A STUDY ON THE FEASIBILITY OF RO-RO VESSEL FROM GUJARAT TO KOCHI THROUGH COASTAL LINE

A dissertation submitted to the School of Maritime Management, Indian Maritime University in partial fulfillment for the requirements for the award of degree in

MBA- International transportation and logistics Management

Submitted

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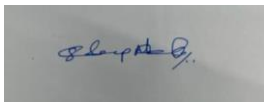
DECLARATION

I**, S SAI SANDEEP NAIK** (Reg. No **2003305032**), student of the School of Maritime Management, Indian Maritime University –Chennai Campus, hereby declare that this project report titled(**FEASIBILITY OF RO-RO SERVICE FROM GUJARAT TO KOCHITHROUGH INLAND WATERWAYS)** submitted in partial fulfilment of the requirement for the degree of Master of Business Administration in International Transportation and Logistics. 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.



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CERTIFICATE

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INDIAN MARITIME UNIVERSITY, CHENNAI.

This is to certify that the project report entitled "**A STUDY ON THE FEASIBILITY OF RO-RO VESSEL FROM GUJARAT TO KOCHI THROUGH COASTAL LINE"** 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 International Transportation and Logistics Management, is a record of work carried out entirely by **S,Sai Sandeep Naik** Reg. No. **2003305032**

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Title of Dissertation: A STUDY ON THE FEASIBILITY OF RO-RO VESSEL FROM GUJARAT TO KOCHI THROUGH COASTAL LINE

*Degree:***Master of Business Administration,International transportation and logistics.**

The Maritime sector is one of the strong factor in terms of economic and sustainable regional balanced development. It plays a major role in the development of the Indian economy and also in development of mutual understanding between countries. India is one out of those countries which had an amazing history in the field of sea trade. Coastal areas play a mojor role in constituting the ports.The higher the throughput of goods and passengers' year-one year, the more infrastructure, provisions, and associated services are required. These will bring varying degrees of benefits to the economy and to the country. Ports are also important for the support of economic activities in the hinterland since they act as a crucial connection between sea and land transport. As a supplier jobs, ports do not only serve an economic but also a social function. In terms of load carried, seaway transportation is the cheapest and most effective transportation system compared to other systems. Industries require a safe and cheap means of exporting finished goods and importing raw materials. Hence most industries in the world are in the coastal belts, in the vicinity of major ports. These industries in turn, influence the lives of the employees and indirect benefactors.Industries require a safe and cheap means of exporting finished goods and importing raw materials. Hence most industries in the world are in the coastal belts, in the vicinity of major ports. These industries in turn,influence the lives of the employees and indirect benefactor.Using the RO-RO vessel there are many benefits that could change the many ways in the means of transport.in the same way to help these RO-RO to have a safe travel the Inland waterways arethe best mean of way to reach from starting point to the end point. With increasing focus on public privatepartnerships (PPP) in port infrastructure sector, the role of regulatory bodies has become very crucial. Tariff, being vulnerable to market monopolies and monopoly/predatory pricing, is a critical regulatory element. After private participation was allowed in port sector, the Tariff Authority for Major Ports (TAMP) was set up in 1997 to regulate tariff at major ports. TAMP was constituted to provide for an

independent Authority to regulate all tariffs, both vessels related, and cargo related, and rates for lease of properties in respect of Major Port Trusts and the private operators located therein. The Major Ports Trust Act, 1963 was amended by Port Laws (Amendment) Act 1997 to constitute the TAMP. TAMP regulated, inter-alia, tariff that port operators could charge from port users. Before TAMP's guidelines were finalised, some of the bids had already been awarded.

The coast of India stretches for 7,516.6 kilometres, connecting the mainland and islands to the Bay of Bengal in the east, the Indian Ocean in the south, and the Arabian Sea in the west.The coast is shared by nine states and four federal territories (UTs). Gujarat has thelongest coastline among the states, and Andaman and Nicobar Islands has the longest coastline among the UTs.

- Because of the resources, productive ecosystems, and diverse biodiversity, the coastal environment is critical to a nation's economy.
- Mangroves, coral reefs, seagrasses, salt marshes, dunes, estuaries, lagoons, and other coastal habitats can all be found in the coastal zone.
- Coastal areas have become more important in recent years as a result of rising human population, urbanisation, and rapid development activities.
- According to Census 2011, the coastal districts account for roughly 15.5 percent of the national population (almost 18.8 crores), with about 4.4 lakh persons living in theisland territories.
- India has thirteen main ports.

Coastal waters and nearby shorelands form the coastal zone, which are heavily influenced by one another. Coastal areas, such as estuaries, lagoons, and coastal wetlands, are some of the most productive and precious environments on the planet. People, trade, the military, and a number of industries all have a strong interest in them. The shore is subjected to environmental alteration and deterioration as a result of reclamation, dredging, pollution, industry, and anthropogenic activities due to its large population.India has a 7,500-kilometer coastline that runs parallel to the Arabian Sea in the west and the Bay of Bengal in the east. Between the Western Ghats and the Arabian Sea, the western coastal plains are divided into the Northern Konkan Coast and the Malabar Coast. Between the Eastern Ghats and the Bay of Bengal,however, are the eastern coastal plains.India's almost 7500-kilometer-long coastline is

incredibly varied and active, with a wide range of rock-, sediment-, and coral-based coastland landforms. Monsoons play a big role in coastal processes along the Indian shores. In various ways, the Arabian Sea coast differs from the Bay of Bengal shore. The east coast is more expansive, with multiple big deltas, massive lagoons, the world's largest mangrove wetland (Sundarbans), and long expanses of sandy beaches backed by dunes or ridges. The west coast, on the other hand, has more rocky headlands, intervening sandy bays, and many estuaries. Cliffs and their accompanying characteristics are more common. Some of the notable characteristics along the west coast include a huge saline marshland and lagoon-barrier complexes (kayals).

In the Indian context, transportation has always been a major challenge. One of the most important means of transportation is water transportation. With a navigable length of around 14500 km, India possesses a vast network of inland waterways in the shape of canals, rivers, lakes, creeks, and backwaters. When compared to other modes of transportation, water-based transportation produces far less pollution. The main advantages of inland water transportation are the main infrastructure (which is frequently already there) and the low operating and maintenance costs. When the origin (source) and destination are both waterfront places, it is most effective. It may be more cost-effective for cargo and passenger transportation, reducing the strain on other modes of transportation.

If we look back through history, we can see that significant civilizations arose as a result of the water resources available in each place. As a result, civilizations are identified by the names of the rivers that aided their growth. They're known as "river valley civilizations." Many of these river valley civilizations arose in different parts of the world at different times. The potential of the world's available waterways has yet to be realised.

CHAPTER – 1

INTRODUCTION

1.1 Significane of the Study

1.1.1RO-ROmeans Roll-on/roll-off, in which loaded trucks are transported straight to their destination by boats (ships, trains, etc.). Konkan Railway operated India's first ever RO-RO service. The Konkan Railway travels across India's rugged terrain. The same route is also crossed by NH-66. Truck drivers find driving laden trucks across ghats, sloping surfaces, small roads, and poor road and weather conditions particularly tough.

The KRC proposed the RORO concept, in which loaded trucks are transported by train on waggons.This has resulted in fuel savings, a reduction in lorry (truck) wear and tear, relief for drivers operating in difficult weather, and the ability to arrive at a destination sooner. This also aids in traffic reduction and pollution reduction. Both the truck operators and KRCL have benefited from this strategy.Prime Minister Narendra Modi recently launched a passenger ferry service between Hazira in Surat and Ghogha in the Bhavnagar district.The service will reduce the 375-kilometer road distance between Bhavnagar and Surat to 90 kilometres through water route, according to the PM.

Many aspects must be considered while discussing the viability of RoRo in the water. Both the technical and economic aspects must be thoroughly investigated.Rather of being hauled onboard by cranes, RoRo allows your products to roll on and off the vessel. Self-propelled vehicles, such as cars and tractors, drive themselves onto and off the ship. Non-self-propelled products are loaded onto handling equipment with wheels in the terminal and rolled onto and off the vessel. As a result, your goods remains on the handling equipment for the duration of the sea cruise.A large stern ramp is used for loading and unloading. Our vessels' ramp capacities can reach 500 tonnes, whereas most other RoRo carriers' ramp capacities are about 150 tonnes. RoRo shipping is a safe and efficient method of transport because it requires less lifting and is not weather-dependent.The RoRo vessels of WW Ocean are designed to transport a wide range of products, from automobiles and rolling stock to breakbulk cargo. A RoRo vessel can have up to 13 decks and functions similarly to a parking garage, with liftable ramps linking the decks. Your products are safely fastened using lashings on the most appropriate deck, according on their weight, height, and length.

Our RoRos' 'high and heavy' decks can bear up to 10 tonnes of pressure per square metre, thanks to their strong body hull and deadweight ranging from 30,000 to 50,000 tonnes. They are thus ideal for carrying big cargo.

1.1.2 Back Waterways

A backwater is a section of a river where there is no or little current. It can refer to a side branch of a main river that runs alongside it before rejoining it, or to a body of water in a main river that is backed up by the sea tide or a dam. [1] Backwaters can be caused by man-made restrictions on natural stream flow or by temporary natural impediments such as ice jams, vegetation blockage, or flooding of a lower stream.If a river has acquired one or more alternative courses during its evolution, the main route is usually named, and subsidiary channels are referred to as backwaters. Backwaters may be shallower and flow more slowly, if at all; the main river course will normally have the fastest stream and will most likely be the major navigation route. Mangrove forests abound in some backwaters. As a result, there is a more diverse ecosystem of scientific importance that deserves to be preserved. Backwaters also offer recreational options such as canoeing and fishing.

The word has been used as a metaphor for portions of the physical and social world that have been overlooked. It could refer to areas that have been overlooked in terms of economic growth, or it could refer to a "culture" area.

1.1.3 Coastal line

Coastal India is a geo-cultural zone of the Indian subcontinent that stretches the length of the country's coastline. (7516.6 km; 5422.6 km on the mainland, 2094 km in the islands). Coastal India in ancient India stretches from the Gulf of Kutch in its westernmost corner, across the Gulf of Khambhat, and through the Salsette Island of Mumbai along the Konkan, and southwards across the Raigad district region and through Kanara, and further down through Mangalore and along the Malabar through Cape Comorin in the southernmost region of South India with coastline along the Arabian Sea. The coastline of the Indian Subcontinent spans from the Utkala Kalinga region in the south to the easternmost corner of the shoreline at the Sunderbans in Coastal East India along the Bay of Bengal.Many beaches and springs may be found here, as well as stunning seas and

oceans such as the Arabian Sea.India's Coastal States: India has a total coastline of 7516.6 kilometres, with 5422.6 kilometres of mainland coastline and 2094 kilometres of island territory. India has nine coastal states. Gujarat, Maharashtra, Goa, Karnataka, Kerala, Tamil Nadu, Andhra Pradesh, Odisha, and West Bengal are the states involved.The Andaman and Nicobar Islands in the Bay of Bengal and the Lakshadweep Islands in the Arabian Sea are India's two island territories.

Coastal Data	
Length of Coastline	7516.6 km
Total Land Area	3,287,263 km^2
Area of the continental shelf	372,424 km^2
Territorial sea (up to 12 nautical miles)	193,834 km^2
Exclusive Economic Zone	2.02 x 106 million km^2

Table1:Coastal data

The islands of Andaman and Nicobar, with a shoreline of little over 1,900 kilometres, had the longest coastline in India, followed by Gujarat. The union territory of Daman and Diu has the smallest coastline throughout the time period studied.

1.2 OBJECTIVES OF THE STUDY:

The following are the main objectives of the study:

- To study the feasibility route for ro-ro through coastal line between two states
- Different types of roro.
- A study on Gujarat and kerala back waterways.
- Brief study about coastal line transportation

1.3METHODOLOGY

A novel methodology is developed for determining the characteristics of a cargo roll-on/roll-off (ro-ro) ship and the fleet size required for a given short sea shipping route. The ship

andrequired fleet size to satisfy the transportation demand (for each pair of speed and freightrate) are determined using a database of existing cargo ro-ro ships to obtain the maintechnical characteristics of the most suitable ship. The time charter, voyage costs and revenueare then calculated considering the technical characteristics of each ship. Fuel costs arecorrected for the actual ship speed and loading condition. A number of restrictions in thetransportation problem are considered leading to the exclusion of unfeasible solutions. Themaximum profit over the period of a year is identified among the feasible pairs of speed andfreight rate. This general methodology is applied in a case study that considers the routebetweenGujarat and Cochin. The study allows the identification of the most suitable shipandcompany profit of changes in parameters such as fuel costs, time charter costs, emissioncontrol area, installed propulsion power and stacking factor.

Due to its convenience for integrating land and marine transportation roll on/roll off (Ro-Ro) ships are very important for offering smooth and flexible services required by the modern world of trade. Ro-Ro ships are able to load trucks or trailer directly via their ramps, thus no lifting equipment is necessary. A lot of seaports are equipped with necessary ramps to facilitate Ro-Ro ships. On the other hand, literature related to Ro-Ro terminal operations is scarce. Thus, this study aims to develop a simulation model for Ro-Ro terminal operations in order to provide a means for better decision making and resource allocation. As a result, it was discovered that the maximum utilisation rate of one of the waiting areas exceeded its capacity, which shows that the model could be a useful tool in order to identify possible bottlenecks for the Ro-Ro terminal.

1.4 SCOPE OF STUDY

- The study discusses about the feasibility of RO-RO vessels and also how backwaterways plays a major role in usage of these vessels through coastal line between two states.
- The present study also discusses about the structure of how ro-ro has been evolved
- and started palying a major role in the transportation of goods through coastal line.
- The study gives a brief knowledge about the coastal lines in india.

- As back waterways plays a major role in connecting the coastal lines, we widiscussing how the back waterways of kerla and Gujarat helps in cost effective model transportation connecting the coastal line.

1.5 STRUCTURE OF THE REPORT

- In chapter one we will be discussing about the Background, objectives,Methodology, and Scope of study, of the given title.
- Chapter two deals with Literature Review of the entire report.
- Chapter three discusses abot the brief description of Ro-Ro vessels and their types, Back Waterways and Coastal Line of India.
- In chapter four we will be discussing about the Feasibility of Ro-Ro vessels from Gujarat to kochin.
- Chapter five deals with the summary and conclusion of the report.

CHAPTER-2

LITERATURE REVIEW

2.1 Review of literature

2.1.1 RoRo Ship Routing and Scheduling with Stowage Limits[1]

The Article by "**Bernt Olav Øvstebø's"** Roll-on/Roll-off ships are used to move automobiles and other rolling equipment across international borders. This article looks at the dilemma of a ship sailing between two geographical zones, picking up cargo in one and delivering to the other. Optional cargoes, variable cargo numbers, and ship stability constraints are all taken into account. The ship's route and schedule, as well as the stowage of cargo onboard, must all be decided. The problem is represented as a mixed integer programme that was solved with Xpress. In addition, components from tabu search and squeaky wheel optimization are used to create a custom heuristic approach. The heuristic is shown to be capable of handling genuinely sized issue cases through extensive computational findings.

2.1.2 An Economic Feasibility Study of Short Sea Shipping Including the Estimation of Externalities with Fuzzy Logic.[2]

The article by **"Athanasios Denisis's"** The continued expansion of freight transportation has put enormous strain on transportation networks in the United States and Europe. Trucking's domination as the primary means of domestic general cargo transportation has resulted in traffic congestion, air pollution, highway accidents, noise, and increased energy usage, among other issues. Short sea shipping (SSS) can help solve these issues by using inland and coastal waterways. As part of an intermodal system, SSS can provide efficient door-to-door transportation, with ships handling the long route and vehicles handling the short haul. The economic viability of SSS is investigated in this paper. SSS has reduced external costs because to its environmental and socioeconomic advantages over competing options. External costs, often known as externalities, are costs that are not included in transportation prices**.**The findings reveal that SSS has a lot of room to improve its environmental performance by cutting ship emissions at ports, which account for the majority of its external

[1]https://www.researchgate.net/publication/251630820_Routing_and_scheduling_of_RoRo_ships_with_stowage_constraints

expenditures, and employing practises like??cold ironing.?? . In two realistic scenarios of future short sea operations along the US East Coast, the dissertation evaluates the feasibility and competitiveness of SSS in comparison to the all-truck method. Due to its substantial energy efficiency, SSS is extremely competitive. Furthermore, because of its location, its environmental performance in terms of monetary impact of emissions is superior.The two case studies exemplify the fair pricing concept in freight transportation, where prices are based on the complete societal cost of a transportation mode, by combining internal and external cost estimations.

2.1.3Ro-Ro Short Sea Shipping Decision-Making Model for Archipelagic Southeast Asia[3]

The purpose of this project, according to "Aminuddin Md Arof" (Associate Professor), Universiti Kuala Lumpur, Malaysia, is to develop a decision-making model for analysing the feasibility of interstate Ro-Ro Short Sea Shipping (SSS) operations in Archipelagic Southeast Asia (ASEA). It is expected to help SSS officials, private investors, and financial institutions focus their limited resources on a few critical variables that will ensure their projects' success. Through a literature review, this study will begin by identifying the important aspects that have contributed to successful SSS operations. Following that, a Delphi poll of sub-regional experts was done to identify any new determinants and gauge their perspectives on the relative relevance of all the variables involved.Finally, the Analytic Hierarchy Process was used to determine the weightages of the determinants (AHP). Brunei Darussalam had twenty expert respondents. The Delphi poll included Indonesia, Malaysia, and the Philippines, while the AHP survey continues to include 18 expert respondents. This research culminates in the creation of a decision-making model that was evaluated on three interstate Ro-Ro SSS routes in the ASEA subregion.

2.1.4 Modal shift from road haulage to short sea shipping: a systematic literature review and research directions[4]

The article published by "**Svanberg, Martin, Wiegmans, Bart"** explains thatfor more thantwo decades, authorities and experts have urged a modal transition from road haulage to short sea shipping (SSS). This study reviews the literature on modal shift and identifies areas for further research in six categories: (1) variables affecting SSS competitiveness, (2) policy-

[3]https://doi.org/10.1016/j.ajsl.2018.03.005
[4]https://www.tandfonline.com/doi/full/10.1080/01441647.2020.1714789

oriented perspectives, (3) environmental laws, (4) SSS performance, (5) port features, and (6) multi-agent perspectives. Specifically,First, three performance-related factors – the economic dimension (e.g. external costs), the environmental dimension, and the dimension of service quality – should be addressed when evaluating the performance of SSS vs road haulage in particular trade corridors. Second, researchers should employ a combination of rich, real-world numerical data and operational research approaches to determine the relative importance of individual drivers and barriers to a modal change from road haulage to SSS. The third proposed direction is to determine which categories of actors should be targeted by various policies.Researchers should broaden their policy-related focus outside the European Union, which has traditionally been the primary geopolitical focus of modal shift research. Fourth, strategic measures must be devised to mitigate the negative impact of environmental regulation on SSS. Fifth, we recommend that the impact of contingencies, such as port strikes and cyberattacks, on SSS operations and management strategies be examined. Sixth, each transport chain agent's economic and financial benefits of cooperation and alliance must be assessed.

2.1.5 MARITIME INDIA VISION 2030[5]

This article published by **"MINISTRY OF PORTS, SHIPPING, AND WATERWAYS"** tells u about, After extensive engagements with public and private sector players, the Maritime India Vision 2030 (M IV 2030) was developed. At the outset of the exercise, 14 thrust area groups from diverse marine sectors were formed to discuss and identify initiatives and targets that would be targeted as part of the Maritime India Vision 2030. MIV 2030 identifies more than 150 initiatives in various marine sectors such as ports, shipping, and waterways. For numerous activities, a detailed phasing and implementation roadmap has been established to ensure tracking and monitoring. As part of this endeavour, policy and regulatory measures to support the identified initiatives were also defined. To increase the performance and efficiency of the Indian marine sector to best in class standards, key targets under significant projects were identified. Port-related initiatives are aimed at increasing capacity, improving operational efficiency, promoting port-driven industrialization, and developing safe and sustainable world-class ports to meet rising trade volume demands while lowering logistics costs through better evacuation and cost-effective processes. Shipping-related activities aim to expand shipbuilding, recycling, and repair sectors, as well as India's

[5]http://www.asean.org/wp-content/uploads/images/2013/economic/transport/EIJR13069_FR_Main_vol2.pdf

global standing as a marine force. Several measures have also been identified to increase the size of the Indian flagged fleet, the number of Indian seafarers through excellent maritime education, and the growth of fledgling sectors such as cruise tourism in the country.

Inland waterways have been quickly expanding in the country, and MIV 2030 builds on this trend to boost multi-modality and the share of inland waterway-borne freight/transit and passenger mobility. MIV 2030 is a comprehensive effort and strategy for all stakeholders in the Indian maritifne sector to strive toward making it globally competitive.

2.1.6 'Developed waterways will change India'[6]

The article published by **"THE HINDU"** tells about The government is considering new ways to raise roughly Rs. 70,000 crore to develop the country's 50,000 kilometres of sea and river fronts as waterways in the first phase, according to Union Minister Nitin Gadkari.Last week, Parliament passed a vital bill designating 111 rivers around the country as National Waterways, paving the path for their development as transportation corridors. Only five river lengths have been designated as National Waterways so far."India has a distinct advantage." Its 14 states have 7,500 kilometres of coastline and 14,500 kilometres of potentially navigable waterways between them. In addition, 116 rivers provide 35,000 kilometres of navigable waterways across the country."We have over 50,000 kilometres of waterways in all, which, if developed, will change the face of India," stated the Minister of Road Transport, Highways, and Shipping.ingenious finance The government was committed to working vigorously to promote these as an environmentally benign means of transportation now that Parliament had given its approval to declare 111 additional rivers as waterways, which was sure to drastically reduce India's hefty 18% logistics cost.

2.1.7 The inland waterways project won't choke rivers[7]

The article published by **"HINDUSTAN TIMES"** explains that It will revitalise the Ganga by constructing a 'Room for River,' a flood mitigation and conservation model.'The Inland Waterways Project Will Destroy India's Rivers,' writes Manoj Misra (Comment, January 4). Both of these assertions are false.According to evaluations by experts hired through global bidding for Detailed Feasibility and Engineering Studies, the Jal Marg Vikas Project (JMVP)

[6]https://www.thehindu.com/news/national/developed-waterways-will-change-india-says-union-minister-nitin-gadkari/article8349095.ece

[7]https://www.hindustantimes.com/analysis/the-inland-waterways-project-won-t-choke-rivers/story-3CTflDhyTxijS5AAqlQeqO.html

Varanasi to Haldia on National Waterway 1 has an economic internal rate of return of 21.40 percent.The Inland Waterways Authority of India (IWAI) is designing standardised vessels with a shallow draught and a large carrying capacity for the National Waterway 1. (up to 2000 tonnes). Even though the Ganga is about 2.5 kilometres broad at some points, these vessels will only require a depth of 2.2 to 3 metres and a channel width of 45 metres.Construction of barrages, diversion structures, and groynes has been avoided to keep physical intrusions to a minimum. Dredged material will not be put outside the river, according to the JMVP dredging (desilting) management plan. The river's bed is not being disturbed. Even though 80 percent of the silt is suspended, only maintenance dredging will be done to desilt 20% of the bed load silt.The findings of a study conducted by ICAR-Central Inland Fisheries Research Institute (ICAR-CIFRI), Barrackpore, titled "Impact assessment of coal transportation through barges along the National Waterway No.1 (Sagar to Farakka) along the Ganga," revealed no significant changes in water quality parameters.The entire stretch of the Vikramshila Gangetic Dolphin Sanctuary is not being dredged.

2.1.8 'Waterways, Sub-continent's lifeline for trade[8]' :

The article published by **"BUSINESS LINE"**tells that SarbanandaSonowal, the Union Minister of Ports, Shipping and Waterways, remarked that the optimal and holistic development of the canal ecosystem might help India establish strong business ties with its neighbours.Sonowal invited the industry to proactively partner with the government in the waterways sector, according to an official statement, speaking at the inaugural session of the Waterways Conclave 2022, a two-day event organised by the Ministry of Ports, Shipping and Waterways and the Inland Waterways Authority of India (IWAI) with the Federation of Indian Chambers of Commerce and Industry (FICCI) and ICC as industry partners in Dibrugarh, Assam.Assam Chief Minister HimantaBiswaSarma said the state is constructing the Assam Inland Water Transport project, worth 770 crore, to provide passengers with safe and convenient ferry services. When discussing the importance of the Northeast's waterways environment, he stated that the Brahmaputra basin contains almost 30% of India's water resource potential, and that cargo transit over waterways would greatly reduce reliance on roadways."Regular freight movement over waterways would create job possibilities and, through cost-effective transportation, unlock the international market for local products," he said.

[8]https://www.thehindubusinessline.com/news/waterways-sub-continents-lifeline-for-trade/article65314547.ece

2.1.9 “India lost one-third of its coastline from erosion, gained almost as much: Report”[9]

The article published by **“THE TIMES OF INDIA”**tells that According to a government research, natural forces such as cyclones and waves, as well as human activity such as construction, have eroded approximately one-third of India's coastline in the last 26 years, but new sediment deposits have contributed roughly an equivalent amount of land.From 1990 to 2016, the National Centre for Coastal Research studied 6,031 kilometres of India's 7,517-kilometer coastline, finding that 33% of it has experienced erosion, the majority of it along the eastern coast facing the Bay of Bengal, with West Bengal experiencing the most erosion. Simultaneously, 29 percent of the observed coastline saw accretion, or an increase in deposits.

"Erosion and accretion are mutually beneficial. Sand and sediments must accumulate somewhere if they have migrated from one side "M V Ramana Murthy, director of NCCR and one of the report's authors, stated.According to the research, erosion occurred on 2,156.43 kilometres of the country's assessed coastline, while accretion occurred on 1,941.24 kilometres.The coastline has long been recognised to be eroding, but officials needed to map and document it so that multiple agencies could take corrective action, according to M Rajeevan, Secretary in the Ministry of Earth Sciences and another report co-author.As sea water seeps into the land, erosion results in the destruction of human habitation. This has an impact on coastal farming as well. Because traditional fisherman with tiny boats do not use fishing harbours, beaches serve as a doorway to the sea. Because of the loss of beaches, they must rely on harbours to access the sea.As beaches are expanded, accretion results in an increase in land area, which is beneficial. However, accretion in deltas and streams has a negative influence on the ecosystem because the silting of sediments prevents sea water from entering these areas. Several varieties of aquatic vegetation and wildlife can be found in the estuaries and creeks. Any disruption is harmful to the ecosystem, according to Murthy.According to the survey, 63 percent of West Bengal's coastline has deteriorated in the previous 26 years, losing 99 square kilometres of land. Puducherry suffered the second-highest loss (57%) followed by Odisha (28%), and Andhra Pradesh (12%). (27 per cent).Kerala is the only state on the western coast where the coastline has been eroded by

[9]https://timesofindia.indiatimes.com/india/india-lost-one-third-of-its-coastline-from-erosion-gained-almost-as-much-report/articleshow/65373127.cms

more than 40%, with Gujarat, Diu, and Daman losing 26% of their coastline, Maharashtra 24%, Goa 12%, and Karnataka 22%.

2.1.10 "Indian coastal landmarks may submerge by 2050"[10]

The given article from **"INDIA TIMES"**said that Many Indian coastal sites may be submerged in the water by 2050, according to a report issued by RMSI, a global risk management agency. Mumbai, Mangalore, Kochi, Thiruvananthapuram, Chennai, and Visakhapatnam's downtown sections are designated as'may' submerge under marine landmarks by 2050.According to the study, the Arabian Sea is threatening the Bandra-Worli Sea Link, Haji Ali Dargah, Western Express Highway, and Marine Drive in Mumbai.According to the paper, the north Indian Ocean might rise by a foot every year in the future decades, based on UN Intergovernmental Panel on Climate Change (IPCC) forecasts.

[10]https://www.indiatimes.com/explainers/news/india-coastlines-are-shrinking-and-bengal-suffers-the-most-erosion-566858.html

CHAPTER-3

3.1 Brief Description about Ro-Ro and its Services

Roll-on/roll-off is abbreviated as Ro-Ro. Ships that transport wheeled cargo are known as roll-on/roll-off ships.The November 1995 revisions defined the roll-on/roll-off ship.to the International Convention for the Safety of Life at Sea, Chapter II-1

SOLAS defines a passenger ship with ro-ro cargo spaces as "a passenger ship with ro-ro cargo spaces or"spaces of particular category"The ro-ro ship is not the same as a Lo-Lo (lift on-lift off) ship.A crane will be used to load the shipment. The ship's cars are loaded and ready to sail.Built-in ramps allow for easy loading. Normally, these ramps are constructed. towards the ship's stern (backside). They are also found on some ships. located on both the front and sides of the bow The vessel might be of any type military and civilian. In the nineteenth century, Ro-Ro barges were designed to convey trains that were too broad for bridges across rivers. The Firth of Forth ferry, for example, is an example of a Ro-Ro vessel. In 1851, activities began. The ship's tracks were installed so that it could be moved. connected to those on the ground After that, a train would just roll onto the track. then roll off the other end of the ship Ro-ro vessels come in a variety of shapes and sizes. Ferries, cruise ferries, cargo ships, and barges are all examples of vessels. The vessels that are ro-ro recognised for solely moving cars and trucks across oceans Pure Car Carriers (PCC) and Pure Truck & Car Carriers (PTCC) are two types of carriers (PCTC) respectively. Unlike other cargoes, ro-ro loads are measured in lanes in meters rather than metric tonnes (LIMs). The LIM is calculated by dividing the cargo length in meters by the number of decks and the cargo weight.breadth of the lane The lane width will differ from vessel to vessel, and some overlap will occur.Several industry standards exist.MS Color Magic is the largest ro-ro passenger ferry in the world. The weight is 75,100 GT.(Total Tonnage) It first appeared on Color Line in September of 2007.Aker Finn yards constructed it in Finland. The ferry is 223.70 meters long and 35 meters broad, with a capacity of 550 automobiles and 1270 lane meters of cargo. The Ulysses is the ro-ro passenger ferry with the most car-carrying capacity. Irish Ferries owns the ferry, which is named after a James Joyce novel. It first began operation on March 25, 2001, and runs between Dublin and Holy head. It is 209.02 meters in length and weighs 50,938 GT. The roll-on/roll-off system's introduction to major global commerce routes has brought additional dimensions to the modern cargo handling procedures available to shippers. The roll-on/roll-off method debuted about the same time as the containership and has only recently garnered widespread adoption. While many ports have

seen a rapid expansion of terminal areas, berths, and container handling equipment, the roll-on/roll-off system has proven that it complements rather than competes with containerships and container handling systems.It is a method that does not require enormous specialised terminal facilities and shore-based equipment, which is especially significant for increasing trade. Many operators believe that the ro-ro system combines the finest aspects of containerization, unitization, and breakbulk methods. These ships, on the other hand, have flaws such as wasted space and lashing issues. Recent ro-ro ships have been designed as nearly full containerships, with forklift trucks loading and unloading containers ro-ro. Heavy earth-moving machinery, autos, farm equipment, massive chunks of lumber, wood pulp, newsprint, sheet steel, pipelines, and other similar commodities are examples of cargo that has literally been rolled onboard ro-ro ships. When rolling stock arrives at the discharge port, it is ready for delivery, and loading, stowing, and discharge activities are simplified. The ro/ro ship can normally discharge a large amount of cargo in a short amount of time. Introduction to the Ro-Ro Ships - 2 - USNS Cometships in the United States, the Comet, loaded 298 vehicles totaling 7,971 measurement tonnes in 4 hours and 55 minutes. The identical cargo was unloaded in 2 hours and 23 minutes. Due to the area required for ramps, access, and underneath the wheeled cargo itself, the ro-ro ship is volume-limited rather than weight-limited. As a result, cargo stowage is commonly discussed in cubic capacity rather than tonnes.

3.1.1 Various ro-ro ship designs

The following are some examples of ro-ro ship variations:

Pure Car Truck Carriers (PCC)/Pure Car Carrier (PCTC)Pure Car Carriers (PCC) and Pure Car Truck Carriers (PCTC) have a box-like structure with ramps to load and unload freight.The pure car carrier transports only cars, but the PCTC transports all kinds of vehicles.

To transfer the automobiles into multi-level decks, these include a quarter ramp in the stern, two ramps on both sides, covered internal ramps, and hostable decks. Vehicles drive straight into the ship and up to the various decks via an internal ramp system.

ROPAX

Roll on/roll off a passenger is abbreviated as ROPAX. It's a ro-ro vessel designed to haul freight vehicles while also accommodating passengers. Cruise ferries are vessels that can accommodate more than 500 passengers.

RoPax is mostly utilised for short-distance marine travel. These ships meet the international criteria for both passenger ships and Ro-Ros. The global distribution of ROPAX traffic is unequal. Its trade is largely found in the northern European seas.

ROLO

The acronym RoLo stands for roll-on, lift-off vessel. It's also a hybrid vessel, with ramps serving the vehicle decks but only crane access to the other cargo decks.

These ships can transport vehicles as well as normal cargo or heavy metals. Ship/shore cranes can be used to load and discharge goods straight into the hold because the weight of ordinary cargo items or heavy metal pieces may surpass the ramp's payload.

CONRO

The ConRo vessel is a cross between a container ship and a ro-ro. The area beneath the decks is used for car storage, while containerized freight is stacked on top of the decks.

Some vessels have systems where the vessel is divided into two pieces, with one side's underdeck having cell guides for loading containers and the other side's underdeck having all facilities for carrying cars or other vehicles. Containers take up the entire freight carrying space on deck.Because of the weight distribution disparity, the loading and discharging operations on these vessels require extreme caution and attentiveness. When compared to other Ro-Ro vessels, this vessel has a smaller windage area. It first appeared in the 1950s.

3.1.2Vehicle Stowage and Securing on Roll-on/Roll-off Ships

Principal Threat Sources

Despite the fact that Ro-Ro vessels account for a small percentage of merchant marine tonnage, they have been involved in several incidents with significantly more serious repercussions. Understanding the "Sources of Danger" that lead to such terrifying circumstances is critical. These dangers threaten not just the safety of roll-on/roll-off vessels, but also the passengers and employees on board.

- The consignment's unsatisfactory state prevents it from being adequately lashed for sea. For instance, insufficient and incorrectly positioned securing points, weak securing points, and so forth.
- In slack tank vehicles and tank containers, the free surface effect;
- Decks that are poorly maintained, improperly lit, or poorly planned;
- Wet decks;
- On vehicle decks and ramps, vehicles are being moved carelessly;
- Road cars reversing on vehicle decks and ramps;
- Insufficient or poorly applied lashings, incorrect use of lashing equipment, or insufficient strength in relation to the vehicle's mass and centre of gravity, as well as the expected weather conditions faced throughout the voyage;
- Vehicle suspension with no free play;

3.1.3 Stowage

The Ro-are Ro's great sea workhorses. Their flexibility in transporting a variety of goods and short port stays demonstrate their efficiency. Any vessel's cargo carrying capacity improves the vessel's earning efficiency. In order to devise efficient stowage plans, it is critical to make optimal use of cargo capacity, which has been intrinsically troublesome with the Ro-Ro concept.

The following are some basic factors to keep in mind when stowing goods in Roll on/Roll Off vessels:

- Individual shippers' unique recommendations or guidelines for vehicle handling and stowage should be followed.
- Vehicles should be oriented in a fore and aft orientation as much as practicable.
- Water spray fire curtains should not be crossed by vehicles.
- Vehicles should be closely stowed athwartships so that transverse movement is limited in the event of a failure in the fastening arrangements or from any other cause. However, sufficient space between vehicles should be allowed to allow safe access for the crew and passengers entering and exiting vehicles, as well as to and from vehicle access points.
- Access to securing arrangements, safety equipment, and operational controls should all be given and maintained in a safe manner. Stairways and escape routes from below the vehicle deck should be kept free of obstructions.

- Vehicles must not hinder the operation of bow and stern doors, accommodation space entrances, ladders, stairways, companionways, or access hatches, firefighting equipment, deck scupper valve controls, or fire damper controls in ventilation trunks.
- Each vehicle's or each element of a combination of cars' parking brakes, if available, should be used.
- Semi-trailers should not be supported on their landing legs during sea transport unless the landing legs are specifically constructed and labelled for that purpose.
- Semi-trailers should not have their landing legs supported.Unless the deck plate is sufficiently enough for marine shipping,the loadings at different points
- Uncoupled semi-trailers should be supported by trestles or other similar devices near the drawplates so that the fifth-connection wheel's to the kingpin is not hampered.
- Freight vehicles should be stored so that the chassis is kept as static as possible by not allowing free play in the suspension, depending on the area of operation, the predominant weather conditions, and the features of the ship. This can be accomplished by securing the vehicle to the deck as securely as the lashing tensioning device will allow, jacking up the freight vehicle chassis prior to securing, or, in the case of compressed air suspension systems, releasing the air pressure first when this option is available.
- Because compressed air suspension systems might lose air, suitable preparations should be made to prevent lashings from slackening during the journey due to air leakage. When this facility is available, such arrangements may include jacking up the car or releasing air from the suspension system.

Cargo operators also have some challenges when it comes to stowing cargo on Ro-Ro ships:

- Stowage of cargo on deck
- Cargo comes in a variety of shapes and sizes.
- Cargo shapes
- Keeping the goods safe within the container
- Transverse bulkheads aren't present.
- Conditions of loading
- Rolling phases and stability

3.1.4 Ro-Ros are they safe?

Ro-Ros have always been commercially successful due to their flexibility, integration, and operational speed. Regardless of its commercial success.

Ro-have Ro's long been chastised for its design, which is also blamed for the distressing accidents involving Ro- Ro's. The main sources of worry are safety concerns. The following are a few of them:

- Internal bulkheads are lacking.
- Access door for cargo
- Stability
- Low free boards
- Stowing and securing cargo
- Appliances that save lives
- The crew

According to an IMO circular issued in January 2017, Ro-Ro incidents accounted for approximately two-thirds of all deaths at sea. This demonstrates that marine incidents involving Ro-Ros have far-reaching implications.

IMO took a number of actions to reduce these accidents, and some of them had a lasting impact on the industry as well. One of the key subjects of discussion has been how to improve safety onboard Ro-Ro ships.

The mere introduction of new laws, norms, or customs has no effect on the situation. According to one study on the causes of big accidents, cargo shift and operational problems were the principal causes of all of these mishaps. These mishaps were caused by a combination of poor regulation execution and human mistake.The construction and operation of these ships are more complicated. Because of the number of passengers on board, any mistake might have disastrous effects.

3.1.5 RO-RO That Serves in India

Ferry Service is a merchant vessel that used to transport passengers, freight, and cars across a body of water in India with multiple stops. The Sagar Mala project includes public transportation as well as the renovation of India's existing ports.

Water metro in kochi

The Kochi Water Metro is set to launch in the Greater Kochi region in 2019, and the boats will be outfitted with the latest safety and communication technology.

RORO Ferry Service Dahej-Ghogha:

India's first ro-ro ferry service started between Ghogha and Dahej, connecting South Gujarat and Saurashtra. The project was part of the India's large transport and logistics project and launched by PM Narendra Modi.

Ferry Service Mumbai-Alibaug:

The fastest way to get from Mumbai to Alibaug is by boat, which runs from GateWay of India to Mandwa in Alibaug. Under the SagarmalaProgramme, a Ro-Ro project is expected to launch from Mumbai, along with a Mumbai-Goa cruise line.

Ferry Service Panjim-Vasco:

The Vasco-Panaji ferry service began a few months ago, but there were already waterways in Goa that were used for transit, transportation, and tourism.

Havelock-Port Blair Ferry Service:

Ferry service in the Andaman is the only option to visit tourist islands while also providing guests with a pleasant experience. Government and private ferry services operate between Port Blair and Havelock Island.

Ferry Service Jorhat-Majuli:

The Jorhat to Majuli island ferry service runs six times a day across the huge Brahmaputra river. The island is only accessible by ferries from Jorhat, and it was the first island in India to be designated as a district, as well as the world's largest river island.

Ferry Service Satapada-Janhikuda:

People and cars in Odisha go from Satapada to Janhikuda via Chilika Lake. The ferry leaves Satapada four times a day and transports passenger automobiles.

Cochin-Travancore Ferry Service:

Kerala ferry services in the Backwaters are governed by the state's inland navigation systems, which enable interior water transportation.

Ferry Service Dabhol–Dhopave:

Suvarnadurga Shipping & Marine Service began operating the DabholDhopave ferry boat service in 2003. The popular Konkan tourist spots of Dapoli, Guhaghar, Velneshwar, and Ganpatipule are all connected by ferries.

Ferry Service Howrah-Babughat:

The Howrah Babughat ferry service, which runs on both sides of the Hooghly River, is the best method to get to Kolkata's Howrah, Belur Math, Kutighat, and Dakshineswar ghats.

3.1.6 DIMENSIONING INITIAL GUIDELINES

- Estimated Length

Lm [m] = Lane length

Ncars is the maximum number of cars.

- Lpp = 110 + (Lm+1000)/ 25

Lpp = 30 + (Ncars - 15) x (10/17)	Ncars< 100
Lpp = 80 + (Ncars - 100) x(5/22)	100 <Ncars< 320
Lpp = 130 + (Ncars - 320)/9	320 <Ncars< 500
Lpp = 150 + (Ncars - 500)/10	Ncars> 500

Table 2:Dimensions of ro-ro

Source[11]: from dimensions of ro-ro

Configurations of a Typical Midship Section

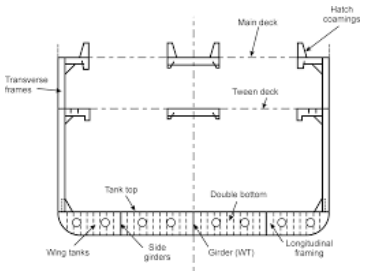

Fig1:Ro/Ro Shortsea

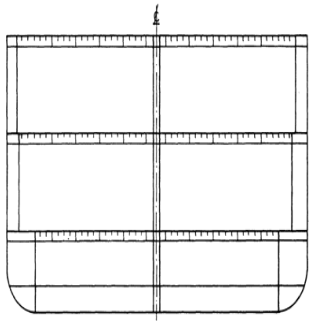

Fig 2: International Ro/R

[11]https://www.researchgate.net/figure/The-principle-dimension-of-ro-ro-ferry_tbl1_281467579

Deck Arrangement

- As a ship grows in size, the number of decks increases.
- Two decks are most usual for ships up to 15000 tdw.
- Larger ships frequently have three permanent decks

Deck Configurations for Ro/Ro (1)

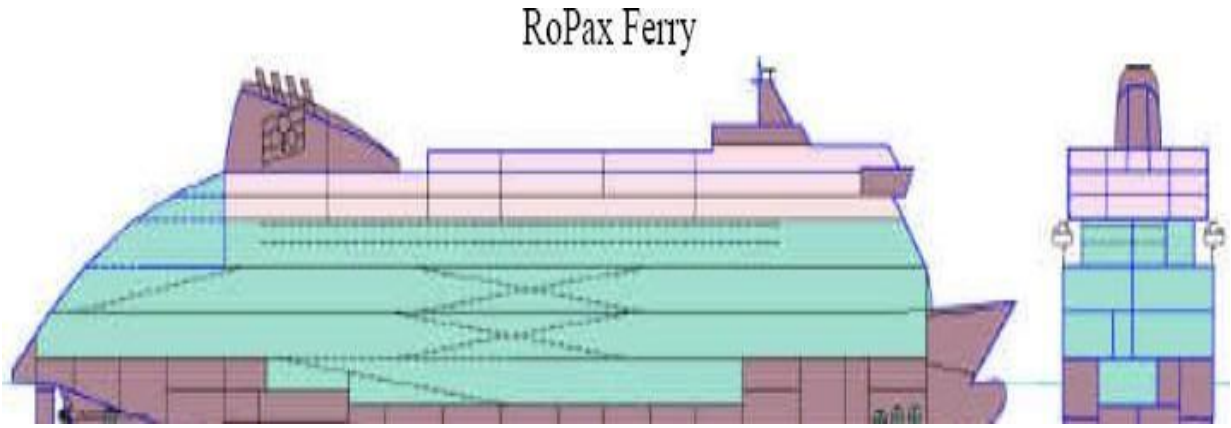

Fig 3:Deck configuration for Ropax

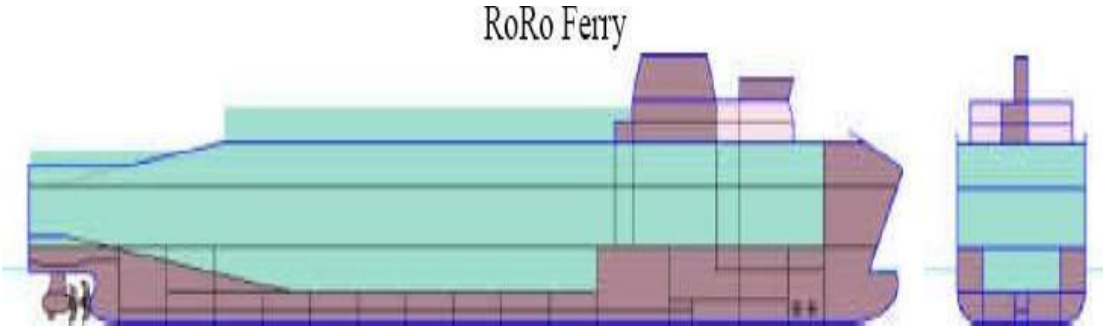

Fig 4:Deck configuration for ROROferry

Deck Configurations for Ro/Ro (2)

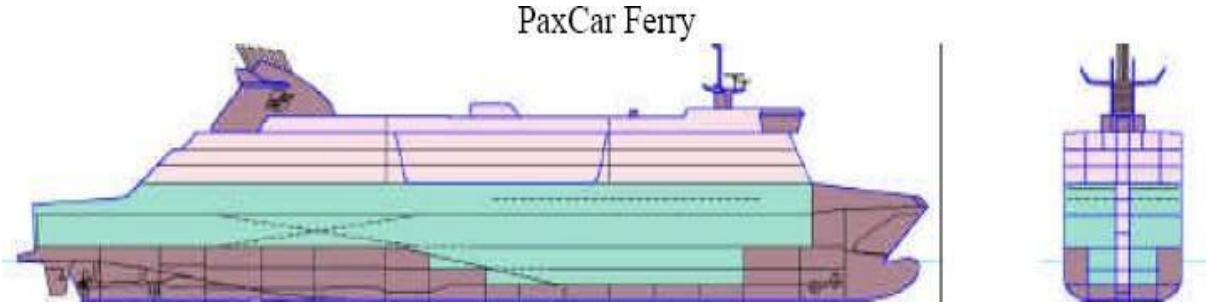

Fig5: Deck configuration for Paxcar Ferry

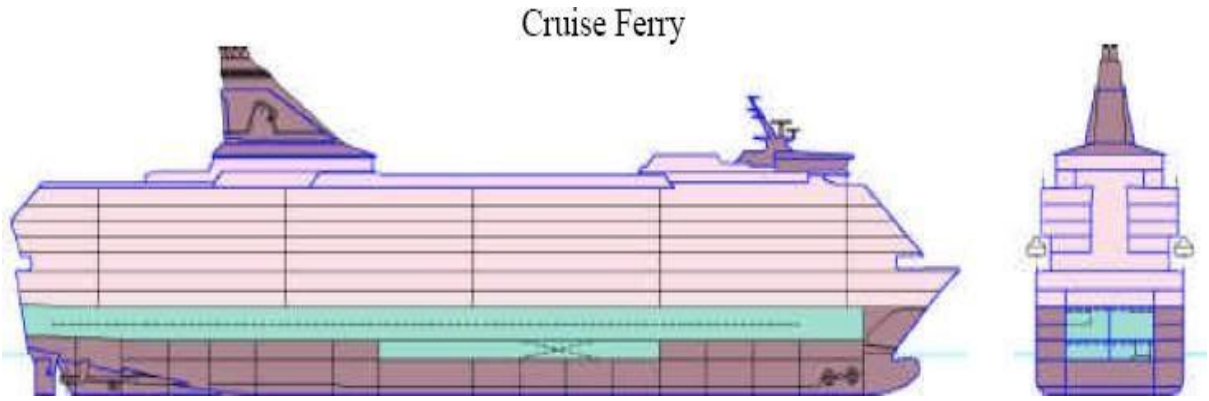

Fig 6: Deck configuration for Cruise Ferry

CARGO EQUIPMENT FOR RO/ROSHIPS

Ro/Ro Ships Cargo Equipment (1)

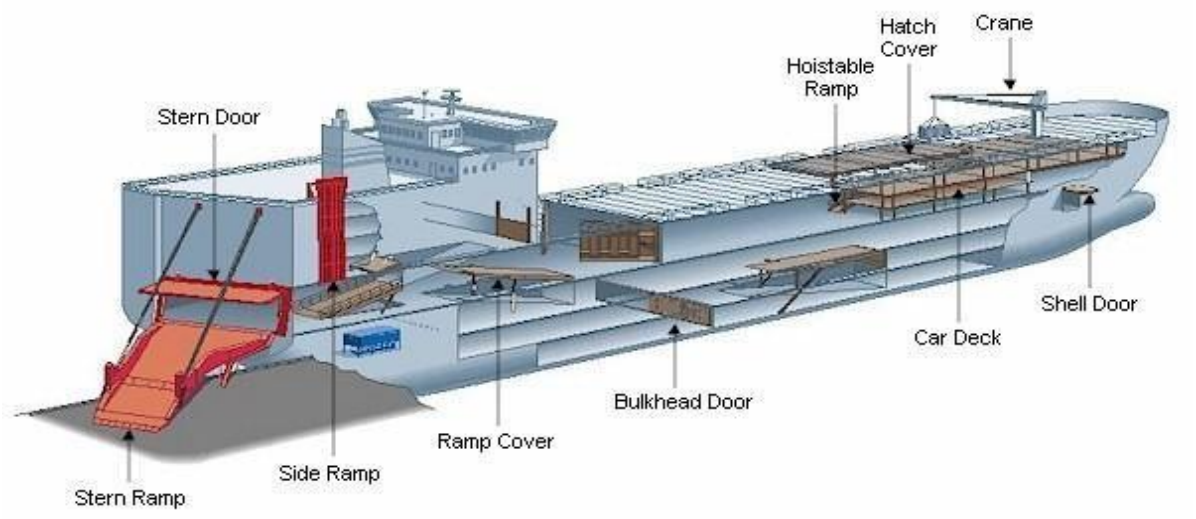

Fig 7: RO/RO ships cargo equipment

Source:[12]Access equipment for RO-RO ships is extensive.

[12]https://www.google.com/url?sa=i&url=http%3A%2F%2Fwww.mar.ist.utl.pt%2Fmventura%2FProjecto-Navios-I%2FEN%2FSD-1.4.4-RO-RO%2520Ships.pdf&psig=AOvVaw3fs7QiaJH8b0B-yCCALH2r&ust=1653392941871000&source=images&cd=vfe&ved=2ahUKEwjYn4jpxvX3AhWZKbcAHaIlAAcQr4kDegQIARBj

Configurations of Stern Ramps:

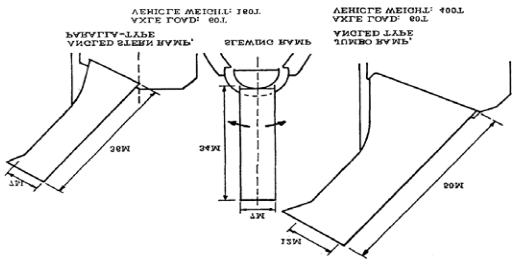

Fig 8:configuration of stern ramps

Cargo Equipment for Ro/Ro Ships (2)

- Bowdoors
- Bowramps
- Internaldoors
- Hoistablecardecks
- Hoistablecarramps

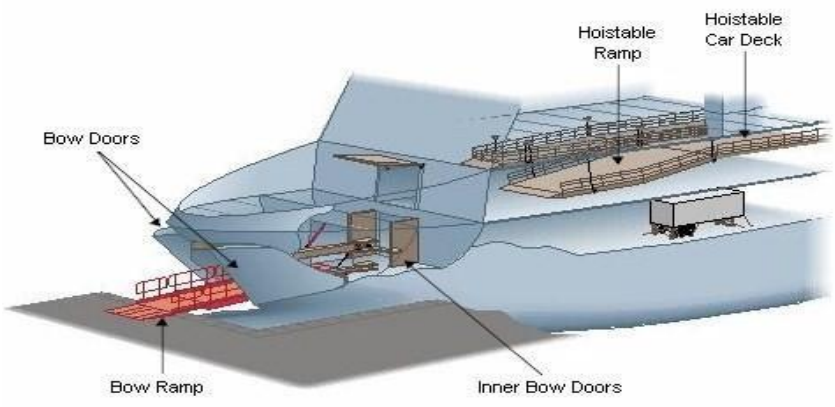

Fig 9:cargo equipment

Bow Access Doors/Ramps

Fig 10:Ships that visit Ro/Ro terminals have stern ramps.

Bow Access Doors/Ramps:

"Folding Frame Type" bow ramp allows the collision bulkhead door to be completely separated from the rest of the ramp.

Fig 11:bow acces ramp

Fig 12:Bow Access Ramp

Type of Bow Ramp Folding Frame:

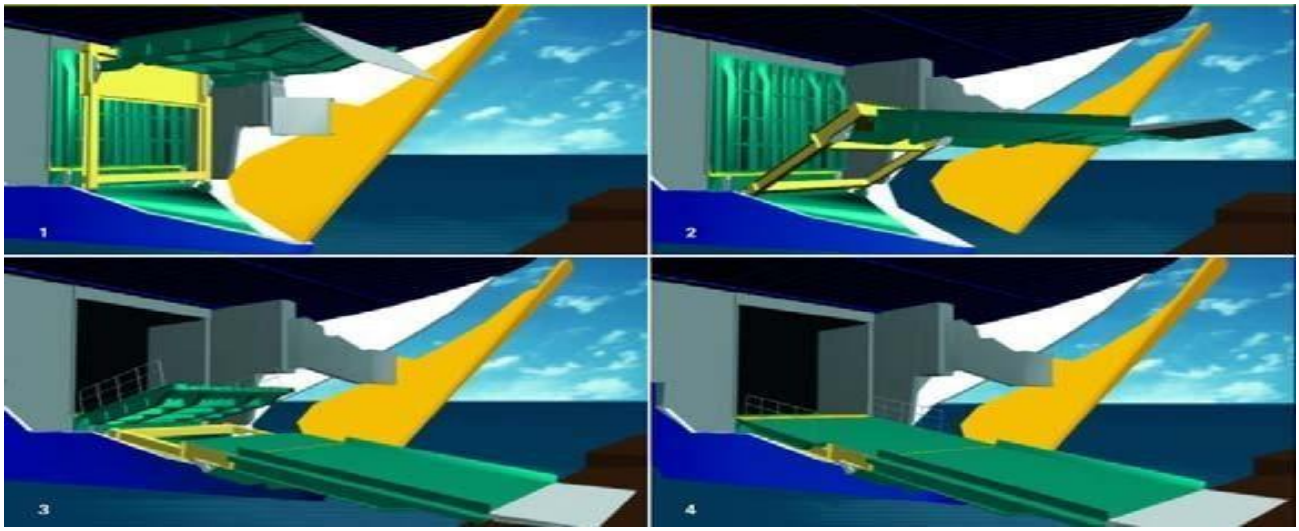

Fig 13:The bow ramp's opening sequence.

Doors on the side:

FIG 14: Side Doors of ro-ro

Internal Ramps:

Fig15:Internal ramps usually which have 7° inclination.

Internal Doors:

Watertight door designed for the subdivision of the cargo spaces with a minimum of interference

Fig 16: Internal doors

Decks for Moving Cars:

Lightweight intermediate decks that allow cars to be stored inside the deck for big vehicles.

Fig 17:Decks of ro-ro

There are two different kinds of movable car decks:

Fig 18: decks of Ro-Ro(a)

Hoistable Car Decks - having an integrated lifting device that is powered by electricity or hydraulics

Fig 19: decks of Ro-Ro (b)

Liftable Car Decks – do not have a built-in lifting mechanism and are moved by scissors lifts.

Cardecks from COREX:

- MacGreggor stainless steel sandwich panels
- Between the top and bottom panels, a 3D truss-core is constructed.
- They have about a third of the depth and nearly a quarter of the weight of standard steel cardecks.

Fig20: Car Decks for Corex

TYPICAL CAR DECK CONSTRUCTION MATERIALS

material	profile	weight
COREX panel deck	100mm	45 kg/m²
Conventional steel deck	350mm	85 kg/m²
Aluminium deck	350mm	35 kg/m²

COREX PANEL CAR DECK CHARACTERISTICS

Total structure depth	100m
Total structure depth with clearance in stowed position	100-140mm
Total structure depth with deflections in working position, maximum	140mm
Steel weight for fixed car deck	45 kg/m²
Complete weight with fittings and hydraulic cylinders for hoistable deck	52 kg/m²
Maximum distributed cargo load on deck (excluding car deck weight)	200 kg/m²
Free span at maximum load	7m

Fig 21: Characteristics of Car Deck

3.1.7Lifts for Cargo:

Handling of Cargo

- Lifts to transport cars between decks in ships with limited longitudinal room.
- When the platform is fastened in its lowest position, it can act as a waterproof hatch cover.

Cargo lift types include:

Fig 22: Scissors

Fig 23:Teleschopic

Fig 24: Chain Driven

3.1.8 Container Cassettet Tapes:

The cassettes are detachable steel platforms onto which containers may be loaded for transportation, and the containers can be double-stacked to transport either 2x40ft or 4x20ft containers. These cassettes have an 80-ton capacity (there are examples of120-ton versions used in the steel industry).

Fig 25: cassett types

• Cassettes have the advantage of acting as a "floating" buffer because containers can be placed on them with or without being connected to a vehicle.

Fig 26:cassett base

Translifter:

A translifter is a steerable lifting trailer for pallets or trestles. The wheels are sup.

Fig27 Translifter

3.1.9SECURITY FOR VEHICLES

Securing Points - IMO Guidelines:

- Securing Arrangements for the Transport of Road Vehicles on Ro-Ro Ships: Guidelines.
- Ro-Ro ships that transport road cars on long or short international voyages in unprotected waters are included.

Are applicable to:

- Road vehicles with a combined vehicle and cargo mass of between 3.5 and 40 t.
- Articulated road trains with a maximum total mass of 45 tonnes.
- The decks must have fastening points with the following dimensions: –Longitudinal

spacing 2.5 m

IMO Regulations – Lashing:

- Chain or any other device composed of steel or another material with equivalent strength and elongation characteristics shall be used for lashing.
- The lashing strength should not be less than 120 KN without irreversible deformation.
- Hooks or other devices should be used to secure the lashings to the fastening points.
- Only secure places should be secured using lashings.
- The angle formed by the lashings and the horizontal and vertical planes should be between 30° and 60°, preferably.

3.1.10 SAFETY – IMPACT OF SOLAS

Firefighting and Fire Prevention

- Closed decks for wheeled freight on Ro/Ro ships must have protection standards similar to machinery areas.
- Class A boundaries (in steel or equivalent material) must be respected.
- Closed spaces must be protected by a permanent fire suppression system, such as CO2 in cargo ships and sprinklers (DeLuge system) in automobile ferries.
- System for detecting smoke
- A fixed fire extinguishing system is not required on open cargo decks.
- Hoses and portable systems

3.1.11Ventilation of Vehicle Cargo Spaces:

The cargo space ventilation system must be totally separated from the other ventilation systems.

The system must ensure that ships with a large number of passengers (N>) are safe.

- N > 36 -> 10 hourly renewals
- N 36 -> 6 hourly renewals

31.84 m in length and width It has the capacity to transport 1342 automobiles and 4101 lane metres of freight.

3.1.12 The Benefits of a ro-ro Ship:

The advantage for the shipper is speed. The shipper saves a lot of time because automobiles and trucks can drive directly on to the ship at one port and then drive off at the other port within minutes of the ship docking.

It can also work well with other modes of transportation, such as containers. Borders have been passed with minimal delay thanks to the deployment of Customs-sealed units. As a result, the shipper's speed and efficiency improve.

3.2 Back Waterways and its Description

Water transport has played a vital role in India's economy and is essential for international trade. India has a vast network of waterways in the shape of rivers, canals, backwaters, creeks, and a lengthy coastline that is accessible by seas and oceans. It has the highest carrying capacity of any mode of transportation and is ideal for transporting heavy, bulky items across long distances. Except for canals, it is one of the cheapest modes of transportation in India because it uses natural tracks and does not require a large financial investment in development and maintenance. Because of its fuel efficiency, it has lower operational expenses and a lesser carbon footprint.Inland waterways of India total 14500 kilometres. Only 5685 kilometres are passable by motorised vessels.

Since 1947, India has achieved significant growth in the shipping industry, eventually becoming Asia's second largest and the world's sixth largest. Indian ships travel the majority of the world's shipping routes. India has a 6100-kilometer-long coastline with only 11 major ports. On the west coast, these are Mumbai, Kandla, Marmagaon, New Mangalore, Kochi, and on the east coast, Kolkata, Chennai, Haldia, Paradeep, Vishakhapatnam, and Tuticorin.Mumbai's Jawaharlal Nehru port has grown into one of the city's major ports. It is India's only fully mechanised port. Mumbai is the largest port, handling the largest number of ships and trade. The loss of Karachi Port is compensated by Kandla Port in Gujarat (Pakistan). Vishakhapatnam is India's third-largest port. Kolkata is Asia's largest inland port.

The objective of the Inland Waterways Authority of India is to increase the existing cargo carrying capacity of India's 111 national waterways from 55 MT in 2017-18 to 72 MT in 2018–19 to 100 MT by 2021–22.

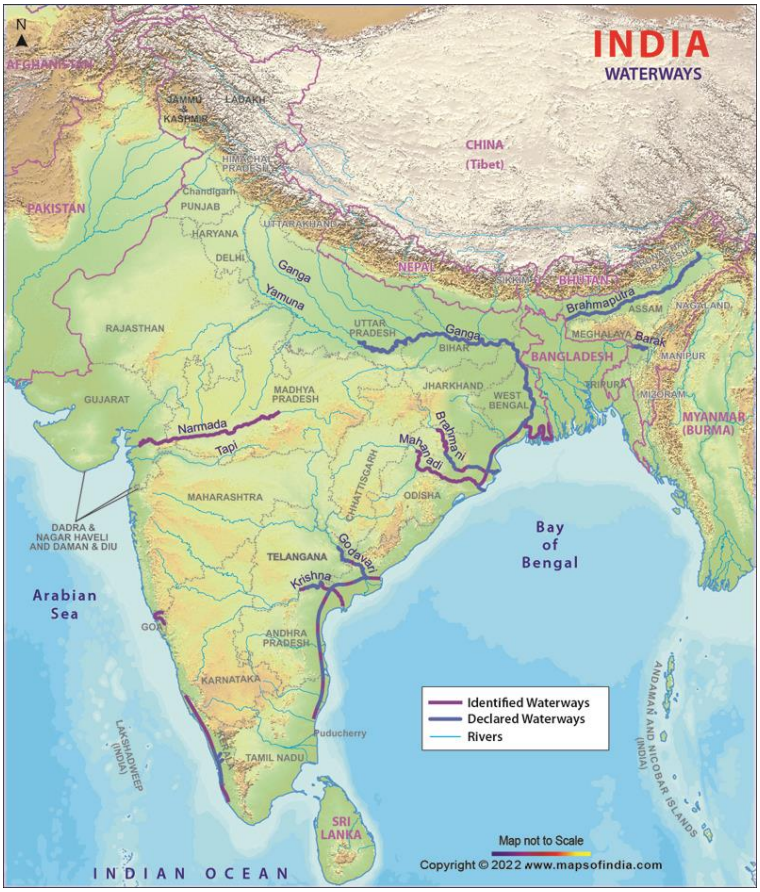

Fig 28: Back Waterways of India

3.2.1 India's Inland Waterways Authority:

In October 1986, the Inland Waterways Authority of India (IWAI) was established to develop and regulate inland waterways for shipping and navigation. On national waterways, the Authority works on numerous infrastructure development projects. It also conducts feasibility studies and draughts recommendations for further waterways to be designated as National Waterways. It also aids states in the growth of the IWT sector by providing subsidies to IWT operators for the acquisition of IWT fleet for freight and passenger transportation.

General information:

IWT is a fuel-efficient, environmentally friendly, and cost-effective method of transportation that has the potential to supplement overburdened rail and congested highways. However, in order to do this, IWT mode must be developed with public money, at least to the point where the private sector is drawn to it.

Navigation by power crafts/country boats played a vital part in the growth of trade and commerce along various rivers and canals during the nineteenth and first half of the twentieth centuries. The introduction of railways and the expansion of their network reduced the use of

water transport in India. The IWT sector was neglected in the later years of the twentieth century, except in a few locations such as Assam, Goa, Kerala, Mumbai, West Bengal, and a few other coastal areas (where it had a natural advantage and no developmental intervention was required).However, given its inherent benefits, the need for systematic growth of the IWT sector has always been felt, as evidenced by the fact that many Committees have reviewed the country's IWT system from time to time and called for systematic development of the mode since independence. In its report from 1980, the National Transport Policy Committee suggested the construction of an Authority for the development and management of inland waterways, which led to the formation of the Inland Waterways Authority of India (IWAI) in 1986.IWAI is responsible for the development and maintenance of infrastructure on National Waterways. It also conducts techno-economic feasibility studies and produces recommendations for other waterways to be designated as National Waterways. It also advises the federal government on IWT issues and aids states in developing the industry.

According to constitutional provisions, only those waterways designated as National Waterways are under the control of the federal government, while the others are under the control of the state governments. Since the inception of IWAI, five waterways have been established:

- Ganga
- Brahmaputra
- Udyogmandal and Champakara Canals are connected to the West Coast Canal.
- Godavari and Krishna rivers, as well as the Kakinada-Puducherry Canals system
- National Waterways have been declared for the East Coast Canal, the Brahmani River, and the Mahanadi Delta.
- The Central Government is considering designating another waterway, the Barak River, as a National Waterway.

Waterways The National Transport Policy Committee has identified these areas for consideration as National Waterways:

The National Transportation Policy Committee recommended the following concepts for establishing a national waterway in 1980.

- It must be capable of being navigated by mechanically propelled vessels of reasonable size.
- It should be around 45 metres broad and 1.5 metres deep.

- It should be a continuous 50-kilometer span. Urban conglomera-tions and intra-port trade are the sole exceptions to waterway length.
- It should pass across several states and serve their interests (or).
- It should link a large, rich hinterland with major ports (or).
- It should pass through a key location where navigation development is deemed necessary for national security logistic assistance (or)
- It should connect locations that are not served by other kinds of transportation.

The National Transport Policy Committee determined that the following waterways might be designated as national waterways.

- The Sunderbans are a group of islands in the Indian Ocean.
- The Mahanadi River
- The Narmada River
- Goa's Mandovi and Zuari rivers, as well as the Cumberjua Canal
- The Tapi,

Hydrographic surveys and technoeconomic feasibility studies are required to determine a waterway's potential and viability. All of the above waterways have undergone extensive studies and examinations, resulting in the declaration of three waterways as national waterways: the Ganga, the Brahmaputra, and the West Coast Canal. During the 9th Plan period, many additional new rivers will be developed as national waterways.

3.2.2 Background of Back Waterways:

'Inland waterways' is one of the 108 levels envisaged under the India-WRIS project. Rivers, canals, backwaters, creeks, and other navigable waterways make up around 14,500 km of India's navigable waterways. Inland Water Transport (IWT) moves over 55 million tonnes of cargo each year in a fuel-efficient and environmentally beneficial manner. Its operations are now limited to a few stretches of the Ganga-Bhagirathi-Hooghly River, the Brahmaputra, the Barak River, the rivers of Goa, Kerala's backwaters, Mumbai's inland waterways, and the Godavari-Krishna rivers' deltaic zones.Country boats of various capacities also operate in numerous rivers and canals, in addition to these organised activities by mechanised vessels. This unorganised sector also transports a significant amount of cargo and passengers. The Ganga-Bhagirathi-Hooghly between Allahabad and Haldia (1620 km) in Uttar Pradesh,

Bihar, Jharkhand, and West Bengal, the Sadiya-Dhubri stretch of the river Brahmaputra (891 km) in Assam, and the Kollam-Kottapuram stretch of the West Coast Canal (205 km) in Kerala have all been declared national waterways and are being developed for navigation by IWAI.IWAI has completed a hydrographic study in five sectors: NW-1, NW-2, NW-3, NW-4, and NW-5. Here is a brief explanation of these stretches.

National Waterway Development:

The following are three basic IWT infrastructure components for waterway development:

- With the proper width and depth, create a fairway or navigational channel.
- Aids to navigation for safe navigation and
- Terminals for berthing ships, loading and unloading cargo, and providing road and rail connections.

Inland vessels for the transportation of goods and passengers are the fourth component for implementing a functional IWT system. Once the fairway, terminals, and navigational aids are completed to a certain level, market forces are expected to drive up private sector investment in inland vessels, culminating in an increase in the inland fleet. On National Waterways, various projects for providing/maintaining fairways, terminals, and navigational aids are underway.National Waterways No. 1 and 2 are typical alluvial rivers, with braiding, meandering, and significant water level fluctuations (both horizontal and vertical) between summer and monsoon months. Several shallow spots (shoals) appear on these rivers during low water season, making maintenance of the 2m Least Available Depth problematic, especially in the higher portions. Conservation operations (dredging and bandaling) on the shoals in these rivers must be repeated every year since the shoals must be recognised again after each monsoon and corrective measures (River Conservancy works) implemented. NW-3, on the other hand, is a tidal canal with regular and consistent water level variations.As a result, once the desired depth is achieved through capital dredging, it can be maintained for a number of years by performing nominal maintenance dredging as needed. NW-4 and 5 have both canal and river segments. While canal sections will need to be substantially dredged once to give depth, yearly dredging will be necessary on the Godavari and Krishna rivers, and five barrages with navigational locks have been proposed on the Brahmani river.After completion of their DPRs, approval of development projects by appropriate authorities, and allocation of adequate money by the Government of India, work on NW-4 and 5 will begin.

A PIB note for the development of the NW-4 has already been created and submitted for approval to the Ministry of Shipping.

3.2.3 National Waterways-1:

In 1986, the Ganga-Bhagirathi-Hooghly river system was designated as National Waterway-1 (NW-1) between Haldia (Sagar) and Allahabad (1620 km). Since then, IWAI has been working on improving the waterway's navigability as well as developing and maintaining additional infrastructure like as navigation aids and terminal facilities, as outlined in the IWAI Act of 1985. (82 of 1985).

The following are the major projects on NW-1 that were completed in 2017-18 for the construction and maintenance of the fairway, navigational aids, and terminal facilities:

Fairway Improvements:

For smooth and safe navigation, a fairway with desired depth and breadth has been built / maintained on NW-1. This was accomplished by using River Conservancy measures such as bandalling, dredging, and other techniques along the NW-1 stretch from Tribeni to Chunar (1226 km). The 196-kilometer length between Haldia (Sagar) and Tribeni is tidal, with a Least Available Depth (LAD) of more than 3.0 m.IWAI was not doing any River Conservancy work beyond Chunar to Allahabad, save for day channel marking, because IWAI's dredgers were being deployed in lower parts of NW-1 due to increased traffic demand. Although, across the entire course of NW-1 from Haldia (Sagar) to Allahabad, day navigational aid is available (1620 km).Bandalling works of 3,900 metres in the Tribeni-Rajmahal (399 km) stretch and 18,300 metres in the Rajmahal-Chunar (827 km) stretch were completed in 2017-18 for the development and maintenance of the navigation channel (fairway), as well as some channel stabilisation. IWAI's dredgers also completed 1.46 lakh m3 of dredging in the Tribeni – Rajmahal and 7.24 lakh m3 dredging in the Rajmahal – Varanasi / Chunar segments.

Fig 29:Along National Waterway-1, a bandal was erected.

Fig 30: Dredging on National Waterway-1 is now underway.

Dredging is underway on National Waterway-1 using a pipeline:

The following is a breakdown of the Least Available Depth (LAD) that was maintained for various segments of NW-1 during 2017-18:

- Haldia to Farakka stretch (560 km) - 2.6 m to 3.0 m
- Farakka–Barh stretch (400 km) - 2.1–2.5 m
- Barh to Ghazipur (290 km) - 1.6 m to 2.0 m

- Chunar/Allahabad – Ghazipur (370 km) - 1.1 m to 1.5 m

Movements of Cargo:

Since November 2013, coal has been transported by National Waterway–1 from sand heads (Bay of Bengal) to Farakka for the NTPC Power Plant. M/s Jindal ITF Ltd. successfully handled about 1.60 lakh tonnes of imported coal (up to July 2017) during FY 2017-18 using barges with a capacity of 1500 – 2000 tonnes.

Furthermore, around 30 lakh tonnes of cargo, including fly ash, food grains, and general freight, were transported between India and Bangladesh via the National Waterway - 1 and the Indo-Bangladesh Protocol Route under Inland Water Transit and Trade.In addition, M/s Dalmia Bharat Cements' trial movement of 240 tonnes of bagged cement from Kolaghat on the river Rupnarayan (NW-87) to Bhagalpur on the Ganga (NW-1) and 300 tonnes of bagged fly ash from Kahalgaon (NW-1) to Kolaghat was carried out by IWAI's shallow draught cargo vessel MV VV Giri under consultancy services for plan and implementation support for commercialization

Aids to Navigation:

Throughout the year, temporary channel markers for day navigation were installed and maintained between Tribeni and Allahabad. In addition, thalweg surveys were conducted every two weeks during low water and every month during floods, river notifications were issued, and freight vessels were given pilotage. Between Tribeni and Farakka, night navigation aids (351 nautical lights installed on rural boats) were also maintained (364 km).Tenders were also requested for navigational lights to be installed on country boats in the Farakka-Patna stretch. DGPS stations are proposed to be built in Katwa, Bhagalpur, Patna, and Varanasi to supplement these aids and provide state-of-the-art 24 hour navigation aids across the river. In 2008-09, civil work in Bhagalpur was completed, and DGPS instruments were supplied. Work on trestle towers, buoys, and lights, among other things, had been awarded and was in way. Land acquisition for the establishment of DGPS stations in Katwa, Patna, and Varanasi has also begun.

24-hours navigational facilities:

IWAI also issues twice-weekly river notices throughout the whole route of NW-1 (monthly during the flood season). Night navigation services are available up to Farakka, with plans to

extend them to Varanasi by March 2010. By December 2010, a new DGPS station had been installed. All navigational aids necessary for safe passage would be in place on NW-1 once they were commissioned. These facilities would drastically cut vessel turnaround times.

Feature of Note:

Important Characteristics of National Waterways-1:

Name	National Waterways-1
Date of Declaration	Declared as National Waterway-1 w.e.f 27th October 1986
Total Length	1620 Kms
Stretch Details	Farakka-Patna- 460 Km, Patna-Allahabad-600 Km

Table 3: characteristics of NW-1(a)

North End	Allahabad
South End	Haldia (Sagar)
operator	Inland Waterways Authority of India (IWAI)
least available depth	2.5m Farakka-Patna,2m Patna-Varanasi,1.5m Varanasi-Allahabad

Table 4: Characteristics of NW-1(b)

Navigational-Aids:

- Munger - Farakka -249
- Patna-Ghazipur-257
- Ghazipur Chunar-143

- Munger-Patna-162 nos (up to Varanasi)

On the entire stretch, there are day navigational aids. On country boats, solar-powered navigational lights are installed.

Terminals of Importance:

The entire route has 18 floating terminals and 2 fixed RCC Jetty-Haldia, Botanical Garden Jetty, BISN Jetty Jetty, Shantipur, Katwa, Hazardwari, Farakka, G.R.Jetty-2, Rajmahal

(Manglahat), Sahebganj (Samdaghat), Bateshwarsthan, Bhagalpur, Munger, Semaria, Barh, Buxar, Ghazipur (Gaighat)

Transport:

Tourism vessels, ODC Carriers, IWAI vessels, and other vessels use the canal at the moment. Several power companies have begun the process of establishing Thermal Power projects, and extensive movement of over dimensional cargo (ODC), imported coal for NTPC projects is expected to take place over the next 5-6 years, while a number of ODC consignments and tourist vessels (Pandaw cruise from Kolkata to Varanasi and VIVADA cruise vessel from Kolkata to Murshidabad) were recorded to have passed through the waterway in 2009-10.

Development of Fairway:

The entire waterway will have a fairway with a bottom width of 45 metres and a minimum depth of 3.0, 2.0, and 1.5 metres.

Owners of Cargo:

Hindustan Lever Ltd., Ambuja Cements, Tirupati Vancom Ltd., Lafarge Cement, P K S Ltd. Saf, Fermion, as well as public sector firms like HFCL, IOCL, Haldia Petrochemicals, FCI, ONGC, Hindustan Paper Corporation, and others, are some of the prominent stakeholders in carrying cargo on this waterway.

NW-1's upper limit:

North-Western Limit: Allahabad's rail-road bridge over the Ganga, about 2 kilometres upstream from the Ganga-Yamuna confluence at Sangam.

South-Eastern Limit: Inland waterway limit on the river's tidal waters from a line drawn between No. 1 Refuge house at the entrance of the Baratola river (Channel creek) and a position 2.5 kilometres south of Saugor lighthouse, and then connected to the right bank at

the entrance to the Hijili or Russulpore river and river Ganga, lock canal and Feeder canal at Farakka, river Bhagirathi and Hoo

Fig 31: National Waterway-1

3.2.4 National Waterway-2:

National Waterway (Sadiya-Dhubri section of the Brahmaputra river) Act 1988 designated the Brahmaputra from Dhubri to Sadiyawas as National Waterway No. 2. (40 of 1988). The river runs for 891 kilometres from Dhubri to Sadiya. The Brahmaputra River runs through the heart of Assam Valley. Subansiri, Jia Bharali, Dihing, BurhiDihing, Disang, Dhansiri, and Kopili are some of its tributaries. The Brahmaputra is a major old IWT route, with its uninterrupted water channels running up to the ports of Calcutta and Haldia. The CIWTC and other Indian vessel owners are plying their cargo vessels between Assam and Calcutta using IWT transit facilities through Bangladesh, thanks to an arrangement with the Bangladeshi government.

Fig 32: National WaterWay-2

Fairway Improvements:

In 2008-09, 16,800 metres of bandals were installed and maintained along the river. In addition, one CSD owned by IWAI was used to dredge 14,530 m3 of water. Throughout the year, a minimum available depth of 2.0 m was maintained between Dhubri and Dibrugarh, and 1.5 m between Dibrugarh and Sadiya. During 2007-08, the government approved a major project for the building and supply of four CSD units at a cost of Rs 75.64 crore, with independent shipbuilders being granted contract. During the 2008-09 fiscal year, the shipbuilder delivered all four ABs while other vessels were being built.

Fig33: NW2 Day Navigational Mark

Terminals:

On 18.4.09, Secretary (Shipping) inaugurated the completion of a low-level jetty of a fixed terminal (capable of handling containers) at Pandu. In January 2009, a revised estimate of Rs 33.02 crore was approved for the development of this terminal's high-level jetty. The work was given to a construction contractor after the CPWD finished the design and tendering procedure. Chairman IWAI lay the foundation stone for this high-level jetty on April 19, 2009. Dhubri, Jogighopa, Pandu, Tezpur, Silghat, Jamuguri, Neamati, and Dibrugarh all have floating terminals.

Fig 34:Jogighopa Floating Terminal in NW2

Aids to Navigation:

Day navigation channel markers were installed and maintained along the waterway. Between Dhubri and Neamati, night navigation aids were also maintained (630 km). In addition, river notifications were issued and cargo vessels were given pilotage during fortnightly thalweg surveys during low water periods and monthly surveys during monsoons.DGPS stations are intended to be built at Jogighopa, Tejpur, and Dibrugarh to enhance these aids and provide state-of-the-art 24 hour navigation aids across the waterway. For this, civil work at Jogighopa began, and the provider provided a DGPS equipment. Work on the delivery of buoys and lights was also awarded and was underway. Land was taken over for the establishment of DGPS stations at Tejpur and Dibrugarh. Tendering was also completed for the construction of 35 trestle towers along the waterway.

Fig 35:NW2 has Night Navigational Marks next to Day Light Marks.

24 hour navigational facilities:

IWAI also issues twice-weekly river notices throughout the whole route of NW-2 (monthly during the flood season). From Dhubri to Dibrugarh, night navigation facilities are available 24 hours a day (768Km). The navigation of all vessels on the Brahmaputra would be greatly facilitated by these facilities**.**

Fig 36 Navigation facility

Feature of Note:

Important Characteristics of National Waterways-2:

Name	National Waterways-2
Date of Declaration	The National Waterway (Sadiya-Dhubri Stretch of the Brahmaputra River) Act, No. 40 of 1988, declared it.
Total Length	891 Km
Stretch Details	Guwahati-Dibrugarh- 508 Km Dibrugarh-Sadiya-123 Km

Table 5 Characteristics of NW-2(a)

North end	Sadiya
South End	Border with Bangladesh
operator	India's Inland Waterways Authority (IWAI)
least available depth	2 kilometres between Dhubri and Dibrugarh (768Kmm) 1.5 kilometres between Dibrugarh and Sadiya

Table 6 Characteristics of NW-2(b)

Aids to Navigation:

Day navigation channel markers were installed and maintained along the waterway. Between Dhubri and Pandu, night navigation aids were also maintained (255 km). In addition, thalweg surveys were conducted every two weeks, river notifications were issued, and freight vessels were given pilotage. Land was taken over for the establishment of DGPS stations in Jogighopa, Tejpur, and Dibrugarh. Night navigation services are available up to Neamati (629 kilometres) and will be extended to Dibrugarh (768 kilometres) by October 2010.

Important terminals:

Dhubri, Jogighopa, Pandu (fixed terminals), Tejpur, Silghat, Neamati, Dibrugarh, Sengajan, Panbari, Sadiya, and Saikhowa are among the 11 terminals.

Transport:

The waterway is currently used by vessels from the Assam government, the CIWTC, the Border Security Force, tourism vessels, and various private operators. Long cruise tourism vessels go continually between Sivsagar near Dibrugarh and Manas wild life sanctuary near Jogighopa. IWT carried PoL from Silghat to Budg- Budg and Baghmari in Bangladesh on trial.

Cargo Owner:

The waterway is currently used by vessels from the Assam government, the CIWTC, the Border Security Force, tourism vessels, and various private operators. Long cruise tourism vessels go continually between Sivsagar near Dibrugarh and Manas wild life sanctuary near Jogighopa. IWT carried PoL from Silghat to Budg- Budg and Baghmari in Bangladesh on trial.

NW-2's upper limit:

A line drawn across the Brahmaputra river from the point on the north bank of the Kundil river at its confluence with the Brahmaputra river near Sadiya to the beginning of the river Island Majuli, and from there through all of the Brahmaputra river's channels on either side of the river Island Majuli up to the end of the river Island Majuli.International boundary downstream of Dhubri, on the south-western side.

3.2.5 National Waterways-3

The National Waterway (Kollam-Kottapuram section of West Coast Canal and Champakara and Udyogmandal Canals) Act 1992 (33-F of 1992) classified the West Coast Canal from Kottapuram to Kollam as National Waterway No.3. The navigable length from Kottapuram to Kollam, including the Champakara and Udyogmandal canals, is 205 kilometres.Natural lakes, backwaters, river portions, and man-made canal sections make up this waterway. The Champakara and Udyogmandal canals connect Ambalamugal and Udyogmandal, respectively, to the Kochi port. The Kochi Edapallikota (120 km) portion of the main West Coast Canal between Kollam and Kottapuram was opened for freight transport in November 1994 as a result of IWAI upgrade work.

Fig37: National waterways-3

Fairway Improvements:

During 2008-09, fairway improvement activities such as maintenance dredging and the upkeep of 24 hour navigational aids were continued. Bank protection work was completed in some parts in 2007-08, and it was resumed in several important stretches of the Champakara and Udyogmandal canals in 2008-09.

The first phase of capital dredging for the widening and deepening of the canal between Kochi and Kollam began in 1997-98. The second phase of capital dredging on the Kochi – Kottapuram line began in September 2002. Dredging in the Kochi-Allapuzha sector has been finished, and dredging in the Kochi-Kottapuram sector (30 km) has been completed except for 4.83 km.

However, work was delayed in the remaining reaches due to a variety of challenges such as dredged waste disposal, fishing nets, local issues leading to contractual issues, and so on. The overall shoal length has been calculated at 87.16 kilometres, out of which 59.75 kilometres have been dredged so far and 24.49 kilometres remain to be dredgedThe total amount of dredged material needed to deepen the entire shoal length was calculated to be 40.33 lakh m3, of which 23.98 lakh m3 has been dredged and 16.35 lakh m3 remains. A scheme with a cost of Rs.89.74 Cr was approved by the government to complete this capital dredging (which also includes widening of the narrow sections, which necessitates the removal of boulders, coconut trees, and old bank protection, among other things) and tenders were invited to take up this work

Fig 38:Rutile loading

Terminals:

Terminals have already been built in seven locations: Kottapuram, Aluva, Maradu, Viakom, Thaneermukam (Chertala), Trikkunnapuzha, and Kayamkulam. Under the PDO/PDC system, the PDO was tasked with developing a PPP project for the operation and maintenance of these terminals. The PDO had conducted a field tour and gathered pertinent data, and they were currently drafting the project. The CPWD was also working on the construction of the 8th terminal at Kollam. Eight mobile cranes and eight fork lifts were acquired and provided at each terminal to offer mechanical handling facilities.

Fig39:Willington Island terminal Ro Ro NW3

Aids to Navigation:

During 2007-08, a project to provide and maintain 24 hour navigational aids in the form of buoys and lights was completed, and now the entire waterway has the capability of 24 hour navigation, which was maintained during 2008-09.3.64 There is a huge potential for container transportation through NW-3 with the building of the International Container

Transshipment Terminal at Vallarpadam in the Cochin Port area. With this in mind, IWAI, in partnership with the Cochin Port Trust, began the development of a Roll on-Roll off cumbersome. Lift on–Lift off IWTterminals on NW-3 in the Cochin port area at Willingdon and Bolgatty islands. The Cochin Port Trust (CPT) currently handles 3 lakh TEU cargo per year through its Willingdon Island facilities.The volume of containerized cargo will significantly increase once the Vallarpadam ICTT is operational. The traffic will arrive at Willingdon Island and be transported to ICTT via barge/RO RO service via IWT. Dedicated IWT terminals on NW-3 will offer the necessary infrastructure and landing facilities for containers in transit from IWAI's existing terminals to ICTT, as well as providing a capability for carrying containers from Cochin Port to Vallarpadam ICTT via RO-RO barges.

Fig40:Boat Race for Snacks

Fig41: NW3 Aluva terminal

God's Own Country River Cruise:

Kerala's backwaters offer unrivalled beauty and a one-of-a-kind experience, making it one of the world's top 50 must-see destinations. The Kuttanad region, often known as Kerala's rice bowl, is home to paddy production on fields below sea level, as well as Lake Vembanad, Kerala's greatest stretch of backwaters, Lake Ashtamudi, and Lake Kayamkulam. Tourists go

to the palm-fringed, calm backwaters, which are home to hundreds of River Cruises between Kochi and Alleppey, often known as the "Venice of the East."The M.V.Vrinda, a luxury river cruiser with eight elegantly fitted luxury cabins, transports tourists from Kochi to Alleppey along the major canal on Lake Vembanad, Kerala's largest backwater stretch. Tourists are taken on a rice excursion, a tour of a typical Kerala tharavad (family dwelling), a visit to St. Marys Church, which was founded by St. Thomas in 1721, and are also exposed to performances of traditional classical dance forms including Kathakali and Mohiniattam

Important Characteristics of National Waterways-3:

Name	National Waterways-3
Date of Declaration	National Waterway (KollamKottapuram section of West Coast Canal and Champakara and Udyogmandal Canals) Act 1992 (3-F of 1992) was enacted on February 1, 1993.
Total Length	205Km
Stretch Details	Udyogmandal canal (Kochi Pathalam bridge)-23 Km Champakara canal (Kochi - Ambalamugal)-14 Km

Table 7:Characteristics of NW-3

North end	Kottapuram
South End	Kollam
owner	Inland Waterways Authority of India (IWAI)
operator	Central Inland Water Transport Corporation (CIWTC)
sea opening	4 nos (Munambam, Kochi, Kayamkulam and Neendakara)
tidal influence	During high tide, the water level rises by about 0.70 m to 1.00 m.
obstacles	Lock gates at Thanneermukkom, and Thrikunnapuzha
narrow portions	Alappuzha – Kollam stretch

Table 8:Characteristics of NW-3

Aids to Navigation:

This is the country's first National Waterway with 24-hour navigation amenities along its full length. Throughout the stretch, navigational aids such as navigation buoys, solar-powered navigation lights, and 18 beacon towers have been placed.

Terminals of Importance:

Kottapuram, Aluva, Maradu, Vaikkom, Thannermukkom, Kayamkulam, Kollam (under construction), Alappuzha, and Willingdon Island are among the nine terminals.

Lock gates on the number of bridges:

There are 38 bridges and two lock gates which are (Thanneermukkom and Thrikunnapuzha)

Development of Fairway:

For the entire waterway, a 38/32 m wide fairway is being created (Lake area: 38m; Canal area: 32m with 2m LAD).

Transport:

The National Waterway 3 is one of India's most navigable and tourism-friendly areas, with plenty to offer potential visitors. The barge movement in NW3 is dominated by raw materials for fertiliser factories**.**

NW-3's upper limit:

A line drawn across the river Periyar parallel to the Kottapuram road bridge (NH-17) connecting Maliankara and ValiapanikanThuruthu at a distance of 1 km upstream serves as the northern limit. A line drawn across the AshtamudiKayal at a distance of 100 metres south of Kollam Jetty defines the southern limit. The Champakkara Canal runs from the West Coast Canal's confluence to the rail bridge at the Fertilizers and Chemical Travancore Limited boat basin (railway siding for Kochi Oil Refinery). The Udyogamandal Canal extends from the West Coast Canal's junction to the Pathalam road bridge (Eloor-Edayar).

3.2.6 National Waterways-4

NW-4 includes the Kakinada-Puducherry canal stretch (767 kilometres), the Godavari River stretch (171 kilometres) between Bhadrachalam and Rajhamundry, and the Krishna River stretch (157 kilometres) between Wazirabad and Vijaywada. NW-4 is 1095 kilometres long. A network of irrigation and transportation canals connects Tamil Nadu's Chennai and Ennore ports with Andhra Pradesh's Kakinada and Machlipatnam ports over a distance of 618 kilometres. The irrigation and shipping canals Kakinad, Eluru, and Commamur connect the two major river systems of Godavari and Krishna**.**The Buckingham canal, which connects the Commamur canal to Chennai port, is tidal and runs for 315 kilometres.The development of this waterway into an efficient IWT system is anticipated during the 9th Five Year Plan, taking into account the port hinterland link, interstate and intercity traffic potential, and historical data on IWT movement. Through the south Buckingham canal and the Cooum

river, a further integrated canal connects Chennai with Mercunam, covering a distance of 103 kilometres.M/s WAPCOS provided the Detailed Project Report (DPR) for this new NW. A consolidated project in PIB format was presented to the government based on the DPR, and the government is considering it for sanction.

Fig42: Inland waterways-4

Characteristics of National Waterways-4:

Name	National Waterways-4
Date of Declaration	Declared on 25th Nov. 2008
Total Length	1095 km
Stretch Details	Godavari River(Bhadrachalam – Rajmundry)171 Km Krishna River(Wazirabad- Vijayawada)-157 Km

Table 9: Characteristics of NW-4(a)

owner	Inland Waterways Authority of India (IWAI)
operator	Central Inland Water Transport Corporation (CIWTC)
sea opening	Marina Beach, Adyar, Muthukadu, Kalpakkam (Ediyuru), Palar, ParamankaniKuppam, and Markanam are some of the places to visit in Kerala.
obstacles	Total 48 locks (Kakinada Canal-6 nos; Godavari Eluru Canal-1; North and South Buckingham Canal-29 nos; Krishna river-1 ; Krishna Eluru Canal-4 nos; Commamur Canal-7 nos)

Table 10: Characteristics of NW-4(b)

Aids to Navigation:

In July 2010, IWAI began developing plans for National Waterways 4 and 5. Water And Power Consultancy Services (WAPCOS), a subsidiary of the Ministry of Water Resources, conducted techno-economic studies for the establishment of National Waterways NW-4. The

development of NW-4 includes canal expansion, dredging, excavation, bank protection, lock building and repair, bridge and road modifications, navigational aids, and the installation of IWT terminals.

Important Terminals:

Kakinada, Rajahmundry, Eluru, Kottapatnam, Maipadu, Durgarajupatnam, Muktiyala, Ennore(South), Muthukadu,Marakanam, Puducherry, Bhadrachalam, Wazirabad, Vijayawada, Tadepaligudam

Transport:

Annually, 11 million tonnes (Coal on Godavari river, Cement on Krishna river, Rice in both Krishna and Godavari). Coal, rice, food grains, cement, salt, sand, forest products, paddy, pulse, building materials, and other bulk cargo were among the principal commodities moved along this canal waterway by country crafts with a capacity of 30 to 40 tonnes.

NW-4's navigation canal section:

Buckingham Canal, Kakinada Canal, Eluru Canal, Commamur Canal

3.2.7 National Waterways-5

NW-5 encompasses the East Coast Canal, as well as the Brahmani and Mahanadi delta river systems. It includes the canal stretch between Geonkhali and Charbatia (217 km), a section of the Matai River between Charbatia and Dhamra (40 km), a section of the Brahmani, Kharsua, and Dhamra river system between Talcher and Dhamra (265 km), and the Mahanadi delta river system between Mangalgadi and Paradeep (265 km) (101 km). NW-5 is 623 kilometres long.IWAI has developed River Navigational Charts for the three National Waterways NW-1, NW-2, and NW-3, which are available, in compliance with Section 14(2) of the Inland Waterways Authority of India Act, 1985 (82 of 1985). After receiving permission from the Survey of India, the maps for NW-4 and NW-5 will be made available.

Fig 43: National Waterways-4

The DPR for this new NW is nearing completion. Following its completion, a consolidated project for canal development will be submitted to the government for approval.

Name	National Waterways-5
Date of Declaration	Declared on 25th November 2008
Total Length	623km
Stretch Details	Matai River (Charbatia-Dhamra)- 40 Km
	Brahmani, Kharsua& Dharma River Systerm-265 Km
	Mahanadi Delta (River Mangalgadi-Paradeep)-101 Km

Table11: Characteristics of NW-5(a)

owner	Inland Waterways Authority of India (IWAI)
operator	Central Inland Water Transport Corporation (CIWTC)
Narrow portions	Talcher to Jokadia- 0.20 m to 0.6m.
important terminals	Talcher, Jenapur , Dhamra, Paradip, Balasore, Nasirabad, Geonkhali

Table12: Characteristics of NW-5(b)

Aids to Navigation:

In July 2010, IWAI began developing plans for National Waterways 4 and 5. Water And Power Consultancy Services (WAPCOS), a subsidiary of the Ministry of Water Resources, conducted techno-economic studies for the establishment of National Waterways NW-4.

Transport:

The most major prospective cargo for this waterway is coal from Talcher to Dhamra and Paradip ports. The DPR estimates that 11 million tonnes of goods can be transported each year immediately following the building of the waterway, with that number rising to 23 million tonnes in the next 15 years or so. Finished goods, manufactured goods, and agricultural products are also possible commodities.

Land Acquisition:

- West Bengal has 846 hectares of land that has been acquired.
- Orissa has acquired 1172 Ha
- Land acquisition cost in Orissa is estimated to be Rs. 176cr.

Dredging:

- 10.07 million cumulative river part
- 44.77 million cumulative canal section

Barrages:

A total of 5 barrages with navigation locks have been proposed near Village Renthapat, Indrajit, Gobindapur, Bartanda, and Matila to maintain a navigable depth of 2 m between Talcher and Jokadia, allowing passage of two 500 tonne vessels at a time.

3.2.8 National waterways-6:

The government of Assam is considering declaring the Barak River as a National Waterway from Bhanga to Lakhipur (a distance of 121 kilometres).

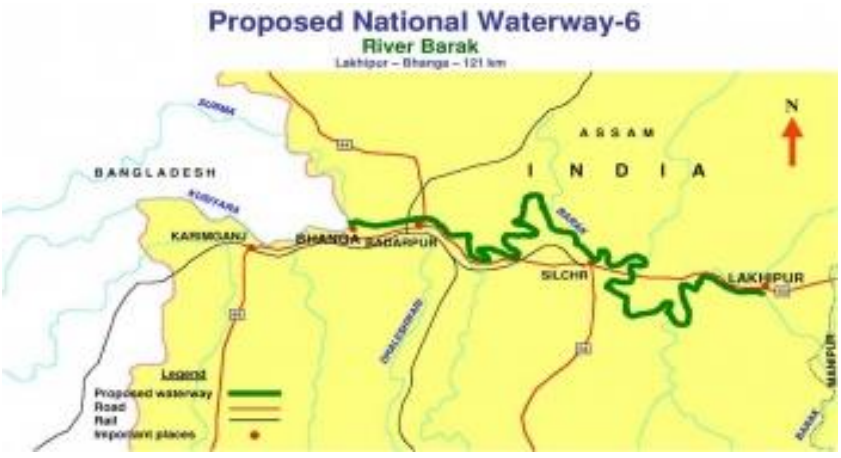

Fig44 National Waterways-6

River Barak rises 2440 metres above sea level in Manipur's Patkari mountain. The river travels through Manipur, along the Manipur-Mizoram and Manipur-Assam borders, and then across Assam before entering Bangladesh. The river runs through Indian territory for 564 kilometres out of its entire length of 900 kilometres.The Indo-Bangladesh Protocol, which allows IWT vessels to travel up to Karimganj and Silchar, has opened the IWT route via Bangladesh to navigation. Hydrographic assessments along the river path have revealed that the river channel may be extended all the way to Lakhipur. Because this IWT route provides a critical transportation link to the North Eastern states, it is planned that during the 9th Five Year Plan, the river be developed as well as the navigational facilities on the Protocol route leading to Karimganj be improved.

National Waterways' Most Important Features-6:

Name	Proposed National Waterway-6 (River Barak) between Lakhipur and Bhanga.
Date of Declaration	National Waterways 6 is is under active consideration of the Government for declaration as National Waterways
Total Length	121km
status	Bill is currently awaiting from Praliament.
north end	lakhipur
south end	Bhanga
owner	Inland Waterways Authority of India (IWAI)
operator	Central Inland Water Transport Corporation (CIWTC)

Table 13: Characteristics of NW-6

3.3Brief Study on Indian Coastal Line:

Coastal India is a geo-cultural zone of the Indian subcontinent that stretches the length of the country's coastline. (7516.6 km; 5422.6 km on the mainland, 2094 km in the islands)Coastal India in ancient India stretches from the Gulf of Kutch in its westernmost corner, across the Gulf of Khambhat, and through the Salsette Island of Mumbai along the Konkan, and southwards across the Raigad district region and through Kanara, and further down through Mangalore and along the Malabar through Cape Comorin in the southernmost region of South India with coastline along the Arabian Sea.

People:

As a result of its coastal topography and sea trade between west Asian Mediterranean traders along its west coast, the people of coastal India exhibit enormous diversity while sharing an underlying commonality.Gujaratis live in the westernmost region, Kannadigas, Tuluvas, Konkanis, and Maharashtrians live along the Konkan coast or western coastline, Malayalis live in the southernmost region of South India, Tamilians live along the southern Cholamandalam coast, Telugus and Odia people live along the southern Circar coast through the Utkala Kalinga region, and Bengalis live along the easternmost coastline along the Bay of Bengal.

Intermixing and thriving marine trade:

The Mediterranean world and the coastal Indian regions had a robust trade. This resulted in extensive intermixing of people from Coastal India and the West Asian continent, particularly along the Arabian Sea's South West Indian Coastline.Several west Asian communities have also settled in coastal south west India, adding to the variety of the region. The Parsis, Bohras, and Baghdadi Jews in the westernmost region, the Bene Israel in the southwestern region, the descendants of Mediterranean traders in Coorg and Mangalore, the Jonakan Mappilas in Malabar, and the Cochin Jews and Syriac Nasranis in the southernmost region of South India are among these. The Chola Empire ruled over a large area of South East Asia, including Indonesia, Java, Bali, and Sumatra.South Indian heritage was carried to Cambodia, Indonesia, and Bali, where Balinese Hindu customs are still alive and well. This resulted in cross-pollination between coastal India and Southeast Asia, particularly along the Bay of Bengal's Cholamandalam coastline.

Fact Sheet of Indian Coastal Line:

- The world's seventh longest
- The coast is home to 1/5 of the population.
- Gujarat boasts the world's longest coast.
- Three of our major cities are located on the seaside.

Natural coastal ecosystems abound throughout India. The Gujarat region, the west coast, the east coast, and the islands make up India's coastline.

- Backwaters and mud flats characterise the western shore, which has a large continental shelf.

- The east coast is low-lying, featuring mangrove forests, lagoons, marshes, beaches, and deltas.
- The Gulf of Kutch in Gujarat, the Gulf of Mannar in Tamil Nadu, and the Lakshadweep and Andaman & Nicobar groups of islands all have coral reefs.

Coral reefs, mangroves, estuaries, and deltas are diverse ecosystems that are sensitive and vulnerable.

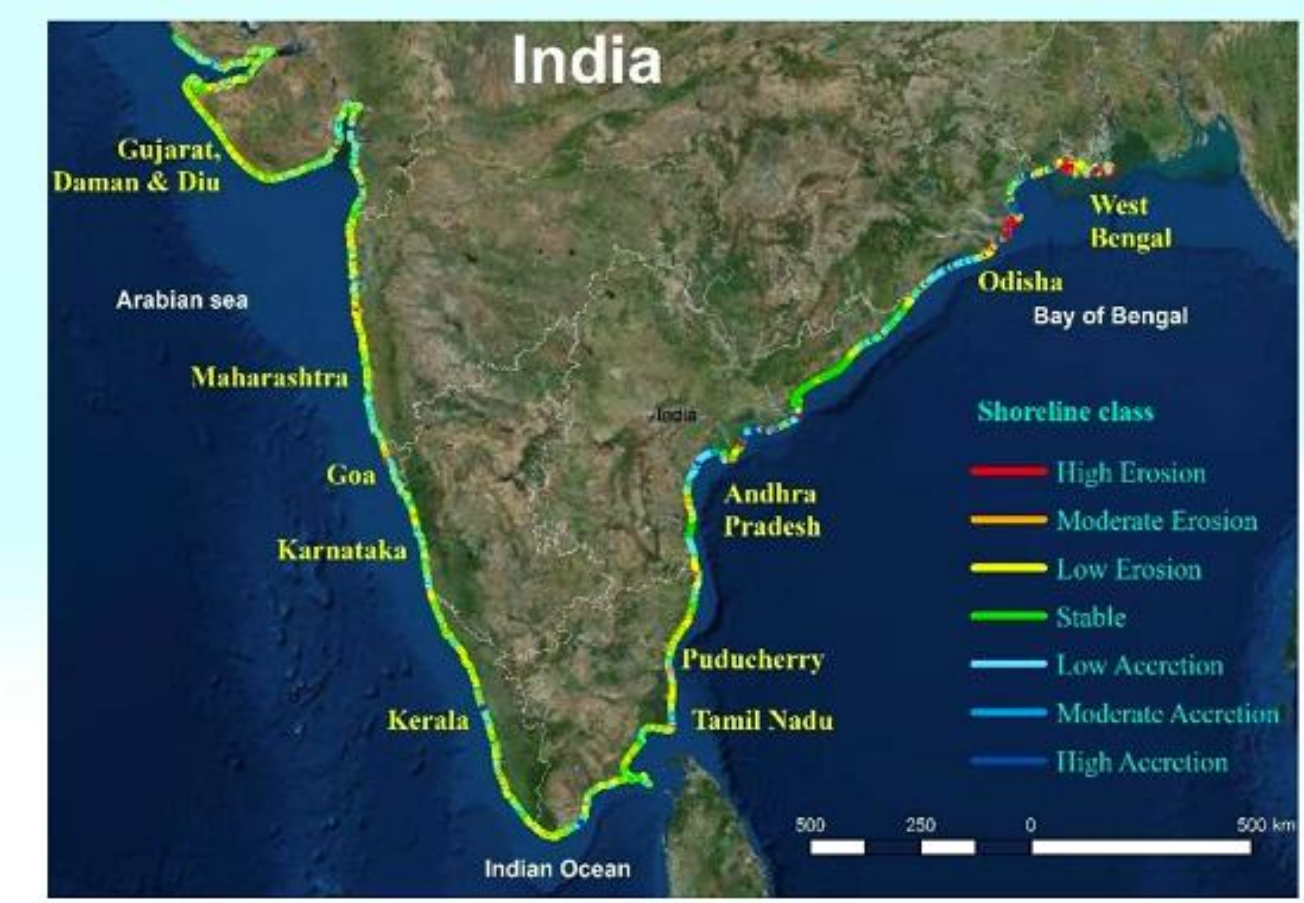

Fig45: Coastal Line of India

3.3.1 Coastal States of India:

Gujarat, Maharashtra, Goa, Karnataka, Kerala, Tamil Nadu, Andhra Pradesh, Odisha, West Bengal, and two union territories, Daman and Diu and Puducherry, are all part of the Indian coastline. The Andaman and Nicobar Islands in the Bay of Bengal and the Lakshadweep Islands in the Arabian Sea are India's two island territories.

Coastal Data:

Length of Coastline	7516.6 km
Total Land Area	3,287,263 km^2
Area of the continental shelf	372,424 km^2
Territorial sea (up to 12 nautical miles)	193,834 km^2
Exclusive Economic Zone	2.02 x 106 million km^2

Table14: Coastal Data

Geomorphology of the Coastal Zone (Mainland):

Sandy Beach	43%
Rocky Coast	11%
Muddy Flats	36%
Marshy Coast	10%
Coastline affected by erosion	1624.435 km mainland,132 (islands) (CPDAC)
Population of the Coastal States and UTs	560 million
Population of Island Territories	0.44 illion

Table15: Mainland Zone Data

1.Gujarat:

Gujarat boasts India's longest coastline, which is 1,600 kilometres long and located in the Kathiawar portion of the state. The Arabian Sea surrounds this coastline, which is peppered with 41 ports: one major and 40 intermediate or minor. Gujarat's beaches include Diu, Dwarka, Porbandar, and others.

Fig46: Coastal line of Gujarat

2.Tamil Nadu

The coromandel coast, located in Tamil Nadu, is India's second-longest coastline (1,076 kilometres). It is bordered on the north by the Utkal Plains, on the east by the Bay of Bengal, on the south by the Kaveri delta, and on the west by the Eastern Ghats. The region's principal crops include rice, lentils, sugarcane cotton, and peanuts. Along the Coromandel coast, coconut plantations are practised. There are also important seaports in Tuticorin and Chennai, fishing harbours, Marina Beach (India's largest natural urban beach), and the Gulf of Mannar Marine National Park.

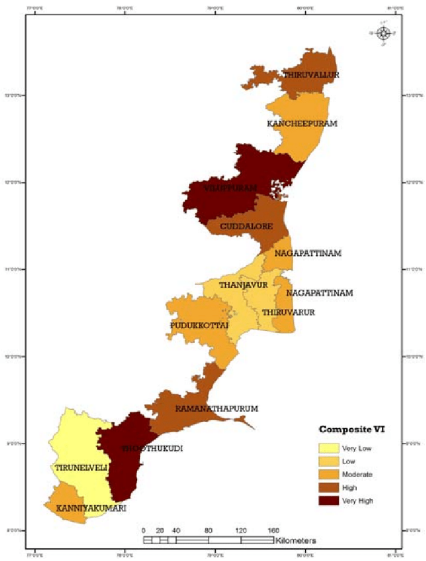

Fig47: Coastal Line of Tamil Nadu

3.Andhra Pradesh:

Andhra Pradesh has India's third-longest coastline, which is located in the Coastal Andhra area. Between the Eastern Ghats and the Bay of Bengal, the coastline stretches for 972 kilometres. Due to the delta—Godavari Krishna river and Penna—this coastline offers abundant agricultural area. Rice is the region's principal crop, followed by pulses and coconut plantations. There are 12 major ports.

Fig 48: Coastal Line Of Ap

4-Maharashtra:

The Konkan Coast is a 720-kilometer stretch of coastline in Maharashtra. It is bordered on the east by the Western Ghats mountain range, on the west by the Arabian Sea, on the north by the Daman Ganga River, and on the south by the Gangavalli River. Rice, millets, lentils, coconut, and other agricultural crops are important in the region. The Konkan coastline is lined with various beaches and is a popular weekend destination for Pune and Mumbai residents. It has 53 ports, including two major ports and 51 minor or intermediate ports.

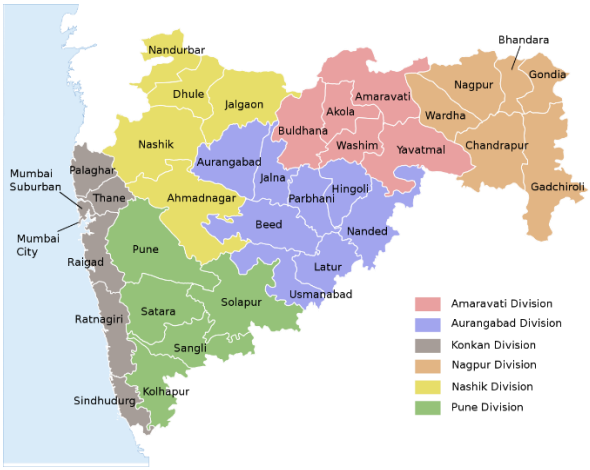

Fig49: Maharashtra coastal line

5.Kerala:

Kerala's Malabar Coast, which stretches over 590 kilometres, is India's fifth longest. It runs from Maharashtra's south-western coast via Goa's coastal region, through Karnataka and Kerala's western coasts, and ends in Kanyakumari. It is bordered on the west by the Arabian Sea and on the east by the Western Ghats. Beautiful scenery, tea and coffee plantations, beaches, brackish water lakes, and other attractions abound along the Malabar coast. There are 13 major ports.

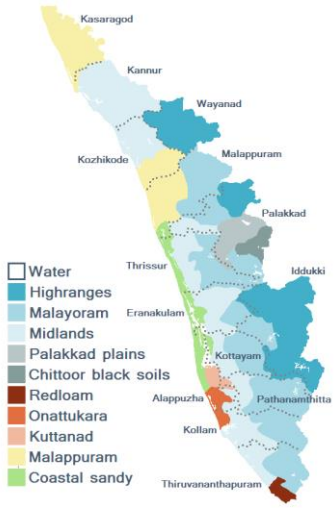

Fig50: Kerala Coastal Line

6.Odisha

Odisha features a 485-kilometer-long coastline known as coastal Odisha or the Utkal Plains. The Lower Ganges Plain to the north, the Bay of Bengal to the east, the Tamilnad Plains to the south, and the Eastern Ghats to the west define the region. Chilka Lake (India's largest lake), the ancient kingdom of Kalinga, beaches (Chandipur, Gopalpur, etc.) and Bhitarkanika are all found in this region (second largest mangrove ecosystem). There is only one major port on the island.

Fig 51:Odisha coastal line

7.Karnataka:

Kanara is the 300-kilometer-long coastal region of Karnataka. The Konkan in the north, the Western Ghats in the east, the Kerala Plains in the south, and the Arabian Sea in the west define the region. It boasts a number of tourist attractions, including Maravanthe and St. Mary's Island Beach. Uttara Kannada, Udupi, and Dakshina are its three districts. There are ten major ports and two minor/intermediate ports in the city.

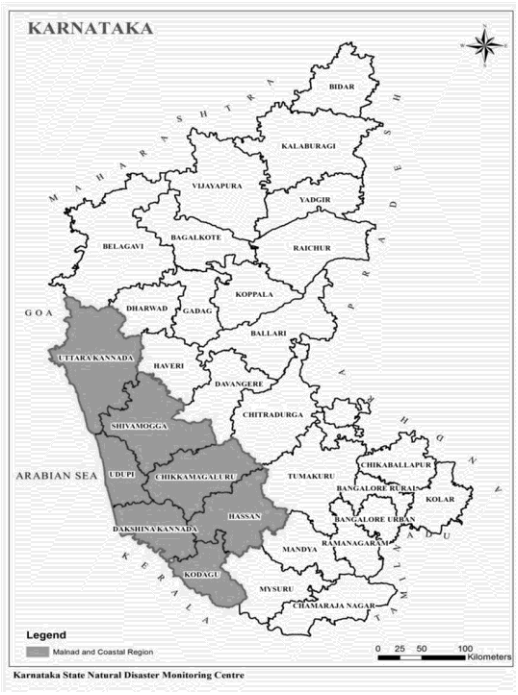

Fig 52:Karnataka Coastal Line

8.Goa:

Goa is the smallest Indian state, with a 131-kilometer-long coastline. It is home to many of the world's most gorgeous beaches. It is bordered on the north by Maharashtra and on the east and south by Karnataka, with the Arabian Sea defining its western coast. Goa's soil is reddish in colour and rich in ferric-aluminium oxides. The soil is generally alluvial and loamy inland and near the riverbanks. Agriculture thrives in this soil, which is rich in minerals and humus. It contains five minor ports and one major port.

Fig 53:Goa Coastal Line

9.West Bengal:

The 158-kilometer-long coastal plain of West Bengal is found in the districts of Purba Medinipur and South 24 Parganas. The Sundarbans delta in West Bengal is home to the world's largest mangrove forest. It is home to a diverse assortment of wildlife, including the royal Bengal swamp tiger. In West Bengal, agriculture is the most important economic sector.

West Bengal's main crops include rice, potato, jute, sugarcane, and wheat. There is only one major port on the island.

Fig 54: West Bengal Coastal Line

The Coastal Plains' Importance:

- Fertile soils encompass large areas of India's coastal plains, which are used to cultivate a variety of crops. The principal crop in these areas is rice.
- Coconut palms can be found all along the coast.
- The entire length of the coast is lined with small and large ports that aid in trade.
- Large amounts of mineral oil are claimed to exist in the sedimentary strata of these plains (KG Basin).
- The MONAZITE used in nuclear power is abundant in the sands of Kerala's seashore.
- People living in coastal areas rely heavily on fishing as a source of income.
- Gujarat's low-lying areas are known for generating salt.
- The backwaters of Kerala are popular tourist locations.
- The beaches in Goa are excellent. This is a popular tourist site as well.

CHAPTER-4

4.1 The First Modern Inland Waterway in India:

Rivers have functioned as useful waterways throughout history, transporting people and goods over large distances. Many countries still rely significantly on inland water transport, particularly for heavy and bulky cargo, because it is less expensive, more reliable, and less polluting than shipping products by road or rail.India is yet to develop this less expensive and environmentally friendly means of transportation. Congested road and rail networks nevertheless transport goods, slowing cargo flow, increasing uncertainty, and raising trade prices. So much so that India's logistics costs are estimated to contribute for up to 18% of the country's GDP.The Ganga river, too, was a major waterway until roughly a century ago. However, with the arrival of the railways, this watercourse became obsolete. The Indian government is rehabilitating the Ganga waterway, also known as National Waterway 1 or NW1, to transport freight from Haldia, India's eastern harbour, to Varanasi, 1,360 kilometres inland. The river has the potential to become northern India's primary logistics corridor.

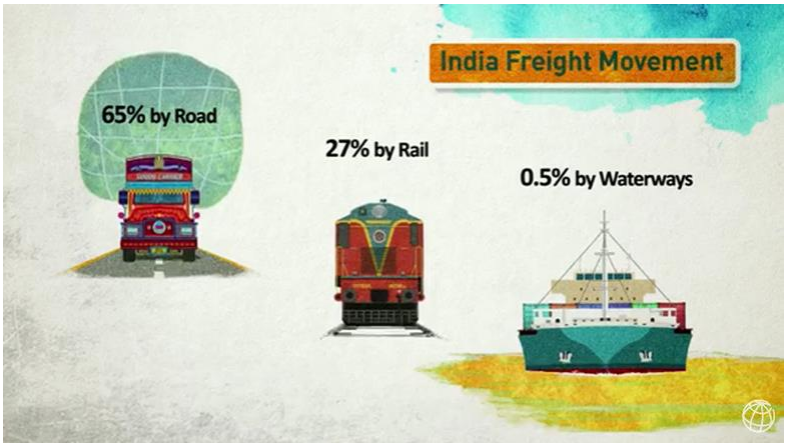

Fig 55 Advantages of Inland Waterways(a)

Between Kolkata and Delhi, the waterway travels through one of India's most densely inhabited districts. A significant portion of India's traded goods originate in this resource-rich region or are intended for its burgeoning markets. While the region is anticipated to generate around 370 million tonnes of freight each year, only around 5 million tonnes of it is now transported by water.Currently, cargo from the Gangetic states of Bihar and Uttar Pradesh travels long distances by land to reach the sea ports of Mumbai, Maharashtra, and Kandla, Gujarat, rather than the much closer port of Kolkata. The building of NW1 will assist these states in diverting some of their freight to the Kolkata-Haldia complex, improving freight transportation and lowering logistics costs.The World Bank is providing a $ 375 million loan

to help develop the Ganga waterway. The National Waterway 1 Capacity Augmentation Project will assist in the development of the infrastructure and services required to guarantee that NW1 becomes an efficient transportation artery in this crucial economic region.

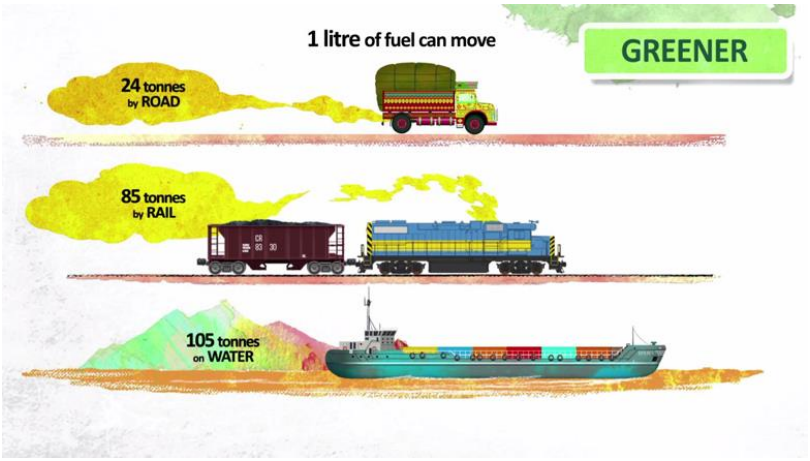

Fig 56: Advantages of Inland Waterways(b)

The waterway will be part of a wider multi-modal transportation network planned for the river once it is operational. It will connect to the Eastern Dedicated Rail Freight Corridor as well as the region's existing highway network. The region's industries and manufacturing units will be able to effortlessly switch between different means of transportation as they ship their goods to markets in India and overseas thanks to this web of water, road, and rail arteries. Farmers on the agriculturally rich Gangetic plain will profit as well, because the waterway expands market opportunities.

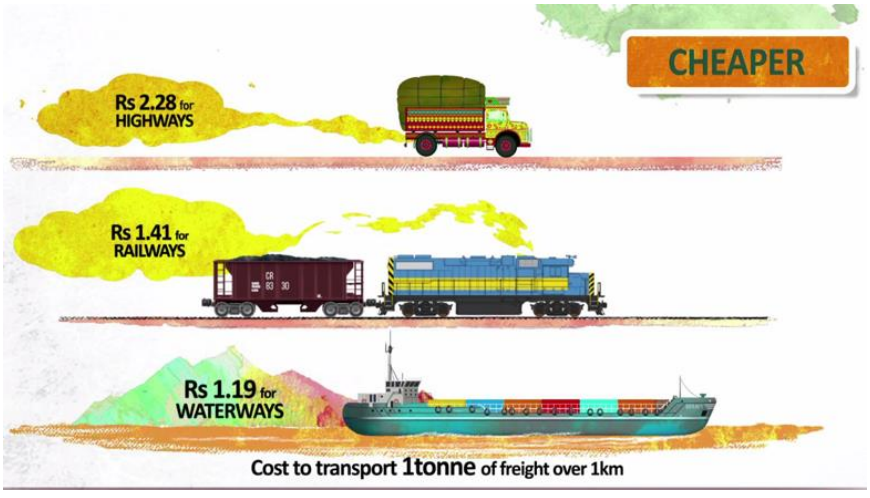

Fig57: Advantages of Inland Waterways(a)

4.2 Creating Infrastructure for Navigation:

Because one of the reasons for the slow development of water transport in the region is the lack of essential infrastructure such as cargo terminals and jetties, the Project will assist in the establishment of six multi-modal freight terminals in Varanasi, Ghazipur, Kalughat, Sahibgunj, Triveni, and Haldia. In addition, five new RO-RO bridges at various places will assist trucks and other vehicles in transitioning from the road to the river and vice versa. The six new cargo ports have the potential to grow into bustling logistical centres, creating work for thousands of people in one of the country's poorest and most densely populated areas. In addition, the project will assist in the establishment of a vessel repair and maintenance facility in Doriganj**.**

In addition, the Project will help to modernise the Farakka lock, which was erected over 40 years ago. Currently, vessels must wait up to six hours to pass through the lock, and two-way traffic is not permitted via its tiny gates. The lock will not only be renovated, but a new lock will be erected to allow barges to flow upstream and downstream simultaneously, allowing for faster and smoother passage of boats through the route. These enhancements will significantly minimise the time it takes to pass through the lock**.**

Furthermore, the Project will assist in the establishment of a cutting-edge River Information System (RIS). The RIS will allow barge operators and cargo owners to follow their vessels, locate berths in ports ahead of time, and better organise their operations, among other things. The Project will assist define out the central channel for boats to ply in and provide night navigation facilities to make navigation safe both day and night. In addition, precise methods are being established for dealing with crises, such as oil spills from boats.

4.2.1 'Collaborating with Mother Nature':

The Inland Waterways Authority of India (IWAI) has endeavoured to use the least invasive techniques of making the Ganga navigable because it holds such a particular role in the country's social, cultural, and environmental landscape. As a result, when planning the Ganga waterway, it adhered to the philosophy of "working with nature."The Ganga, unlike many of the world's main rivers, is a seasonal river that increases during monsoon rains and recedes during dry winters. Small boats may navigate this seasonal river, but huge freight barges require a minimum depth to navigate. The changing depths of water in the Ganga have so limited shipping on the river. Currently, traffic is mostly restricted to the river's downstream stretch between Farakka and the Haldia, where the water is deep enough for boats to sail in all year (2.5 m to 3.0 m).To make such a river accessible, large-scale dredging of the riverbed

is typically required to achieve the depth required by larger boats, particularly massive barges carrying up to 2,000 tonnes of cargo. In the case of the Ganga, extra care has been taken to allow such vessels while minimising the need for dredging.

In the river's deepest point, a 45-meter-wide channel has been designated, and the Least Available Depths (LAD) required for navigation have been identified while keeping dredging to a minimum. The depth of the channel thus follows the natural gradient of the river in different sections and is sufficient to sustain the two-way movement of huge barges.Dredging will be required for only 1.5 percent of the river's yearly silt load of 10-11 million cubic metres as a result of these procedures. Even this restricted dredging will be carried out only when absolutely necessary, and only with contemporary, less intrusive technology. The suggested water injection method, which will employ water pressure to liquefy silt deposits and wash them away, is one of these methods. The dense slurry that produces will subsequently be deposited into depressions along the riverbed, either naturally or through induced currents, ensuring that sediments remain within the river's ecosystem.Temporary structures made of natural materials such as bamboo will be created where big shoals and islands occur to channelize the water flow. These makeshift shelters, known as 'bandals,' will be created around aquatic sanctuaries to conserve the Ganga's rich wildlife.

Dredging will be minimised by contract customization.

4.2.2 Aquatic Biodiversity Protection:

IWAI is also ensuring that water traffic does not negatively effect the Kashi Turtle Sanctuary in Varanasi and the Vikramshila Dolphin Sanctuary in Bhagalpur, which are both located along this section of the river.

Information about these protected aquatic habitats and other sensitive sites like wetlands will be put into the new River Information System being established under the World Bank-supported Project as a first step. This will guarantee that vessels operating in these areas adhere to the operational framework established to reduce impacts in sensitive zones.

This framework consists of:

- Dredging is prohibited in protected habitat zones.
- Dredging shall be prohibited during the breeding and spawning seasons in other locations recognised to be the home of valuable aquatic species.

- The speed of barges travelling through the sanctuaries' protected regions will be limited to 5 kilometres per hour.
- To ensure that aquatic life is not unnecessarily disturbed, all vessels travelling the Ganga will be equipped with noise control and animal exclusion systems.
- To prevent solid or liquid waste from leaking into the river and damaging biodiversity, all vessels must adhere to 'zero discharge' requirements.

4.3 Gujarat Back WaterWays:

Gujarat is a state on India's western coast with a population of 60.4 million people and a 1,600 km (990 mi) coastline — the country's longest, with the majority of it on the Kathiawar peninsula. It is India's fifth-largest state by area and ninth-largest by population. Gujarat is bordered on the northeast by Rajasthan, on the south by Dadra and Nagar Haveli and Daman and Diu, on the southeast by Maharashtra, on the east by Madhya Pradesh, and on the west by the Arabian Sea and Pakistan's Sindh region. Gandhinagar is the capital, and Ahmedabad is the major city. Gujarati people are native to the state, and Gujarati is the state's official language.Gujarat has India's fourth-largest economy, with a GSDP of 19.44 trillion dollars (US$260 billion) and the country's tenth-highest GSDP per capita of 243,761 dollars (US$3,200). In terms of human development, Gujarat is ranked 21st among Indian states. The state has a long history of low unemployment and is largely regarded as one of India's most industrialised and manufacturing hubs.The state is home to 23 ancient Indus Valley Civilisation sites (more than any other state). Lothal (the world's first dry dock), Dholavira (the fifth largest site), and Gola Dhoro are the most important (where 5 uncommon seals were found). Lothal is thought to have been one of the first seaports in the globe. In the Maurya and Gupta empires, as well as during the succession of royal Saka dynasties in the Western Satraps era, Gujarat's coastal cities, particularly Bharuch and Khambhat, served as ports and commerce centres. Gujarat is one of four Indian states that prohibits the selling of alcohol, along with Bihar, Mizoram, and Nagaland. The world's sole wild population of Asiatic lions can be found in Gujarat's Gir Forest National Park.Gujarat boasts India's longest sea shoreline at 1214 kilometres. Kandla Port is one of Western India's most important ports. The Port of Navlakhi, Port of Magdalla, Port Pipavav, Bedi Port, Port of Porbandar, Port of Veraval, and the privately owned Mundra Port are also notable ports in Gujarat. Ro-Ro ferries are also available in the state.

4.4 Ro-Pax ferry service in Gujarat (Gogha- Hazira):

By taking the water route, the 370-kilometer road distance between the two locations will be reduced to 60 kilometres. In a single voyage, the Ropax ferry vehicle can transport 550 passengers, 30 trucks, seven smaller vehicles, and 100 two-wheelers. It will be an all-weather service that will run throughout the year, regardless of weather or high tide. The 100-meter-long and 40-meter-wide Ro-Pax terminal, which cost over Rs 25 crore to build, includes amenities such as an administrative office building, parking area, substation, and water tower.The reduction in freight transit time from 10 to 12 hours to roughly four hours will result in significant fuel savings of around 9,000 gallons per day, as well as a significant reduction in vehicle maintenance costs.

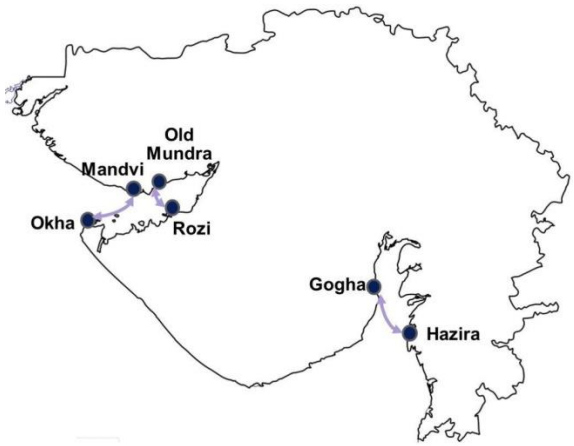

Fig 58: Ropax service in gujarat

In the last five years, Gujarat's waterways have transported almost 120 million tonnes of freight:

National Water Way 73 on the Narmada River and National Water Way 100 on the Tapi River were among the 26 national waterways identified under the National Waterways Act 2016 as viable for cargo and passenger traffic.According to data presented in the Lok Sabha earlier this month, cargo transportation through national waterways began in Gujarat in 2017-18, with 11.52 million tonnes transported. Cargo transportation reached 25.72 million tonnes in 2020-21, and 26.68 metric tonnes were recorded in the fiscal year 2021-22 till February 28, 2022.The Tapi river in Gujarat is where the majority of freight is transported. In 2020-21, 25.6 million metric tonnes of goods were moved by Tapi, while only 82,311 metric tonnes were handled via Narmada. Tapi transported 26.5 million metric tonnes of freight from April 2021 to February 2022, but Narmada only handled 36,399 metric tonnes.In the last five years, over 120 million tonnes of goods have been transported over national waterways in Gujarat, accounting for 34% of total freight flow by inland waterways in the country.

Gujarat is only second to Maharashtra in terms of cargo handling via waterways, having handled 178.59 million tonnes in 2016-17. Goa Waterways, Sunderban Waterways, Ganga-Bhagirathi-Hoogly river system, Brahmaputra river, Kottapuram-Kollam-Champakara and Udyogmandal canals (Kerala), and Krishna river are among the other waterways that have reported cargo movement since 2016. (Andhra Pradesh). The Jawai-Luni-Rann of Kutch river system in Gujarat and Rajasthan, as well as National Waterway 66 on the Mahi river, were among the 62 national waterways judged to be economically unviable.

4.5 Kerala Back WaterWays:

The Kerala backwaters are a network of brackish lagoons and lakes, as well as interconnecting canals, rivers, and inlets, that run parallel to the Arabian Sea coast (known as the Malabar Coast) of Kerala state in southern India, and are sometimes compared to American bayous. The system consists of five big lakes connected by canals, both man-made and natural, fed by 38 rivers and spanning about half of Kerala's length. Waves and shore currents created low barrier islands at the mouths of the various rivers coming down from the Western Ghats range, forming the backwaters.There are a number of villages and communities scattered throughout this region that serve as the starting and ending sites for backwater cruises. Kerala is home to 34 backwaters. 27 of them are either closer to the Arabian Sea or run parallel to it. The remaining seven are inland waterways.Freshwater from rivers meets seawater from the Arabian Sea in the backwaters, creating a unique ecology. A barrier has been built near Thanneermukkom to prevent saline water from accessing the deep interior, preserving the fresh water. Fresh water of this quality is widely utilised for irrigation. [6] [7] Crabs, frogs, and mudskippers, as well as water birds such as terns, kingfishers, darters, and cormorants, and animals such as otters and turtles, all dwell in and around the backwaters. Along the backwaters, palm trees, pandanus shrubs, different leafy plants, and bushes provide a green colour to the surrounding area.

Kerala has historically relied heavily on waterways for transportation. Kerala's overall navigable route length was 1,900 kilometres, with navigable rivers accounting for around 54% of the waterways. Kerala's inland navigation system includes the 41 west-flowing rivers as well as the backwaters. Small distance passenger services, informal country boats, and freight transit to PSUs such as Fertilizers and Chemicals Travancore, Kochi, and others use these waterways in Kerala.The state's inland waterways travel through densely inhabited areas, including the majestic but unfinished West Coast Canal (WCC). The bulk of the people who lived in the area worked in traditional industries including coir, cashew, brick-making,

and fishing. Any attempt to develop the inland waterways will have a positive impact on these people's well-being. WCC will also build a network of multimodal north south corridors across Kerala, including the Thiruvananthapuram–Kasargode Semi High Speed Rail Corridor and National Highway 66 Kanyakumari to Mumbai (Trivandrum - Kasaragod length in Kerala).Boats were the primary mode of transportation in Kerala before to independence. The state's road networks were severely lacking. However, as roads and railways were more developed, the role of waterways began to fade. The historical brilliance of rivers had significantly decreased in the 18th and 19th centuries by the late twentieth century. However, in the twenty-first century, a renewed focus on state waterways began to emerge. Shri. A. P. J. Abdul Kalam, then-President of India, proposed a 10-point development programme in 2005 with the goal of making India an economic powerhouse by 2015. He spoke passionately on the possibilities of Kerala's waterways.

Kerala's Major Waterways:

The West Coast canal system connects almost all of Kerala's important waterways (WCC). Backwaters, river streams, and man-made canal networks make up this canal system. The following are a few notable navigable stretches in this vast system (some of which are currently in a decrepit state):

- National Waterway 3 stretches for 375 kilometres from Kollam to Kozhikkode, and includes the West Coast Canal, Champakkara Canal, and Udyogamandal Canal, as well as Ashtamudi Lake, Kayamkulam Kayal, Vembanad Lake, and Periyar distributaries (river).
- The Thiruvananthapuram–Shoranur canal includes the Bharathappuzha river system, the Kollam Canal, and the Kadinamkulam Kayal, among other things.
- The Conolly Canal, which runs from Kodungallur to Vatakara via Kozhikode, is almost 200 kilometres long.
- Alappuzha-Sherthala (AS Canal) - 22 km from Alappuzha's Vada Canal to Cherthala's Vembanad Lake.
- National Waterway 8 runs for 28 kilometres between Alappuzha and Changanassery.
- The 38-kilometer Alappuzha-Kottayam-Athirampuzha Canal is part of National Waterway 9. This waterway has the potential to increase cargo navigation to Kottayam Port. It also makes advantage of the Meenachil and Vembanad River

systems. It runs between Mannanam and Kainikkara, where St. Kuriakose Elias Chavara was born.

- National Waterway 59 runs for 28 kilometres between Kottayam and Vaikom. [5] It begins near Kodimatha in Kottayam town and travels through Meenachil River via Illikkal, Thiruvaataa, and Pulikkuttisseri to enter Vembanad Lake near Cheepungal, then through Thanneermukkom Bund to reach Vaikom.
- From Colachel in Tamil Nadu to Pozhiyoor in Trivandrum, the AVM Canal (National Waterway 13)[7] is 11 kilometres long.

Canal System of the West Coast (WCC):

WCC is the state's main inland canal, which is being developed to National Waterway standards. This is a 2,300-crore-rupee project that aims to make the entire 633-kilometer-long waterways along Kerala's coast navigable from Kovalam (Thiruvananthapuram district) to Bekal (Kasaragod district) by May 2020, and to connect the state's three major international airports, Trivandrum International Airport, Cochin International Airport, and Kannur International Airport, via waterways. Kerala Waterways and Infrastructures Ltd., a Special Purpose Vehicle (SPV) established in October 2017 for the timely development of inland waterways, was in charge of the project.Their first project was the 18-kilometer Akkulam-Kovalam length of Parvathi Puthannaar in Trivandrum, which they were granted in May 2018. In a techno-economic feasibility analysis, the National Transportation Planning and Research Centre estimated that 16.6% of total goods traffic by road may be shifted to the inland water transport system after WCC is completed.

Mechanical Analysis:

The Ro- Ro vessel currently has a flat bottom structure. There is no need to secure the containers because they are sailing through backwaters and covering a short distance. However, if it is to be sailed in rough seas, it will require structural changes and lashing to ensure the vessel's stability.the characteristics of sea waves Sailing on the sea uses more fuel as well. While introducing to the high seas, more facilities should be added in terms of engine capacity, ballast water storage, fresh water storage, and so on.Importers and exporters can link with the CFS in Willingdon through the Ro-Ro Cochin service, which helps them save money on logistics.

As a result, when implementing high-seas Ro-R services, the route's distance and traffic must be considered.

Fig 59: Mechanical analysis of RoRo

Fig 60: Mechanical analysis of RoRo

4.6 To carry out the study, the route from Hazira (Gujarat) to Cochin (Kerala) is taken under observation:

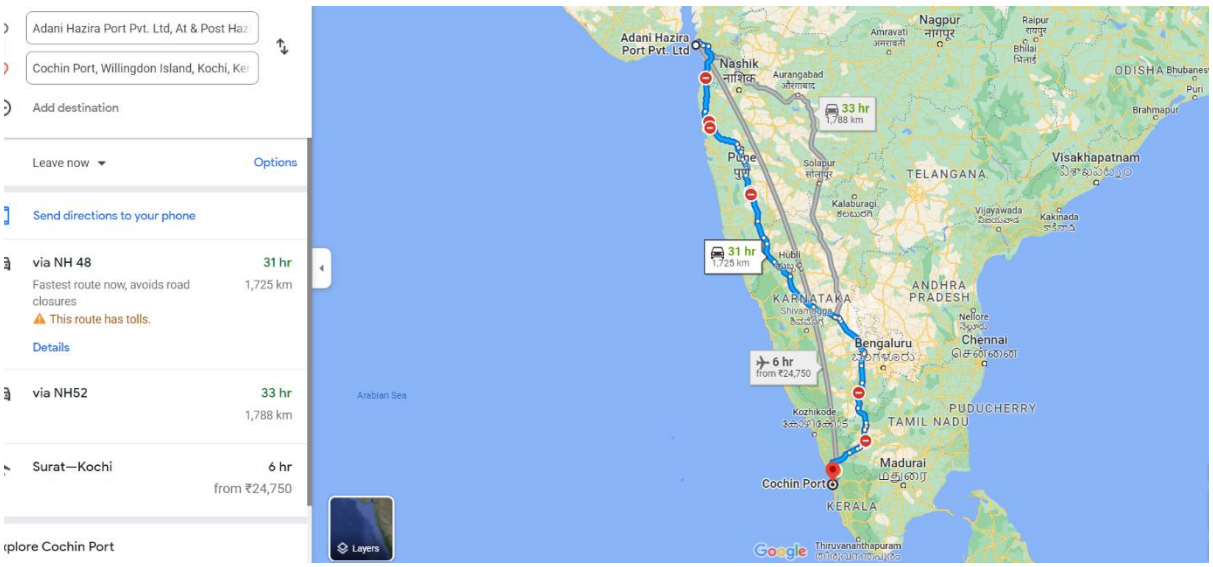

Fig 61: roadway length from Hazira to Cochin

The current state of road transportation:

The freight expenses connected with transportation are usually determined by the weight (Metric Ton) of cargo being transported. The type of truck employed (flat bed trailer, semi low bed trailer, multi axle trailer), the type of cargo (tiles, grains, and cotton are the key cargo movements from North to South, and rubber items from South), and other considerations are all important.

Cargo weights range from 5MT to 9MT, 12MT to 15MT, and so on.

If 28 MT of cargo is transported from Gujarat to Kerala, the total cost will be roughly Rs.2,38,000 + GST. Damage to items can also occur during transit, as well as theft (rare cases). All of these expenses must be considered.Insurance should be purchased by the consignee or consignor during the transportation of cargo to avoid large losses. The cost of insurance is determined by the invoice amount.

It is also clear that the Transportation done by road way takes more time than any other transportation.

Let the truck speed be 20km/hr,Distance to be travelled is 1725kms

Hence it takes 7days to reach the destination.

Cost of fuel 90rs per litre., avg mileage per litre is 20km,

Hence, it takes 90ltrs of petrol costing around rs8,500

Each truck carries 1MT,where for 28MT it needs 28trucks,

Hence 28*8500/- =2,38,000/-

4.7 The current state of sea transportation:

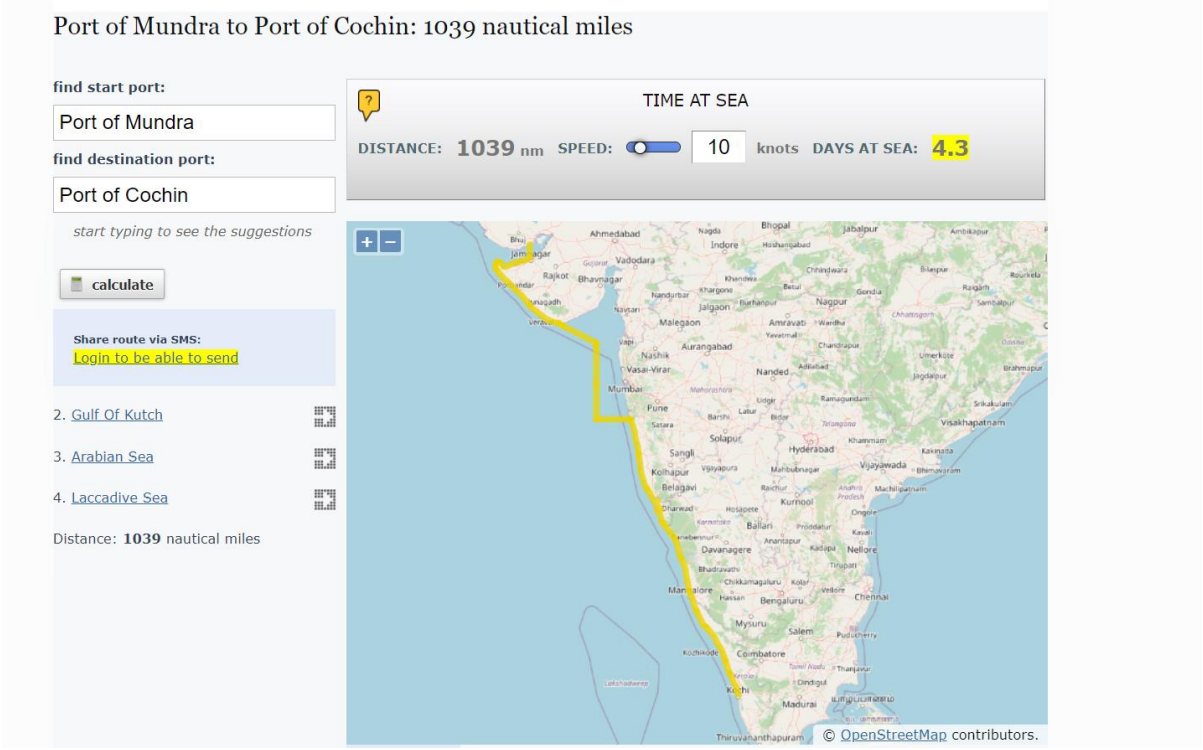

Fig 62: Sea way from Hazariya to Cochin

Container cargo services are being provided from Hazira port to Cochin port by Shreyas Shipping and Logistics Ltd (SSL), the Indian flagged vessel owning unit of Transworld Group, the pioneer and market leader in domestic coastal container shipping.

Let the ship speed be 15 knots.

Distance from port of mundra to Cochinport is 1039nm.

Therefore the time taken = 1039/(15*24)

= 2.88 (round to 3 days)

Let's say a ship consumes 15 tonnes of gasoline each day on average and the cost of fuel is $15 per tonne.

Fuel cost=3*15*15

= $675

= rs 52,528.5/-

Costs for crew members, insurance, and other expenses will also be incurred. Loading, unloading, and cargo handling are all operations that add up to a cost of Rs. 53000 when travelling by sea.

From the above calculations we can see that there is a lot of difference in time and price for a cargo to transport from Hazira port to cochin port.

The feasibility of Ro-Ro is determined by various elements, including traffic movement frequency along the route, truck driver accommodations, capabilities to handle dangerous goods, days spent at sea, and so on. When it comes to costs, the cost of fuel alone in sea mode is approximately $84,000, which we may assume in RoRo as well. However, cargo handling, stowage, loading, and unloading charges can be overlooked when trucks are loaded directly into the ship rather than using containers to load cargo. As a result, RoRo transportation is projected to cost around Rs. 52,528.5/-.Other considerations include the fact that RoRo vessels may have a longer trip duration at sea, increasing the cost of truck driver accommodation. Despite the fact that we offer unaccompanied RoRo services, drivers at destination ports must be accessible on time and all consignees must be looked after. The relocation of an unloaded RoRo vessel along the route may also result in a loss for the shipper. To cover shipping costs, the route must have consistent freight movement. Reduced port expenses could make intermodal RoRo services less expensive than unimodal road freight, increasing their competitiveness. Shippers and major shippers may see the value of collaboration and coordinated planning with other transportation agents.Intermodal integration between diverse means of transportation or strategic collaboration between cargo owners, shippers, and forwarders could improve system efficiency, reduce lead times, emissions, and costs, and produce additional money for all parties involved.

Increased frequency of a transport service for shippers and increased capacity utilisation of a traffic mode are both critical aspects in operating a financially viable RoRo business.

Policymakers should create policies that take into account the demands of shippers and stimulate innovation in the sector, as innovation can minimise wasteful costs (e.g., port costs).

4.8 Cochin Port, Beypore Port, and Azhikkal Port's First Voyage:

Round The Coast Pvt. Ltd. operates the Green Freight Corridor service, which connects Kochi, Beypore, and Azhikkal ports, with Kollam port added subsequently. This regular delivery will significantly cut the logistic costs in Northern Kerala.

For this service, the Operators have dispatched a River Sea Vessel, Class IV, M.V. Chougule-8, which will be renamed M.V.Hope Seven (LOA 67.2 m, Beam 13.30 m, Draft 3.2 m).The tanker will make two weekly calls to Cochin Port, feeding exim and coastal boxes to the ports of Beypore and Azhikkal. The service's general agent is JM Baxi.

Through its flagship programme, 'Sagarmala,' the Ministry of Ports, Shipping and Waterways has given a high focus on creating better synergies between large and minor ports in a state in order to encourage coastal trade and improve logistics efficiencies. The ministry hopes to achieve this through providing seaborne connectivity to the hinterland's trade and industry, as well as reducing road and rail congestion and logistical costs.Rice, wheat, salt, construction materials, sanitary products, cement, and other goods would be shipped from Gujarat and unloaded in Cochin. The operators want to transfer exim cargo such as plywood, footwear, textiles, coffee, and other items on the return trip. Similarly, the imported cashew containers would be relocated to Kollam at a later date.

Cochin Port is offering a 50% discount on vessel related charges for River Sea boats in order to stimulate container shipping along the coast. Similarly, according to the NATPC study report, the Kerala government has granted an operating incentive of 10% over the cost of road transportation for coastal shipping in the state's minor ports for a year starting January 23, 2021. These hand-holding methods would aid in the service's long-term viability and stimulate the development of other similar programmes on a regular basis.This service is predicted to result in a significant mode change in container transportation, reducing road congestion and carbon emissions. This bodes well for connecting northern Kerala's hinterlands, particularly the exim commerce in Calicut and Kannur.

4.9 Providing Propylene Handling Ro-Ro Facilities at Cochin Port:

M/s. Deepak Phenolics Limited has requested that Propylene (flammable gas of 2.1 hazardous class) be transported via Ro-Ro ships from Cochin to Dahej (Gujarat) since it will be cost effective and environmentally beneficial.The shipment is currently being carried by road. Because Dahej Port lacks the required draught of 5m for Ro-Ro ships, M/s. DPL proposed looking into the idea of using Hazira Port instead. Meanwhile, CoPT has received

feedback from M/s.DPL, who have indicated that they would be interested in patronising the service if the cost per tonne of transportation remained lower than the current road transportation cost. As a result, CoPT has contacted the Ro-Ro operator, M/s. DG Connect, who are currently operating service between Hazira and Ghogha, to inquire about the possible freight tariff.

The fundamental goal of this effort is to use Coastal Shipping to create a modal shift that is cost-effective, safe, and less polluting, lowering carbon footprints and being environmentally benign.

Because Cochin Port only has linear berths, which can only accommodate Ro-Ro vessels with quarter stern ramps or side ramps, CoPT has proposed to build an additional Ro-Ro handling facility on the southern side of the existing Q1 berth of Mattancherry Wharf, which can accommodate Ro-Ro vessels with straight stern and front ramps.

The proposed additional Ro-Ro handling facility between Q1 berth and South Coal Berth (SCB) includes I the construction of a 900-square-meter jetty, (ii) the strengthening of the existing road surface up to IG Road, (iii) the construction / re-construction of the existing compound wall and drain, and (iv) the refurbishment of existing buildings as a drivers' comfort station.

The project's entire cost is anticipated to be around Rs.11.06 crores. Because the Port's contribution to the project is the use of existing Berth Q1, the Ministry of Ports, Shipping and Waterways has requested financial support for the entire project cost.

The Project is expected to be completed within 12 months of the competent authority's permission. If a dedicated berth for Ro-Ro ships is offered at Cochin Port, more users may be attracted to handle various types of cargo via Ro-Ro ships to various locations. CoPT would operate and maintain the facilities for multiple users after they were completed.

- The berth's total estimated capacity is 0.60 MMTPA.
- The Ministry of Ports, Shipping, and Waterways is actively considering the proposal

LAYOUT OF PROPOSED RO- RO FACILITIES FOR PROPYLENE HANDLING NEAR SCB & Q1

Fig63: Layout of Ro-Ro for Propolyne

CHAPTER-5

5.1 Summary and Conclusion:

Findings:

The Ro-Ro services have made a huge change in mode of transportation,it is cost effecient and time effecient, its also a safety way to transfer cargo without getting damaged.and using Ro-Ro through Coastal Line it seriously generates a profitable economy to the sea trade.as India got a huge Coastal Line it can be used in many ways to transport the cargo from starting point of loading the cargo to ending point of unloading the cargo it also reduces the traffic in roadways and railways.Though we have a large coastal line we are using very minimal of its worth.using Ro-Ro services through coastal line we can make lot of cahnges in the transport system of India.

Conclusion:

IWT (Inland Water Transport) is often regarded as a more cost-effective, fuel-efficient, and ecologically friendly means of transportation. India has a huge number of inland waterways, including rivers, canals, backwaters, creeks, and lakes, among other things, that have the potential to be developed into effective waterways.network of transportation IWT must be aggressively pushed in order to have a meaningful part of the intermodal mix.inland transportation Again, a robust IWT industry will create new avenues for private investment.Shipbuilding, terminal construction, and so forth. Private engagement on a large scale should be encouraged. PPP method for infrastructure building and fleet operation. In this regard, the Central Government has previously stated its support for the public-private partnership (PPP) model for the development of numerous national waterways in the country. As with other infrastructure sectors employing the PPP model, the terms and conditions outlined in the model concession agreement will be critical to properly developing national waterways using the PPP model. Of course, attracting private investment into the IWT industry in India, which has mostly remained unknown ground for such investment, would be difficult at first. Nonetheless, the necessary infrastructure, such as fairways, terminals, channel markings, night navigational aids, and the possible deployment of GPS and river maps and charts for navigation, should be facilitated in order to ensure a wider coverage of national waterways, making the IWT sector more competitive and appealing. An economy has little chance of growing if some essential prerequisites, such as effective transportation, are not met. However, increasing traffic levels have a negative impact on the environment.

Because of traffic congestion and pollution, we search for ecologically friendly ways of transportation. As a result, inland water transport offers enormous potential in terms of capacity and logistics. In order to handle coastal and international traffic, it may be conceivable to connect interior rivers with coastal ports. Until date, high transhipment costs have hampered the rise of intermodal transportation. The cost of transhipment can be greatly reduced by integrating inland ports with a modern automated Ro-Ro system. On some corridors, Ro-Ro equipped ferries are an effective alternative to road transport. Interior canals would allow such vessels to access specific inland areas. This might relieve some of the traffic on the road network and improve the balance of various types of transportation. Because inland waterways connect enroute settlements/villages and service backward regions, they encourage the development of small scale and cottage enterprises in rural areas. Inland waterways play a significant role in the economic development of rural regions by providing much-needed jobs, connection, improved irrigation, fish culture enhancement, and tourist development in the state.

Bibilography:

- https://www.emerald.com/insight/content/doi/10.1108/IJIS-09-2020-0173/full/html
- https://books.google.com/books?hl=en&lr=&id=QUXU955JfCQC&oi=fnd&pg=PA2&dq=Gujarat+waterways&ots=rgClf9KMWF&sig=Wv7Ae5oiDaegFMGiOYIerjGV9Sk
- https://www.indianjournals.com/ijor.aspx?target=ijor:pag&volume=6&issue=2&article=003
- https://link.springer.com/chapter/10.1007/978-981-16-9636-7_18
- https://books.google.com/books?hl=en&lr=&id=0pvnUISD8BYC&oi=fnd&pg=PA115&dq=Gujarat+waterways&ots=vB8jjfozYa&sig=YM-taT8OQcbh8GcdBqJPMf9t5WY
- https://brill.com/downloadpdf/book/9789004283909/B9789004283909-s005.pdf
- https://search.proquest.com/openview/4a7f7500522fbf9a5d55e4af8f96929f/1?pq-origsite=gscholar&cbl=18750&diss=y
- http://nopr.niscair.res.in/handle/123456789/34440
- https://www.indianjournals.com/ijor.aspx?target=ijor:zijbemr&volume=4&issue=6&article=004
- http://www.ojcoca.org/july-2019.pdf#page=101

- http://nirdprojms.nirdpr.in/index.php/jrd/article/viewFile/93505/69325
- http://ibm.nic.in/writereaddata/files/04252019125239Port%20Facilities.pdf
- https://www.ksidc.org/wp-content/uploads/2018/02/KSIDC-KPMG-Kerala-IP-Final-Report-May-2018-Version-2.pdf
- https://iwai.nic.in/
- https://www.ieor.iitb.ac.in/files/faculty/narayan/transport/iwt-tec-rep-oct-05.pdf
- https://www.pomsmeetings.org/confpapers/059/059-0097.pdf
- https://www.tandfonline.com/doi/abs/10.1080/02692171.2020.1837082?cookieSet=1
- http://data.conferenceworld.in/ICSTM8/P111-118.pdf
- https://www.researchgate.net/publication/305381020_A_Case_Study_on_Inland_Water_Transportation_System_in_Kochi_City_Region
- https://ijcrt.org/papers/IJCRT_194912.pdf
- https://www.manthan-india.org/wp-content/uploads/2018/04/Strategic-Status-Report-on-Inland-Waterways-V5-26-Apr-17-FINAL.pdf
- https://www.projectstoday.com/News/Coastal-shipping-service-flagged-off-to-connect-Kochi-Port-to-Beypore
- https://m.economictimes.com/industry/transportation/shipping-/-transport/govt-identifies-new-routes-for-ferry-services-through-inland-waterways/amp_articleshow/79838558.cms
- https://indianexpress.com/article/cities/ahmedabad/over-120-million-tonnes-of-cargo-transported-through-gujarat-waterways-in-past-five-years-7856973/lite/