"AN EVALUATION OF INLAND WATER TRANSPORTATION AND ITS EFFECT ON LOGISTICS"

A dissertation submitted to Indian Maritime University for the partial fulfilment of the requirement for the degree of MBA Port and Shipping Management

By

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DECLARATION

I, **ANUPAMA S ARUN, 2005304009** student of **School of Maritime Management, Indian Maritime University, Kochi Campus** pursuing **Master of Business Administration in Port and Shipping Management**, hereby declare that this report titled **"AN EVALUATION OF INLAND WATER TRANSPORTATION AND ITS EFFECT ON LOGISTICS"** has been prepared by me towards the partial fulfilment of the requirement for the award of the degree of **"Master of Business Administration in Port and Shipping Management"** under the guidance of my project guide **Dr. Jayan P A**. I also declare that this project report is my original work and has not been copied from any other report previously submitted for the award of any Degree, Fellowship, or other in the similar title.

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CERTIFICATE

This is to certify that the report titled **"AN EVALUATION OF INLAND WATER TRANSPORTATION AND ITS EFFECT ON LOGISTICS"** submitted to the School of Maritime Management, Indian Maritime University, Kochi Campus, by **ANUPAMA S ARUN**, (Registration Number: 2005304009) in partial fulfillment of the requirements for the award of degree of Master of Business Administration in Port and Shipping Management is a record of project work done under my supervision.

Place:

Date:

Prof. Dr. Jayan P A

Project Supervisor

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ANUPAMA S ARUN

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ABBREVIATION

IWT : Inland Water Transport

IWAI : Inland Water Authority of India

IMO : International Maritime Organisation

IMF : International Monetary Fund

UNCTAD : United Nations Conference on Trade and Developement

NW : Natioanl Waterways

DFC : Dedicated Freight Corridors

JMVP : Jal Marg Vikas Project

RIS : River Information System

DGPS : Digital Global Positioning System

NHAI : National Highway Authority of India

PPP : Public- Private Parrtnership

MMLP : Multi Modal Logistics Park

GST : Goods and Services Tax

RC : Registration Certificate

DL : Drivers License

CEZs : Coastal Economic Zones

GLOSSARY

Bill of lading: A document that establishes the terms of contract between a shipper and a transportation company. It serves as a document of title, a contract of carriage, and a receipt for goods.

Beam: The width of a ship.

Berth: A place in which a vessel is moored or secured; place alongside a quay where a ship loads or discharges cargo.

Bunkers: Fuel used aboard ships.

Bulk vessel: All vessels designed to carry bulk cargo such as grain, fertilizers, ore, and oil.

Container: Steel or aluminum frame forming a box in which cargo can be stowed meeting International Standard Organization (ISO)-specified measurements, fitted with special castings on the corners for securing to lifting equipment, vessels, chassis, rail cars, or stacking on other containers.

Container freight station: A dedicated port or container terminal area, usually consisting of one or more sheds or warehouses and uncovered storage areas where cargo is loaded ("stuffed") into or unloaded ("stripped") from containers and may be temporarily stored in the sheds or warehouses.

Dock or quay: A structure attached to land to which a vessel is moored.

Draft (or draught): The depth of a ship while in the water. Measured as the vertical distance between the waterline and the lowest edge of the keel.

Dredging: Removal of sediment to deepen access channels, provide turning basins for ships, and maintain adequate water depth along waterside facilities.

Dry bulk: Loose, mostly uniform cargo, such as agri-bulk products, coal, fertilizer, and ores, that are transported in bulk carriers.

Feeder service: Transport service whereby loaded or empty containers in a regional area are transferred to a "mother ship" for a long-haul ocean voyage.

Freight forwarder: Person or company who arranges for the carriage of goods and associated formalities on behalf of a shipper. The duties of a forwarder include booking space on a ship, providing all the necessary documentation, and arranging customs clearance.

Gantry crane: A crane fixed on a frame or structure spanning an intervening space typically designed to traverse fixed structures such as cargo (container) storage areas or quays and which is used to hoist containers or other cargo in and out of vessels and place or lift from a vessel, barge, trucks, chassis, or train.

Keel: A flat steel plate running along the center line of a vessel.

ABSTRACT

The global economic crisis triggered from Covid19 pandemic has underscored the deep-rooted fault lines in the massive offshore dependent global value chains. Transportation has always been a topic of prime concern in Indian context. Water transportation is one of the consequential modes of transportation. India has a widespread network of Inland waterways in the form of canals, rivers, lakes, creeks, backwaters, with navigable length of approximately 14500 km. Water based transportation, when compared to other means of transport is always a medium less environmental pollution. The major advantages of Inland Water Transportation are the main infrastructure and low running and maintenance cost. It is predominantly effective when the origin (source) and destinations are waterfront locations. It can be more beneficial for movement of cargo as well as passengers with lower costs and which in turn can reduce the stress on other means of transportations (Rail, road.etc.) hence boosting the economy in active or passive way.

The project will give an overview of the operation of Inland Waterway Transportation in India along with the effects on logistics. This project will help in understanding the six National Waterways and analyses the growth and development in inland water transportation and also the modal split of freight movement of all inland transportation. The focus is given upon the different inland transportation modes and it's cost in logistics. The role of IWAI (Inland Waterways Authority of India) in developing and maintaining these waterways has also been mentioned in the study. The comparison has also been made between the percentage of cargo carried on different modes of transportation such as the roadways, railways, and the inland waterways and the benefits of carrying the cargo on inland waterways as compared to the other modes of transportation. The project also studies government initiatives that are changing the course of Indian logistics, the role of transport network in the development of India, and the economic rationale of inland water transport.

Key words: Inland Water Transportation (IWT), Transport, Logistics Management, Inland Water Authority (IWAI), Navigable Waterways, National Waterways.

CHAPTER 1

INTRODUCTION

1.1 INTRODUCTION

The presence of an efficient and reliable transportation system is one of the major factors contributing to a region's economic growth. This is primarily because a well-developed transportation system provides adequate access to the region, which is a necessary condition for the efficient operation of manufacturing, retail, labour, and housing markets. Transportation is a crucial component of economic development and growth. It is a wealth-generating industry in and of itself. Inadequate transportation restricts a country's ability to exploit its natural resources, distributes foods and other finished goods, connects the manufacturing and agriculture sectors, and provides education, medical, and other infrastructure. For national wealth, it is therefore necessary to maintain and improve existing transportation systems as well as to construct new infrastructure. The growth domestic products (GDP), which is an indicator or measure of the rate of economic growth, is the national wealth. Our economy's main arteries are transportation routes or channels.

⇒ **Importance of Transportation**

- They serve as vital links between goods producers and consumers.
- The well-organized public transportation system brings people very close together.
- They encourage people to be self-sufficient in an increasingly diverse economic, social, and cultural environment.

Water is an important mode of transport. Maritime transport accounts for roughly 95 percent of India's trade volume and 70 percent of its trade value. It is the movement of people, goods, animals, and other products by boats, ships, and rivers across the sea, lakes, canals, and rivers. Water transport is the cheapest mode of transportation because it runs on a natural trail for carrying and transporting bulky goods over long distances. It is one of the most ancient modes of transportation. It has played a significant role in bringing various parts of the world closer together and is essential to international trade. However, as railways and highways were built, the use of water as a mode of transportation declined. Inland Waterways were the primary mode of transportation prior to the advent of railways.

Inland Water Transport (IWT) is a fuel-efficient, environmentally friendly, and cost-effective mode of transportation that has the potential to supplement the country's overburdened rail and congested roads. Despite India's abundance of navigable waterways, such as rivers, canals, backwaters, creeks, and lagoons, IWT accounts for only 3.5 percent of domestic surface transportation. IWT mode must be developed with public funding at least to a threshold level in order to entice the private sector to invest and participate in the development of infrastructure facilities and operations.

1.2 STATEMENT OF PROBLEM

This study will address the precise issues such as the challenges faced in developing these waterways, the environmental and social impact, what will be the solution to these challenges and what measures should be undertaken to achieve the desired goals. The study also addresses the effects of inland transportation on logistics. The growth of inland waterways in India offers a great prospective for the growth and development of the country. However, it should not be done at the cost of environment and the interests of the weaker sections of the society. Therefore, there should be appropriate safeguards and measures neededto make the inland water transportation in India more competent as well as sustainable in the long run.

1.3 RESEARCH OBJECTIVES

1. To study the inland transportation modes in India and the cost in each transportation mode.
2. To identify and evaluate the inland water transportation, national waterways and its benefits, issues and challenges.
3. This project is attempted to identify the economic rationale of IWT and logistics management.

1.4 RESEARCH METHODOLOGY

The study uses the secondary data to analyses and to understand about inland transportation. This study is mainly exploratory, conceptual and broadly qualitative in nature, based on review of relevant reports, studies and statistics related to various policies / programs unleashed from the

Ministries of Commerce & Industry, Ports, Shipping & Waterways, Road Transport & Highways and Finance of Central Government, World Bank, WTO, IMF, UNCTAD and other UN agencies' studies, which are directly downloaded from their respective web sites.

1.5 SIGNIFICANCE OF THE STUDY

In this study, I have set out to evaluate the inland transportation and its effect on logistics system in India in Inland Waterways Authority of India. It would enable the officer's in-charge to improve on the system of transportation where lapses are discovered or exists.

The study would also educate those who do not understand the essence of transportation and its economic growth of any nation.

To stakeholders and interested persons in transport sector, this study is expected to enkindle their interest the more and they will take note of various recommendations mentioned here and help steer the management team towards forming a study organization to present accurate economic growth that will measure the Indian gross domestic product.

This study will also help to serve as literature (reference source) to students, individuals or corporate bodies into what to carry out on further research on the similar topic.

1.6 SCOPE OF THE STUDY

This study is limited to Inland Waterways Authority of India and upon the research topic which is an evaluation of the inland transportation and its effect on logistics in India.

1.7 LIMITATIONS OF THE STUDY

1. The study uses the secondary data to analyses and to understand about inland transportation.
2. There were a lot of secondary data sources available, so it was difficult to determine theauthenticity of the available data.
3. It is limited to current inland freight movements through various modes due to heavily skewed modal mix where it accounts about to 70% of logistics costs.

1.8 CHAPTER SCHEME

Chapter I : Introduction.

Chapter II : Review of Literature

Chapter III : Inland Transportation Modes

Chapter IV : Inland Water Transportation

Chapter V : Logistics Management

Chapter VI : Data Analysis & Interpretation

Chapter VII : Summary of Findings, Suggestions and Conclusions

CHAPTER 2

REVIEW OF LITERATURE

The resources and goods won't be always readily available at the point of demand as the global resources are unevenly distributed which leads to economic and social interdependency of different societies, from which transportation services are derived. Accordingly, goods and services in demand are assumed to be moved very fast, safe and efficient at absurdly low freight. Hence transport economics is caught in the vortex of time, cost and reliability of delivery. Thus transport, social cohesion and the economy are strongly inter-related.

The below reports and articles were studied to comprehend the different ideas and various concepts that are pertinent to the development Inland Waterways Transportation system in India.

The World Bank: "Developing India's first waterway":

Through the ages, rivers have served as effective waterways, carrying people and goods overlong distances. Even today, many countries depend heavily on inland water transport, especially for large and bulky cargo, as it is cheaper, more reliable and less polluting than transporting goods by road or rail. India has yet to develop this cheaper and greener mode of transportation. Goods still travel by congested road and rail networks, slowing the movement of cargo, addingto uncertainties, and increasing the costs of trade. So much so that logistics costs in India are estimated to account for as much as 18 percent of the country's GDP.

Until about a hundred years ago, the Ganga River, too, was a busy waterway. But with the coming of the railways, this watercourse fell into disuse. The Government of India is now reviving the Ganga watercourse – known as National Waterway 1 or NW1- to ferry cargo from the eastern seaport of Haldia to Varanasi, some 1,360 km inland. The waterway has the potentialto emerge as the leading logistics artery for northern India.

The waterway's stretch between Kolkata and Delhi passes through one of India's most densely populated areas. A sizeable forty percent of all India's traded goods either originates from this resource-rich region or are destined for its teeming markets. While the region is estimated to generate about 370 million tonnes of freight annually, only a tiny fraction of this - about 5million tones - currently travels by water.

Currently, cargo from the Gangetic states of Bihar and Uttar Pradesh takes circuitous land routes to reach the sea ports of Mumbai in Maharashtra and Kandla in Gujarat, rather than going to the much-closer port at Kolkata. The development of NW1 will help these states direct some of their freight to the Kolkata-Haldia complex, making the movement of freight more reliable and reducing logistics costs significantly.

The World Bank is financing the development of the Ganga waterway with a loan of $ 375 million. The Capacity Augmentation of National Waterway 1 Project will help put in place the infrastructure and services needed to ensure that NW1 emerges as an efficient transport artery in this important economic region.

Once operational, the waterway will form part of the larger multi-modal transport network being planned along the river. It will link up with the Eastern Dedicated Rail Freight Corridor, as well as with the area's existing network of highways. This web of water, road and rail arteries will help the region's industries and manufacturing units switch seamlessly between different modes of transport as they send their goods to markets in India and abroad. Farmers in the agriculturally-rich Gangetic plain will also benefit, as the waterway opens up the markets.

“Inland waterways – positive impact on economy”

Inland waterways have been accorded a central role in maritime development in India. The National Waterways Act 2016, has declared 111 rivers or river stretches, creeks, estuaries in India as National Waterways. Navigation in rivers, lakes and other water bodies by smaller

vessels connecting places not far from each other has been around for centuries, and been the mainstay of our inland waterways. In a few cases, especially near ports and coastal areas, this has also evolved to large-scale, commercial shipping. The national waterways project now intends to create such large-scale, commercial shipping and navigation systems in all these 111 waterways. These are expected to realize the potential of cargo and passenger traffic, including tourism and cruise, offer seamless connectivity at lower per-unit cost and make transportation more efficient. The project, in its entire implementation and operation phase, would generate a series of forward and backward linkages with prospects to penetrate deep into the economy. The multiplier effect of the investment and its linkages can result in a virtuous cycle of all-round growth. This potential virtuous cycle, however, can well be interrupted if implementationof the network is not well coordinated. Besides, there are other challenges.

The National Waterways Act mandates the Central Government to regulate these waterways for systematic and orderly development of shipping and navigation activities. Spread across the Eastern, Western, Southern and Central regions of the country, these waterways cover nearly 15000 kilometers across 24 states and two union territories. Theyinclude the country’s 138 river systems, creeks, estuaries and related canal systems, and can be utilized as a channel to move passengers and cargo within the country and to the neighboring countries.

The waterways are also proposed to be linked to the eastern and western Dedicated Freight Corridors (DFCs), as well as the Sagarmala Project, which aims to promote port- led direct and indirect development. The linkages are being planned in a manner such thatcommodities and cargo can be swapped/shifted from and to the waterways, the DFCs and road transport. The inland waterway in its full scope is conceived as part of an ambition to link several big infrastructure projects.

"Viability of Inland Water Transport in India"- Narayan Rangraj and G. Raghuram

Water based transport is effective as generally speaking, operating costs of fuel are low and environmental pollution is lower than for corresponding volumes of movement by road, rail or air. A major advantage is that the main infrastructure – the waterway – is often naturally available, which then has to be "trained", maintained and upgraded. Transport over waterways isespecially effective when the source and/or destination are waterfront locations. This paper attempts to assess the viability of movement of passengers and freight by inland water transport (IWT) in India. The methodology of the study is given in Appendix 1. Inland waterways refer torivers, canals, lakes etc., but there is an overlap of this sector with coastal shipping where tidal rivers are involved. Legally, there are separate Acts covering inland waterways, the vessels that can ply on them [MOLJ, 1986] and the setting up of the Inland Waterways Authority of India (IWAI) [MOLJCA, 1985]. Three waterways in the country have been designated as National Waterways (NW-1, NW-2 and NW

CHAPTER 3

INLAND TRANSPORTATION MODES

3.1 INLAND TRANSPORTATION

Inland transportation – the movement of goods by road, rail, barge, and pipeline – is critical to global trade and the international shipping process. While the majority of goods are shipped by sea and some are shipped by air, the shipping process would be incomplete without inland transportation, particularly in the first and last miles. Trucks and trains, for example, transport cargo from an exporter's warehouse to a port where it can be loaded onto a ship, or from the port to the final destination of an importer. As a result, multimodal and intermodal transportation – which combines two or more modes of transportation for cargo movement – are important components. For a country like India, inland transportation is critical. With its vast land mass and extensive road and rail networks, inland transportation is critical for a country like India. With 5.89 million kilometers of road and 123,236 kilometers of rail, India has the world's second largest road network. According to a 2018 government study, 59 percent of all freight volume in the country travels by road and 35 percent by rail. Waterways account for 6% of cargo volume, including barge transportation.

3.2 INLAND TRANSPORTATION MODES

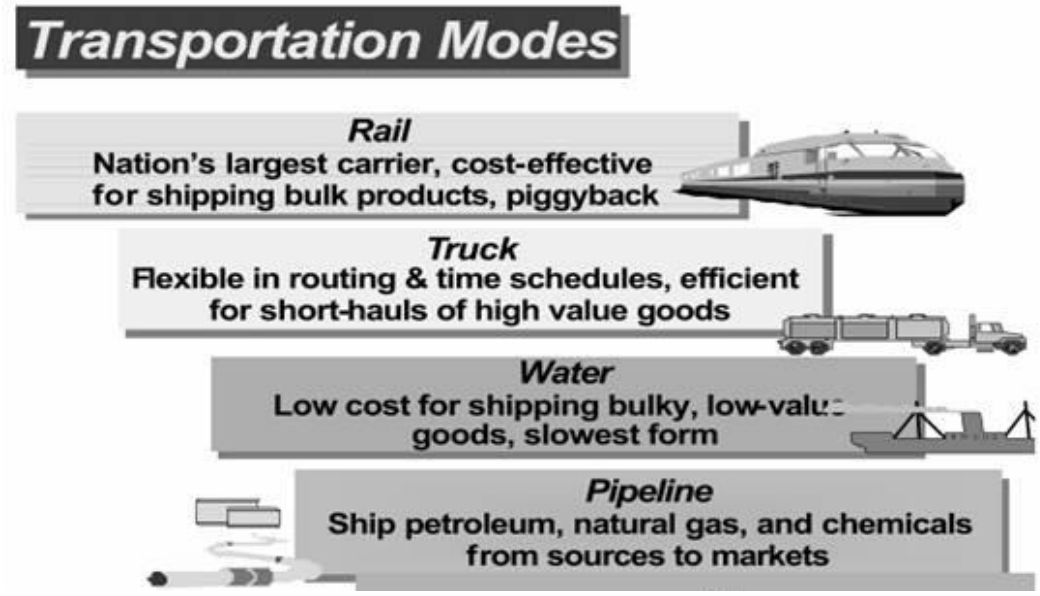


Fig 3.1 Inland Transportation Modes

3.2.1 ROAD TRANSPORTATION

The most common mode of transportation for goods is by road. It has the least geographical constraints and is the most versatile of the others (sea, air, rail, barge, pipeline). India has one of the world's largest road networks. Roads have existed since the dawn of time. Roads were constructed by Ashoka and Chandergupta. Sher Shah Suri built the Grand Trunk Road across the Indo-Gangetic Plains from Kolkata in the east to Peshawar in the west.

⇒ **Advantages of road transport**

- Only mode of transportation capable of providing door-to-door service
- No need to adhere to schedules or routes because of the vast network of roads. It can be used at any time and easily adapts to the needs of a particular route or cargo.

- Cheaper than air and sea shipping for moving goods over short distances, especially perishables. There are fewer packaging requirements, which means more savings.

- Low capital requirements. Road construction, operation, and maintenance costs are all relatively low. Ships, planes, and trains are all more expensive than trucks and trailers.

- A vital link in the shipping of goods by air, sea, and rail • Serves the world's most remote regions and facilitates trade in landlocked countries

⇒ **Disadvantages of road transport**

- Road transportation is less safe than air, sea, rail, and other modes of transportation because of the high risk of accidents.
- It is unsuitable for long distances and heavy and bulky goods.

- Delays in traffic and breakdowns can affect delivery times.
- Tolls and road taxes are high in some countries.
- Poor road maintenance is a major issue.
- Fuel price fluctuations have a significant impact on road transportation costs.

⇒ **Cost in Road Transportation**

- Motor carriers have a lower fixed investment in terminal facilities than railroads and operate on publicly maintained highways. Although license fees, user fees, and tolls are expensive, they are directly proportional to the number of units and miles driven.
- Roadways require far less capital investment than railways designed to transport the same amount of traffic.
- Because each trailer or combination of tandem tailors requires its own power unit and driver, the variable cost per mile for motor carriers is high.

3.2.2 RAIL TRANSPORTATION

Nothing beats rail transportation for transporting large volumes of goods over long distances at a low cost. In countries with large land masses and railway networks, such as India, China, and the United States, freight trains are an important part of international shipping. They help to develop major industries by transporting cargo from point of origin to point of destination within the country. Railways are India's primary mode of inland transportation. The railways in India are 150 years old. The first train between Mumbai and Thane ran in 1854. The total distance covered by railways is approximately 67368 kilometers. India has the second-largest railway network in Asia. Every year, India's railways transport 12 billion passengers and 1,200 billion tons of cargo. India has the second-largest railway network in Asia. India's railways transport 12 billion people and 1,200 billion tons of cargo each year. It is the largest public-sector project in the country. India has an 8500-station network

spanning 68 thousand kilometers. The running track measures 107,9694 meters. Approximately 25% of the route is electrified.

⇒ **Advantages of rail transport**

- Less expensive than road transportation. Rail transport costs Rs 1.41 per ton km in India, whereas road transport costs Rs 2.58 per ton km.
- Trains consume less energy and have a lower carbon footprint than trucks. According to the Indian Railways, emitting 28 gm CO2e per net ton km compared to 64 gm CO2e by road (CO2e being a measure of relative global warming potential).
- Trains cover long distances in a short time.
- Because of the large volumes and minimal packaging requirements, cargo loading and unloading is simple.
- Less chance of cargo damage during transit.
- A higher level of safety. The cost of road accidents in cargo movement is eight times that of train accidents.
- Weather conditions have little impact on rail transportation.

⇒ **Disadvantages of rail transport**

- Trucks are not a universal cargo transport solution. Rail transport is primarily used to transport large volumes of goods over long distances.
- Longer transit times rule out time-sensitive goods.
- India's rail network, while extensive, is overcrowded.
- Rail networks in most countries are not as extensive as road networks. Many container ports in India are not connected to rail lines.
- Trains are less dependable than trucks, particularly in India.
- Rail transport lacks the flexibility of road transport.

⇒ **Cost in Rail Transportation**

- Because of expensive equipment, right of way, switching yards, and terminals, railroad operations have high fixed costs.
- The operating costs of rail are relatively low. The railroad's variable costs are reduced as steam is replaced by diesel power.
- Electrification has the potential to reduce costs even further. New labour agreements have reduced labour requirements, lowering variable costs even more.

3.2.3 WATER TRANSPORTATION

A barge is a non-mechanical cargo boat with a long flat bottom that is propelled by a towboat or tugboat. Barges are typically used on inland waterways, such as interconnected rivers and canals, but they are increasingly being used at sea ports. They are a cost-effective and secure method of transporting large quantities of goods. In Europe and the United States, barges play an important role in cargo transportation, and India has made a push for inland waterway cargo services in recent years.

⇒ **Advantages of water transport**

- More cargo capacity than trucks, trailers, and rail wagons.
- More environmentally friendly and energy efficient than trucks and trains.
- Safer than road and rail transport due to fewer accidents.
- Lower risk of cargo theft and damage.

⇒ **Disadvantages of water transport**

- Not recommended for perishable goods because it is slower than trucks and trains
- Not time and cost-effective for short distances
- River levels fluctuating can cause potential shipping issues.

⇒ **Cost of Water Transportation**

- In terms of fixed costs, water transport ranks between rail and motor carrier. Although water carriers must construct and operate their own terminals, the government develops and maintains the right of way, resulting in lower fixed costs than railways and highways.

- Even though operating costs are high, they are spread out over a large number of units, resulting in a low cost per unit.

3.2.4 PIPELINE TRANASPORTATION

Pipelines used to transport water to cities and industries are now also used to transport natural gas crude and natural gas fields to refineries, fertilizer factories, and large thermal power plants. Pipelines have made it possible to build large thermal power plants in the shortest amount of time and as close to the market as possible, providing a vibrant and sustainable solution for large-scale cargo movement and commercial use**.**

⇒ **Advantages of Pipeline transportation**

- They're perfect for transporting liquids and gases.
- It can be laid through difficult terrains and under water.
- It involves very low energy consumption.
- It needs very little maintenance.
- Pipelines are both safe and environmentally friendly.

⇒ **Disadvantages of Pipelines transportation**

- It is rigid, meaning it can only be used for a few fixed points.

- Its capacity cannot be increased once it is installed.
- Making pipeline security arrangements is difficult.
- Underground pipelines are difficult to repair and leak detection is difficult.

⇒ **Cost in Pipeline Transportation**

- Pipelines have the highest fixed costs and the lowest variable costs among transportation modes.
- Since pipelines are not labor-intensive, their variable operating costs are extremely low once they are built.
- Right-of-way, construction, and control station and pumping capacity requirements all result in high fixed costs.

Mode	**Speed**	**Dependability in meeting schedules**	**Frequency of shipments**	**Availability in different locations**	**Flexibility in handling**	**Cost**
Rail	Average	Average	Low	Low	High	Average
Water	Very Slow	Average	Very low	Limited	Very High	Very low
Road	Fast	High	High	Very extensive	Average	High
Pipeline	Slow	High	High	Very limited	Very low	Low

Table 3.1 Comparison of Inland Transportation Modes

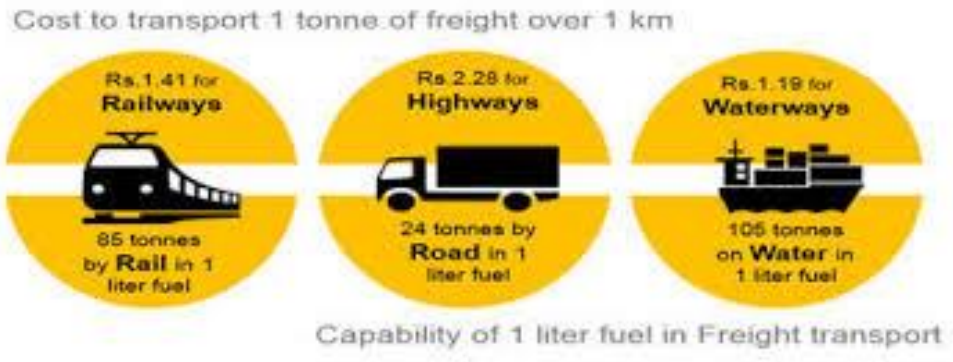


Fig 3.2 Capacity of 1 Liter fuel in Freight Transport

Fig 3.3 Freight movement in India

3.3 THE ROLE OF TRANSPORT NETWORK IN THE DEVELOPMENT OF INDIA

1. **Life Lines of the country**: Modern modes of transportation aid in the preservation of a nation's sovereignty and economic unity. In India, the central government has direct control over national highways and railways. They serve as the veins of our land transportation system. They're all real-life stories from our country.

2. **Transportation:** A transportation network transports food grains and other manufactured goods from their point of origin to their final destination. They transport industrial raw materials; power plants use live coal and mineral oil as fuel.

3. **Turning of local market into national market**: The transportation network transforms yesterday's local markets into today's national markets. Ships transport surpluses to other countries and import goods that meet our needs.

4. **Help in development of economy:** Branch roads, feeder railway lines, and inland waterways meet the needs of inner-city residents. As a result, they are integrated into the country's market economy. People's mobility is increased as the transportation network develops.

5. **National integration of the country:** Aircraft and helicopter services give people in the High Himalaya, the Thar Desert, and North-East India a sense of belonging to India. In today's world of trade and commerce, air transportation brings near and far neighbors closer together.

6. **Cultural Integration:** The transportation network brings people of various castes, creeds, races, colors, religions, languages, and regions closer together. They interact, act, and react to one another. As a result, the transportation network aids the country's cultural and national integration.

CHAPTER 4

INLAND WATER TRANPORTATION

4.1 INTRODUCTION

River systems, canals, back waters, creeks, and tidal inlets are among the many navigable waterways in India. However, mechanized craft can only travel a short distance, covering about half of the reported navigable waterways. The navigable waterways are limited to a few states and are geographically restricted. Inland water transport (IWT) is functionally important in the Brahmaputra and Ganges basins in the country's north and east, as well as in the deltas of the Krishna and Godavari rivers in Kerala and Goa, where IWT provides natural advantages.

IWT plays an important role in many parts of the country because it provides a cost-effective, energy-efficient, job-creating, and nearly pollutant-free mode of transportation. Despite its merits, IWT's operation is limited by a number of factors, including shallow water, narrow width during dry weather, siltation and bank erosion, and insufficient vertical and horizontal clearances in a large number of overhead structures, all of which make navigation difficult throughout the year.

Waterways are the most cost-effective mode of transportation for transporting heavy and bulky materials with low specific costs. Water transportation is a low-cost, environmentally friendly mode of transportation with significant employment potential. However, because it could not compete with the speed of road and rail transportation, it suffered greatly at the hands of roadways and railways. Coastal and inland waterways currently account for 6% of India's freight modal mix, whereas neighbouring developing economies such as Bangladesh (16%) and Thailand (12%) have a higher share of water-based transport, highlighting India's room for improvement. The Central Government has sole jurisdiction over shipping and navigation on inland waterways designated as "national waterways" by an act of Parliament. Vessel usage/sailing in other waterways is covered by the concurrent list or falls under the jurisdiction of the respective state governments.

4.1 INLAND WATER TRANSPORT (IWT): A HISTORICAL PERSPECTIVE

The growth of navigation on inland waterways is chronicled in India's commercial history. The presence of a large number of towns along waterways that were also centers of trade and commerce long before railways demonstrate the value of this mode of transportation in the past. The first propelled craft, the Diana, weighing 89 tones, sailed with passengers from Kulpi Road to Calcutta, a distance of 80 kilometers on the Hooghly, in 1823. In 1834, a monthly steamer service between Calcutta and stations upstream on the Ganga was established to transport East India Company officials and supplies. On the river Yamuna, a regular fortnightly service began in 1842 between Calcutta and Agra. A regular steam service between Calcutta and Assam began in 1863. A network of steamer services grew quickly, reaching as far as kilometers on the Ganga in Uttar Pradesh, about 645 kilometers from Allahabad, and Ajodhya on the Ghagra, about 325 kilometers from the Ganga's confluence.

The development of trade and commerce along river banks and catchment areas of the navigable river and canal system was dominated in the nineteenth century by navigation by power crafts and country boats. The majority of traffic, however, was transported by country boats from Delhi and the Nepalese border to Assam. Country boat traffic peaked in 1876-77, with about 180,000 cargo boats registered in Calcutta, 124,000 cargo boats in Hooghly, and 62,000 cargo boats in Patna.

The introduction of railways and the subsequent expansion of their network marked a water-transport turning point in India. To begin with, the construction of main railway lines boosted river traffic because the two modes supplemented each other, with waterways serving as feeders for railways. However, the complementarity between IWT and railways was only temporary. Around 1860, navigation began to decline. By that time, the East Indian Railways' expansion had begun to make an impact. With the expansion of the rail network, new economic centers far from the waterways arose. IWT gradually lost its dominance.

4.2 INLAND WATER TRANSPORT

Rivers, canals, backwaters, creeks, and tidal inlets are all options for inland water transportation in India. In India, over 5,000 kilometers of navigable inland waterways are being built. These not only provide a cost-effective alternative mode of transportation (30% lower than railways and 60% lower than roads), but they also provide a sustainable mode of freight logistics and passenger transportation. In 1986, the Inland Waterways Authority of India (IWAI) was established to maximize the benefits of IWT. It has been working to develop and regulate inland waterways since then. The government has designated a few key waterways as National Waterways in order to increase the importance of inland waterways and improve their efficiency.

The National Waterways Act of 2016 added 106 new waterways to India's list of National Waterways, bringing the total number of National Waterways to six. The government has taken steps to accelerate infrastructure development in addition to NW notification.
These include:

- Jal Marg Vikas Project (JMVP) for NW-1.
- Arth Ganga and Arth Brahmaputra for holistic and sustainable development leveraging NW-1 and NW-2 for freight and passenger movement.
- Inland Vessels Bill.
- Land Use Policy for Inland Waterways (IWs).
- Dredging Policy for IWs.
- Promoting private participation in terminal operations and maintenance.

As a result, the total cargo volume transported through India's inland waterways reached 73.6 million tons per annum (MTPA) in 2019-20, up 19% from the previous five years.

- South Indian rivers are seasonal and unsuitable for navigation.
  - The deltaic areas of the Godavari, Krishna, Mahanadi, Narmada's lower reaches, and Tapi, on the other hand, serve as waterways.
- Inland waterways are also served by some navigable canals.

- Buckingham Canal in Andhra Pradesh and Tamil Nadu is one such canal, which provides water transport for a distance of 413km
- The other navigable canals are Son Canal, Odisha Canal, Damodar Canal

⇒ **Why is there a need of inland water transportation?**

- It requires low operational costs, low capital costs and low maintenance cost.
- Inland water transport is considered to be the most efficient mode of transport from the point

  of view of fuel efficiency. According to a study 1 liter of fuel can move 105 tones on water as compared to 24 tones by road and 85 tones by rail.
- Less accident and less congestion as compared to the road and rail transportation.
- Inland water transportation provides accessibility to remote areas mainly in the north-eastern region of India.

⇒ **Advantages Of Inland Water Transportation:**

1. Low Cost:

Rivers are a natural highway that do not require any construction or maintenance costs. Canals are also less expensive to build and maintain, and they are used for a variety of purposes other than transportation, such as irrigation. In addition, the cost of operating inland water transportation is very low. As a result, it is the most cost-effective mode of transport for transporting goods from one location to another.

2. Larger Capacity:

- It can carry much larger quantities of heavy and bulky goods such as coal, and, timber etc.

3. Flexible Service:

- It provides much more flexible service than railways and can be adjusted to individual requirements.

4. Safety:

- The risks of accidents and breakdowns, in this form of transport, are minimum as compared to any other form of transport.

⇒ **Disadvantages Of Inland Water Transportation:**

1. Slow:

- Speed of Inland water transport is very slow and therefore this mode of transport is unsuitable where time is an important factor.

2 Limited Area of Operation:

- It can be used only in a limited area which is served by deep canals and rivers.

3. Seasonal Character:

- Rivers and canals cannot be operated for transportation throughout the year as water may freeze during winter or water level may go very much down during summer.

4. Unreliable:

- The inland water transport by rivers is unreliable. Sometimes the river changes its course which causes dislocation in the normal route of the trade.

5. Unsuitable for Small Business:

- Inland water transport by rivers and canals is not suitable for small traders, as it takes normally a longer time to carry goods from one place to another through this form of transport.

4.3 INLAND WATERWAYS AUTHORITY OF INDIA(IWAI)

The Inland Waterways Authority of India (IWAI) was established on October 27, 1986, with the goal of developing and guiding inland waterways for shipping and navigation. The IWAI is in charge of developing and maintaining the necessary infrastructure on India's national waterways. IWAI's headquarters are in Noida. It also has regional offices in Patna, Kolkata, and Guwahati, as well as sub-offices in Allahabad, Varanasi, Bhagalpur, Dibrugarh, Kollam, Bhubaneswar, and Vijayawada, among other places. IWAI is also assisting the Government of Myanmar as a Project Development Consultant (PDC) for Kaladan Multimodal Transit Transport Project by developing and maintaining the Indian side of the assigned waterway courses under the Indo-Bangladesh Protocol for Transit and Trade through Inland Vessels from one country to the other.

India has a vast network of navigable waterways, including rivers, streams, canals, and backwaters. Inland Water Transport (IWT), a fuel-efficient and environmentally friendly mode, moves around 55 million tons of payload per year. Its operations are currently limited to a few stretches of the Ganga-Bhagirathi-Hooghly waterways, the Brahmaputra, the Barak stream, Goa's waterways, Kerala's backwaters, Mumbai's inland waters, and the Godavari-Krishna waterways' deltaic districts. Aside from these organized operations by mechanized vessels, this unorganized sector transports a significant amount of freight and passengers.

The contribution of IWAI to the overall expansion of the IWT sector is significant. It could be developed as an environmentally friendly, affordable, and feasible mode of transportation to support India's economy in areas such as exchange, trade, commerce, tourism, and so on, as well as to meet the needs of the country's teeming millions.

The functions of Inland Waterway Authority of India are:

- National Waterways functions:
    - Survey
    - Navigation, infrastructure and regulation.
    - Fairway development.
    - Pilotage and coordination with other modes of IWT.

- General functions:
    - Advise central government.
    - Carry out surveys.
    - Assist state governments.
    - Research and development.
    - Establishing standards and safety.

4.4 NATIONAL WATERWAYS

As per the National Waterways Act, 2016, 111 have been declared as National Waterways (NW). These waterways pass through 24 states and two union territories, with an approximate total length of 20274 km. These proposed waterways will pass through nearly 138 river systems, creeks, estuaries and related canal systems of India.

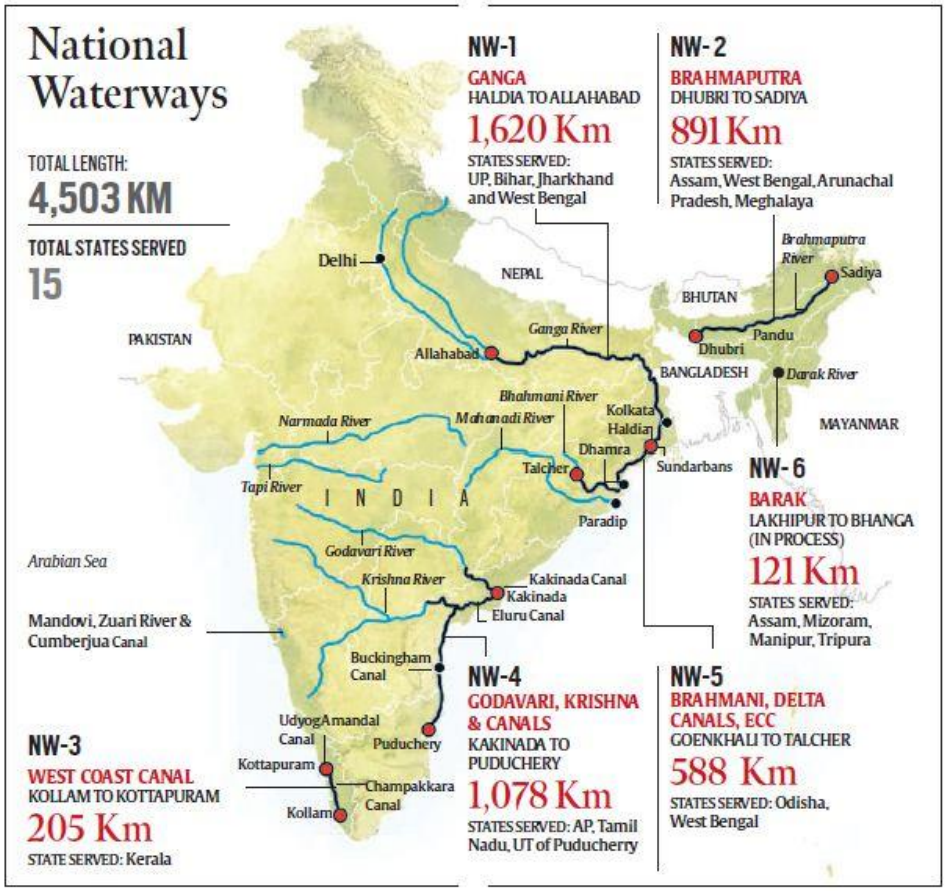


Fig 4.1 NATIONAL WATERWAYS

⇒ **Advantages of Inland Waterways**

- A well-coordinated inland waterways network could bring a fundamental alteration in the logistics scenario of the country.
- Waterways can decongest roads, including highways by moving cargo away.
- Waterways do not involve challenges associated with land acquisition, which has always

  been a sensitive issue, causing time and cost overruns of numerous projects.
- Waterways are a cheaper mode of transportation vis-à-vis the available alternatives, significantly reducing the point-to-point cost of goods.

⇒ **Disadvantages of Inland waterways**

- Inland waterways have low transport speed thus not suitable where time is an important factor.
- It has limited area of operation, depending on the infrastructural premises and depth of the waterways.
- There are only very few cases in which Inland water transport (IWT) can offer door-to-door transport of cargo.
- Operational disruptions due to weather is a major disadvantage.

⇒ **Challenges related to Inland Waterways**

- The channel draft of the national waterways is not uniform at 2 meters throughout the year, as is required. Some of these rivers are seasonal and do not offer navigability through the year
- Further, all the identified waterways require intensive capital and maintenance dredging, which could be resisted by the local community on environmental grounds, including displacement fears, thereby posing implementation challenges
- The presence of waterfalls and sharp bends in the course of river hinders the development of waterways
- Silting of river beds reduces the depth of water and creates problems for navigation. And Desilting of river beds is a costly affair
- Diversion of water for irrigation purposes reduced the quantity of water in river channel, and hence should be done carefully
- Also, the demand for sufficient waterways needs to grow, to make it an economically viable mode of transportation.

Six National Waterways had been identified by separate acts, these identified national waterwayswere as follows-

NW	Stretch	Length (Km)	Declared in (year)
1	River Ganga from Haldia to Allahabad	1620	1986
2	River Brahmaputra from Dhubri to Sadiya	891	1988
3	West Coast Canal from Kottapuram to Kollam with Udyogmandal & Champakara Canals	205	1993
4	Kakinada – Puducherry stretch of canals with River Godavari and River Krishna	1078	2008
5	East Coast Canal with River Brahmani and River Mahanandi's delta	588	2008
6	Barak river between Lakhipur and Bhanga	121	2013

Table 4.1 National Waterway Systems

4.4.1 National Waterway 1

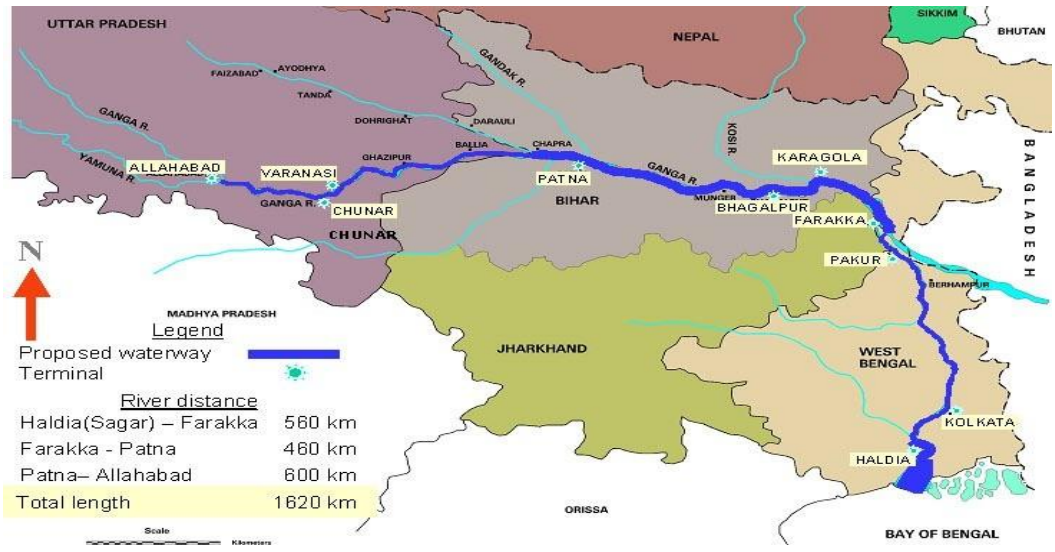


Fig 4.2 NATIONAL WATERWAY 1 (Ganga-Bhagirathi-Hooghly)

After the formation of IWAI in 1986, NW1 began operations. It is the world's longest waterway, stretching 1,620 kilometers from Allahabad, Uttar Pradesh, to Haldia, West Bengal. The river has two barrages to control water discharge at Farakka and Jangipur, allowing it to maintain a navigable depth of two metres throughout the year. The Farakka Feeder Canal and navigation lock connect the Hooghly and Ganga rivers. It will be India's longest National Waterway.

The Jal Marg Vikas project will continue to develop the NW1, including the construction of a fairway, new multi-modal terminals in Varanasi, Haldia, and Sahibganj, a modern river information system (RIS), a digital global positioning system (DGPS), night navigation facilities, and a state-of-the-art navigational lock at Farakka.

A Memorandum of Understanding (MoU) has been signed between the IWAI and M/s Maruti Suzuki India Ltd. for the transportation of cars between Kolkata and Varanasi, and the Ministry of Shipping plans to start Ro-Ro service on this waterway. In August 2016, the first trial run was completed, with 200 newly assembled Maruti cars and 1,000 tonnes of construction material being transported from Varanasi to Kolkata. During the monsoon season, when the river's water level is usually between 7 and 15 metres, this exercise was carried out. However, once the monsoon passes, water levels in some areas fall below two metres, making navigation difficult for ships.

The National Waterway I is divided into 4 stretches.

SI NO.	Stretch (km)
1.	Haldia-Farakka (560)
2.	Farakka-Barh (400)
3.	Barh-Ghazipur (290)
4.	Ghazipur-Allahabad (370)

Table 4.2 Stretch of National Waterway I

4.4.2 National Waterway II

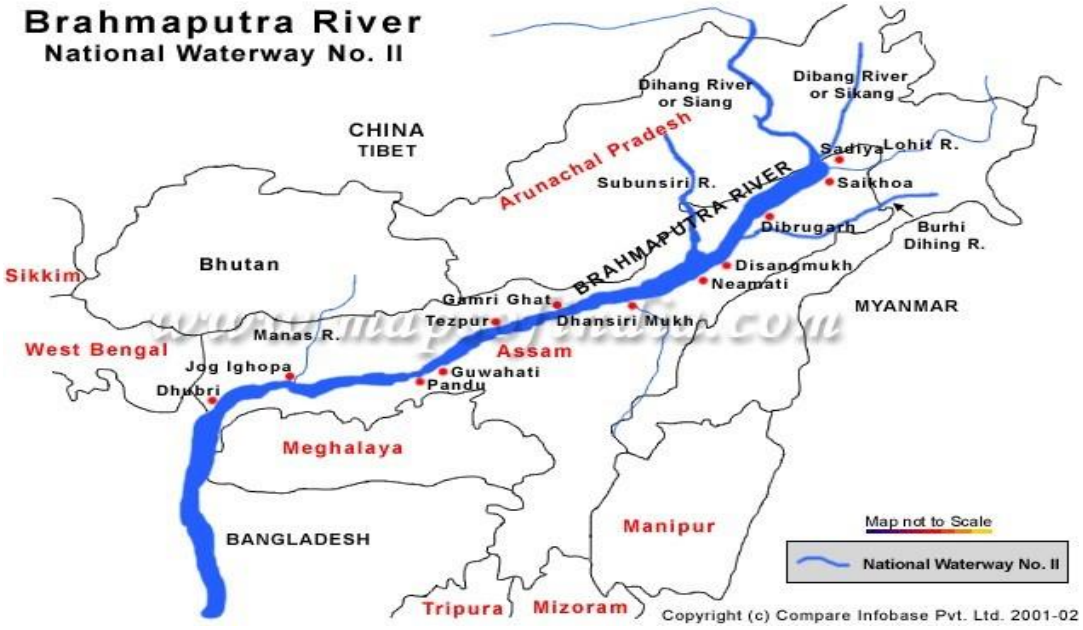


Fig 4.3 NATIONAL WATERWAY II (Brahmaputra)

NW2, which connects Dhubri on the Bangladesh border to Sadiya in Assam, was declared open in 1988 and is one of the major freight transportation waterways in north east India. It is the third longest waterway in the country, stretching for 891 kilometres along the Brahmaputra River. Through Bangladesh, this historic route connects the ports of Kolkata and Haldia. Indian vessels use IWT transit facilities to transport goods to Kolkata, which is made possible by an agreement with Bangladesh. 10 The section of the waterway between Guwahati terminal and Dhubri is the busiest. IWAI began developing a ship repair facility (Slipway project) in Guwahati and a Roll on-Roll off Ferry service on NW2 in February 2016. From Dhubri to Dibrugarh, the stretch also has night navigation facilities. National Waterway 2 will run from Sadiya to Dhubri in Assam, along the Brahmaputra River.

Government of Assam, Central Inland Water Corporation Limited (CIWTC), Indian Army, Border Security Force, tourism vessels, and other private operators currently use the

waterway. Between Sivsagar, near Dibrugarh, and Manas, near Jogighopa, there are also tourist cruise vessels. Because this waterway is already in use for tourism, it can be expanded for trade and community development.

The National Waterway II is divided into 4 stretches.

SI NO.	Stretch (km)
1.	Bangladesh border-Pandu (255)
2.	Pandu-Neamati (374)
3.	Neamati-Dibrugarh (139)
4.	Dibrugarh-Oriumghat (92)

Table 4.3 Stretch of National Waterway II

4.4.3 National Waterway III

Fig 4.4 NATIONAL WATERWAY III (West Coast Canal)

The West Coast Canal in Kerala, which runs from Kottapuram to Kollam, was designated as National Waterway No. 3 in 1993. It is a chain of salt water lagoons, lakes, rivers, and man-made canal sections that run parallel to the Arabian Sea coast and are part of the famous Kerala Backwaters. The canal, along with the Champakara and Udyogmandal canals, spans 205 kilometres and connects the industrial centres of Ambalamugal and Udyogmandal with the Kochi port.

In 1994, the NW3 cargo terminal was opened. Since then, it has become the country's most developed waterway. Since 1998, capital dredging has been done, and it is the first waterway in the world to have a 24-hour navigation facility running the length of it. To improve inland waterway connectivity, IWAI and Cochin Port Trust have built two new Roll on-Roll off (Ro-Ro) and Lift on-Lift off (Lo-Lo) IWT terminals at Willingdon Island and Bolgatty in the Cochin port area. This entire stretch has been used for both cargo and passengers, and it is one of India's most navigable waterways, with enormous tourism potential.

The National Waterway III is divided into 3 stretches.

SI. NO	**Stretch (km)**
1.	Kottapuram-Kollam (168)
2.	Udyogmandal canal (23)
3.	Champakara canal (14)

Table 4.3 Stretch of Natioanl Waterway III

4.4.4 National Waterway IV

Fig 4.5 NATIONAL WATERWAY IV

NW4 is a 1,095-kilometer stretch of irrigation and navigation canals that was declared in 2008. The Buckingham Canal connects the Tamil Nadu ports of Chennai, Puducherry, and Ennore with the Andhra Pradesh ports of Kakinada and Machlipatnam. The Godavari River at Rajmundry and the Krishna River at Vijayawada cross this stretch. Widening canals, dredging, excavation, bank protection, construction and repair of locks, navigational aids, and the establishment of IWT terminals are all part of the NW4 development plan. The maximum potential of this Krishna River waterway between Amaravati, Andhra Pradesh's new capital, and the ports on the East coast. Container transportation is also possible via a multimodal hub near Amaravati on the riverfront.

Along this stretch, the government has established the Vizag-Chennai Industrial Corridor (VCIC), and three upcoming Coastal Economic Zones (CEZ) will complement each other. Petrochemicals, electronics, shipbuilding, iron and steel, and textiles would all be present in these CEZs. Coal, rice, food grains, cement, salt, sand, forest products, paddy, pulse, building materials, and other bulk cargo were once major commodities transported through this waterway. With the emergence of new industries, this waterway would have enormous potential in terms of lowering logistics costs.

4.4.5 National Waterway V

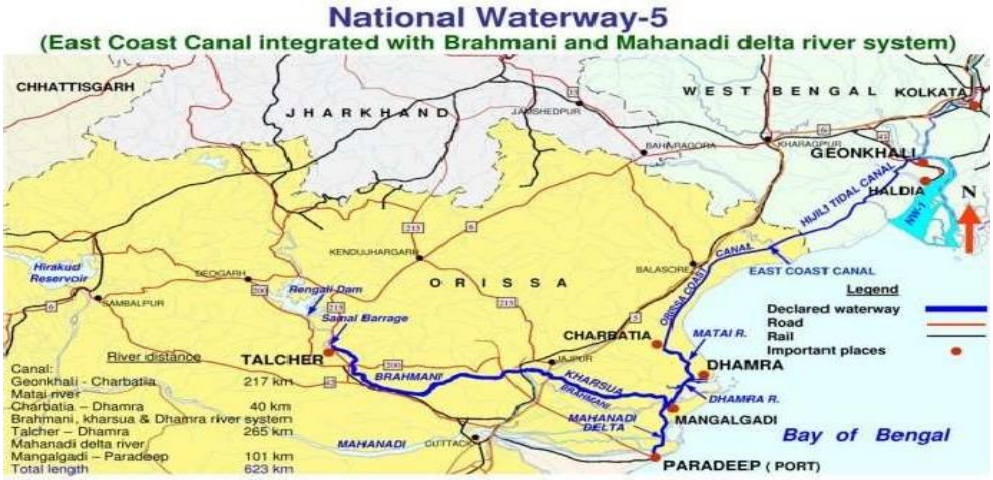


Fig 4.6 NATIONAL WATERWAY V

The NW5, which was established in 2008, runs along the Brahmani and Mahanadi delta systems, linking the ports of Goenkhali in West Bengal and Paradip in Odisha via the Hijli and Odisha Tidal Canals. Coal, fertiliser, cement, and iron will be transported through the 623-kilometer canal system. Five barrages with navigation locks have been proposed to maintain a navigable depth of two metres, allowing two 500-tonne vessels to pass simultaneously. The surrounding areas are rich in resources such as coal and iron ore, and will also be home to the proposed leather and marine processing industries in CEZs. As a result, this waterway will be essential for the transportation of coal, finished goods, manufactured goods, and agricultural products.

4.4.6 National Waterway VI

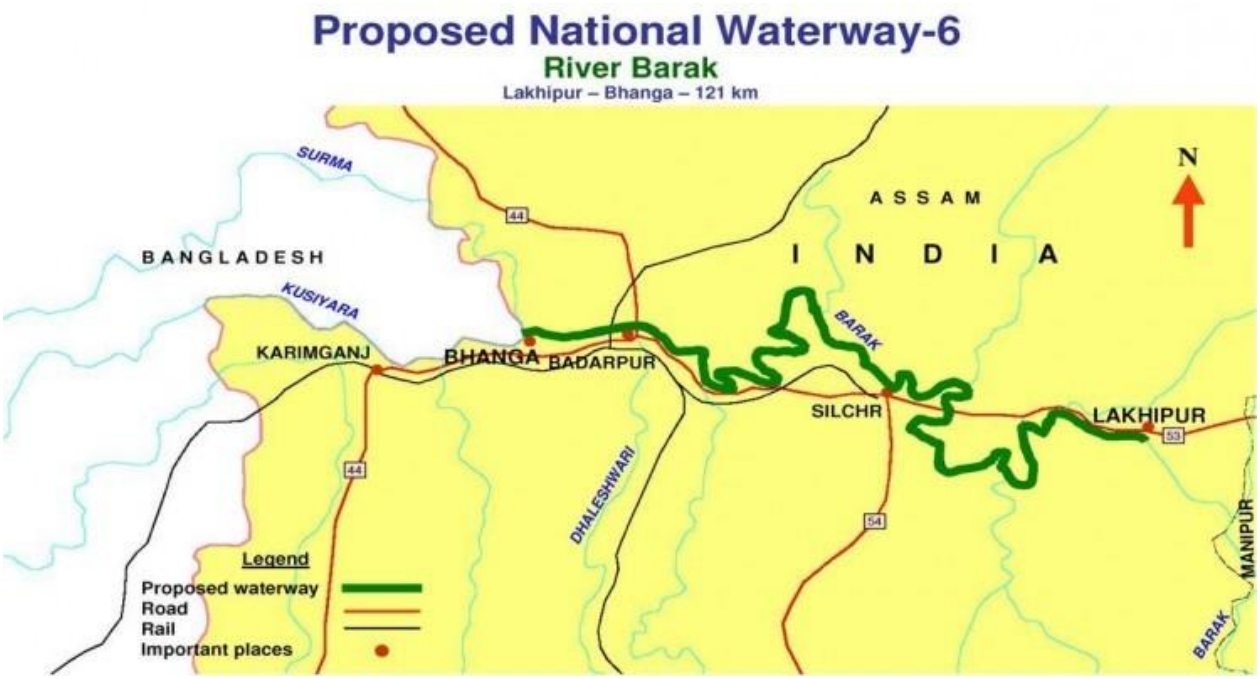


Fig 4.7 NATIONAL WATERWAY VI

The total navigable length is 14,500 kilometres, with about 5,200 kilometres of river and 4000 kilometres of canals open to mechanised craft. The proposed National Waterway 6 in Assam will connect Lakhipur and Bhanga along the Barak River. The 121-kilometer waterway will facilitate trade between Silchar and Mizoram State.

Out of the 111 National Waterways (NWs) declared under the National Waterways Act, 2016, 13 NWs are operational for shipping and navigation and cargo/passenger vessels are moving on them. The details of operational NWs are as follows:

Details of Operational National Waterways

Sl. No.	National Waterway (NW) No.	Length (km)	Location (S)
1.	**NW-1:** Ganga-Bhagirathi-Hooghly River System (Haldia - Allahabad)	1620	Uttar Pradesh, Bihar, Jharkhand, West Bengal
2.	**NW-2**: Brahmaputra River (Dhubri - Sadiya)	891	Assam
3.	**NW-3**: West Coast Canal (Kottapuram - Kollam), Champakara and Udyogmandal Canals	205	Kerala
4.	**NW-4:** Phase-1development of the stretch Muktiyala to Vijyawada of river Krishna	82	Andhra Pradesh
5. 6. 7. 8.	**i) NW-10** (Amba River) **ii) NW-83 (**Rajpuri Creek**)** **iii) NW-85** (Revadanda Creek - Kundalika River System) **iv) NW-91** (Shastri river–Jaigad creek system)	45 31 31 52	Maharashtra
9. 10.	**NW-68 – Mandovi** – Usgaon Bridge to Arabian Sea (41 km) **NW-111 – Zuari**– Sanvordem Bridge to Marmugao Port (50 km).	41 50	Goa
11. 12.	**NW-73- Narmada river-** **NW-100- Tapi river**	226 436	Gujarat & Maharastra
13.	**Sunderbans Waterways (NW-97):** Namkhana to AtharaBankiKhal in West Bengal.	172	West Bengal (Through Indo-Bangladesh Protocol Route)

Table 4.5: Details of Operational National Waterways

4.6 ISSUES AND CHALLENGES

1. **Cost estimation**: In respect to operating costs per ton-km, IWT has lower cost than rail and road transport. However, this cost argument is challengeable. There are two factors which distinguishes how freight moves on land versus on water:
   i) A road travels straight while rivers bend and curve; therefore, the difference between freight costs for IWT and road/ railways is not much
   ii) Cost of loading and unloading freight.

2. **Inadequate depth**: A river must have sufficient depth throughout the year to be viable as a navigable inland waterway. Many Indian rivers, on the other hand, do not have enough water in their natural state to necessitate extensive dredging. Furthermore, Indian rivers (particularly those in the northern plains) face severe siltation problems all year.

3. **Impact on other activities**: Dams and agriculture, for example, compete for river water. Water use for such other activities may be curtailed in order to maintain river water levels to the level required for them to function as inland waterways.

4. **Inadequate Air Draft**: Multiple bridges with low vertical clearance obstruct the passage of bigger inland water transport vessels on many inland waterways such as
   NW 3.

5. **Lack of night navigation infrastructure**: Rudimentary night navigational facilities and markings are also a major issue.

6. **Shortage of IWT vessels**: Vessel building is highly capital intensive and faces difficulties in obtaining project finance from banks and financial institutions.

7. **Shortage of MRO facilities**: There is severe shortage of MRO (Maintenance, Repair and Overhaul) facilities for IWT vessels.

8. **Inadequate industries**: The lack of industrial units along riverbanks, particularly along the Brahmaputra, is a major impediment to the development of inland waterways. The lack of cargo commitments by private players is a result of inadequate industrial units, according to the National Policy Dialogue on transboundary cooperation related to the Ganga and the Brahmaputra rivers – states.

9. **Lack of funds**: Dredging as well as infrastructure for IWT requires huge investments. However, both public and private funding in the sector is low.

10. **Environmental Impact**:

- Dredging operations will damage the riverbed and may result in changes in aquatic flora and fauna habitats.

- Dredging along the river could damage aquifers, preventing water from percolating underground.

- The removal of river bed material during capital dredging in estuaries and river creeks can result in the ingress of excess saline water into the creek or rivers. One of the reasons why Kerala has opposed many of the proposed waterways is because of this.

- The removal of trees and mangrove forests in the area will be required for the construction of jetties and river ports. The mangrove forest belt on the bank has been removed at Dharamtar port in NW10 for the construction of a jetty.

- Other environmental concerns include pollution from ships' oil and diesel, as well as cargo leakage and spillage.

11. **Social impact**:

- Ecological impacts may have ramifications for people who rely on rivers and creeks for their livelihood. Consider the impact on the fishing community and those who rely on riverbed cultivation.

- Land is required for a variety of facilities such as ports, jetties, and other infrastructure, so displacement is a major concern.

4.7 MAJOR ENVIRONMENTAL, SOCIAL AND ECONOMIC BENEFITS FROM DEVELOPMENT OF INLAND WATERWAYS FOR TRANSPORT

1. It is a resource-conserving transportation project that does not use water.

2. It will help relieve congestion on the railway and road networks, as well as reduce emissions from vehicles and railway engines on non-electrified routes, lowering carbon emissions.

3. The use of modern inland water vessels powered by natural gas (LNG/CNG) will reduce SOx, NOx, particulate matter (95%) and CO2 emissions by 70%. (25 percent). As a result, the impact on ambient air quality will be minimal.

4. Because LNG/CNG engines produce less noise than diesel engines, they have a lower impact on ambient noise levels.

5. Land acquisition is a significant barrier to all infrastructure projects, including highways, railways, and urban transportation. However, except in a few places where terminals are likely to be built, water transportation does not necessitate extensive land acquisition. It is almost insignificant in comparison to other infrastructure projects. Due to the minimal land acquisition requirements, there will be little impact on ecology and biodiversity, agricultural activities, and people's livelihoods.

6. Increased river flow as a result of improved/augmented navigation facilities will benefit aquatic flora and fauna.

7. Increased economic opportunities, including job and business opportunities (both in relation to cargo movement and peripheral petty business activities).

8. Local communities should have access to a mode of transportation that allows them to conduct activities on both sides of the river.

9. Maintaining minimum water levels will improve water flow, resulting in increased fish production and catch, which will directly benefit the fishing communities along the river stretch.

10. Compared to rail and road transportation, the cost of transporting goods across waterways will be significantly lower.

11. The burden on road and rail transportation will be reduced, resulting in reduced fuel consumption and pollution.

12. Local, regional, and international business will benefit from improved access to trading centres and ancillary infrastructure (cargo handling, etc.) along rivers and navigation.

13. Tourist attractions along the rivers will draw a large number of visitors.

14. IWT is the best option for bulk and over-dimensional cargo.

15. Land acquisition is not required for fairway development.

16. Railways and roads have a lower rate per tonne per kilometre.

The socio-economic and environmental advantages of IWT mode of transportation over other modes such as rail and road are enormous. Few important advantages are given below:

(a) Capital Savings: Upgrading/constructing existing two-lane roads is estimated to cost Rs. 1 crore per kilometre, upgrading an existing single-lane road to two lanes is estimated to cost Rs. 4 crore per kilometre, and constructing a new two-lane road is estimated to cost Rs. 5.5 crore per kilometre. Similarly, the cost of building a rail line outside of a terminal is estimated to be Rs. 5 crore per km and Rs. 10 crore for rail siding inside a terminal. In comparison, the capital cost of developing inland waterways is significantly lower. The Jal Marg Vikas Project is expected to cost Rs. 2.53 crore per km to increase navigation capacity on NW-1 by strengthening open river navigation techniques and hardware [dredging, modern river information system (RIS), Digital Global Positioning System (DGPS), night navigation facilities, and modern methods of channel marking].

(b) Savings in transportation costs:

- 1 Horse Power energy moves 150 kg on road, 500 kg on rail and 4000 kg on water
- 1 litre of fuel moves 24 ton-km on road, 85 ton-km on rail & 105 ton-km on Inland Waterways.
- Reduces transportation and transition losses.

(c) Environment friendly:

- Least fuel consumption per ton-km
- CO2 emission is 50% that of trucks

- Negligible land requirement
- Safe mode for hazardous and over-dimensional cargo

(d) Supplementary mode:

- Reduces pressure on road and rail
- Reduces congestion and accidents on road

4.8 WHY IS THE IWT MODE IN INDIA NOT SO MUCH DEVELOPED COMPARED WITH OTHER COUNTRIES?

The major reasons for the poor development of IWT in India are:

1. **Very low level of investment**: In comparison to road and rail modes, India has made pitiful investments in the preservation and development of IWT. As a result, this mode of transportation remained underdeveloped, with a very small share of overall internal cargo transportation (less than 1 percent in terms of ton-kilometer). This is a significant economic loss for the country. A comparison of IWT investment in India with that in other countries reveals that China spent US$ 15 billion on IWT between 2005 and 2010 (five years), while Germany's budget for IWT development in 2012 alone was 15 billion Euros.In contrast, India spent only Rs. 1117 crore (US$ 200 million) on IWT over a 25-year period from 1986 to 2010. This is significantly low for India, which has a total length of 14,500 km of navigable inland waterways, according to data from various studies.

2. **Lack of convergence between IWT and other modes of transport:** Inland waterway transport is one of India's oldest modes of transportation. It grew over time based primarily on private participation for passenger and local produce transportation, with minimal government intervention. This, combined with the lack

of a common transport policy to bring all four major modes of transportation, rail, road, and air, resulted in IWT being pushed to the sidelines and low investment. In India, IWT has received only Rs.200 million in total investment, while road infrastructure has received Rs.12 billion.

3. **Emphasis on development of rail and road networks:** India's successive planners have emphasised the development of road and rail networks to provide last-mile connectivity to all habitations and trade centres over the years. The following statistics show India's comparative position in terms of road, rail, and IWT development.

(a) The National Highway Authority of India (NHAI) was created in the year 1988 through an Act of Parliament.The road network consists of the following as in 2013-14:

Expressways - 200 kms. National highways -96,260 Kms State highways- 1,31,899 kms. Rural roads- 26,50,000 kms. NHAI alone invested Rs. 106,378 crore on national highways.

(b) State governments place a high priority on the development of state highways and rural roads. The Prime Minister's Grameen Sadak Yojna (Rural Roads Programme) was launched in 1992 with the goal of connecting all habitations with a population of 500 households to either a major thoroughfare or a commercial centre.

(c) Similarly, the Indian Railways was able to invest significant amounts in the sector thanks to a dedicated Railway Board, lucrative revenue earnings, and investment opportunities.

4. **Expensive development of ancillary facilities:** Multi-modal and inter-modal terminals are part of an inland waterway's fairway development. Modern multimodal terminals, jetties, ferry points, and river information systems are highly capital intensive, and the private sector was not prepared to bring in the required level of capital for investment on its own.

5. **High cost of development of Ancillary facilities:** Banks were hesitant to lend to private players because IWT investment was perceived as a high-risk investment.

6. **Lack of public-private-partnership (PPP) investment interventions:** When compared to investments in road networks, PPP investment interventions in inland waterways for transportation are minimal.

CHAPTER 5

LOGISTICS MANAGEMENT

5.1 LOGISTICS MANAGEMENT

The art and science of managing and controlling the flow of goods, energy, information, and other resources such as products, services, and people from the point of origin to the point of sale is known as logistics. Without logistics support, marketing and manufacturing are difficult to achieve. Information, transportation, inventory, warehousing, material handling, and packaging are all part of it. The geographic repositioning of raw materials, work in progress, and finished inventories where required at the lowest cost possible is the operating responsibility of logistics.

Logistics is concerned with delivering goods and services when and where they are required. In today's society, most customers take excellent logistics service from a company as granted and only notice logistics until something goes wrong. For example, non-availability of goods and services which they need very badly when they visit a retail store, they expect goods to be in good condition, such as fresh fruits, meat, vegetables, and other items.

It's difficult to imagine manufacturing and marketing actively, efficiently, and effectively without the help of logistics. Logistics is a broad, far-reaching function that has a significant impact on a modern society's standard of living.

5.2 THE ECONOMIC RATIONALE OF INLAND WATER TRANSPORT

Waterborne transportation is widely acknowledged as the most cost-effective, environmentally friendly, energy-efficient, and accident-free mode of transportation because the force/energy required to move a floating freight is always less than any other mode. The very foundation of maritime transport prudence is based on neoclassical economic theory: commodities can only be traded from high supply to low supply regions if the price differential is large enough to cover the transportation costs. Adam Smith, the Scottish

economist, philosopher, author, and father of modern economics, conceived of shipping as the architect of international trade toward economic development. He claimed (in Chapter 3 of The Wealth of Nations) that the dominant economic force in a capitalist society is division of labour, which is directly influenced by market size, or, to put it another way, a small market size can stifle high levels of specialisation.

Frequent economic shocks, soaring oil and energy bills, climate change resulting from increased greenhouse gas emissions, environmental threats, ecological ramifications, and green initiatives have all pushed countries across the continents to promote a modal shift from surface transportation (rail and roads) to waterways whenever possible. Inland water transport – IWT is 0.3 times cheaper than railways and 1.2 times cheaper than roads. Railways require 8 times the energy and roadways require 25 times the energy to transport inland water loads, making inland waters the most energy efficient mode. Rails and roads emit 30 percent and 1000 percent more CO2 than waterways, respectively (US Waterways Report 2014). The Planning Commission's (2014) estimate of cost savings from modal shifts in terms of environmental costs is still valid.

Environment Cost Per Tonne-KM	
Mode	**Cost in Rs**
Road (Freight)	**0.202**
Rail (Diesel Traction)	**0.051**
Rail (Electric traction)	**0.015**
Airways	**0.690**
Coastal Shipping	**0.030**

Table 5.1 Environment Cost Per Tonne-KM

According to a RITES study on the Integrated National Waterways Transportation Grid, one litre of fuel can transport 24 tonnes over one kilometre on the road, 95 tonnes over rail, and 215 kilometres over inland waterways. "Inland water transport is recognised as a fuel-efficient, cost-effective, and environmentally-friendly mode of transportation, especially for bulk goods, hazardous goods, and over-dimensional cargos," according to the National Waterways Bill 2015, which was introduced in Parliament. It also cuts down on travel time, costs, and congestion on highways." They'll also "help create seamless interconnectivity connecting hinterlands along navigable river coasts and coastal routes," and "are likely to play a crucial role in connecting the north-eastern United States. "They'll also "help create seamless interconnectivity connecting hinterlands along navigable river coasts and coastal routes" and "are likely to play a crucial role in connecting the north-eastern states to the mainland," according to the plan.

The Indo-Bangladesh protocol facilitates export and import trade to and from Bangladesh using both NW-1 and NW-2. The riverine trade through Bangladesh facilitates trade through Assam, as domestic movements on NW-2 between Assam and Haldia/Kolkata areas pass through a significant stretch in Bangladesh and are subject to the bilateral protocol. A number of inland and river ports in Bangladesh with cargo handling facilities makes the riverine route viable. The protocol now further permits utilisation of the Chittagong and Mongla port for transit of Indian cargo and opens up the internal markets in Tripura, which is just a couple of hundred kilometres from Bangladesh.

Early signs of success in inland waterways transportation, as evidenced by increased use of the waterways for cargo movement in the North East, are expected to accelerate as infrastructure and vessels improve. The pandemic has shifted the focus of supply chains in the boardroom, where they are now seen as a source of transformational and competitive domain rather than a cost centre or a necessary evil. Supply chain resilience has become more important than ever before in any successful business model. Shippers are also

increasingly requesting single-window digital logistics management platforms to deal with customers and manage relationships.

The logistics cost differential between India (13-14 percent of GDP) and the global average (7-8 percent) is extremely high and requires immediate correction. Furthermore, transportation accounts for a large portion of the above cost (roughly 70%), which is a heavily lopsided modal mix, with

about 57-60 percent freight moving on roads, 30 percent on rail, 7% through coastal waters, 1-2 percent inland waters, and the rest in other modes (air, pipe lines, conveyors etc.) NITI Aayog's Strategy for New India at 75. At the same time, India has a plethora of coastal and inland waterways. In line with the above facts, inland and coastal water transport is to be assimilated with logistics at a greater pace due to low infrastructure and external costs.

5.3 GOVERNMENT INITIATIVES THAT ARE CHANGING THE COURSE OF INDIAN LOGISTICS

1. Sagarmala program

It focuses on port modernization and development, as well as port connectivity, coastal community support, and port-linked industrialization. The goal of sagarmala is to lower logistics costs for both international and domestic trade. It also aims to increase the proportion of water transportation in the modal mix by twofold.

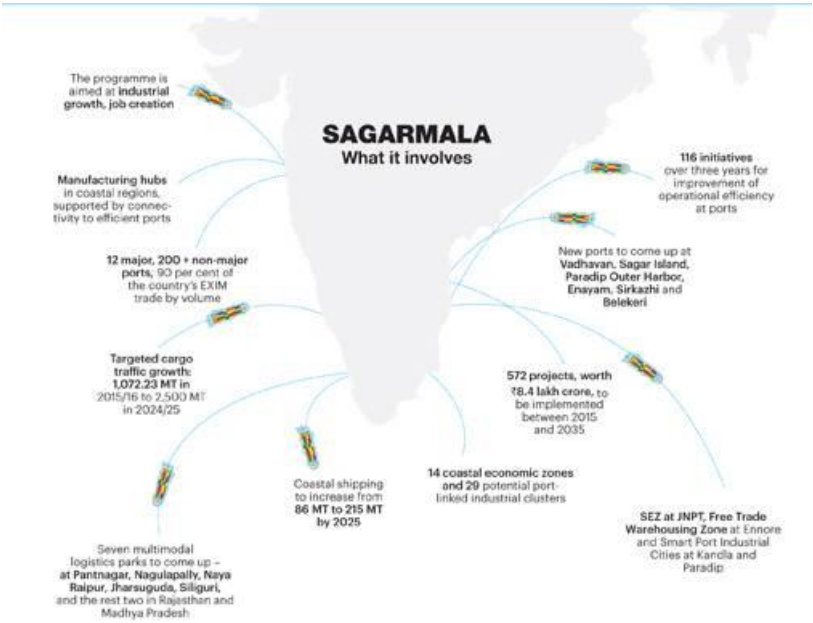


Fig .5.1 Sagarmala program

2. Jal Marg Vikas project

The Jal Marg Vikas project (JMVP) is an initiative to develop India's national waterways. JMVP was implemented as a national integration initiative with the goal of reducing rail and road congestion, carbon emissions, and resource depletion.

3. Central Road and Infrastructure Fund

The ministry of finance has amended the central road fund act of 2000 to include a list of projects and infrastructure sub-sectors for which the CRF could be used, including inland waterways. The central road and infrastructure fund has since replaced the CRF.

4. Development of Multi-Modal Logistics Parks in India

- The Multi-Modal Logistics Park (MMLP) is a freight-handling facility that will be built on at least 100 acres and will provide access to various modes of transportation. MMLP also offers storage options such as automated warehouses and cold storage, as well as customs clearance and quarantine zones.

- The Indian Ministry of Transport is currently planning a network of 35 MMLPs across the country. These parks will reduce freight and warehouse costs as well as traffic congestion.

5. GST Effects on Logistics

- The integration of multiple layers of taxes into a single one is one of the significant consequences of the Goods and Services Tax (GST) on the Indian logistics sector.
- Since the implementation of GST, there has been a significant reduction in waiting times and paperwork. It has increased vehicle utilization, reduced costs, and eliminated the need for multiple warehouse stations throughout India.
- According to the IBEF study, the logistics sector will be worth $500 billion by 2025.

6. Parivahan Portal

- Previously, different states had different policies for processing basic documents such as the Registration Certificate (RC) and the Driver's License (DL). The government wanted to standardize processes across the country so that accurate data could be shared easily between systems regardless of their location. As a result, the ministry launched two software programmers: SARATHI for driver licensing and VAHAN for vehicle registration. VAHAN provides services such as fitness, permit taxes, and registration, while SARATHI provides services such as Common Service Centre (CSC), E-Payment Gateway, and State Service Delivery Gateway (SSDG).
- All of these services are available through mParivahan, a mobile app that makes it simple to obtain information about RC, DL, and other topics. There is also an SMS alert service that keeps the user informed at all times.

7. Introduction of E-Way Bill

- An E-way bill is an electronic document generated from the E-way site that must be carried by anyone transporting a truckload valued at more than Rs. 50,000. Registered suppliers transferring goods from one state to another use the E-way bill. Its validity is primarily determined by the shipping distance.

- The E-Way bill facilitates vehicle movement across states and reduces overall turnaround time by eliminating state boundary check posts and physical paperwork. It has proven to be one of the best initiatives taken by the Indian government in recent years.

-

5.4 INLAND WATER TRANSPORT TO REDUCE OVERALL LOGISTICS COST

Inland Water Transport (IWT) is widely recognized as a cost-effective and environmentally friendly mode of transportation. One liter of fuel moves 24 tones kilometers on the road, 95 tones kilometers on rail, and 215 tones kilometers on the IWT, according to a RITES report from 2014. The following are the intermodal costs in comparison: -

Mode	Pre tax freight (Rs. per ton Km)	Post Service tax freight (Rs. per ton km)
Railways	1.36	1.41
Highways	2.50	2.58
IWT	1.06	1.06

Table 5.2 Comparative Inter Modal Costs

The significant cost savings indicate that promoting inland water transport (IWT) will have a positive impact on overall logistics cost reduction. However, compared to roads and railways, development of national waterways transportation is still in its early stages.

The Ganga-Bhagirathi–Hooghly River system (NW-1), the River Brahmaputra (NW-2) and the West Coast Canal (NW-3) have all been developed with specific depths, fixed and floating terminals, and mechanized cargo loading, unloading, and navigational aids. These waterways are used by vessels.

CHAPTER 6

DATA ANALYSIS

6.1 TRAFFIC ON NATIONAL WATERWAYS (NWs)

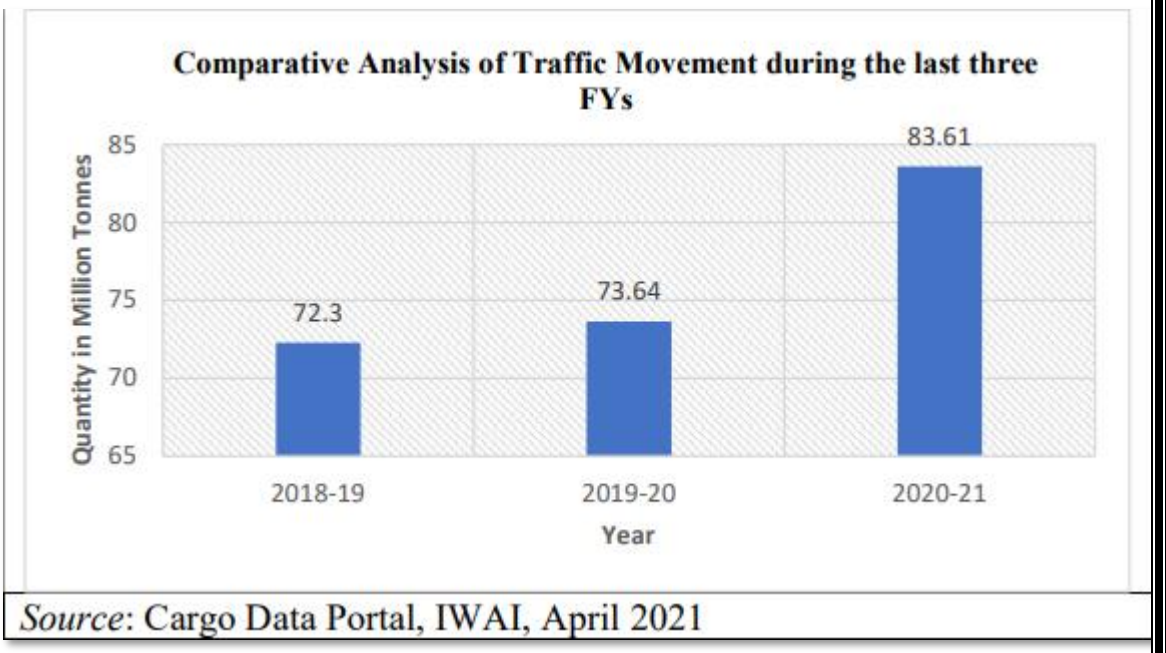


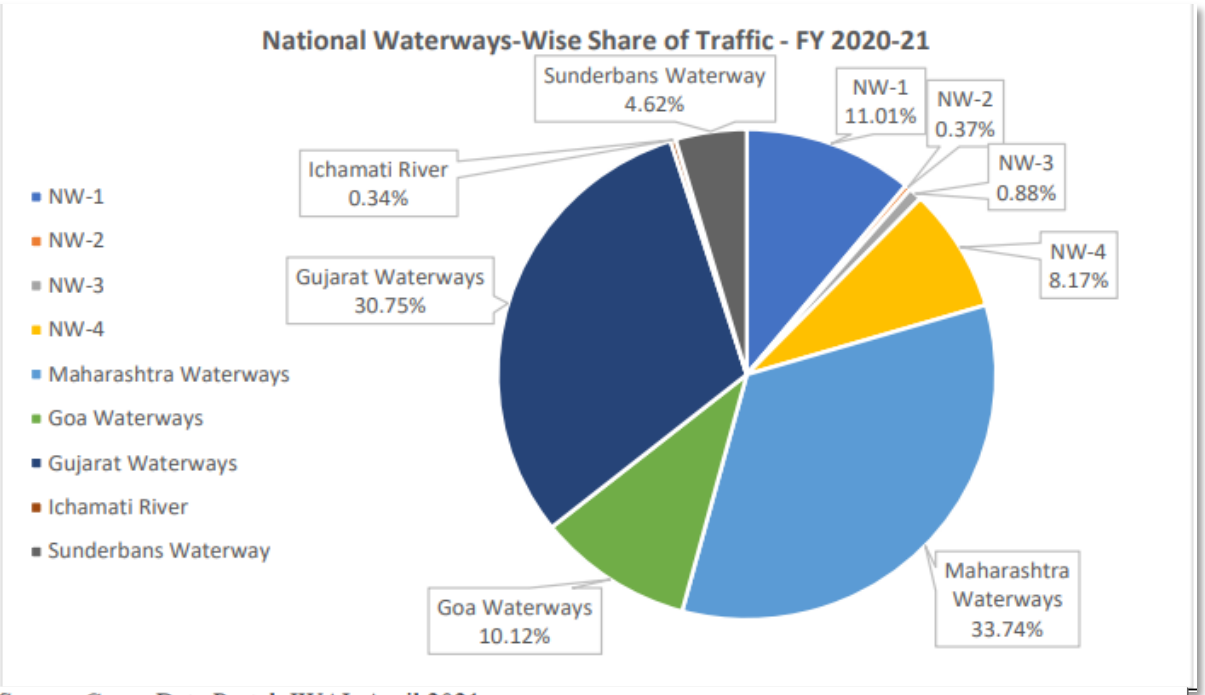
Fig 6.1 Comparative Analysis of Traffic Movement during the last three FYs

Interpretation:

Despite the pandemic, traffic on inland waterways has grown at an exponential rate of 10.81 percent with CAGR over the last four years, reaching 83.61 million tons in 2020-21. IWAI hopes to increase the modal share of freight movement via IWT from 2% to 2.5 percent by FY 2030, utilizing the potential.

The following graph depicts a comparison of cargo/traffic movement during the last three financial years: 2018-19 (72.30 MMT), 2019-20 (73.64 MMT), and 2020-21 (83.61 MMT) (6.1). Despite the pandemic, traffic movement increased by 13.54 percent in FY 2020-21, as compared to 1.8 percent in FY 2019-20.

6.2 NATIONAL WATERWAYS - wise SHARE OF TRAFFIC



Source: Cargo Data Portal, IWAI, April 2021

Fig. 6.2 National Waterways-wise Share of Traffic – FY 2020-21

Interpretation:

National Waterways-wise share of traffic during the financial year 2020-21 is mostly shared by

Maharashtra Waterways (34%) followed by Gujarat Waterways (31%), NW-1 (11%), Goa Waterways (10%), NW-4 (8%) and Sundarbans Waterways (5%). This is as presented in the following Fig. (6.2).

6.3 NATIONAL WATERWAYS- COMMODITY PROFILE OF TRAFFIC

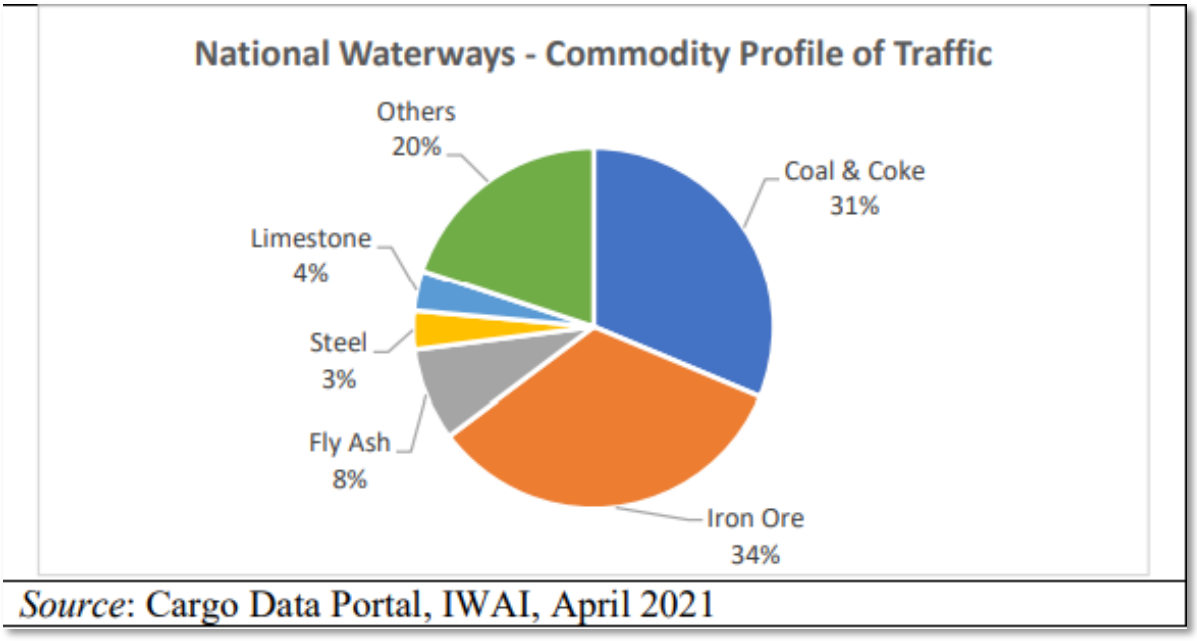


Fig 6.3 National Waterways – Commodity Profile of Traffic – FY 2020-21

Interpretation:

The most preferred commodity in the overall traffic is Iron Ore (34%) followed by Coal & Coke
(31%), Fly-Ash (8%), Limestone (4%) and Steel (3%). Others (20%) mainly includes sand, stone chips, cement, etc., as presented in Fig. (5.3).

During lockdown, 243 Bangladeshi vessels were in Indian territory, which were also sent back to Bangladesh.

6.4 LOGISTICS COSTS AS A SHARE OF GDP

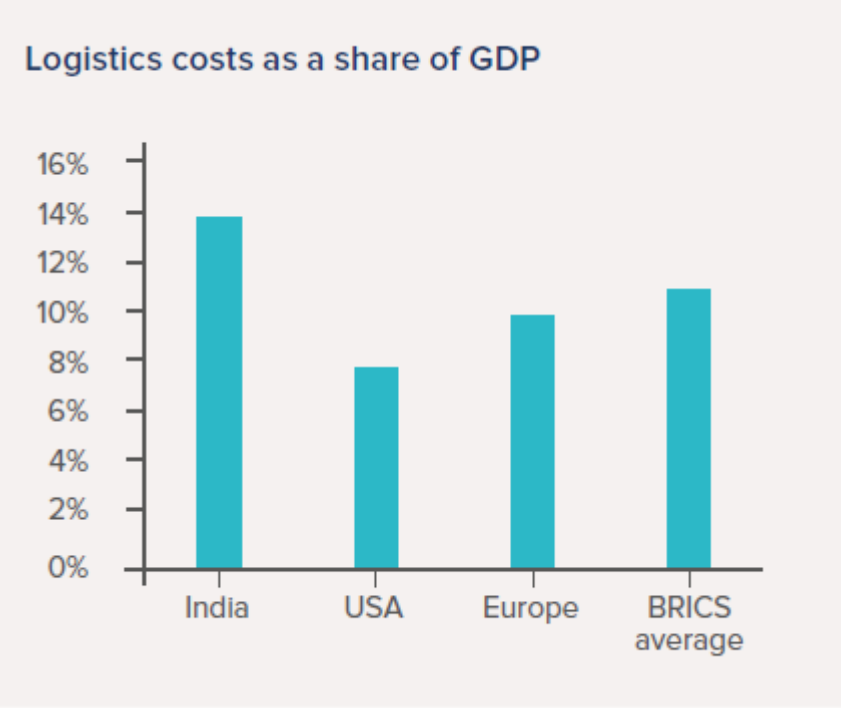


Fig. 6.4 Logistics Costs as A Share o1f GDP

Interpretation:

India's logistics cost as a share of GDP is 14 percent, which is high when compared to developed nations, where it ranges between eight and ten percent.45. Compared to the United States, road transportation costs in India are 30 percent higher, while rail and coastal are 70 percent higher.46,47 The high cost of logistics hampers the economic prosperity of the nation.

6.5 MODAL SPLIT FOR FREIGHT MOVEMENT IN INDIA IN 2020

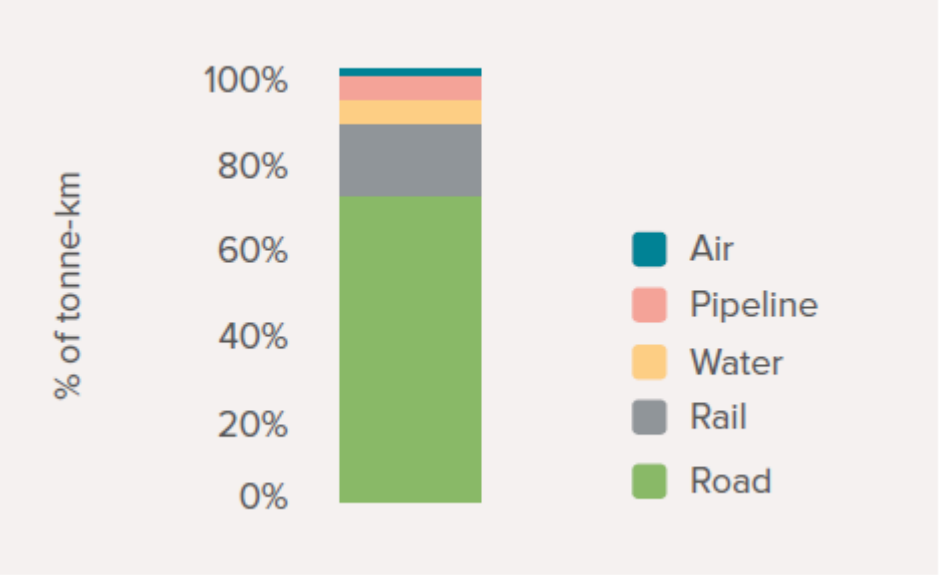
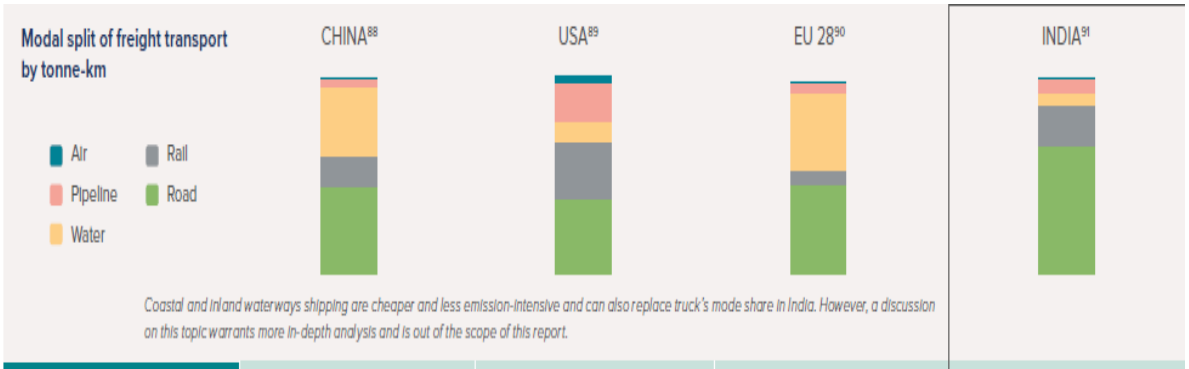


Fig 6.5 Skewed Modal Share

Interpretation:

Around 71 percent of India's freight is transported through road, and only 17.5 percent is through rail. Road transport is more energy and CO2 intensive, costly, and accident-prone than other modes for moving freight like rail and water. India's current overuse of heavy trucks lead to high costs, air pollution and excess traffic deaths, especially from overloaded trucks. If these issues grow, they put the development of the logistics system at risk.

6.6 MODE SHARE OF INDIA WITH CHINA, THE UNITED STATES, AND EU



	CHINA[88]	USA[89]	EU 28[90]	INDIA[91]
DEVELOPMENT STAGE	Developing	Highly developed	Highly developed	Developing
GEOGRAPHIC CHARACTERISTICS	• Coast on the east boundary with many large economic centres, limited inland economic activity concentrated in a few cities.	• Coasts on east and west boundaries, rural inland with several significant cities. • Substantial goods movement between west and east.	• Long coastline surrounded by the Atlantic and Arctic Oceans and the Mediterranean Sea. • Extensive network of navigable waterways.	• Coastline narrowing on the southern half boundaries. • Substantial inland economic activity and goods movement.

Fig 6.6 Modal Share with China, US and EU

Interpretations:

- **The mix between rail and water varies by country, with one mode tending to dominate based on geography and policy**: Rail makes up a high share of the USA modal split because of development of the United States Class 1 rail, which is almost entirely dedicated to freight and not capacity constrained.
- **Waterways are a dominant mode of transport for countries with high coast-to-landmass ratios or high concentration of cities near the coast**: The EU, with a high ratio of coastline to landmass, has developed an effective water freight transport system through convenient access to the Atlantic Ocean and the Mediterranean Sea. On the other hand, the United States, with a smaller coastline relative to its land mass, has developed a rail dominant mode share. China with a large landmass but economic activity concentrated on the coast, has developed a mixed mode share that uses both rail and water.
- **Mode share depends on country's policy focus**: India's logistics policies have focused on road transport. As a result, about 70 percent of freight transport is road-based in India.

6.7 COMPOSITION OF LOGISTICS COSTS IN INDIA

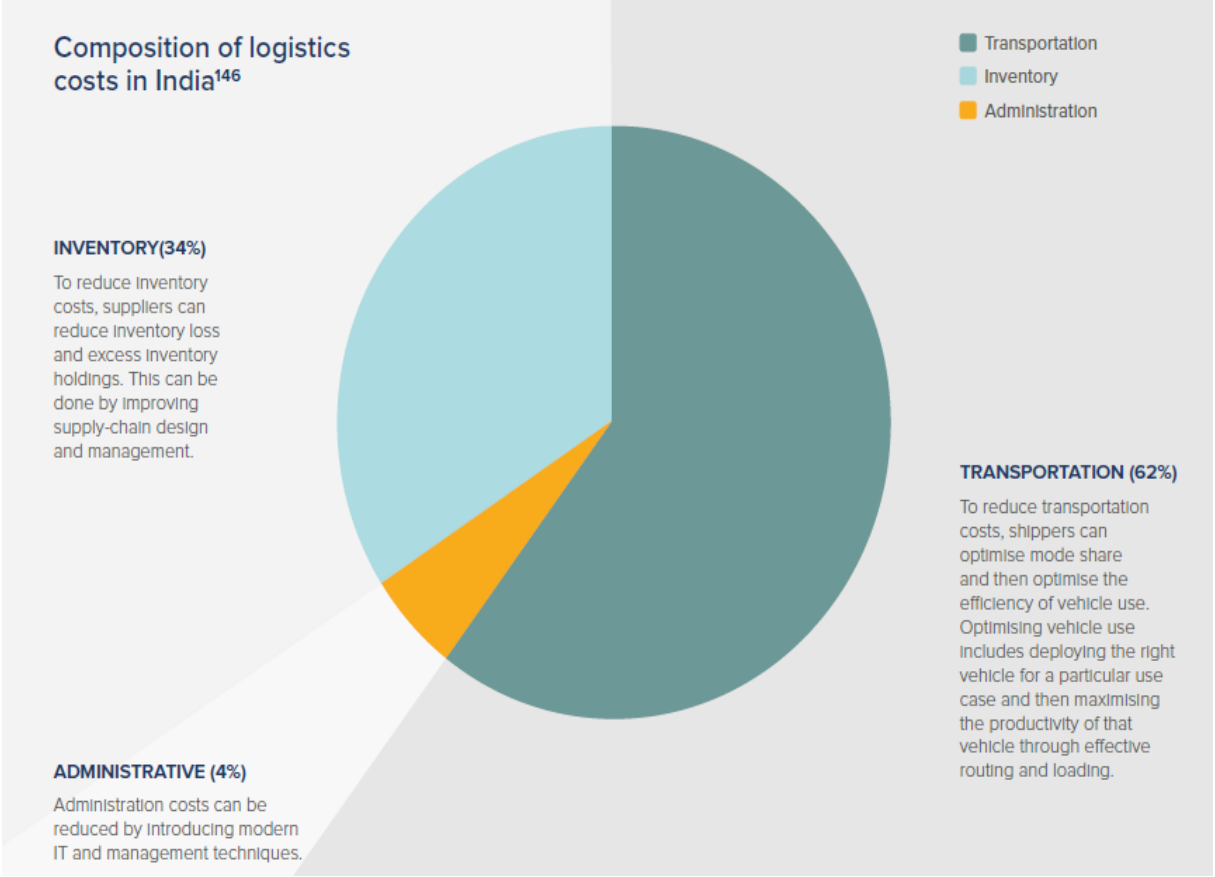


Fig. 6.7 Logistics Costs in India

Interpretations:

India's logistics costs are currently 14 percent of the GDP—higher than the United States and Europe. As shown in Figure 5.7, over 90 percent of logistics costs are attributable to transportation and inventory management (inventory holding and warehousing). To increase logistics efficiency, it is essential to increase transportation efficiency by optimizing truck use and incorporating inventory management best practices in supply chains.

6.8 CHARACTERISTICS OF VARIOUS MODES OF FREIGHT TRANSPORT

There are many modes, discussed below, by which freight is moved, each with its own strengths and weaknesses. A healthy mode share matches goods to the mode best suited for them. This minimizes cost to the final consumer as well as negative externalities such an emissions and congestion. Sometimes, the most efficient mode for transport changes over the course of a goods journey. To accommodate that, supply chain managers can change modes over the course of a shipment – a practice known as multimodal or intermodal transportation.

MODE	RAIL	ROAD	WATERWAYS	AIR	PIPELINE
Cost (INR/ton-km)	1.6	3.6	2	18 (5 times the rate of road transport)	2 (equivalent to water transport cost)
CO2 emissions (gm CO2/ton-km)	11.5	101	11	610-650	8
Route flexibility	❷	❺	❶	❷	❶
Timeliness/ quickness of transport	❷	❹	❶	❺	❶
Volume flexibility	❷		❶	❷	❶
Flexibility with respect to the type of goods	❷	❸	❶	❷	❶
Suitable use cases	Suitable for the long-haul of large, regular flows of low-to-medium-value density goods between fixed origin/destination points.	Suitable for non-bulk goods moving over shorter distances and on corridors with lower transport volumes.	Suitable for the long-haul of large, regular flows with less fragmentation along the coastline or navigable inland waterways.	Suitable for high value goods in need of urgent delivery.	Suitable for liquids and gases and any stable chemicals such as water, oil, natural gas, and biofuels.

Source: NITI AAYOG, RMI, AND RMI INDIA | JUNE 2021

The numbers indicate score between one and five.

CHAPTER 7

FINDINGS, SUGGESTIONS & CONCLUSION

7.1 FINDINGS

- A well-coordinated inland waterways network could significantly alter the country's logistics situation.

- Inland waterways in India have a significant impact on the country's transportation system. However, as other modes of transportation, such as railways and highways, have grown in importance, the importance of inland waterways has diminished.

- By moving cargo away from roads, including highways, waterways can help to relieve congestion.

- Waterways avoid the difficulties of land acquisition, which has always been a sensitive issue that has caused numerous project delays and cost overruns.

- Waterways are a less expensive mode of transportation than the alternatives, lowering the cost of goods from point A to point B.

7.3 RECOMMENDATIONS

- A well-coordinated strategy on lines of complementarity between the national network and other undesignated waterways, as well as between waterways and roadways/railways, would be required for an effective waterways network.

- Because each riverine system is unique and faces different challenges, separate studies based on a detailed micro-level review of viability must be conducted for each before implementation.

- The said strategy should investigate various undercurrents, such as competing uses/needs and possible local resistance, as well as work closely and in coordination with local governments to ensure that this important national project is implemented quickly and successfully**.**

- The government must liberalize the dredging market to attract more players, particularly international players, to engage in dredging activities in order to increase and maintain draught depth at ports, allowing them to attract large vessels and become hub ports.

- Expedite the completion of various Sagarmala projects, particularly those aimed at improving port connectivity, establishing new ports, and establishing coastal economic zones (CEZs).

- Inland vessel financing could be included in banks' priority sector lending.

- In order to increase throughput, a single-window facility for cargo clearance and fully mechanized cargo handling infrastructure will be required.

- Improve port technology and, where possible, learn from successful global ports like Rotterdam, Felix Stowe, and Singapore to increase efficiency.

7.4 CONCLUSION

Inland and coastal waterways are becoming increasingly integrated with transportation networks and logistics chains. The effectiveness of inland waterways as a cost-effective, fuel-efficient, safe and secure mode of transportation for goods and passengers has sparked renewed interest. Several countries have launched projects to develop inland waterways and invest in related infrastructure. With rising demand, the IWT authority is working hard to improve its efficiency and provide better and improved services. Inland water transportation has a significant economic, social, and environmental impact on the region. If proper planned development and innovations are done with the introduction of improved technology, it can become a very good alternative to rail and road transportation, reducing the pressure on it very effectively. If the inland waterways are to emerge, a number of planned steps must be taken.

Multimodal, seamless transportation and just-in-time delivery of a diverse range of cargo over short and long hauls are supported by smart and intelligent logistics solutions. High-throughput intermodal corridors will be able to compete on price, lead time, and distance with traditional surface transportation, and will be able to create more rural employment opportunities. In the realm of an integrated logistics platform, inland and coastal container barging plays a significant role. IWT can be viewed as a maritime hinterland land mode shipping operation in shallow waters rather than a mini maritime division, and it can take the lead in technological and operational innovations. An Indian version of the Marco Polo funding programmed could help accelerate modal shifts.

This option of developing the waterways in conjunction with available depths and the natural flow of the rivers should also be critically examined, according to the findings. It is necessary to establish a legal framework that makes the assessment of appropriate environmental and social impacts mandatory. Even though a variety of issues impede the development and progress of these waterways and create obstacles, the study shows that these can be overcome to a large extent by implementing a variety of innovative and technological advancements.

BIBLIOGRAPHY

A. BOOKS

- Breeze, F. (2002). The globalization of the oceans: Containerization from the 1950s to the present. St. Johns, NF, Canada: International Maritime Economic History Association.

B. WEBSITES

- https://iwai.nic.in/
- http://www.allprojectreports.com/CBSE-HBSE-School-Projects/Biology-Project Report/meaning-of-transport-sources-modes-air-water-uses.htm
- https://www.insightsonindia.com/indian-economy-3/infrastructure/water-transport-in-india/
- https://iwai.nic.in/sites/default/files/1013443659FAQ%20JMVP%20Final%20PDF.pdf
- https://issuu.com/sanjaykumarguptaa/docs/project_report_on_airways_as_a_mode_of_transportat
- https://spb.kerala.gov.in/sites/default/files/inline-files/1.34Inland%20Water%20Transport%2010052017.pdf
- https://www.cogoport.com/blogs/complete-guide-to-road-rail-barge-transport-what-exporters-importers-need-to-know
- https://maritimeindia.org/indias-emerging-quest-to-develop-inland-waterways/

C. ARTICLES

- UNCTAD, How Covid19 is changing the global value chains, Sept 2020
- MOs, Report of the Committee on Standards for coastal & inland vessels, January, 2014
- Niti Aayog, RMI, And RMI India, Fast Tracking Freight in India - A Roadmap for Clean and Cost-Effective Goods Transport, June 2021.