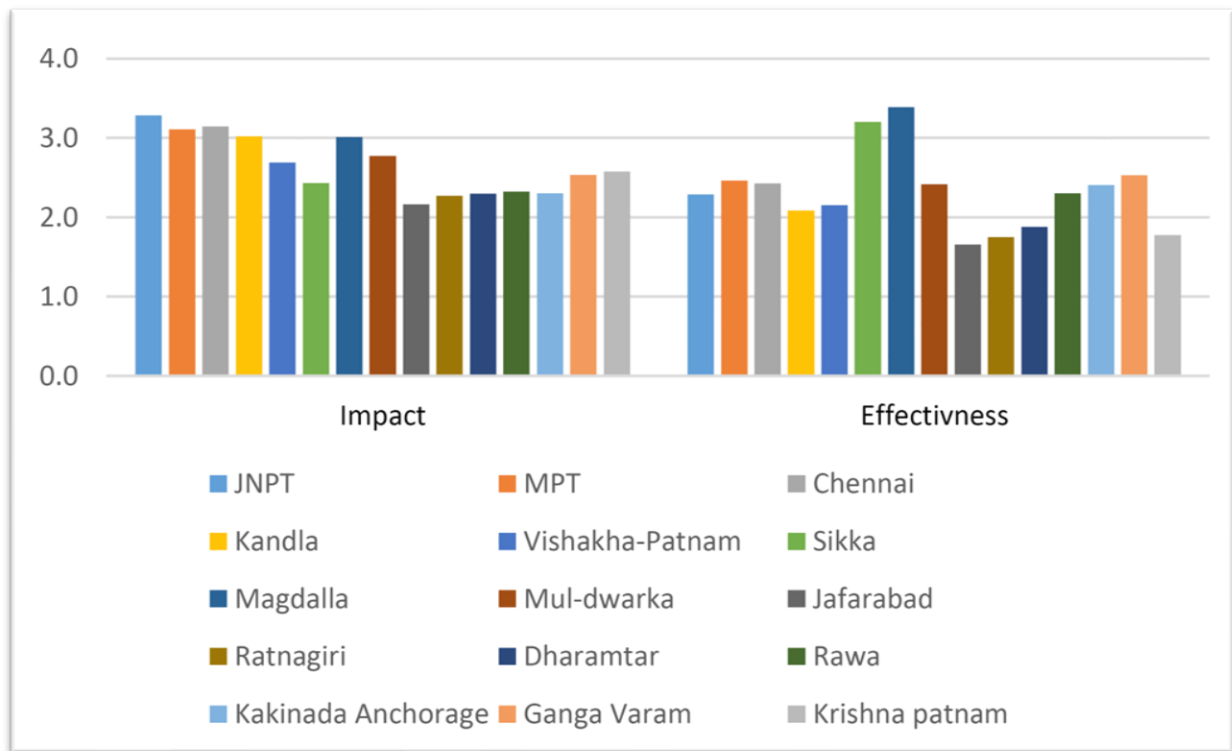
### 3.2.5 EFFECTIVENESS OF MEASURES TAKEN BY PORTS FOR ENVIRONMENT

<i>Factors responsible for environment pollution</i>	<i>Major port</i>	<i>Minor port</i>	<i>Total</i>	<i>T-value</i>	<i>p-value</i>
Double hulled tankers	2.70	2.13	3.33	5.335	.000
Strategic placement of salvage tugs	2.74	2.62	3.48	1.218	.224
Duplicate/replacement of equipment on ships and vessels	1.65	2.21	3.58	-8.060	.000
Dust suppression systems	1.98	2.17	3.50	-2.413	.016
High compound walls	1.99	2.13	3.49	-1.650	.100
Contained handling of toxic materials like sulphur	1.95	2.18	3.57	-2.852	.005
Documented environment management plan (EMP)	2.22	2.24	2.19	-.335	.738
Replacement of ill-functioning equipment like broken oil-water separators, old/decommissioned oil pipelines	2.44	2.31	2.41	1.552	.121
Gas detectors to be made mandatory for use by ship breakers	2.50	2.68	2.43	-2.202	.028
Proper disposal equipment like incinerator plant	2.48	2.85	2.02	-4.859	.000
Laboratory-cum-pollution control cell	3.22	3.56	3.12	-3.532	.000
Sewage treatment plants	1.59	2.47	2.02	-11.802	.000
Training to personnel/crew members	4.23	4.01	3.88	2.156	.001

(Result of a study done in 2016-17) Fig 3.5 (Source: Measuring impact of Indian ports on environment and effectiveness of remedial measures towards environmental pollution). Effectiveness of measures taken by ports for environment

Because of stringent rules as well as constant surveillance by individuals, superficial ports usually do more effectively after carrying out less environmental safeguards like air sensors, burning facilities vegetation, as well as pollution prevention cell types. The implementation of remedial measures, nevertheless, including the use of salvaging tugboats, increase barriers, as well prompt machinery substitutes, proved effective across significant alongside smaller interfaces. Both of kinds of harbours acknowledge the importance of appropriate strong-stakes handling of machinery as well as getting a climate leadership the schedule.

### **3.2.6 PORT-WISE IMPACT ON ENVIRONMENT AND EFFECTIVENESS OF REMEDIAL MEASURES**



(Result of a study done in 2016-17) Fig 3.6 (Source: Measuring impact of Indian ports on environment and effectiveness of remedial measures towards environmental pollution)

It's an examination of fifteen hubs' impacts on the natural world. Although Jafrabad connection possesses little detrimental effect on the surrounding area, JNPA as well as Chennai ports had the greatest impact. Chennai is adept at managing cargo, but this efficiency shouldn't be achieved at the cost of the surroundings. The ports of Dharamtar and Sikka are the most successful at reducing contamination, whereas Ratnagiri and Jafrabad are not as effective. Jafrabad's inadequate remedial methods have led to a decline in the region's <sup>5</sup>fisheries as a result from chemical contamination, in spite of the fact that it has lessened the harm done to the environment.

### 3.3 CASE STUDIES ON ENVIRONMENT IMPACT- 2 LEADING PORTS

The Jawaharlal Nehru Ports Authority (JNPA), situated in Mumbai, is one of India's main ports. One of the most active ports in the nation, the port manages roughly 56 percent of the nation's container trade. Nevertheless, a number of ecological problems are also brought on by that frequent traffic.

<sup>55</sup> JNPA REPORT 2020-2021, Measuring impact of Indian ports on environment and effectiveness of remedial measures towards environmental pollution

The pollution of the air brought on by port activities constitutes one of JNPA's main concerns regarding the environment. The pollutants like Sulphur oxides, which are oxides of nitrogen, and particulates are among the contaminants that are emitted by vessels, vehicles, as well as transportation machinery.

The residues not only aid in global warming, but they may additionally trigger cardiovascular and respiratory conditions in towns nearby. The port has put in place evaluates to lessen the adverse impact of those emission levels, including encouraging the use of battery-powered cargo trucks as well as setting up the shore generators for vessels to utilize when berthed.

The contamination of the water brought about by the release of waste water without treatment to vessels as well as port operations is a different ecological issue at JNPA. Chemicals in the sewage, including metals, fats, and substances, have been shown to be harmful to the ecology and aquatic organisms. The seaport has taken steps to tackle the matter, which include mandating that vessels discharge their effluent at chosen the front desk amenities, observing the caliber.

Background noise is a further problem at ports and in alongside air and water contaminants. Those who live nearby as well as animals may be affected by the loud noise that vessels and cargo managing machinery produce. To reduce pollution from noise, JNPA has implemented steps like setting up noise reduction devices and exhaust systems on machinery and enforcing bans upon the deployment of trumpets while notifications.

In general, it is crucial to examine Indian port activities to a sustainability perspective in order recognize possible hazards and put policies in place to lessen the negative environmental effects. The JNPA case study illustrates the variety of challenges that Indian ports encounter as well as the solutions which may be implemented.

The negative effects of significant activities, such as water contamination, disposal of solid waste, pollutants in the air from fuel combustion, dangerous contaminants, as well as sound pollution, were extremely observed at an extent that was nearly twice as high in significant ports compared to what was in smaller ports. As observed at the primary port, JNPA, the combustion of fuel pollutes the environment with dangerous levels of Sulphur dioxide (SO<sub>2</sub>) and this pollution has a direct connection in the volume of maritime activity as well as movement. Therefore, more severe conditions compared to a smaller port may be caused by increased traffic and occupied action at larger ports. Neighborhoods that have grown up within

ports may experience sudden deaths as a result of illnesses brought on by particulate matter, or PM, greenhouse gases generated by ships. The infiltration of sewage waste products, effluent, and other materials into a connection's surroundings degrades the fluid excellence.

Major seaports performed more severe compared to non-major ports when it came to of disposing of discharges, petroleum-contaminated fluid, as well as sewage left over to oil-lubricant elimination. Such discharges from large ports result in significant changes in the local ecosystem, upsetting the situation status much more severely compared to aquatic life have the capacity to handle. The same thing was discovered at Mumbai Port, in which the flora and fauna of the diligently the foundation in the Mumbai harboring surroundings underwent alarming shifts that were primarily caused by the expansion of the maritime sector. However, when it came to managing thermal contaminants, electrical transfers, sludge, as well as contaminated water from ballast vessels, smaller ports fared more severe compared to major ports. The ballast fluid, which plays a significant role in life sciences-invasion, enables the introduction of a calculated 4,000 organisms of seafood and plants to alien circumstances at ports. The smaller ports additionally recorded higher concentrations of the oily substances tainted by biological cleaners. Yet, major and minor ports experienced fairly comparable outcomes when it came to getting rid of sewage from wastewater treatment facilities. Additionally, it was discovered that both major and small ports had comparable amounts of removing tank sewage before the docking process.

### **3.3.1 STUDY OF JNPA OPERATIONS IN INDIA AND FUNCTIONS FROM THE ENVIRONMENT PERSPECTIVE**

In order to preserve ecological equilibrium, JNPA Port is dedicated to a sustainable future and is taking the necessary steps. The port has won numerous honours for its environmental initiatives. Approximately 1147 acres of land, or 34% of the port's total surface area of 3402 acres of land are covered in vegetation, such as mangrove forests.

In order to take on the issue of worldwide warming at the port straight, JNPA Port took steps to achieve "Green Port Status." The Energy Leadership and Tracking Plan (EMMP) has been carried out at JNPA Port, and an action plan has been created that includes all aspects of the port's operations, such as carrying cargo, storage, as well as departure.

The JNPA Port has additionally launched a number of programmed to become a "Green Port," including the commissioning of an additional wastewater treatment plant itself, expansion of the environment Park's actions, Green Talent Education, endeavors involving the use of clean energy, electricity-saving/conservation assignments, an infrastructure to deal with a spill of oil of tier one scale, underwater conservancy, broad cultivation, restriction of elimination of any kind of waste in the oceans, MARPOL rules, and sustainability measures.

The triple bottom line, or the security of the environment, the well-being of society, and the effectiveness of the economy, is the focus of the port's growth strategies. The port has substantial expansion objectives of increasing its ability for managing containers by an additional five million container equivalent units as well as to create connection-based sectors throughout the protection region.

In order to expand the port in an environmentally friendly way, JNPA Port's growth objectives are coordinated in accordance with the coastline Area Administration and Development Strategies. The connection's CZMP has been completed in every way and complies with ICZM objectives, including preserving the ecological integrity of coastline asset structures, lowering source of material-use conflicts, preserving environmental health, and accelerating tasking-sectoral progress.

getting regulatory approval for a project, tracking contaminants throughout the course of the project, continually tracking the influence on the port's operations on the surrounding environment, assessing the findings of monitoring with respect to the norms embraced in the EMP, and finding nonconformities are all things that JNPA Port does as part of its tiny level's ecological surveillance on the actual site. In order to lower the release of carbon dioxide and to protect the <sup>6</sup>environment, the port has also adopted unconventional sources of energy applications in its operations.

JNPA has chosen multiple efforts aimed to enhance the atmosphere and lessen <sup>7</sup>emissions from port operations within the framework of the maritime sector India Vision 2030. These proposed measures involve the following:

**Acceptance of environmentally friendly methods:** In order to decrease its reliance on petroleum products and carbon dioxide emissions, JNPA is considering implementing a

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<sup>7</sup> Ray, A.S. (2004) Managing Port Reforms in India: Case Study of Jawaharlal Nehru Port Trust (JNPT) Mumbai

number of environmentally friendly measures, including the electrical conversion of port machinery, the use of electric and hybrid transportation for carrying cargo, and the setup of solar energy systems.

Implementing the coast generators will allow vessels to turn away their propulsion systems and link to the structure for influence, decreasing greenhouse gases coming from vessels. JNPA is going to put the mainland energy provides at a berth.

**Renewable transportation is being promoted by JNPA:** These modes, which are more environmentally friendly than both rail and road shipping, include shipping along the coast and waterways that are used for transporting cargo.

To restrict the emissions, they produce and guarantee that they meet ecological laws, JNPA plans to establish emission limits for connection machinery and automobiles that operate within the port regions.

**Increasing ecological surveillance:** JNPA intends to increase its environmental surveillance efforts to make sure that pollutants from shipping operations as well as the condition of the air are regularly monitored.

### **3.3.2 STUDY OF ADANI PORTS OPERATIONS IN INDIA AND FUNCTIONS FROM THE ENVIRONMENT PERSPECTIVE**

The most prominent private port operator in India, Adani Ports and Special Economic Zone Limited (APSEZ), has operations in ten ports spread throughout a total of six states. The business's activities include port management, transportation services, and shipping offerings, and they cover every aspect of the logistics industry chain of value.

Port activities may have a significant negative effect on the natural world, such as pollution of the environment, changes in how land is used, and emissions of greenhouse gases. Adani Ports has nevertheless made a number of efforts to lessen its ecological footprint and advance environmentally friendly habits.

The erection of a system to measure air quality at Adani Port's Mundra port in the state of Gujarat is one illustration of the business's attempts to reduce its negative environmental impact. The equipment evaluates the level of airborne contaminants like PM10, PM2.5, SO2, NOx, and CO on a continuous basis. via a website, this information becomes accessible for the public at large, enabling participants to monitor the atmosphere excellence near the marina.

Additionally, Adani Ports has made efforts to lessen its carbon footprint. The business declared a goal to achieve carbon neutrality by 2025 in 2020. This includes a pledge to expand its use of renewable energy sources and switch its operations over to electric vehicles. Additionally, the business is investigating the use of environmentally friendly the hydrogen as a power to supply

The creation of a protected mangrove place at its Gujarati the port of Hazira district is a different ecological initiative taken by Adani Ports. An underwater mangrove plantation after plantation a bird safety, and an information focused are all part of the 55 hectare of land park. The nature preserve protects the shoreline from deterioration and provides ecosystems for a number of threatened species.

Adani Ports and Special Economic Zone confined is a major player in the Indian port sector, along with the effects of its business activities on the surroundings are substantial. nonetheless the business has made a number of efforts to lessen its negative environmental impact, such as installing air quality monitoring systems, creating a carbon-negative tactics, and creating a mangrove swamp preservation the park. These programmes show how businesses may promote economic growth while promoting long-term viability in how they operate.

### **3.4 TO STUDY THE LEVEL OF CONTROL OVER WASTE AND RESOURCE USAGE.**

The present research evaluates the management of solid waste and utilization of resources in ports as well as the practices, regulations, and advances currently in use to reduce negative ecological impacts. Depending on the shipment, its size, and laws, different ports have varying levels of under control. Major Indian ports have implemented thorough disposal and utilization of resources rules as well as practices, such as JNPA and Chennai Port Trust. Actions have limitations in smaller ports like Ennore Port. In addition to cutting-edge waste treatment systems, environmentally friendly lighting, and automation technologies, ports have set up renewable energy, waste elimination, and reusing initiatives. A collected rainwater structure, solar power, lights that are energy-efficient, or a nil-garbage rules are all features of JNPA. By making ports environmentally sound and reducing their negative effects on the ecosystem.

### **3.4.1 EFFECTIVENESS OF WASTE AND RESOURCE USAGE CONTROL POLICIES, PRACTICES, AND TECHNOLOGIES:**

The effectiveness of waste and resource usage control policies, practices, and technologies employed by ports varies depending on various factors such as the nature and volume of cargo handled, the level of investment in waste and resource control measures, and the level of enforcement of the policies and practices.

In India, the effectiveness of waste and resource usage control policies, practices, and technologies in ports varies between ports. Major ports such as JNPA and Chennai Port Trust have demonstrated a high level of effectiveness in their waste and resource usage control measures. However, smaller ports such as Ennore Port have limited effectiveness due to a lack of investment in waste management and resource control measures.

Waste and resource usage control in ports is critical in ensuring that ports remain sustainable and that the negative environmental impact of port operations is minimized. In India, major ports have demonstrated a high level of control over waste and resource usage through the adoption of various policies, practices, and technologies. However, smaller ports require significant investment in waste management and resource control measures to achieve a similar level of effectiveness. There is a need for a uniform waste and resource control framework across all ports in India, coupled with effective enforcement mechanisms to ensure compliance with the policies and practices.

### **3.5 IDENTIFY PARAMETERS FOR THE ENVIRONMENTAL PROTECTION PRACTICES AT THE PORT**

considering their respective positions important environmental damage, this work addresses protecting the environment procedures at Indian ports. Successful waste management techniques, such as segregation, dealing with, storage, delivery, and destruction, are essential to reducing the adverse effects of different types of waste produced. Another crucial element in port management is air quality, as port operations can produce air pollutants that have a negative impact on both individuals and the environment. For the purpose of tracking air excellence in its port areas, JNPA has teamed together with the Indian Institute of Technology, Madras, to set up a climate observing testing and actual time air quality monitoring setup. To comply with the most stringent requirements of environmental protection, JNPA continually strives to improve its buildings and ecological surveillance programmes.

## AIR QUALITY LEVEL AT JNPA

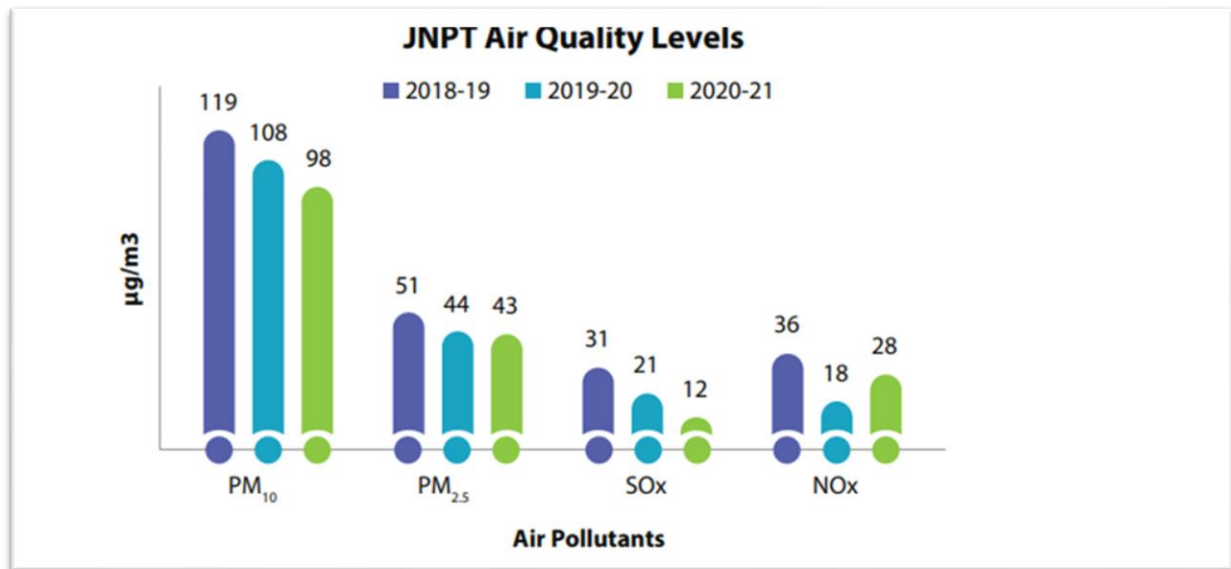


Fig 3.7 (Source JNPA REPORT 2021-2022)

Some instances include starting integrate-terminal shifts (ITT) for semi-trailers and keeping an extensive green zone. JNPA implemented various ways to cut expenses, such as covering speculators with tarpaulin roofing at construction locations, regularly washing both laid and unpaved paths, and moving from diesel engines to electricity-powered e-RTGCs.

The levels of PM<sub>10</sub> have fallen and are expected to stay inside the acceptable range in FY2020–21 as a result of the success of these measures. JNPA obtains samples from the environment by means of IIT Madras and analyses them for levels of noise, surrounding quality of the air, underwater quality of water, marine biology, and water consumption excellence. IIT Madras established a real-time via the internet air quality surveillance established at Port Management center while a sustainability observing the laboratory in JNPA townships as a component the overall exertion.

**Planned actions by JNPA:** In accordance with Maritime India Vision 2030, the following initiatives have been identified to be undertaken by the major ports in India, including JNPA, in order to improve air quality:

Sr. No.	Initiative	Proposed Recommendations	Planned Activities by JNPT
1.	Clean Fuels to Reduce Vehicle Emissions at Ports	Indian ports shall look to achieve 50% vehicle switch towards cleaner fuels – CNG, LNG, and Electricity by 2030	JNPT is exploring the feasibility of using bio-diesel for RTGCs
2.	Reducing Air Emissions by Ships Inside Port Ecosystem	Ports shall mandate and adopt current SOPs of providing shore power to all vessels up to 150 KW. For other vessels rated above 150 KW or working on 60 Hz power supply, ports shall adopt a 3-phase targeted approach	Project for providing shore power to all ships is in conceptual stage
3.	Port Equipment Electrification	Indian ports shall drive a 2-phased pan-India electrification programme aimed to achieve more than 50% electrified material handling equipment by 2030	JNPT has already hired 09 nos. electrically operated light motor vehicles for internal movement
4.	LNG Bunkering	Indian ports shall aim to increase adoption of LNG to reduce carbon footprint and greenhouse gas emissions. Indian ports shall adopt a 3-phased approach to increase the adoption of LNG with bunkering facilities in next 5-10 years	Market assessment has been carried out for LNG bunkering facilities
5.	Dust Emissions Management	Indian ports shall deploy a dust emission management programme leveraging sensor-based tracking technology	Port has commissioned Real Time Continuous Ambient Air Quality Monitoring for tracking air quality  Fine aerosol dust particles are identified by IIT Madras using Dust Track to find the level of dust deposition. In future, vehicle dust emission will also be calculated as part of research activities

Fig 3.8 (Source JNPA REPORT 2021-2022)

Issues about global warming, contamination, and declines in biodiversity have made sustainable development practices at Indian ports more and more crucial. Implementing standards of excellence, including technologies that are energy-efficient, solar power, and systems for energy management for lowering consumption of energy and emission levels, is necessary for guaranteeing long-term sustainability. In addition, it is possible to preserve ecological diversity by means of safeguarding of environmentally sensitive regions and conservation initiatives, as well as improve water quality through regular surveillance and avoidance of pollution actions. By establishing challenging objectives and deadlines and consistently looking for fresh obstacles to increase its efforts, the JN Port continues to progress along the path to ecological sustainability. In order to pursue successful ecologically friendly

practices at ports in India, constantly enhancement and acquisition of knowledge from previous decades are essential.

### AMOUNT OF ENERGY USAGE IN JNPA

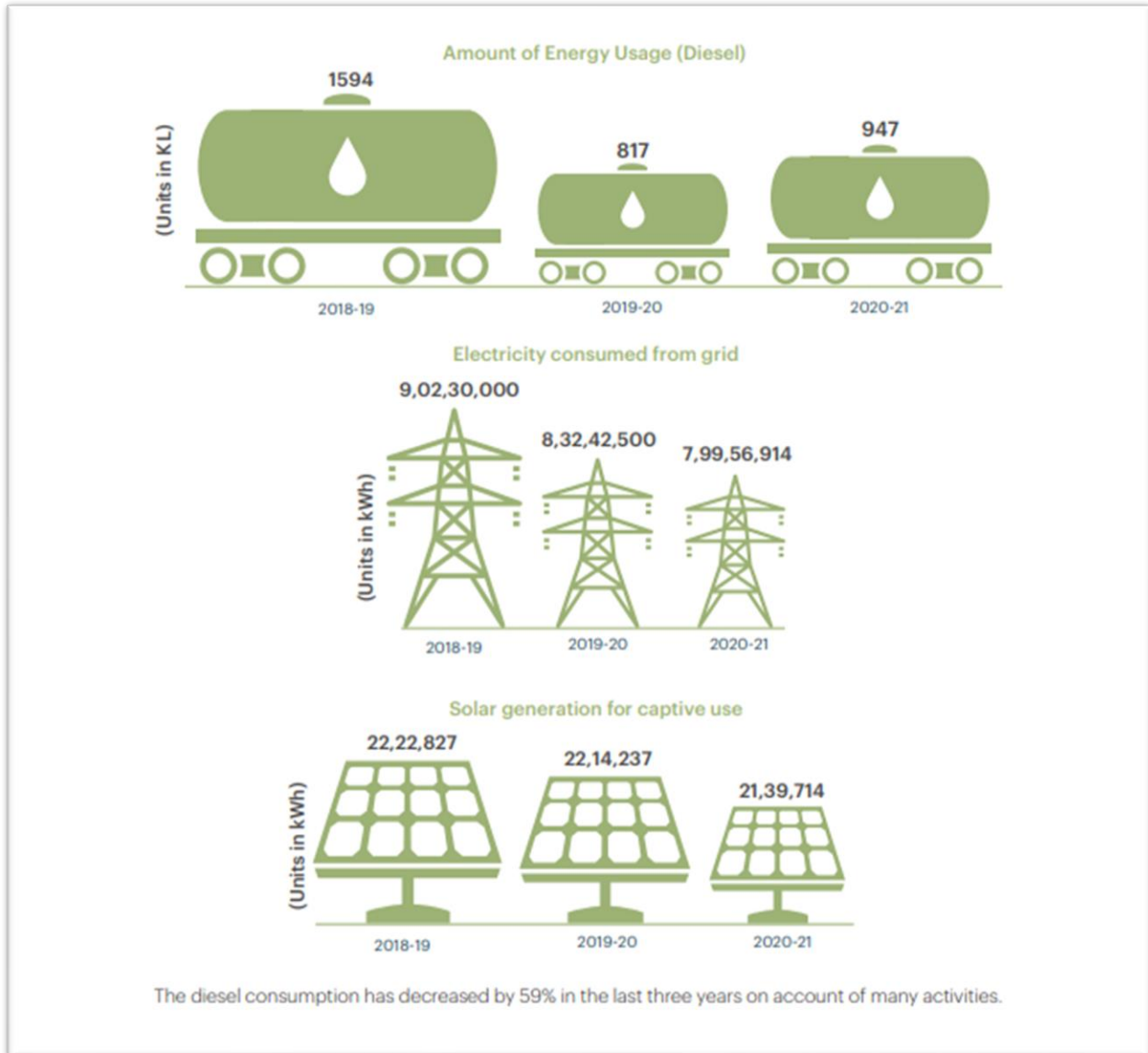


Fig 3.9 (Source JNPA REPORT 2021-2022)

### DETERMINES TO AVOID ENVIRONMENTAL DAMAGE

In order to lessen the environmental impact of ports, measures to prevent pollution are essential. Utilizing negligible-sulfur energy sources, setting up air quality control devices, treating water from ballast ships, and managing squander and dangerous substances are just a few examples of the actions that can be taken. These initiatives have been carried out in many Indian ports, such as the Jawaharlal Nehru Port Trust and the Mumbai Port Trust, which both

have waste management procedures that include the discrimination and disposal of waste. The Mumbai Port Trust has set up a marine wastewater management plant.

### **Environment-Management Methods**

A system for environmental management (EMS) is an organizational structure for controlling how port activities affect the natural world. The EMS has rules, regulations, and resources that can be used to understand, track, and manage risks related to the environment. Numerous ports in India have put in place an environmental management system (EMS), such as the Chennai Port Trust, which has done so with an EMS that is ISO 14001-certified and addresses every aspect of the port's activities, from disposal of waste to air inspections.

### **The Utilization of Sustainable Energy Sources**

Taking advantage of sources of clean energy, like wind and sunlight, can lessen the negative effects of shipping operations on the natural environment. In order to produce power, many Indian ports are using photovoltaic cells, such as the Visakhapatnam Port Trust, which has a 10 MW photovoltaic plant. The Cochin Port Trust additionally put into place an offshore wind power plant that produces 2.25 MW of electricity.

### **Nature Protection**

Maintaining biological diversity is essential to the sustainable future of ports. Ports may have a significant effect on regional ecosystems such as wetlands and mangroves. Many ports across India are employing ecological preservation regulations such as the building of constructed coral reefs as well as the regrowth of forests of mangroves, to reduce this adverse effect. In this regard, the Ennore Port Trust has carried out an extensive mangrove conservation initiative that has culminated in the establishment of more than 22,000 mangrove forests tree saplings.

### **Participation Of Stakeholders**

Stakeholder involvement is essential for guaranteeing that conservation practices are both successful and environmentally friendly. Ports in India have collaborated with a variety of those who matter, such as local communities, non-governmental organizations (NGOs), and government departments in order to come up with and execute measures to safeguard the environment. As one instance, the Kandla Port Trust has launched a stakeholder involvement programme which involves periodic conferences with neighborhoods groups and non-governmental organizations to talk about environmental issues.

## **Control Of the Green Supply Network**

It is a strategy aimed at reducing the harmful effects of every supplier, as well as ports in the nation are using a variety of practices to accomplish this. The recognition and execution of key sustainability criteria, such as prevention of pollution policies, sources of clean energy, and sustainable procurement, are critical for long-term port operations. These parameters can be used as a guide to develop effective environmentally friendly follows that are specific to the specific challenges of each port. Ports across the nation are able to contribute to less <sup>8</sup>polluted, more environmentally friendly growth through the implementation of these measures. Effective sustainable development procedures are essential to guarantee the sustainable future of Indian ports.

### **3.6 AN INTERNATIONAL EXAMPLE OF PORT OF ANTWERP – ITS GREEN INITIATIVES**

#### **SIMILARITIES AND DIFFERENCES OF SUSTAINABILITY WITH INDIAN PORTS AND PORT OF ANTWERP**

When it comes to sustainability, the Port of Antwerp and Indian ports have some similarities and differences.

One major similarity is that both ports have taken steps to reduce their environmental impact. The Port of Antwerp has implemented a number of initiatives, such as using electric vehicles for transportation around the port and investing in renewable energy sources. Similarly, Indian ports have also implemented measures such as using solar power and reducing emissions from ships.

However, there are also some differences between the two ports. The Port of Antwerp has a more established sustainability program, with a dedicated sustainability department and a wide range of initiatives in place. Indian ports, on the other hand, are still in the process of developing their sustainability programs and may not have as many resources dedicated to this area.

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1. <sup>8</sup> CHALLENGES TOWARDS SUSTAINABLE PORT DEVELOPMENT IN INDIA  
([https://commons.wmu.se/cgi/viewcontent.cgi?article=1671&context=all\\_dissertations](https://commons.wmu.se/cgi/viewcontent.cgi?article=1671&context=all_dissertations) )
  2. JNPA REPORT 2021-2022

Another difference is that the Port of Antwerp has a stronger focus on circular economy principles, such as reusing and recycling materials. Indian ports may not have as strong a focus on this area, although they are starting to implement some circular economy initiatives.

while both the Port of Antwerp and Indian ports are taking steps towards sustainability, the Port of Antwerp has a more established program and a stronger focus on circular economy principles.

**Emission Reduction Strategy:** Several Indian ports have taken measures to reduce emissions, such as the Jawaharlal Nehru Port Trust (JNPA) which has installed a 10 MW solar power plant and is working on a 25 MW wind power project. The Chennai Port Trust has also installed a 5 MW solar power plant.

**Shore Power (Cold Ironing):** Indian ports are also working on providing shore power to ships to reduce emissions. The V.O. Chidambaranar Port Trust in Tuticorin has installed shore power facilities and is providing shore power to vessels.

**Rainwater Harvesting:** Many Indian ports have implemented rainwater harvesting systems to conserve water. For example, the Paradip Port Trust has installed rainwater harvesting structures with a capacity of 60,000 cubic meters.

**Green Energy:** Indian ports are also exploring renewable energy sources such as wind, solar, and tidal power. For example, the Cochin Port Trust has installed a 10 MW solar power plant and is working on an 8 MW wind power project.

**EV Charging Stations:** Several Indian ports are also working on providing EV charging facilities. The Jawaharlal Nehru Port Trust has installed EV charging stations and is providing free charging to EVs.

#### **PORT OF ANTWERP:**

The Port of Antwerp-Bruges has an outstanding infrastructure for all types of transport and goods. To guarantee fast and efficient transport, the Port of Antwerp-Bruges will focus on the sustainable organisation of freight transport to, from and at the port sites.

#### **A MERGER CRUCIAL FOR SUSTAINABILITY**

While sustainability was already a key issue in both Antwerp and Zeebrugge, the merged port is now raising the bar. Hydrogen is set to play an important role in energy solutions of the future.

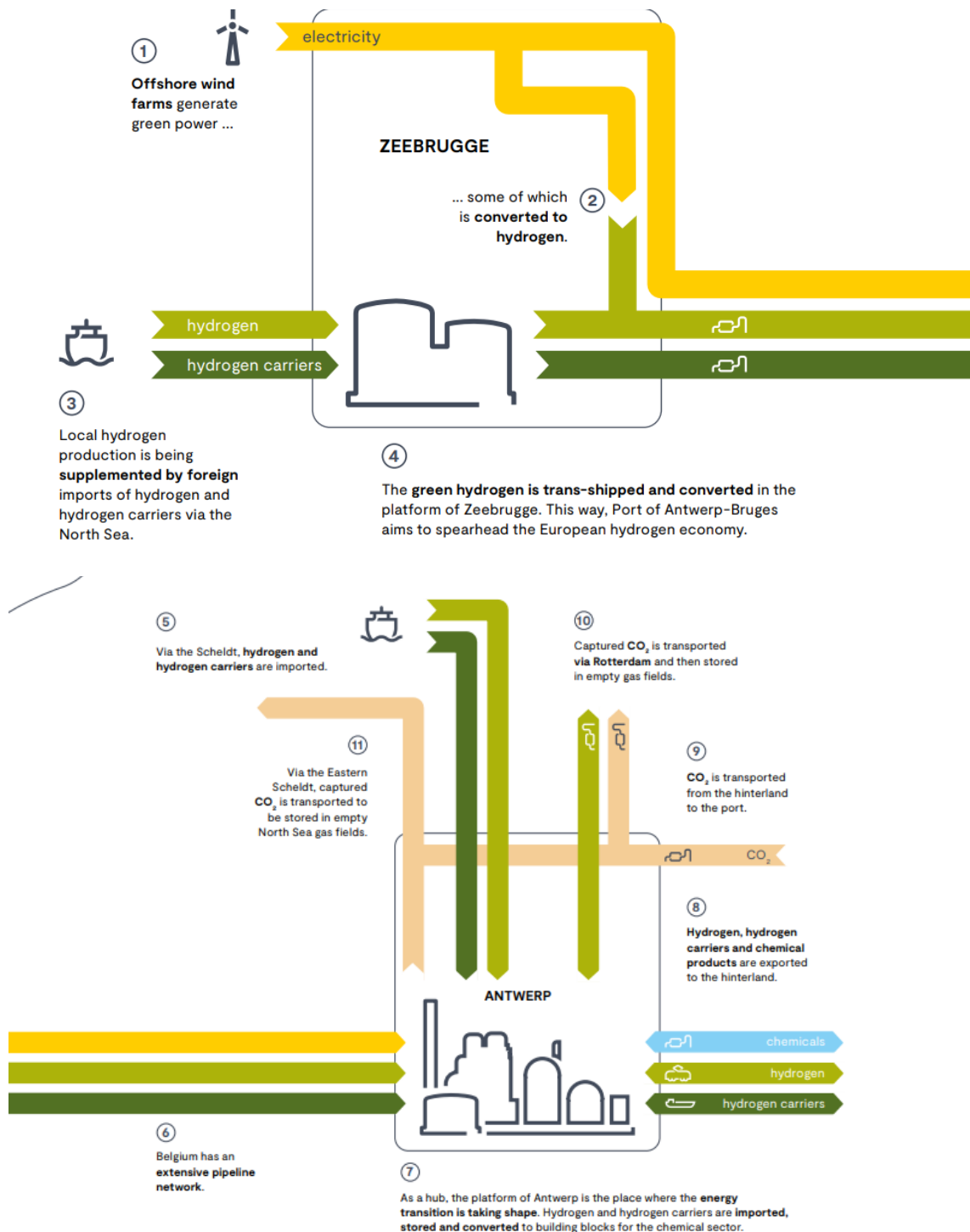


Fig 3.10 (Source: portofantwerpbruges.com/m/122baaae59492c7f/original/Port-of-Antwerp-Bruges.pdf)

**Emission Reduction Strategy:** The Port of Antwerp has set a target to reduce CO<sub>2</sub> emissions by 80% by 2050. It has implemented several measures to achieve this target, such as promoting the use of LNG as a marine fuel and providing shore power to vessels.

## Alternative fuel

As the fifth-largest bunkering port in the world, offer alternative fuels for shipping in addition to conventional fuels. Again, hydrogen is a good alternative.

At CMB's petrol station in Antwerp, ships, trucks, cars and tractors can fill up with hydrogen.

HyTrucks wants 300 trucks in the Antwerp port area to run on hydrogen by 2025.

Through the PIONEERS project, port is testing port equipment that runs on electricity, hydrogen or methanol.

Along with Port of Duisburg, facilitating the development of the hydrogen chain and hydrogen economy. Port of Antwerp-Bruges is a member of the German foundation H2Global, which promotes the import of green hydrogen and wants to get the market going.



Fig-3.11(source:<https://www.portofantwerpbruges.com/en/our-port/climate-and-energytransition/hydrogen#verbruik>)

## PRODUCTION AND IMPORTING PORT OF ANTWERP

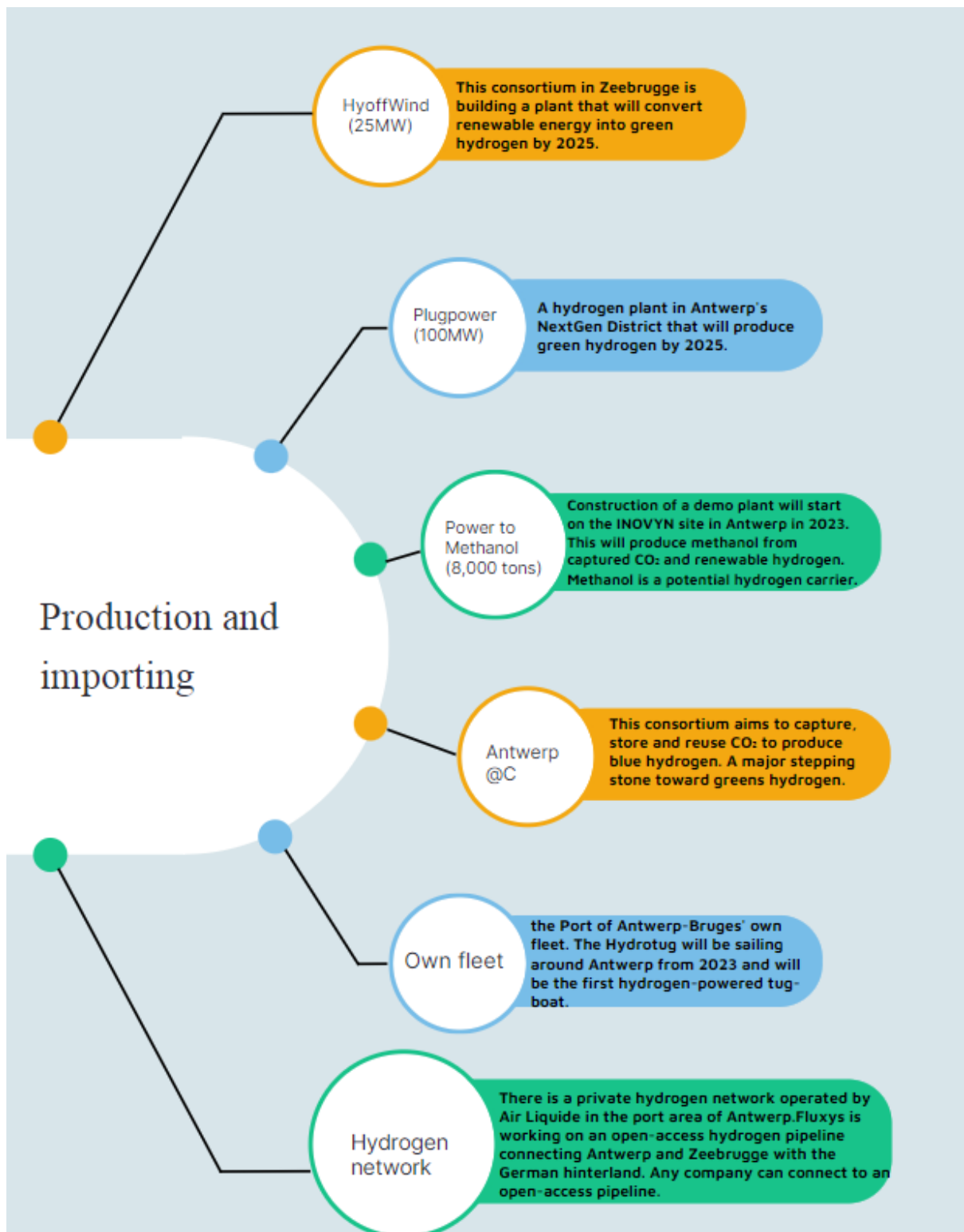


Fig 3.12 (source by author referring port of Antwerp website)

**Shore Power (Cold Ironing):**

**“Shore power can play a role in the sustainable transition of our port platform. That is why the development of shore power is a strategic priority for the coming years”**

**Jacques Vandermeiren, CEO Port of Antwerp-Bruges**

The Port of Antwerp has several shore power facilities for vessels, with plans to expand these facilities in the future. Shore power is an environmentally friendly and noise-free way of mooring ships. Instead of using diesel generators, ships can connect to the electricity grid available at the wharf. This reduces emissions and therefore helps make ports greener. Numerous connection points are already available for barges and tugboats. Port of Antwerp-Bruges is committed to also providing shore power for the largest container ships by 2028.



Fig 3.13 (source:<https://www.portofantwerpbruges.com/en/our-port/climate-and-energy-transition/shore-power>)

Port of Antwerp use their own vessels all use shore power when moored in Port of Antwerp-Bruges. This is possible at the NOC (K602), at the Zandvliet and Berendrecht locks, at the Boudewijn and van Cauwelaert locks and at the Kieldrecht lock.

This involves a fleet of 32 vessels, consisting of tugs, dredgers and support vessels, which therefore use 1.5 GWh of shore power annually, thereby preventing 1,500 tons of CO<sub>2</sub> and 9 tons of NO<sub>x</sub> emissions.

**Rainwater Harvesting:** The Port of Antwerp has implemented several measures to reduce water consumption, such as rainwater harvesting and using treated wastewater for industrial purposes.

**Green Energy:** The Port of Antwerp is exploring renewable energy sources such as wind and solar power. It has installed a 2.6 MW wind turbine and is working on a 6.2 MW solar power project.

## **WIND POWER IN ANTWERP**



Fig 3.14 (Source: <https://www.portofantwerpbruges.com/en/our-port/climate-and-energy-transition>)

### **Zeebrugge**

50 wind turbines

130 MW capacity

90,000 families

### **Antwerp**

80 wind turbines

200 MW capacity

140,000 families

**EV Charging Stations:** The Port of Antwerp has installed several EV charging stations for employees and visitors, with plans to install more in the future.

To compare the sustainability of Indian ports, such as JNPA, Chennai Port, and New Mangalore Port, with the Port of Antwerp, we can examine various environmental and social indicators.

**Carbon emissions:**

The Port of Antwerp has set a target to reduce CO<sub>2</sub> emissions by 80% by 2050 and has already reduced emissions by 24% between 2005 and 2019. In contrast, JNPA has reported a slight increase in carbon emissions from 2018 to 2020, while Chennai Port and New Mangalore Port have shown a decreasing trend in emissions. The following graph shows the trend in carbon emissions for these ports:

Antwerp is home to the largest integrated energy and chemical cluster in Europe. This makes it the perfect location for creating new inter-company collaborations and reducing CO<sub>2</sub>.

It all starts with the capture and local transport of CO<sub>2</sub>. This requires pipelines, a joint CO<sub>2</sub> liquefaction plant, intermediate storage units, etc. Because Belgium does not have the suitable subsoil to store CO<sub>2</sub> underground, international cooperation will be necessary. Firstly, to transport CO<sub>2</sub> across borders, and secondly, to store it permanently, for example in empty gas fields under the sea.

Antwerp@C envisages two possibilities for cross-border CO<sub>2</sub> transport infrastructure. In the first phase, the CO<sub>2</sub> is shipped in liquid form to empty gas fields in the North Sea area. In a second phase, Antwerp@C will also explore the possibility of transporting CO<sub>2</sub> by pipeline to the Netherlands.

**INNOVATIVE CO<sub>2</sub> REDUCTION**

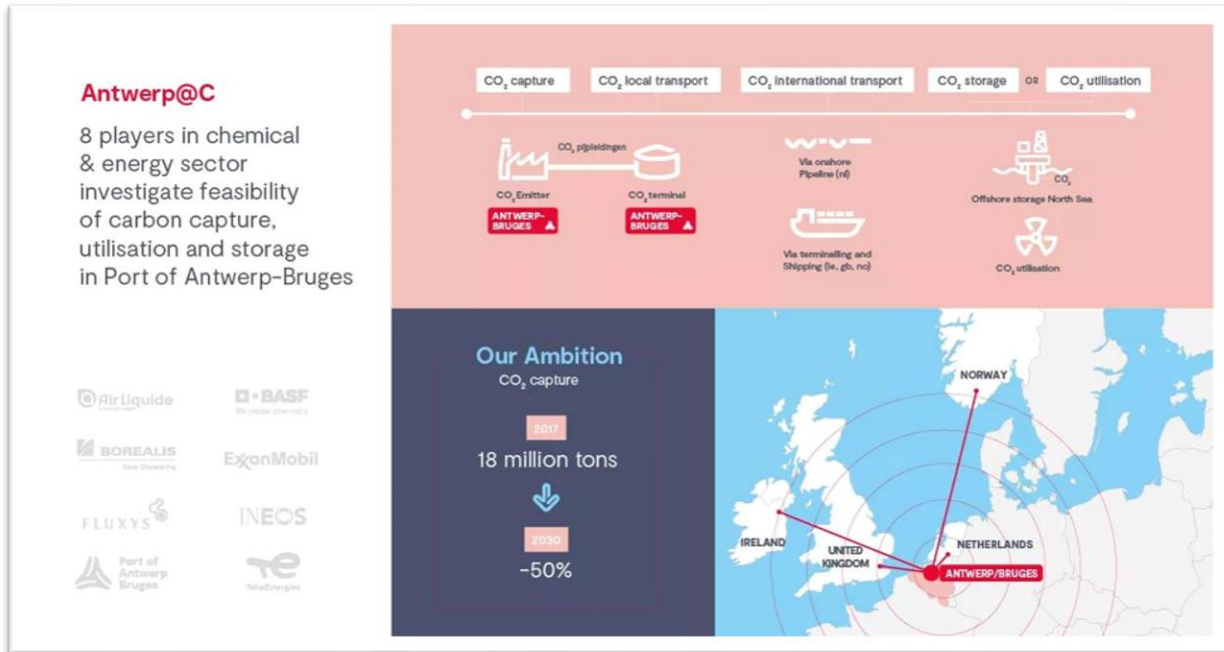


Fig 3.15 (source: <https://www.portofantwerpbruges.com/en/our-port/climate-and-energy-transition/antwerp>)

### Renewable energy:

The Port of Antwerp has made significant progress in promoting renewable energy, with the construction of wind turbines and the installation of solar panels. In contrast, Indian ports are still in the early stages of adopting renewable energy sources. For example, JNPA has recently installed a 25 MW solar power plant, while Chennai Port has installed a 1 MW solar power plant.

### Waste management:

The Port of Antwerp has implemented a comprehensive waste management system, including waste separation, recycling, and treatment. In comparison, Indian ports are still facing challenges in managing their waste, with some ports relying on landfilling and incineration. However, JNPA has taken steps to improve its waste management by implementing a zero waste to landfill policy and promoting recycling and composting.

### Social indicators:

While the Port of Antwerp has made significant progress in environmental sustainability, it<sup>9</sup> also recognizes the importance of social sustainability, such as promoting diversity and

<sup>9</sup> <https://pioneers-ports.eu/>

inclusion, supporting education and training, and investing in the local community. In comparison, Indian ports are also making efforts towards social sustainability, such as promoting local employment and providing healthcare and education facilities to nearby communities.

Indian ports such as JNPA, Chennai Port, and New Mangalore Port are also making efforts towards reducing emissions, promoting renewable energy, improving waste management, and promoting social sustainability. However, Indian ports still face challenges due to limited resources and competing priorities, and there is scope for further improvement.

### 3.7 CASE STUDY: GREEN PORT MEASURES AND ACTIONS FOR WALVIS BAY PORT



Fig 3.16 (source: Development and Implementation of a Green Port Concept – Case Study of Walvis Bay Port, Namibia.)

Walvis Bay is strategically located halfway down the coast of Namibia, with direct access to principal shipping routes. This strategic location has made it the gateway port for trade between landlocked African countries and the rest of the world. Apart from cargo transshipment, Walvis

Bay is also known internationally for its commercial fishing industry. The fishing and cargo imports and exports sectors have also spawned a number highly skilled auxiliary services such as marine engineering, stevedoring, chandelling and other services types. Not to mention that excellent tax-free incentives the Export Processing zone (free trade zone) offers.

As Namibia's largest commercial port, Walvis Bay is in a sheltered deepwater harbor benefiting from a temperate climate and experiencing few delays as a result of bad weather. In order to deal with even higher levels of throughput, Namport have steadily improved its cargo-handling facilities, and remains committed to infrastructure development, in line with Namport's Mission to provide efficient and effective port and related services.

Walvis Bay port is an important gateway for Namibia's international trade and contributes significantly to the country's economic development. However, the port's growth also comes with environmental challenges, including air and water pollution, solid waste generation, and greenhouse gas emissions. To address these challenges, the port has adopted a green port concept, which is a holistic approach towards achieving long-term sustainability.

The development and implementation of the green port concept at Walvis Bay port began with an environmental assessment of the port's operations, which identified areas for improvement. Based on the assessment, the port management developed a sustainability policy and action plan, which outlines the port's environmental goals, targets, and actions to achieve them.

One of the key measures adopted by the port to reduce its environmental impact is the use of renewable energy sources. The port has installed a solar power plant with a capacity of 1.5 MW, which provides clean energy to the port's facilities and reduces reliance on fossil fuels. Additionally, the port is exploring the use of wind power and has conducted a feasibility study for a 5 MW wind turbine project.

Another initiative undertaken by the port is the implementation of energy-efficient lighting. The port has replaced traditional lighting with LED lights, which are more energy-efficient and have a longer lifespan. This initiative has not only reduced energy consumption but also decreased maintenance costs.

Waste management is another crucial aspect of the green port concept, and the port has implemented a comprehensive waste management system. The system includes the separation of waste at source, the use of waste recycling facilities, and the proper disposal of hazardous

waste. The port has also established a waste-to-energy project, which converts waste into energy to reduce its environmental impact.

In addition to these measures, the port has also implemented several initiatives to reduce its carbon footprint. The port has developed a carbon footprint inventory, which tracks emissions from the port's operations. Based on the inventory, the port has identified several emission reduction measures, including the use of cleaner fuels, energy efficiency measures, and the promotion of low-carbon transport modes.

The implementation of the green port concept at Walvis Bay port has not only reduced its environmental impact but also improved its operational efficiency and competitiveness. The use of renewable energy sources has reduced the port's energy costs, while the implementation of energy-efficient lighting has decreased maintenance costs. Additionally, the waste-to-energy project has generated revenue from the sale of energy.

The development and implementation of the green port concept at Walvis Bay port have demonstrated the port's commitment to sustainable development. The adoption of renewable energy sources, energy-efficient lighting, waste management practices, and emission reduction measures has not only reduced the port's environmental impact but also improved its economic performance. The success of the green port concept at Walvis Bay port serves as a model for other ports to adopt sustainable practices to achieve long-term sustainability.

<b>MEASURES</b>	<b>ACTION</b>
Port development (land related) (Land use planning/landscape management)	Land reclamation - Compensation for property loss (in the event of unavoidable port development) - Grow flowers and trees in port areas - Use non-chemical composition of pesticides and fertilizers - Adopt LEED standard for green building - Wetland and nature compensation (in the event of unavoidable port development)

	<ul style="list-style-type: none"> <li>- Use eco-friendly materials for construction</li> </ul>
<p>Air quality (Air quality, dust &amp; climate change)</p>	<ul style="list-style-type: none"> <li>- Air quality monitoring system</li> <li>- Use dust-free blasting machines</li> <li>- Use energy from renewable sources (solar, hydro, wind, waves, tides)</li> <li>- Store dry bulk cargo in closed warehouses</li> <li>- Clean tracks within the port area</li> <li>- Use paper mill sludge to protect coal or iron-ore in uncovered stockpiles</li> <li>- Dust concentration monitoring and measurement</li> <li>- Provide shore power (OPS)</li> <li>- Use electric mobile equipment</li> <li>- Vessel speed reduction</li> <li>- Automate gateway systems</li> <li>- Use of clean fuel in port areas (LNG, LPG, Biomass)</li> <li>- Promote environmentally friendly transport like carpooling for port employees</li> <li>- Create carbon footprints</li> <li>- Replace or improve (retrofit) old equipment</li> <li>- Implement a clean truck program</li> <li>- Provide parking space for idle trucks and equipment</li> <li>- Cover bulk cargo entering/leaving the port by truck or train</li> <li>- Use dust covers on grabs/conveyors</li> <li>- Encourage modal split</li> <li>- Use loading chutes with heavy duty dust skirts</li> </ul>

	<ul style="list-style-type: none"> <li>- Realtime tracking of shipments to avoid port congestion</li> </ul>
<p>Water quality (Surface water &amp; sediment quality, soil &amp; ground water quality)</p>	<ul style="list-style-type: none"> <li>- Monitor water quality</li> <li>- Emergency plan for oil/hazardous spills</li> <li>- Create standards on effluent quality discharge</li> <li>- Investigate sewage sources</li> <li>- Monitor and protect ground water and sediment quality</li> <li>- Monitor underground bunkering pipes for leakage/spill control</li> <li>- Stringent rules/penalty for illegal discharges</li> <li>- Use floating curtains to contain spills from flowing into the sea</li> <li>- Use schemas for the separation of oil from water</li> </ul>
<p>Noise (Sound/noise impact)</p>	<ul style="list-style-type: none"> <li>- Monitor noise levels in port areas</li> <li>- Use noise reduction machines (particularly at night in container terminals)</li> <li>- Set standard limit for noise</li> <li>- Insulate port buildings against noise</li> <li>- Provide PPE for employees working directly with noise producing equipment or in noisy sites</li> <li>- Use damping materials for equipment</li> <li>- Replace diesel RTGs with electric RTGs</li> </ul>
<p>Dredging operations (Dredging)</p>	<ul style="list-style-type: none"> <li>- Dredge monitoring and assessment</li> <li>- Reuse dredge materials</li> <li>- Adopt LEED in dredging and dredge material management</li> </ul>

<p>Energy efficiency (Energy)</p>	<ul style="list-style-type: none"> <li>- Use energy from renewable sources in port buildings (solar, wind, waves, tides, hydro)</li> <li>- Use clean fuels (LNG, LPG, Biomass)</li> <li>- Use energy efficient control systems</li> <li>- Use energy efficient lights in port areas and buildings (sensor &amp; LED bulbs)</li> <li>- Use LED bulbs for light house</li> <li>- use solar &amp; wave powered life buoys</li> <li>- Use energy efficient desks and laptops in offices</li> <li>- Use electric bikes/bicycles in port areas</li> <li>- Minimize cargo handling equipment moves by optimizing cargo handling operations</li> </ul>
<p>Climate adaptation</p>	<ul style="list-style-type: none"> <li>- Build resilient port infrastructures</li> <li>- Program frequent maintenance of port infrastructures, superstructure, and equipment</li> <li>- Adopt LEED standards in the construction and installation of port infrastructures</li> <li>- Raise quay walls</li> <li>- Build flood barriers</li> <li>- Reuse of dredge materials to elevate land in port area and nearby community</li> </ul>

<p>Waste (ship-related, general &amp; hazardous waste)</p>	<ul style="list-style-type: none"> <li>- Proper handling of ballast water, sewage, sludge, and bilge</li> <li>- Avoid misuse of drinkable water</li> <li>- Reduce waste of water used in cleaning</li> <li>- Monitor water usage and leakage</li> <li>- Segregation of waste</li> <li>- Introduce a paperless port policy</li> <li>- Practice waste reduction, recycle, and reuse policy</li> <li>- Compulsory waste handling fee on all vessels</li> <li>- Practice recycling of water onsite</li> <li>- Only professionals should handle hazardous waste</li> </ul>
<p>Habitat quality (Habitat/species health)</p>	<ul style="list-style-type: none"> <li>- Monitor habitat quality</li> <li>- Create indicators for habitat quality</li> <li>- Create habitat/species compensation area (in the event of unavoidable port development)</li> <li>- Expansion of tidal areas for habitat restoration</li> </ul>

Table 4.1 (Source: author)

## **CHAPTER-IV**

### **SUSTAINABILITY INITIATIVES OF INDIAN PORT SECTOR**

#### **4.1 SUSTAINABILITY ISSUE:**

- Because the utilization of capacity is seriously overwhelmed, it is critical to carry out a thorough flow research and evaluate the economic viability for future expenditures.
- Container goods is being transshipped via overseas ports such as Colombo, Singapore, Jebel Ali, Port Klang, JNPA, Chennai, and Tuticorin. Cabotage rules for EXIM containers for computing and empty should be relaxed.
- To attract traffic at ports, strong marketing of shipping to the coast is required. Major ports ought to try for status as finish-client partners in the supply chain. Cabotage laws for agricultural goods and chemical fertilizers ought to be at ease.
- In order to ease the transportation of cargo via coastline transport, a from beginning to end ecological network of suppliers of services must be established and simplified. Port taxation must be rationalized.
- 

#### **4.2 INITIATIVES:**

##### **SAGARMALA PROGRAM:**

- The Sagarmala Programme is a government initiative that has established the Sagarmala Development Company Ltd. to provide funding support for project SPVs and residual projects.
- Master plans have been finalized for major ports, identifying 142 projects with a total cost of Rs. 91,434 crores for implementation till 2035. 46 of these projects are already under implementation or have been awarded.
- Perspective plans have been prepared for 14 Coastal Economic Zones (CEZs), with master planning of 4 CEZs in Phase I.
- The Coastal Berth Scheme has been expanded and integrated into Sagarmala.
- SEZs at JNPA and Smart Industrial Port Cities at Kandla and Paradip are being implemented.

- Efforts are being made for Coastal Community Development, including the inauguration of the JNPA-APEC Training Centre in collaboration with the Port of Antwerp and the initiation of a skill gap study in 21 coastal districts. District-wise skill action plans are being prepared.
- Initiatives have been taken for Multi-Skill Development Centers at JNPA, a Centre of Excellence in Shipbuilding at Vizag and Mumbai, and 8 fishing harbor projects funded in convergence with DADF.

### **4.3 DIGITIZATION:**

- The major ports have achieved 100% cashless transactions, and a Port Community System has been implemented and integrated with Ice Gate in all major ports.
- Radio Frequency Identification (RFID) has been implemented, and mobile scanners are being installed in ports for container scanning.
- All land records have been digitized and uploaded on GLIS. Direct Port Delivery (DPD) has been increased from 37% to 80%, and it is now mandatory for AEO, with facilities for container inspection in port areas and government CFS for RMS storage.
- E-invoice, E-payment, and E-Delivery Order are to be made mandatory for shipping lines, and inland container depots (ICDs) need to be rationalized.
- PCS 1x has been implemented, and PCS 2.0 Business Process Re-engineering (BPR) and Service Provider vis-à-vis Off-the-Shelf product with customization model is in the process.
- E-visa facilities and deduction of port charges for cruise ships have been created, and a logistic data bank has been established for tracking container movement.
- ERP is being implemented.

### **4.4 CASE STUDIES IN SUSTAINABILITY IN PORTS:**

#### **NMPA**

study area focus on New Mangalore Port is a small water all-weather port at Panambur, Mangalore in Karnataka state in India, the total land area of the port is approximately 480 hectares or 1,186 acres. The New Mangalore Port is the deepest inner harbor on the west coast.



implementing a green port strategy. notional research on implementing a green port strategy at the New Mangalore Port Trust and transform it into a case study.

### **Green Port Initiative:**

A green port method is an all-encompassing strategy for environmentally friendly handling of ports that takes into account the commercial, ecological, and social repercussions of port activities. The approach intends to lower the port's ecological footprint, enhance the quality of the water and air, and minimize the adverse effects of its activities on communities nearby. A green port tactics includes a number of efforts, such as:

**Energy conservation and green energy:** By implementing environmentally friendly practices and utilizing sources of clean energy such as wind and solar electricity, the port may decrease the amount of energy it uses.

**Waste treatment:** The port of entry can put in place a waste management strategy which involves reusing as well as correct disposal of waste.

**Air quality:** It can be improved by lowering pollutants from port machinery which includes vessels and automobiles and encouraging the utilization of vehicles with minimal emissions.

**The health of the waters:** It can be protected by decreasing the release of pollutants through the ocean and guaranteeing that port activities are not damaging the marine environment.

## **IMPLEMENTING A GREEN PORT STRATEGY AT THE NEW MANGALORE PORT AUTHORITY**

The New Mangalore Port Trust can benefit greatly from implementing a green port strategy. The port is located in a highly populated area, and its operations have a significant impact on the environment and local communities. The following are some steps that the port can take to implement a green port strategy:

Energy efficiency and renewable energy:

The port can reduce its energy consumption by implementing energy-efficient practices, such as using LED lighting, optimizing the use of air conditioning systems, and using energy-efficient motors for port equipment. The port can also explore the use of renewable energy sources, such as solar and wind power.

Green connection approaches are critical to minimizing port activities' negative environmental effects. The New Mangalore Port Trust is a prime instance of a port that has taken different green initiatives. The disposal of waste is one of the port's main concern sectors. The port can reduce its harmful effects on the environment through the implementation of a waste handling strategy which involves recycling and proper waste disposal. This can be accomplished by establishing separate waste centers, providing recycling incentives, and collaborating with nearby waste disposal organizations. Enhancing the atmosphere is an additional essential component of environmentally friendly port methodologies. By encouraging the transportation of negligible-emission automobiles, port facilities may decrease pollutants from port-related vehicles such as vessels and vehicles. This could involve urging ships to operate on close to zero-sulfur fuel and incentivizing trucking companies to employ vehicles with fewer emissions. safeguarding the integrity of the water, as well as to air excellence, is a vital component of environmentally responsible handling of ports.

The port can reduce pollutants emitted into the seawater while also ensuring that port activities are not detrimental to aquatic creatures. This can be accomplished through setting up a ballast water management strategy, continually monitoring the state of the water, and collaborating with community entities for the sake of the marine ecosystem. The New Mangalore Port Trust may mitigate its ecological effects while contributing to the worldwide drive to battle the effects of climate change through adopting efficient in terms of energy follows, carrying out an environmental management plan, enhancing the condition of the water and air, and encouraging sustainable port operations. This example points out the significance of an integrated approach to feasible port oversight and indicates a few specific efforts which ports may undertake in order to grow greener in their operations.

#### **4.5 INTERNATIONAL STANDARD OF SUSTAINABLE PORT DEVELOPMENT:**

Sustainable development becomes a widely acceptable and key concept of development in recent times, the (United Nation Sustainable Development Goals) SDGs gave it a universal recognition, which is perceived as global goals to end poverty, protect the planet and enhance the peace and prosperity among countries and people. These goals are interconnected; one may help in achieving the issues related to the other goals (UN,2016).

Several international organizations have actively involved in promoting the sustainable development of ports. The International Association of Ports and Harbors (IAPH) has decided to start a World Ports Sustainability Program (WPSP), which enhances and coordinate the future sustainability efforts and cooperation of the ports globally (IAPH,2018).

This program builds on the World Ports Climate Initiative that was adopted by IAPH in 2008 and evolved to the sustainable development. This program aims to demonstrate global leadership of ports and committing to the Sustainable Development Goals of the United Nations, by empowering both the port community and the societal stakeholders of the local community.

As per the OECD (2011) and PIANC (2014) the green growth strategy of port development, helps in achieving the concept of sustainability by improving and developing: innovation of new technology, active sharing of knowledge, transparent stakeholders' participation, increased social concern in the development, long-term vision

for the nature and actionable policy framework. Global Reporting Initiative (GRI), an international organization helps governments and businesses worldwide to recognize and report their impact on sustainability issues such as governance, social well-being, human rights and climate change. In which many major ports worldwide are being a member of the reporting system, that enhances the sustainability concept and provide an overall achievement of the triple bottom line of sustainability The GRI has provided sustainability reporting standards, organized with valid multi- stakeholder inputs and established in the public interest (GRI, 2018). Such practice of reporting helps in identifying and managing the risk, protecting the environment and improving the society and economy, by improving governance and stakeholder relationship.

The government initiative of 'project green port' only address the issues related to the pollution and its control measures. Also, the 'Sagarmala Programme' addresses the key issues such as capacity building of coastal community and fisheries development.

However, it does not include the active and transparent involvement of the coastal community. Therefore, India needs to accept and recognize the global standards and the guidelines on sustainability provided by the international organization such as OECD, PIANC, IAPH, and GRI on sustainable techniques to pioneer in the sustainable development of ports and harbors.

**4.6 JUSTIFICATION ON RESEARCH QUESTION:** Is it feasible for ports in India to find an equilibrium between efficiency and sustainability? Is it feasible to reconcile the execution of environmentally friendly efforts alongside the requirement over ports to keep operating profitably? The study investigates if an economical approach may be implemented for Indian port activities without having an adverse impact on their efficiency and bottom line.?

The study addressing the controversy to determine if it is possible for Indian ports to balance efficiency and sustainability is timely and significant. As the economy of India develops and the amount of trade grows, its ports are going to grow ever more vital to the economy as a whole. nevertheless, increased shipping activity has been linked with adverse effects on the environment like pollution of the environment, loss of habitat, and carbon dioxide emissions. As a result, it is critical to consider whether green initiatives can coexist in the requirement over ports to stay profitable and efficient.

Pay attention at both noticeable ports in the country to respond to this study's the question Jawaharlal Nehru Port Trust (JNPA) and New Mangalore Port Trust. JNPA is the nation's biggest container port and the globe's 28th largest. It manages over fifty percent of India's shipping containers and is vital to the nation's commerce. In a similar vein the New Mangalore Port Trust is one of the nation's major ports, managing a variety of freight such as metals, petroleum-based goods, substances, caffeine, and wood.

JNPA and the New Mangalore Port Trust both took steps to strike a balance environmental sustainability and efficiency. JNPA, for instance that has undertaken a number of environmental initiatives, including the utilization of green power, the selection of energy-efficient equipment, and the execution of a waste disposal strategy. These efforts have lowered the port's ecological impact, enhanced the overall quality of water and air, and decreased garbage era. In a similar vein the New Mangalore Port Trust took steps to lower its negative environmental impact through enacting a waste reduction schedule, expanding the quality of the water and air, and encouraging feasible port activities.

Regardless of the aforementioned attempts, there are still worries which enacting environmentally friendly measures will have an adverse effect on port profitability and efficiency. In particular, using green power places may raise the port's expenses while reducing its financial viability. Furthermore, carrying out a waste management strategy may necessitate more assets and may result in less rapid handling of cargo times, cutting port efficiency.

As a result, by examining the subject matter regarding if it could be done for Indian ports to balance environmental sustainability and efficiency, we are able to assess whether or not these worries have merit as well as if environmentally friendly efforts may be incorporated with the necessity of ports to stay profitable as well as productive. This can provide port officials, politicians, and participants associated with the Indian port industry with useful information.

#### **4.7 SUSTAINABILITY AS A GOAL IN INDIAN PORT**

The concept of sustainable development, as defined by the Brundtland Commission Report in 1987, refers to a process of change where the exploitation of resources, investments, technological development, and institutional changes work together to enhance the potential for meeting both current and future human needs. This requires development that meets present needs without compromising the ability of future generations to meet their own needs. Economist Robert M. Solow stresses the need for preserving the environment and resources to ensure intergenerational distribution of income or welfare.

Sustainability is becoming increasingly important across industries, including ports in India, which has over 7500 km of coastline and 13 major ports. These ports account for a significant portion of India's external merchant trade. However, air pollutants and greenhouse gases emitted by shipping have adverse effects on air quality and the environment. Port-side measures can contribute significantly to decarbonizing the maritime transport sector, including financial incentives, efficiency improvement programs through digitization, and alternate energy use. Many ports worldwide are implementing programs to reduce pollution and improve sustainability, and India is also gradually moving towards sustainable growth and development.

Sustainability is an important goal for Indian ports as it is for all ports globally. Ports play a crucial role in international trade and transportation, and their operations can have significant environmental and social impacts.

In India, several initiatives have been taken to promote sustainability in port operations. These include:

**Green Port initiatives:** The Government of India has launched the Green Port initiatives to promote sustainability in Indian ports. This initiative aims to minimize the environmental impact of port operations by reducing air and water pollution, conserving energy, and promoting the use of renewable energy sources.

**Energy efficiency:** Indian ports are working towards becoming more energy-efficient. They are adopting energy-efficient technologies, such as LED lighting, and implementing measures to optimize energy consumption.

**Waste management:** Indian ports are implementing waste management programs to reduce the amount of waste generated by port operations. This includes recycling, composting, and proper disposal of hazardous waste.

**Coastal and marine conservation:** Indian ports are taking steps to conserve coastal and marine ecosystems. They are implementing measures to prevent oil spills, managing ballast water, and promoting sustainable fishing practices.

**Social sustainability:** Indian ports are also focusing on social sustainability by promoting the welfare of local communities. This includes providing employment opportunities and supporting local businesses.

#### **4.8 PRODUCTIVITY VERSUS SUSTAINABILITY IN INDIAN PORT**

In order to operate efficiently, Indian ports must strike an equilibrium between efficiency and environmental sustainability. While environmental sustainability relates to a connection's capacity to satisfy current demands without jeopardizing the capacity of generations to come to satisfy their own needs, efficiency relates to the success and output of the port's operations. For both growth in the economy and global trade, ports must be productive. Efficiency, though, can have a negative impact on safety, health, and the natural world. For example, greater cargo throughput may result in increased emissions, nuisance noise, and additional detrimental effects on the surrounding community and ecological system. The goal of long-term viability on the contrary together, is to lessen the detrimental effects that port operations have on both people and the natural world. This also entails lowering warming

As an overtime development and achievement, it is frequently believed that Indian ports' efficiency and long-term viability must be harmonious as two battling factors. The Non-Major Port of Adani (NMPA) and the Jawaharlal Nehru Port Trust (JNPA) are both ports which may be utilized as instances to illustrate this matter. The biggest container port in India, JNPA, is situated in Maharashtra and manages a sizable portion of the nation's commerce. The port has put in place an array of strategies to boost output, including boosting the amount of the cranes and container yards and enhancing the effectiveness of cargo handling. However, this has

resulted in a rise in water and air pollution in the neighborhood, which has an effect on the well-being of local people and the natural world. To deal with this problem, In Gujarat, India, the Non-Major Port of Adani (NMPA) has prioritized sustainability from the beginning. The port is outfitted with green elements like solar energy, fluorescent lighting, and collecting rainwater. the mangroves plantations and the preservation of marine life are two additional environmental mitigation strategies incorporated into the port's layout. These green initiatives have, however, had an adverse effect on the port's productivity, resulting in reduced capacity for handling and less rapid shipments. The expansion and achievement of Indian ports depend on efficiency and the environment. Other ports, such as NMPA, priorities sustainability from the start, whereas ports like JNPA initially place a greater emphasis on earnings before shifting to a long-term in order to ensure growth and development that is sustainable of Indian ports, both of these elements must be balanced.

#### **4.9 TECHNOLOGY AND INNOVATION FOR SMART-GREEN PORTS**

Smart-Green Ports are the future of sustainable port operations, and India is not far behind in adopting this transformative journey of digital innovation. The integration of modern technology has allowed Indian port authorities to enhance their operations, improve efficiency, and reduce environmental impact. Digital technologies such as IoT, AI, Blockchain, Bigdata, and Automation are being adopted to create highly efficient port operations while improving transparency and trust in information sharing among different stakeholders. Alternative energy sources such as solar and wind power are being harnessed to significantly reduce the carbon footprint of ports. Green infrastructure solutions such as green roofs, green walls, and rainwater harvesting systems are being adopted to reduce the environmental impact of ports and promote sustainable development. The use of smart logistics technologies such as IoT, RFID, and GPS can improve the efficiency of port operations, reduce turnaround times, and optimize the use of resources. Environmental monitoring using drones and satellite imaging is helping to identify potential environmental risks and develop proactive measures to mitigate them. By promoting and adopting these technologies, Indian ports can become highly efficient and sustainable, leading the way in strengthening the overall Circular Economy.

#### **4.10 ACTION POINTS FOR SMART-GREEN PORTS IN INDIA**

The transition to highly digital and environmentally sustainable ports is a challenging and complex process. To make this process more manageable, a step-by-step approach is required to involve all stakeholders. There are numerous technologies available, and the intent to transform is what truly matters. Indian ports should begin working on several initiatives to transform into smart-green ports, many of which are already being implemented.

One of the most critical actions for ports is to develop an emissions inventory to set up a carbon emissions management system and provide a baseline for accurate tracking and monitoring of emissions over time. Most international world-class ports maintain emission inventories to develop strategies for reducing emissions and monitor progress over time. Indian ports should immediately begin working on carrying out emission assessment studies to develop short, mid, and long-term strategies for emission control.

Shore power, also known as cold ironing, is another initiative that Indian ports should consider. When a ship docks, it no longer needs energy for propulsion. However, ships may still consume significant amounts of energy when stationary, as several ship functions continue to operate, including ventilation/heating/cooling, pumps, control systems, and cargo handling systems. Consequently, generators are running when in port, resulting in local noise and air emissions as well as global climate-driving emissions. Instead of allowing the generators on board to make electricity, shore power can provide electricity from the shore.

Steps regarding the collection and reuse of rainwater could also be taken at ports, which could be used for non-drinking purposes in ports, such as harbor cleaning, gardening, construction, cleaning of terminal vehicles, etc. Ports should set targets to increase the use of rainwater for non-drinking purposes.

Initiatives to set up renewable energy generation facilities such as solar power, wind power, and tidal power should also be taken at ports. The aim should be to maximize the use of renewable energy for all port operations. Feasibility studies for such projects could be immediately started at all ports with the goal of maximizing the use of unused or available areas in port premises.

Many foreign ports, particularly in Europe and America, offer incentives in terms of tariff discounts to ships listed in the Environmental Ship Index (ESI) based on their ESI score. The aim is to encourage sea-going vessels, cruise ships, and barges that call on the port annually to

operate as rapidly and efficiently as possible, using the least number of resources. The feasibility of similar schemes should be explored at Indian ports as well.

Ports, in collaboration with terminal operators, should take steps to replace fossil fuel vehicles used within port premises with electric vehicles (EV). The first step towards this would be setting up of EV charging facilities at ports. With the recent government notification, setting up of EV charging facility has become very easy. Having EV charging facilities at port would encourage other transporters and logistics companies to shift more towards EV trucks as the government has already set an agenda to set up EV charging stations along the highways.

In coastal cities in India, there is already a significant shortage of drinking water. In such a scenario, by installing desalination plants, ports can not only meet all their requirements for portable water but also supply access water to nearby villages and communities. Port reception facilities in accordance with IMO's MARPOL guidelines should be strengthened at ports. Although many ports have reception facilities, many do not cover all types of waste collection. Efforts should be made at all ports to increase the type of garbage and waste for collection and disposal. Going digital is the way forward for ports to reduce their carbon footprint. Current trends in Indian ports focus on the automation of port handling equipment and operation processes. The Port Community System (PCS) project being implemented for all major ports is one such futuristic step aiming to transform Indian ports from antiquated ports to modern ports by bringing in a paperless regime.

## CHAPTER – V

### INTEGRATED DISCUSSIONS AND CONCLUSION

#### 5.1 FINDINGS

- India has a coastline of about 7,500 km and has been working towards making its ports more sustainable and environmentally friendly.
- Green port initiatives in India can be categorized into three areas: energy efficiency, waste management, and sustainable transportation.
- Energy efficiency is a key focus area for green ports in India, and various policies and schemes have been introduced to promote it in port operations.
- The Green Port Initiative, launched by the Ministry of Shipping in 2016, aims to make Indian ports energy efficient and reduce their carbon footprint.
- Measures such as energy-efficient lighting, installation of solar panels, and use of energy-efficient equipment are being implemented in Indian ports to achieve this goal.
- Waste management is another important focus area for green ports in India.
- The Indian government has introduced various policies and initiatives to promote waste management in ports, including provisions for waste segregation and treatment facilities.
- Sustainable transportation is also a key focus area for green ports in India.
- The Indian government has introduced various policies and initiatives, such as the Coastal Shipping Agreement, to increase the use of coastal shipping for the transportation of goods.
- Challenges that need to be addressed to make Indian ports truly green include a lack of awareness and understanding of green port initiatives among port stakeholders.
- There is a need for more awareness programs and training initiatives to educate port stakeholders on the importance of green port initiatives.
- Another challenge is the lack of adequate infrastructure for waste management in ports.
- The Indian government has launched the Sagarmala Programme to modernize port infrastructure and enhance port connectivity to address this issue.
- The green port initiatives in India are a positive step towards making port operations more sustainable and environmentally friendly.

- With continued efforts and investments, India can become a leader in green port operations and set an example for other countries to follow.

## 5.2 CONCLUSION

India has made efforts to make its ports more sustainable and environmentally friendly through green port initiatives. The government's initiatives in promoting energy efficiency, waste management, and sustainable transportation have yielded positive results in Indian ports. Energy efficiency in port operations is a key priority for the Indian government, and policies and schemes have been introduced to promote it. The Green Port Initiative launched by the Ministry of Shipping in 2016 is a significant step towards making Indian ports more energy efficient.

- The installation of energy-efficient lighting, use of solar panels, and energy-efficient equipment are being implemented in Indian ports to reduce their carbon footprint.
- Waste management is another important focus area for green ports in India, and various policies and initiatives have been introduced to promote it.
- The Green Port Initiative includes provisions for waste management, including the establishment of waste segregation and treatment facilities in ports.
- While there are challenges in terms of infrastructure and lack of awareness among stakeholders, Indian ports are making progress towards effective waste management.
- Sustainable transportation is also a key focus area for green ports in India, and various policies and initiatives have been introduced to promote it.
- The Coastal Shipping Agreement aims to increase the use of coastal shipping for the transportation of goods, thereby reducing the carbon footprint of port operations.
- The lack of awareness and understanding of green port initiatives among port stakeholders is one of the major challenges that need to be addressed. There is a need for more awareness programs and training initiatives to educate port stakeholders on the importance of green port initiatives. The government's Sagarmala Programme, which aims to modernize port infrastructure and enhance port connectivity, is a significant step towards addressing this challenge. With sustained efforts and investments, Indian ports can become beacons of sustainability and contribute towards a cleaner and greener future.

### **5.3 PRACTICAL IMPLICATIONS**

The study offers information on the procedures that lead to contamination at India's significant and smallest ports in addition to an evaluation of the actual efficacy of the negative environmental impact prevention efforts put in place. By identifying and defining those elements that require enhancement, assisting the Indian port officials to assess their environmental report card and then allocating contributes for promoting more sustainable port operations. Researchers and officials who are intrigued in the differences that the amount of flow as well as focus may have in the ecological effects of shipping operations can benefit from the study's special focus on the effects of significant ports and non-major ports. Information from Indian ports was gathered for the analysis, which may be utilised to assess achievement among ports which are in competition and find new approaches for reducing the negative effects of shipping operations. Other investigations that aim to develop a useful and universal port working model can also use the results of the research about the effectiveness of outcomes in India's significant compared to non-major interfaces.

### **5.4 FUTURE SCOPE**

This study endeavour gathers its port-related information. India is the only country whose ports were examined for the purpose of study. Additionally, the study excludes port-related operations like transportation from its examination because they could have additional, unforeseen impacts on the administration of the natural environment. If there are any additional green measures exclusively used by ports above those questioned and covered in this analysis, they weren't independently evaluated. The sheer number and geographic diversity among the ports included in the current study prevented it from with assurance suggesting a general working model that could be used in the growth across all ports. The present analysis fails to make the assumption which the difficulties leading to ineffectiveness of evaluates aren't specific depending on each port's unique physical location and operational limitations. Instead, it assesses the success rate of standard mitigation strategies towards harm to the environment from the perspectives of every stakeholder in significant and non-major ports. As a consequence, the analysis has not taken the risk of expressing opinions or suggestions regarding the suitability and efficacy of the general port working model. To address these topics and provide more thorough results, additional research could be conducted.

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