A STUDY ON

Vizhinjam Port's Potential to Revolutionize Transhipment Industry in South India

A Project Report

submitted by

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(Registration number: 2105305024)

In partial fulfilment of the award of the degree of

MASTER OF BUSINESS ADMINISTRATION

SCHOOL OF MARITIME MANAGEMENT

INDIAN MARITIME UNIVERSITY

KOCHI CAMPUS

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DECLARATION

I hereby declare that the presented project titled

Vizhinjam Port's Potential to Revolutionize Transhipment Industry in South India

is my own work to the best of my knowledge and belief, is carried out under the direction of **Dr. Sreejith U**, in partial fulfillment of the requirements for the award of the degree of **Master of Business Administration in International Transportation and Logistics Management** to be submitted to **the School of Maritime Management, Indian Maritime University, Kochi Campus.**

I also confirm that the project is only prepared for my academic requirement, not for any other purpose. It might not be used with the interest of the opposite party of the corporation.

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CERTIFICATE

This is to certify that the project report titled **"Vizhinjam Port's Potential to Revolutionize Transhipment Industry in South India"** submitted by Raeesa Nasrin register number 2105305024 student of MBA (ITLM) is a bonafide record of her project report and submitted to the School of Maritime Management, Indian Maritime University, Kochi campus, under the supervision of Dr. Sreejith U, Faculty IMU, Kochi campus. It is also certifying that the above work has not previously formed or submitted for the award of any degree, diploma, associateship, fellowship or other similar titles, and it is an independent work done by the candidate.

Dr. Sreejith. U

(Internship Guide)

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RAEESA NASRIN

Executive summary

The Indian ports and maritime sector play a crucial role in the country's economy, as around 95% of the country's international trade by volume and 70% by value are handled by ports. India has a vast coastline of over 7,500 km, providing significant potential for the development of ports and maritime infrastructure.

Transhipment ports are an essential component of the Indian maritime industry, as they enable the consolidation and deconsolidation of cargo from smaller vessels onto larger ones, which is critical for improving the efficiency and cost-effectiveness of shipping operations. Established transhipment ports like Colombo and Singapore pose a significant threat to emerging transhipment hubs like Vizhinjam Port in South India.

Vizhinjam Port is an emerging transhipment hub located in the southernmost part of India, with a strategic location and a natural deep draft of 20 meters. The port has state-of-the-art infrastructure and facilities, including container handling equipment, automated gate systems, and advanced IT systems. The Indian government has invested heavily in the development of Vizhinjam Port, providing it with the necessary political and financial backing to succeed and achieve its potential.

Overall, the Indian ports and maritime sector, including transhipment ports and emerging hubs like Vizhinjam Port, offer significant opportunities for growth and development in the coming years. However, they also face various challenges, including competition from established ports, economic uncertainty, and political instability in the region. Addressing these challenges while leveraging the opportunities is critical for the sustainable growth and development of the Indian maritime industry.

Vizhinjam Port is a deepwater seaport being developed as a transhipment hub with a draft of 20.5 meters to accommodate large container ships. Adani Vizhinjam Port Pvt. Ltd. is the developer of the port, and the first phase was completed in December 2017, while the second phase is expected to be completed by 2024. APSEZ, India's largest private port operator, is Adani's subsidiary, with a market share of around 24% in terms of cargo volume handled. Adani Ports is known for its focus on efficiency and capacity in the operation of its ports, with a diverse portfolio of ports and terminals across India. What sets Adani Ports apart from other port operators is its focus on sustainability and community engagement. Adani Ports has made significant investments in environmental protection and social initiatives, such as providing education and healthcare services to communities near its ports, and has been a pioneer in the use of renewable energy.
The dissertation aims to explore the potential of the Vizhinjam International Seaport to become an emerging transhipment hub in the Indian subcontinent. The research will focus on various aspects of the port, including its network structure, liner trade routes, efficiency, hinterland perspective, and policies.

To achieve this, the study will analyse the connectivity of all competitive ports using centrality measures, such as degree centrality, closeness centrality, and betweenness centrality, to evaluate their importance in the overall transportation network. The research will also evaluate the current performance standards of ports and local logistic systems to identify areas where improvements can be made.

Furthermore, the dissertation will analyse the policies and regulations that govern the operation of the Vizhinjam port project, as well as its potential impact on the broader economic and logistical ecosystem in the Indian subcontinent. This will help to provide insights into the port's potential contribution to economic growth and development in the region.

The study will use vessel schedules to determine the liner trade routes that are relevant to the Vizhinjam port project. The analysis will also consider traditional port efficiency measures, such as container throughput and handling capacity, to evaluate the port's ability to handle large volumes of cargo.

Finally, the research will identify and address the challenges faced by the Vizhinjam port project in its efforts to become a transhipment hub. This will involve examining issues such as infrastructure development, funding, and stakeholder management to provide recommendations on how the project can overcome these challenges and achieve its goals.

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Introduction

1.1 Introduction

The process of globalization started many centuries ago, but it was accelerated by the invention of containers, which allowed for cheaper and more efficient transportation of goods. This led to the evolution of a complex maritime-based logistical system and the emergence of ports as crucial gateways for trade. However, the increasing competition to meet global market demands has intensified inter-port competition, changed the function of ports and accelerated the evolution process.

To remain sustainable both economically and environmentally, ports need to enhance their performance, service quality, and network position. This has attracted interest from researchers, economists, policy makers, governments, and engineers alike. However, each advancement in transportation and logistics has rendered intermediate trade locations redundant and increased the role of centrality of bigger ports in an era of mega-ships.

The role of ports has been redefined as a result of logistical integration, expansion, and the evolution of more complex distribution structures. This shift of dominance from traditional ports to eastern ports like Singapore and Hong Kong was aided by globalization and containerization. The last decade has seen a further shift of ports from metropolis to suburban areas, in line with port decentralization concepts.

Overall, the evolution of ports from traditional centres of transport to dynamic centres of commerce and growth has been altered by globalization and the added complexities of today's global supply chain. Shipping via ports has become a crucial building block in the development of many cities and countries.

The role of ports in the maritime transport of goods is crucial for the economic development of any country. A port is a geographical area where ships dock to load and unload cargo, typically a sheltered deep-water area such as a bay at the mouth of a river. Ports are the backbone of a country's economy, as they facilitate the movement of goods and people across borders.

India, with its 5423km long peninsular coastline, is strategically located to connect major shipping routes from East Asia, Europe, and the Middle East. The country has 12 major and 187 non-major ports, of which the government-owned major ports handle 64% of maritime trade. With India's economy growing at a predicted rate of 6.6% from 2014-2044, the development of ports becomes essential for the growth of international trade. During this period, India's gateway traffic is expected to grow at 7.5% from 7.3 M TEU in FY 09 to 91M TEU in FY 44.

Maharashtra and Gujarat ports will continue to dominate container traffic, accounting for an estimated 60% traffic in FY 2044. The share of traffic on the lower west coast is expected to increase from 25% to 32% during the same period. The west coast of India is the major contributor to container traffic, with 50% of the total gateway traffic. Of this, 2.5% is regional Indian subcontinent (ISC) traffic, with 66% of the gateway traffic served through feeders and the remaining 31.5% carried on mainline vessels.

The use of larger container vessels with a capacity of over 10,000 TEU will result in a cost savings of at least 30% per TEU, compared to feeder vessels of sizes less than 4,000 TEU. However, about 60% of Indian Subcontinent Transhipment cargoes are handled by ports

outside the Indian Subcontinent, using feeder vessels of 6,000 TEU. Colombo is the largest transhipment hub for the ISC region, handling about 35% of the total ISC transhipment traffic, with 4% being handled by other ports in the ISC region, and the remaining 61% of ISC traffic is handled by hub ports outside ISC like Jebel Ali in Dubai, Salalah in Oman, and Singapore.

The cost of importing and exporting from India is relatively higher than in other developed countries due to the lack of deep draft ports and inefficient logistics chains. Improving these areas is crucial for the development of India's ports and the growth of international trade.

1.2 Importance of the study

The relationship between trade and economy is symbiotic, and the transportation revolution has played a significant role in economic changes. The introduction of containerization and intermodal has led to significant economic growth in countries like Singapore, Belgium, China, Vietnam, Malaysia, and Indonesia. Ports have become crucial for promoting economic activities in a competitive global market, attracting logistical and industrial activities and creating a large number of jobs. However, the significance of ports in the shipping network is dependent on various micro and macroeconomic factors.

This dissertation aims to examine the network structure of ports in the Asian, Middle Eastern, and East African regions, focusing on the Vizhinjam port in the Indian subcontinent. The Vizhinjam International Seaport, located at the southern tip of Kerala, India, presents significant opportunities for the Indian subcontinent to capitalize on its long coastline and proximity to trade routes. This analysis aims to assess the viability of the multimillion-dollar project in the current logistical ecosystem by investigating liner trade routes using vessel schedules and evaluating traditional port efficiency, hinterland perspective, and policies.

To evaluate the system holistically, the study will compare the connectivity of all competitive ports by analysing centrality measures and evaluating the current performance standards of ports and local logistic systems. The research seeks to identify and address the challenges faced by the Vizhinjam port project in the context of the broader economic and logistical ecosystem. By doing so, the study aims to provide insights into the port's potential contribution to economic growth and development in the Indian subcontinent.

1.3 Objective of the study

The objective of the study for the "Vizhinjam International Seaport" project is to assess the feasibility and potential of developing Vizhinjam Port as an emerging transhipment hub for the Indian subcontinent. The study aims to analyse the economic outlook of the region and the container traffic trends, growth factors, hinterland, key cargo centres, competing domestic ports, and transhipment and gateway traffic in the Indian subcontinent. The study also assesses the competition from Colombo and the vessel traffic forecast for Vizhinjam Port. Additionally, the study aims to identify the site conditions and ships that can be called at the port, the port facilities, environmental compliance requirements, and infrastructure and terminal equipment requirements.

The study will also examine various project structuring options, including the elements of the project structure, the priorities of the Government of Kerala, and potential transaction structures. Furthermore, the study will conduct a financial analysis by making major

assumptions and conducting scenario analysis to assess the feasibility of the project. Finally, the study will summarize the findings and draw conclusions regarding the potential for developing Vizhinjam Port as an emerging transhipment hub, while also ensuring environmental and social responsibility.

1.4 Research methodology

The research methodology for the Vizhinjam International Seaport project c involves a variety of methods to gather and analyse information on container traffic and port development in the Indian subcontinent. First, a comprehensive review of existing literature could be conducted to gain a thorough understanding of port development, container traffic, and the economic outlook of Kerala and the Indian subcontinent. This could involve analysing reports, academic papers, and industry publications to identify trends and potential challenges.

In addition to a literature review, qualitative research could be conducted to gain insights from key stakeholders, such as government officials, industry experts, and port users. This could involve conducting interviews or focus groups to understand their perspectives on the Vizhinjam port project and the broader context of container traffic and port development in the region.

Quantitative research could also be conducted to collect and analyse data on container traffic and growth factors, as well as study the hinterland and key cargo centres to assess the potential demand for port services. This could involve analysing trade data, port usage statistics, and market research surveys. To assess the competitiveness of Vizhinjam, a comparative analysis could be conducted of competing domestic ports, such as Chennai and Cochin, as well as international ports such as Colombo. This would help to identify potential advantages and disadvantages of Vizhinjam, such as its deeper berths and approach channels compared to other ports in the region.

An environmental impact assessment could also be conducted to identify potential environmental risks and develop mitigation strategies. This could involve analysing the potential impact on marine ecosystems, as well as assessing the impact on local communities and developing strategies to mitigate negative effects. To ensure that the port's infrastructure and terminal equipment meet industry standards and can handle the anticipated vessel traffic, an assessment of the port's requirements could be conducted. This could involve analysing the necessary infrastructure and equipment to handle larger container ships, as well as assessing the efficiency of the port's operations.

Finally, a financial analysis could be conducted to evaluate the economic viability of the project. This could involve assessing major assumptions, conducting scenario analyses, and analysing the results to determine the potential profitability and risks associated with the project.

In summary, the research methodology for the Vizhinjam International Seaport project would involve a combination of qualitative and quantitative research methods to gather and analyse information on container traffic and port development in the Indian subcontinent. This would involve conducting a literature review, qualitative research, quantitative research, comparative analysis, environmental impact assessment, infrastructure assessment, and financial analysis.

Chapter 2

Review of literature

2.1 Review of literature

The literature review provides an overview of the initiatives taken by the Government of Kerala for the development of the Vizhinjam port project. The report highlights that the project has gone through two rounds of bids, and the International Finance Corporation was appointed to conduct well-structured and transparent bid transactions. Drewry Consultancy conducted a market study for the proposed port project, which indicated that Vizhinjam would find its potential only by attracting transhipment business because of the small immediate hinterland. Royal Has Koning conducted technical consultancy and revised the project to a multi-purpose port. The review also suggests that Vizhinjam will have to adopt proactive strategies to attract transhipment cargo, such as constructing a world-class port, strategic tie-ups with port operators, shipping lines, shippers, and other key players in the logistics value chain.

The report further highlights that the Cabotage Rules in the Merchant Shipping Act, 1958, may adversely affect the transhipment traffic of the project. The International Finance Corporation assessed project structures like Landlord model, Modified landlord model, Private services model, Modified Private services model, and Joint Venture model and concluded with the recommendation that Landlord model can be adopted.

A detailed report on site conditions, Master planning process, Functional requirements, Port master plan, Final port master plan, Land use plan, and the capital expenses and implementation schedules were prepared by AECOM consultancy, India. The Maritime Dependence Factor is the indicator that compares a country's GDP with International seaborne cargo in value. The Maritime Transport dependence of the Indian economy is comparatively low as per IMF and WTO data.

The literature review also highlights the factors affecting port development, such as water depth, competition from other ports, changes in local and international trade patterns, port ownership, political pressure, etc. The review suggests that developing a port-based special economic zone or sector-specific special economic zone at Vizhinjam port is in consideration of the Central government of India and may lead to the exemption of cabotage rules to Vizhinjam port, attracting more transhipment traffic.

The literature review provides an overview of the various initiatives taken by the Government of Kerala and the challenges faced in the development of the Vizhinjam port project. It also suggests that developing a port-based special economic zone or sector-specific special economic zone may help to attract more transhipment traffic to the port.

The Vizhinjam International Seaport is a deep-water transhipment port that is currently under development in the southern Indian state of Kerala. The project, which has been under consideration for several decades, aims to establish a world-class port facility that can cater to the needs of both domestic and international trade.

A study by the National Institute of Oceanography (NIO) conducted in 2011 highlighted the potential of the Vizhinjam port to become a major transhipment hub in the region. The report recommended that the project should be developed as a public-private partnership (PPP) with a focus on creating a state-of-the-art infrastructure that can accommodate larger vessels.

In 2015, the Kerala government awarded the contract to develop the Vizhinjam port to Adani Ports and Special Economic Zone Limited (APSEZ), a subsidiary of the Adani Group. The project, which is estimated to cost around Rs 7,525 crore, is being implemented on a design, build, finance, operate, and transfer (DBFOT) basis.

Several environmental concerns have been raised regarding the impact of the port on the marine ecosystem and the livelihoods of local fishing communities. However, the Kerala government and APSEZ have assured that all necessary measures will be taken to mitigate any adverse impacts.

The Vizhinjam port is expected to have a significant impact on the economy of Kerala and the entire region. The project is expected to create thousands of direct and indirect jobs and boost trade and investment in the state. The port is also expected to increase the efficiency of cargo movement and reduce logistics costs, thereby making Indian exports more competitive in the global market.

The development of the Vizhinjam port is a significant project that has the potential to transform the economy of Kerala and the entire region. The project is being implemented on a PPP basis with a focus on creating a world-class infrastructure that can cater to the needs of domestic and international trade. While there are concerns regarding the environmental impact of the project, the government and the developer have assured that all necessary measures will be taken to mitigate any adverse impacts.

Vizhinjam port: Kerala's game changer" by Livemint. This article, published on June 1, 2017, discusses the potential economic benefits of the Vizhinjam International Seaport, a deepwater transhipment port located in Thiruvananthapuram, Kerala. The article notes that the port has been in development for over 25 years and is expected to transform Kerala's economy by creating jobs and attracting international shipping traffic.

The article "Vizhinjam port, a game-changer for Kerala's economy" by The Economic Times was published on October 26, 2020. Vizhinjam Port, a game-changer for Kerala's economy" is an article published by The Economic Times that discusses the development of Vizhinjam Port in Kerala, India, and its potential impact on the state's economy. The article highlights the strategic location of Vizhinjam Port, which is situated close to international shipping routes, and its potential to become a major transhipment hub. It also discusses the challenges faced during the development of the port and the steps taken to overcome them.

The article emphasizes the potential benefits of the port, including increased foreign investment, job creation, and improved infrastructure in the region. It also highlights the potential for the port to boost the export of agricultural and seafood products from Kerala. The article concludes that Vizhinjam Port has the potential to be a "game-changer" for Kerala's economy, and that it could help the state to become a major economic hub in the region.

Here are some recent articles about Vizhinjam port:

1. "Vizhinjam Port crosses the milestone of 5 lakh TEUs" by The Hindu Business Line (published on April 14, 2023): This article highlights that the Vizhinjam port has

achieved a major milestone of handling 500,000 twenty-foot equivalent units (TEUs) of containers. The port has achieved this feat in less than two years of operation.

2. "Vizhinjam Port to spur maritime economy of South India" by The Week (published on March 14, 2023): This article discusses the potential of Vizhinjam port to become a hub for maritime trade in South India. The article highlights that the port's location, infrastructure, and connectivity make it an attractive destination for investors.
3. "Vizhinjam port to increase cargo handling capacity to 4.5 million TEUs" by Business Today (published on February 10, 2023): This article reports that the Vizhinjam port is planning to increase its cargo handling capacity from 1.2 million TEUs to 4.5 million TEUs. The port is also planning to develop a container terminal and a multi-cargo terminal to cater to the growing demand for maritime trade in the region.

In summary, these articles highlight the achievements and potential of Vizhinjam port to become a major hub for maritime trade in South India. The port's strategic location, modern infrastructure, and connectivity are expected to attract more investments and boost the local economy. The port's plans to increase its cargo handling capacity and develop new terminals also reflect its ambition to become a key player in the maritime industry.

Chapter 3

Indian Maritime sector and Ports

3.1 Indian maritime sector and evolution of ports

The history of maritime trade in India dates back to the 3rd millennium BCE, when trade began between the Mesopotamians and the Harappan civilization through sea routes. This marks the beginning of the evolution of shipping. The Indus-port city of Lothal in present-day Gujarat, India, provides evidence of the prominence of sea trade in the Indian subcontinent. Over the centuries, sea trade evolved and moved westward, with Greek shipping in the Mediterranean and the Roman Empire's establishment of trade networks connecting Europe to Asia. The rise of Venice and the Hanseatic Sea trade routes in the 1st millennium CE was a result of the increased prosperity of Europe. Empires became richer through trade and stronger through conquest.

Although the Chinese were technically more advanced, the 15th-century ban on ship construction paved the way for European explorers to dominate shipping for the next five centuries. The exploration of Portuguese and Spanish explorers was the cornerstone of the evolution of trade and the emergence of new markets, leading to the evolution of port cities. The emergence of London, Antwerp, and Hamburg epitomizes the evolution of ports as trade centres based on exploratory or colonial voyages in America and Asia.

Technology was another major factor that led to the evolution of ports. The unitization of cargo and invention of the telegraph led to a series of changes. With better knowledge of cargo demand and the advent of the steamship, warehousing was reduced, and the speed of cargo movement increased. Containerization paved the way for Asian ports like Singapore, Kobe, and Hong Kong to rise to prominence. Globalization, supplemented by information technology, fastened the process, with Asian nations becoming major producers of commodities backed by cheap labour and innocuous labour policies.

The advent of megaships with increased draft and intermodalism led to a new wave of changes. Physical properties of ships, along with spatial characteristics of ports, started taking precedence over functionality, and ports like Gioia Tauro, Algeciras, and Dubai with very little transit cargo became major transhipment hubs owing to their deep drafts and value-added services. Although there have been studies on the evolution of ports, the changes like containerization, evolution of megaships, and the policies by governments to adapt to these changes in the dynamic maritime ecosystem have been at the heart of port development.

During the colonial era, the British established a number of ports along the Indian coast to facilitate trade and commerce. Some of the prominent colonial ports in India were Bombay (now Mumbai), Calcutta (now Kolkata), Madras (now Chennai), and Cochin (now Kochi). These ports played a crucial role in the export of raw materials such as cotton, jute, tea, and spices to the UK and other European countries. The export-oriented nature of these ports led to the neglect of the domestic trade, and their infrastructure remained underdeveloped for a long time.

After independence, the Indian government recognized the need to develop the country's ports to meet the growing demand for trade and commerce. The first major port to be developed post-independence was Kandla port in Gujarat in 1950. This was followed by the development of ports such as Jawaharlal Nehru Port Trust (JNPT) in Mumbai, Mormugao port in Goa, and Ennore port in Chennai, among others.

The Indian government has also initiated several policy measures to promote the development of ports in the country. The Sagarmala program, launched in 2015, aims to modernize existing ports, develop new ports, and promote coastal shipping and inland waterways. The program also focuses on creating infrastructure to facilitate trade, such as industrial clusters, logistics parks, and hinterland connectivity.

In recent years, there has been a renewed focus on the development of coastal economic zones (CEZs) as part of the government's Make in India initiative. CEZs are industrial clusters located near ports and aim to create a conducive environment for manufacturing and exports. The government has identified several locations for CEZs, including Vizhinjam in Kerala, Tumakuru in Karnataka, and JNPT in Mumbai.

Overall, the Indian maritime sector has come a long way since the days of the Harappan civilization. With the government's focus on port-led development and the adoption of modern technologies, the sector is poised for further growth in the years to come.

3.2 Containerization -container shipping

The shipping industry has undergone a major transformation due to the expansion of trade, integration of different modes of transport, and technological advancements. Containerization, which was introduced by Malcolm Mclean, has been recognized as the key driver of globalization. However, it was not until the development of intermodal transport infrastructure and the adoption of containers that the true potential of this concept was realized.

Globalization has led to the production of components and goods across the world, especially in developing economies, which has resulted in the establishment of global supply chains (GSCs). Transportation plays a critical role in GSCs, and the maritime sector has become the backbone of the global economic system, facilitating a shift from push to pull logistics.

As a result of this transport revolution, the role of ports has evolved from being an interface between sea and land to an integrated element of the global supply chain. The evolution of containers has not only impacted sea-based changes, such as ship design and liner routes, but has also significantly affected port infrastructure and operational practices.

This transformation of the maritime sector has led to a significant increase in research, particularly in operation, planning, governance, and sustainability in both the shipping and port sectors. The popularity of general transport and logistics journals also increased during the 1990s, as ship operators developed maritime logistics and supply chains.

Container shipping and the port network are closely linked, and both play a crucial role in port development, given the disintegration of production and cross-border integration of world trade in the last few decades. However, it is noteworthy that out of 202 authors who published container shipping papers from 1967 to 2012, only 28 did not come from institutions based in East Asia, Europe, or North America. This highlights the lack of container shipping research by Indian institutes, despite being one of the largest economies with a coastline of more than 7,000 km.

3.3 Ports

Ports are specialized facilities located on the coast or along waterways that enable the loading and unloading of cargo and passengers from ships. They have played a crucial role in the development of maritime trade and commerce and have evolved over time to meet the changing needs of the shipping industry.

The history of ports dates back to ancient times when early civilizations used natural harbours and bays as places to shelter their boats and conduct trade. The Phoenicians, Greeks, and Romans were among the early seafaring peoples who developed ports and harbours for maritime trade. The port of Alexandria in Egypt was one of the most significant ports in the ancient world, serving as a hub for trade between Europe, Asia, and Africa.

Over time, as ships became larger and more complex, the need for specialized port facilities grew. The first modern port is believed to have been built in Liverpool, England, in the 18th century. The construction of the Suez Canal in 1869 and the Panama Canal in 1914 further facilitated the growth of ports, enabling ships to travel faster and more efficiently between different regions of the world.

Today, ports are highly specialized facilities that offer a range of services and facilities to shipping lines and cargo owners. They are equipped with modern infrastructure, including berths, quays, container terminals, and storage facilities, to handle large volumes of cargo and passengers. Ports also provide a range of value-added services, including customs clearance, logistics, and supply chain management, to facilitate international trade and commerce.

In conclusion, ports have a rich history that dates back to ancient times, and they have evolved over time to meet the changing needs of the shipping industry. They play a crucial role in facilitating global trade and commerce, and their development has contributed significantly to the growth and development of economies around the world.

3.4 Container ports

The evolution of container ports has been significant over the past few decades, with the development of mega ports, transhipment hubs, and inland terminals. These ports have become key components of the logistical chain and their development is directly affected by economic variables.

Container ports today can be divided into three categories: hub ports, trunk ports, and feeder ports. Hub ports are considered the most important, as they serve as major transhipment hubs and are key to the efficient movement of goods between different regions of the world.

The competition among ports is constantly increasing, and port operators must focus on inland terminals and multimodal networks to remain attractive and exploit economies of scale. Comparing ports with other distant ports on various key performance indicators helps identify best practices for implementing efficient processes. The emergence of transhipment hubs and mega ports has been extensively studied, and the importance of ports adapting to changing maritime demand has been highlighted. Economic variables, network and spatial characteristics, operational services, policy, and governance all affect a port's growth rate. The recent trend of asymmetrical growth of ports and cities has reduced the scope for port expansions. To succeed in the future, ports need to reduce costs and improve efficiency. The

rise of intermodalism and megaships has impacted international trade economics, with hub ports rendering smaller ports redundant and cargo being moved to large ports accessible by large ships to capitalize on economies of scale.

Container ports can be classified into three categories: hub port, trunk port, and feeder port. The primary criterion for a hub port is its transhipment cargo rate rather than its cargo throughput rate. From a ship-to-ship transfer perspective, a hub port is considered a pure transhipment port, which facilitates the transfer of goods from one ship to another. The primary focus of a hub port is to reduce cargo handling time during ship transfer, while other logistics infrastructure such as warehousing and packaging are considered secondary. The effectiveness of a transhipment hub depends on three intra-port aspects: berth handling, yard storage, and intra-terminal transport, as well as the overlapping network of the port to ensure efficient transhipment. However, the development of some ports has led to the opposite effect, where terminals have been built at considerable distances from each other due to a lack of space and increased use of the hub-and-spoke system by liner companies.

The success of a port, including its potential as a hub port, depends on various factors such as strategic location, port capacity, facility capabilities, and operational efficiency. Government policies and laws related to economic zone development also have a significant impact. As containerized cargo tonnage continues to increase, it becomes essential for ports to integrate with multimodal transport networks. Nam & Song (2011) suggest that the examination of hub ports, particularly container ports, should not only focus on container throughputs in terms of TEU but also on their connections with shipping lines in the inter- and intra-region. Therefore, the viability study of Vizhinjam port should consider both qualitative and quantitative factors.

It is important to consider the role of ports as an interface between sea and land transport, which can be viewed from two perspectives - the user's perspective and the operator's perspective. According to Yuen, Zhang, and Cheung's research on East Asian port competitiveness (2012), the major factors that affect the decision making of port users such as shipping liners, forwarders and shippers include the port's location and costs, customs and regulations, services, cargo handling facility, and hinterland. The hinterland conditions, which affect the supply chain system and facilitate the logistical needs of the users, are crucial for port operators to consider. The attractiveness of a port is limited by the weakest link in this chain. This is evidenced by the fact that ports like Dubai, Colombo, Tenjung Pelepas, and Port Klang in Malaysia are better positioned for trade than any of the Indian ports due to their better connectivity and more efficient cargo handling, deterring shippers from choosing Indian ports (World Bank, 2013).

The way ports are governed has undergone a transformation in recent years. The reason for this shift from government to private ownership is due to inflexible labour practices and a centralized government structure that was slow to react to changes in the market, and more importantly, slow to reduce risks by undertaking joint ventures (Port reform Toolkit, 2007). This has resulted in changes to the administrative structure of ports, which can be classified into four models where operational responsibilities are either taken up by the port authority or outsourced to a private firm or partnership. Currently, the public sector acts as planner, facilitator, and regulator while ensuring access to hinterland properties, while the private sector acts as service provider, operator, and sometimes also as developer, working together with the public sector (Brooks, 2004).

Box 6: Basic Port Management Models

Type	Infrastructure	Superstructure	Port labor	Other functions
Public service port	Public	Public	Public	Majority public
Tool port	Public	Public	Private	Public/private
Landlord port	Public	Private	Private	Public/private
Private service port	Private	Private	Private	Majority public

Source: Author.

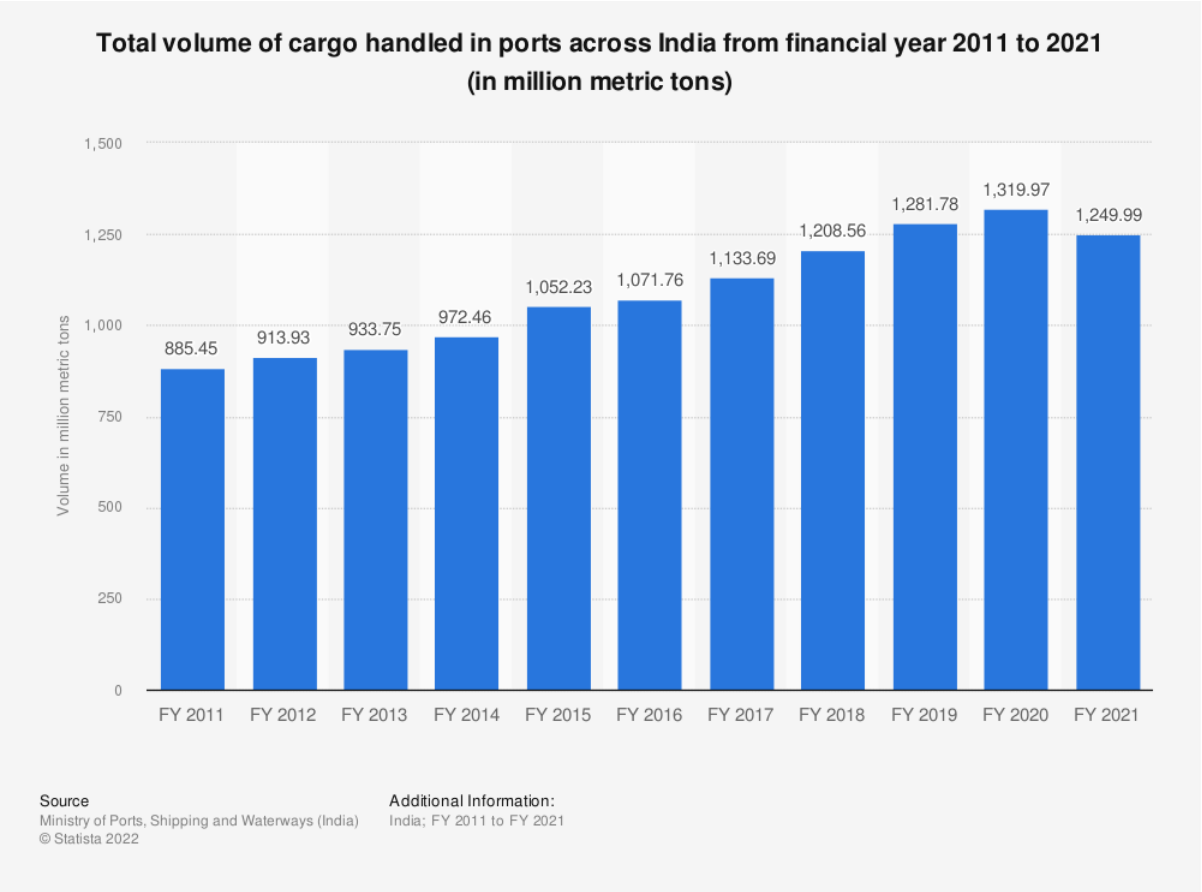
Table 1 - Basic Port Management Models

3.5 Port and Economy

Ports have historically been important centres of trade and economic activity, serving as catalysts for change and development in surrounding areas. The impact of ports on economic growth and competitiveness cannot be underestimated, as they serve as crucial intersections connecting the hinterland to the foreland. The evolution of ports has varied across different regions of the world, with western ports following the Hoyle's port city model and Asian ports following a consolidated model. The efficiency of ports, which affects transportation costs and growth rates, is a crucial factor in their impact on the economy. The changing role of ports in different eras and regions has been extensively studied and documented, highlighting their importance in promoting economic growth and development.

Ports are not just a connection between sea and land transport but rather a functional system that stimulates four different types of industries. Firstly, there are port-specific industries such as stevedoring and port services like bunkering. Secondly, there are port-related activities that include firms involved in shipping activities like import-export firms and provision or store suppliers. Lastly, there are port-induced activities like manufacturing industries and other industries that support maritime trade such as banks, legal firms, brokers, and commodities trading firms (Yochum & Agarwal, 1988, 1987). Ports also contribute to the generation of employment directly or indirectly, as seen in the Port of Hamburg where it supports more than a quarter of a million people and generates a gross domestic product of 12.6 billion euros in 2010 (Dwarkish & Salim, 2015).

Zhao, Wall, and Stavropoulos conducted a study using social network analysis to examine the characteristics of foreign direct investment (FDI) networks in port and non-port cities. The study found that port cities attract a higher degree of FDI compared to non-port cities, with London and New York being examples of previously port cities that developed on Hoyle's port city model. While mega ports like Singapore and Hong Kong attract major investments, smaller ports such as Mumbai, Dubai, and Los Angeles are positioned higher in the FDI network compared to some larger Asian port cities. This highlights the significant influence of port and hinterland development on the economic growth of port cities. Increased frequency of vessel calls can also lead to incentives to invest due to reduced transportation costs. Analysing the position of a port, such as Vizhinjam, in the port network can help authorities and governments understand its connectivity and make informed decisions.



Graph 1- India: Total volume of cargo handled in ports

3.6 Overview of Maritime Network

In 1959, Perpillou proposed that ports and maritime transportation are interconnected systems. However, no further research was conducted on the subject until the introduction of network theories on ports through cluster theory and industrial interconnection in 1998. With the emergence of complex supply chains and globalized economies, port systems became a significant topic of discussion. Notable researchers in this field include Taaffe, Ducruet, and Notteboom, who analysed spatial changes in port infrastructure through network theories. In 2012, Notteboom and Ducruet used graph theory to develop the first network structure of ports and highlighted the influence of shipping networks and port choices on container throughput. To benefit from economies of scale in today's competitive market, there is a tendency to deploy larger ships and reduce the number of port calls. Consequently, network analysis with a focus on the physical and operational features of ports is crucial to assess feasibility. The increasing emphasis on transhipment cargo and reduced port calls has put pressure on ports. High-capacity liner services and megaships have led to the emergence of global hubs and maritime transport corridors in close proximity to underdeveloped and peripheral nodes.

Ports play a crucial role in the shipping industry, and their operational and geographical properties are vital factors in liner network planning, especially in terms of transhipment hubs. Despite the economic evolution of ports, their spatial importance remains essential. Port centralities have remained relatively unchanged over the last two decades. In a Ph.D.

dissertation, Firat Bolat used network analysis to assess the feasibility of Turkish ports in the Bosporus region in two ways: port connectivity and port collaboration. This approach was different from the network analysis of Ducruet and Notteboom, which focused on a global network based on liner vessel movement data from Lloyd's list. No research exists on the South Asian region, and very few Indian studies have been conducted on port economics, operation, and management, despite the country's geographical and economic significance. The lack of network understanding from an Indian port system perspective leaves numerous questions unanswered, which puts port developers at a disadvantage when developing strategies and policies to compete at the global level.

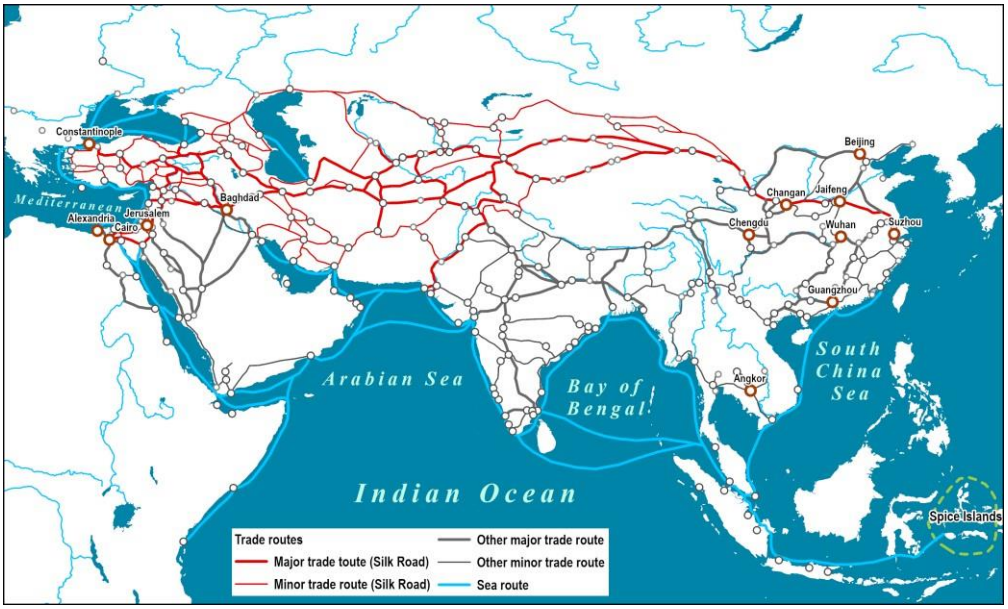
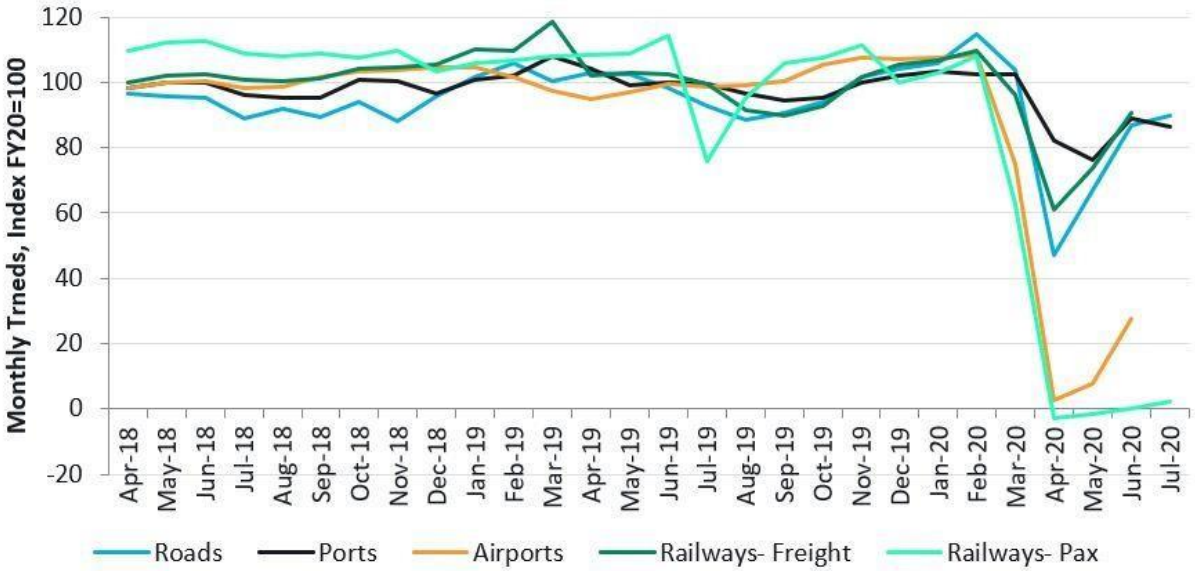


Figure 1- Maritime Transportation-Geography of transport system

3.7 Indian port system

India, with a coastline of more than 7,500km, is strategically located near two major shipping routes - the east-west route and the Suez Canal route. The country has a historical significance in the Eurasian trade, being one of the largest exporters of spices and linen during the Silk Route period. The British colonial rule played a significant role in developing port cities like Mumbai, Chennai, and Kolkata, which were used to transport goods from different hinterlands to England. However, India's shipbuilding industry almost decimated due to colonial rules, and post-independence, the country struggled to recover. In the last century, Mumbai, Kolkata, Chennai, Mormugoa, Kochi, and Vizag ports have been operating and handling a significant amount of cargo, but their throughput is still low compared to other global ports. Additionally, the throughput of ports on each coast differs significantly due to historical growth and geographic position. Currently, India has 12 major ports and more than 150 non-major ports, out of which only a little over 20 can handle containerized cargo.



Graph 2- steer analysis of month-on-month traffic across different traffic modes indexed to annual average daily volumes of FY20

Sector	BE 2021-22		RE 2021-22		Actual Expenditure	
	GBS	IEBR	GBS	IEB	RGBS (2021-22)*	IEBR (20-21)
Ports & Light houses	647.50	4337.12	580.37	3233.92	447.42	1974.24
Shipping	171.25	480.00	166.56	450.00	66.55	678.24
IWAI	623.60	0.00	580.30	0.00	382.07	0.00
Others	260.00	0.00	258.14	0.00	199.60	0.00
Total	**1702.35**	**4817.12**	**1585.37**	**3683.92**	**1095.64**	**2652.48**

***upto 31st December, 2021**

Table 2 - period of previous year. The composition of the cargo

The growth of port infrastructure has become increasingly important for economic growth in the global logistics ecosystem. However, the inefficiencies of port and logistical infrastructure have highlighted the need for increased investment in transport and port infrastructure in India. To address this, the Indian government has opened the sector to private investment.

Asia has become one of the largest consumer and producer of finished goods in the world, with developing countries playing a key role in global import and export. The Indian shipping sector has identified several weaknesses in their industry, including judicial shortcomings and underinvestment in comparison to other major seaborne trading nations. This has impacted India's potential in the shipping industry, with other countries in the region, such as China, Sri Lanka, and Dubai, developing at a much faster rate.

Despite these challenges, the container traffic in India is set to grow due to several factors. Growing international trade, the penetration of containerization, the development of hub and

feeder service structures, and the presence of a huge market and service industry are all driving factors for the growth of container traffic in India. However, addressing inefficiencies in port handling and investing in the maritime sector are key areas that need to be addressed to ensure India can fully realize its potential in the global shipping industry.

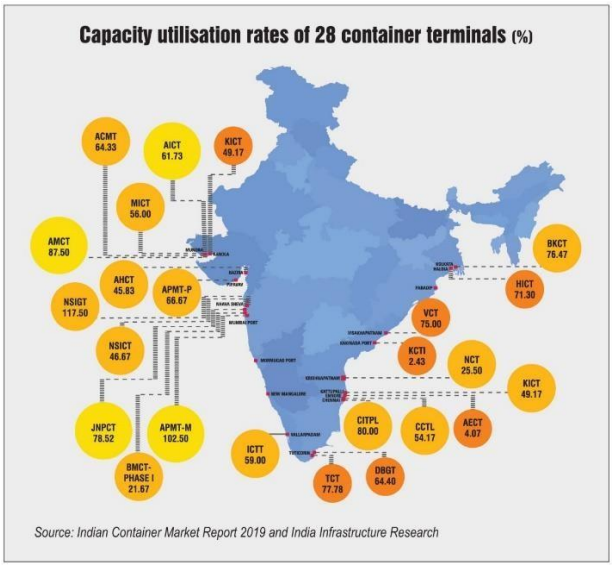


Figure 2- capacity utilisation rates of 28 container terminals (%)

3.8 Assessing the Present State of Indian Ports: An Overview of Performance

India has a vast coastline spanning over 7,500 kilometres and has 12 major ports and several minor ports that play a significant role in the country's economic growth. These ports serve as gateways for the country's trade with other nations, with a major portion of India's foreign trade being handled through these ports.

From the table, it can be observed that major Indian ports have experienced a decline in cargo volume in the fiscal year 2020-2021 due to the COVID-19 pandemic, which has affected global trade. However, the decline has not been uniformed across all ports, with some ports such as Paradip experiencing a slight increase in cargo volume.

It is worth noting that while cargo volumes are an important indicator of port performance, it is not the only factor that determines the effectiveness of a port. Other factors such as efficiency, turnaround time, and infrastructure are also important in ensuring the smooth functioning of a port and optimizing its potential to contribute to the country's economic growth.
India has been investing heavily in its port infrastructure to improve its standing in the global logistics ecosystem. In recent years, Indian ports have seen significant growth in container traffic, although they still lag behind the world's top ports. According to data from the Indian Container Market Report 2020, the top 10 Indian ports handled a total of 18.6 million TEUs (twenty-foot equivalent units) in 2019-2020, an increase of 2.7% compared to the previous year.

Port	Total Cargo Handled (Million Tonnes)	% Change from Previous Year
Kandla	119.97	-5.15%
Mumbai	61.89	-18.08%
JNPT	56.13	-14.73%
Mormugao	19.54	-14.15%
New Mangalore	39.77	-14.26%
Cochin	26.21	-18.31%
Chennai	57.34	-11.56%
VO Chidambaranar	37.55	-7.27%
Vishakhapatnam	68.54	-3.12%
Paradip	113.1	0.67%
Kolkata	56.27	-16.17%
Haldia	39.35	-11.23%

Table 3- overview of the performance of major Indian ports in the fiscal year 2020-2021

However, this performance pales in comparison to the world's top 10 ports, which collectively handled over 211 million TEUs in 2019. The largest port in the world, Shanghai, alone handled over 43 million TEUs in the same year. In terms of container throughput, Indian ports rank 13th globally, with Jawaharlal Nehru Port Trust (JNPT) in Mumbai being the highest-ranked Indian port at 28th position.

Despite this, India's ports have made significant progress in recent years. For example, the average turnaround time for vessels has decreased from 4.67 days in 2018-19 to 2.94 days in 2019-20, and the average pre-berthing waiting time has decreased from 62.74 hours to 43.08 hours in the same period. Additionally, the government's focus on increasing private investment in the sector has led to the development of new terminals and the expansion of existing ones.

However, Indian ports still face challenges such as outdated technology, inadequate infrastructure, and inefficient processes. Addressing these challenges will require sustained investment and a focus on improving efficiency and productivity. While India's ports have made progress in recent years, they still have a long way to go to compete with the world's top ports.

3.9 India's Key Shipping Routes and Main Exports and Imports

India has several major shipping routes that connect it to different parts of the world. The country is strategically located on the major East-West trade route that connects Europe, the Middle East, and Asia. Here are some of the major shipping routes of India:

1. West Coast of India: This route connects the ports on the west coast of India, such as Mumbai, Mundra, and Pipavav, to destinations in the Middle East, Africa, Europe, and the Mediterranean.

2. East Coast of India: This route connects the ports on the east coast of India, such as Chennai, Kolkata, and Visakhapatnam, to destinations in Southeast Asia, China, Japan, and Australia.
3. North-South Corridor: This route connects the ports on the east and west coasts of India to each other and also to countries in the Indian Ocean region such as Sri Lanka, Bangladesh, and the Maldives.
4. Trans-Pacific Route: This route connects India to the west coast of North America, mainly the ports of Los Angeles and Long Beach.

India's major export products include petroleum products, precious stones and metals, chemicals, textiles, engineering goods, and agricultural products. On the other hand, the country's major import products include petroleum and petroleum products, electronic goods, gold, chemicals, and machinery.

Petroleum products are India's top export, accounting for more than 14% of total exports in 2020-21, followed by precious stones and metals at around 7%. In terms of imports, petroleum and petroleum products accounted for the highest share at over 22% in the same year, followed by electronic goods at around 18%.

India is also a major exporter of agricultural products such as rice, wheat, and fruits, and a significant importer of palm oil, crude soybean oil, and pulses. Textile and clothing products are another important export segment for India, accounting for around 10% of total exports in 2020-21. Engineering goods such as machinery, transport equipment, and chemicals also account for a significant share of India's exports.

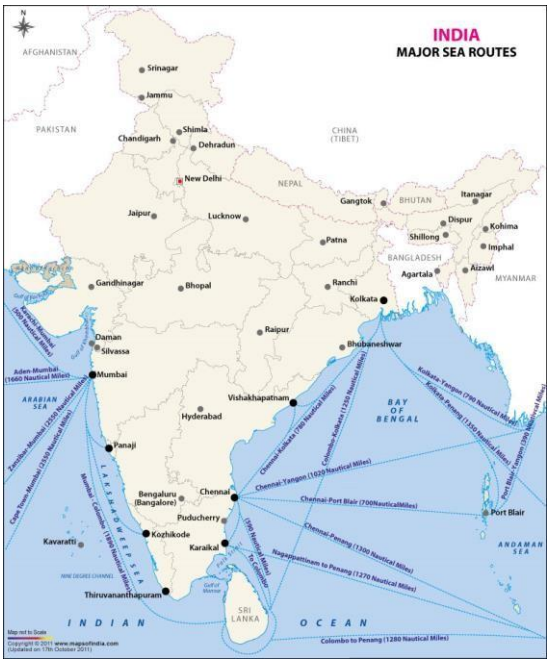


Figure 3- India; major shipping routes map

3.10 Transhipment hub concept

A transhipment hub is a transport hub, typically a port, where cargo is transferred between different modes of transportation, such as from a large container ship to smaller feeder vessels, trucks, or trains. The purpose of a transhipment hub is to facilitate the movement of

goods between different regions and countries by acting as a transfer point between different transportation modes.

Transhipment hubs play a critical role in global trade as they allow goods to be efficiently transported across different continents and regions. For example, a container ship coming from China may stop at a transshipment hub in Singapore, where containers are transferred onto smaller feeder vessels to be transported to ports in nearby countries like Malaysia, Indonesia, or Thailand. Similarly, goods coming from Europe may be transhipped at hubs in the Middle East or Asia to be transported to destinations in Africa or Oceania.

The concept of a transshipment hub is particularly important for landlocked countries or regions without direct access to ports, as they rely on transshipment hubs to move their goods across different regions. Additionally, transshipment hubs can provide economies of scale and cost savings for shipping companies by enabling larger ships to call at fewer ports and transfer their cargo onto smaller feeder vessels, which can then serve a larger number of ports.

- Transshipment hubs are usually located at strategic points along major shipping routes, such as at key ports where cargo can be transferred from one vessel to another.
- These hubs play a critical role in facilitating the movement of goods between different regions of the world, helping to connect various markets and supply chains.
- In addition to providing a platform for transshipment operations, these hubs may also offer a range of other value-added services, such as warehousing, distribution, and logistics support.
- The success of a transshipment hub depends on a number of factors, including its location, the quality of its infrastructure, the efficiency of its operations, and its ability to attract shipping lines and other key players in the maritime industry.
- Some of the world's leading transshipment hubs include Singapore, Dubai, Rotterdam, and Busan, which are all known for their advanced logistics capabilities and strategic location on major shipping routes.

3.10.1 Major transhipment ports in the world: -

Some of the major transshipment ports in the world are:

1. Port of Singapore: The Port of Singapore is one of the world's busiest ports and the largest transshipment hub in the world. It is strategically located along major shipping lanes and serves as a gateway to Asia.
2. Port Klang, Malaysia: Port Klang is the largest port in Malaysia and a major transshipment hub in the region. It is strategically located along the Straits of Malacca, one of the busiest shipping lanes in the world.
3. Port of Colombo, Sri Lanka: The Port of Colombo is the largest port in Sri Lanka and a major transshipment hub in South Asia. It is strategically located along major shipping routes between Europe and Asia.
4. Port of Algeciras, Spain: The Port of Algeciras is one of the largest ports in Europe and a major transshipment hub in the Mediterranean. It is strategically located along major shipping routes between Europe, Africa, and Asia.
5. Jebel Ali Port, Dubai: Jebel Ali Port is the largest port in the Middle East and a major transshipment hub in the region. It is strategically located along major shipping routes between Asia, Europe, and Africa.

6. Port of Rotterdam, Netherlands: The Port of Rotterdam is one of the largest ports in Europe and a major transshipment hub in the region. It is strategically located along major shipping routes between Europe and the rest of the world.
7. Port of Hamburg, Germany: The Port of Hamburg is one of the largest ports in Europe and a major transshipment hub in the region. It is strategically located along major shipping routes between Europe and the rest of the world.

These ports have a well-established infrastructure and connectivity to major shipping routes, making them ideal locations for transshipment operations.

Figure 4- The port of Singapore; one of the busiest ports in the world

3.10.2 Indian transhipment ports

Transhipment ports are ports where cargo is transferred from one vessel to another for further transportation to the final destination. In India, transhipment ports play a crucial role in facilitating international trade and boosting the country's economy. They offer several advantages over traditional ports, including reduced transit time, improved connectivity, increased employment opportunities, and increased revenue.

India has several major transhipment ports located on both the east and west coasts of the country. These ports are equipped with modern facilities and advanced technology to handle various types of cargo efficiently. Some of the major transhipment ports in India are Kochi Port, Mundra Port, Jawaharlal Nehru Port, Chennai Port, and Krishnapatnam Port.

Kochi Port is one of the largest transhipment ports in India, located in Kerala on the west coast. It is strategically located on major international shipping routes and offers efficient transhipment services for various types of cargo. The port is equipped with modern facilities, including a container terminal, bulk terminals, and liquid terminals, and is well-connected to major international shipping routes.

Mundra Port is one of the busiest ports in India and is located in Gujarat on the west coast. It is operated by the Adani Group and has the capacity to handle large volumes of cargo. The port has modern infrastructure and advanced technology to handle various types of cargo efficiently.

Jawaharlal Nehru Port is one of the largest container ports in India, located near Mumbai on the west coast. It is well-connected to major shipping routes and offers efficient transhipment services for various types of cargo. The port is equipped with modern facilities, including a container terminal, liquid terminal, and general cargo terminal.

Chennai Port is located on the east coast of India and is one of the oldest ports in the country. It has modern facilities and offers efficient transhipment services for various types of cargo. The port is well-connected to major international shipping routes and plays a key role in the trade between India and other countries.

Krishnapatnam Port is one of the fastest-growing ports in India, located in Andhra Pradesh on the east coast. It has modern facilities and offers efficient transhipment services for various types of cargo. The port is well-connected to major international shipping routes and is a key hub for trade between India and other countries.

In addition to these ports, India has several other transhipment ports, including Kandla Port, Visakhapatnam Port, and Tuticorin Port. These ports play an important role in the international trade of India and help to boost the country's economy.

In conclusion, Indian transhipment ports are an important part of the country's economy and play a crucial role in facilitating international trade. They offer several advantages over traditional ports and help to reduce transit time, improve connectivity, create employment opportunities, and generate revenue for the government. With the growth of international trade, the importance of transhipment ports in India is likely to increase in the coming years.

Indian transhipment ports play a vital role in the country's economy by facilitating the movement of goods between different regions of the world. They offer several advantages, including:

1. Reduced transit time: Transhipment ports help to reduce the transit time of goods by allowing cargo to be transferred from one vessel to another. This helps to speed up the delivery of goods and reduce transportation costs.
2. Improved connectivity: Indian transhipment ports are well-connected to major shipping routes and offer efficient services for handling various types of cargo. This helps to improve connectivity between different regions of the world and boost trade.
3. Increased employment opportunities: Transhipment ports create a large number of employment opportunities for people in the surrounding areas. This helps to boost the local economy and improve the standard of living.
4. Increased revenue: Transhipment ports generate revenue for the government through taxes and other charges. This helps to boost the overall economy of the country.

Overall, Indian transhipment ports are an important part of the country's economy and play a crucial role in facilitating international trade. They offer several advantages that help to boost the economy and create employment opportunities for people in the surrounding areas.

Port Name	Location	Annual Capacity (TEUs)	Terminal Operators	Notes
Jawaharlal Nehru Port	Navi Mumbai	5.5 million	DP World, JNPT	Largest container port in India; handles over half of India's container traffic
Mundra Port	Gujarat	4.5 million	Adani Ports	Largest private port in India
Chennai Port	Chennai	1.5 million	Chennai Container Terminal, PSA Chennai, DP World Chennai	Oldest port in India; located on the Bay of Bengal
Pipavav Port	Gujarat	1.3 million	APM Terminals	First port in India to be developed in public-private partnership
Krishnapatnam Port	Andhra Pradesh	1.2 million	Adani Ports	Located on the east coast of India
Kattupalli Port	Tamil Nadu	1.2 million	L&T Infrastructure	Located near Chennai; owned by L&T Infrastructure
Hazira Port	Gujarat	1 million	Adani Ports	Located on the west coast of India

Port Name	Location	Annual Capacity (TEUs)	Terminal Operators	Notes
Visakhapatnam Port Trust	Andhra Pradesh	860,000	Visakha Container Terminal, PSA Sical, Adani Ports	Located on the east coast of India
Tuticorin Port Trust	Tamil Nadu	680,000	PSA Sical, DP World Tuticorin	Located on the southern tip of India
Cochin Port Trust	Kerala	600,000	DP World Cochin	Located on the west coast of India; handles container traffic for the southern states of India

Table 4 - Top Container Ports in India by Annual Capacity

3.11 Vizhinjam port

Vizhinjam Port is a deepwater seaport in the Indian state of Kerala, being developed as a transhipment hub with a draft of 20.5 meters to accommodate large container ships. Adani Vizhinjam Port Pvt. Ltd., a subsidiary of Adani Ports and Special Economic Zone Ltd., is the developer of the port. Construction started in December 2015, and the first phase was completed in December 2017, with the port officially inaugurated by the Prime Minister of India in February 2018. The second phase is currently under construction, and is expected to be completed by 2024, with a design capacity of 4.1 million TEUs per annum. The port is well connected to major cities in India and abroad through road, rail, and air, and is expected to generate employment for around 4,000 people directly and 8,000 indirectly.

The Vizhinjam Port project aims to connect the east coast of India with the west coast of India, the Middle East, South East Asia, and Europe, reducing shipping time and costs. The port is located near the international shipping route between Europe and Asia, making it a strategic hub for international trade. The project has been controversial due to potential environmental impacts, particularly on the fishing community in the area. To address these concerns, the government and Adani Ports have created a fishing rehabilitation package for affected fishermen. Overall, the completion of the second phase of the Vizhinjam Port project in 2024 is expected to enhance its transhipment capabilities and increase its importance as a hub for international trade.

3.12 Adani Ports and Special Economic Zones Limited (APSEZ)

Adani Ports and Special Economic Zones Limited (APSEZ) is India's largest private port operator and a subsidiary of the Adani Group. The company operates 12 ports and terminals along the eastern and western coasts of India, with a combined capacity of over 450 million tonnes per annum (MTPA). APSEZ is also involved in the development of three new ports in India and has acquired port assets in other countries, including Australia and Sri Lanka.

In terms of financial performance, APSEZ has demonstrated strong growth over the years. In FY 2020-21, the company reported a consolidated revenue of INR 13,282 crore ($1.8 billion USD) and a net profit of INR 4,284 crore ($580 million USD). The company's market capitalization as of April 2021 was over INR 1,20,000 crore ($16.2 billion USD).

APSEZ's success can be attributed to its focus on efficiency and capacity in its port operations, as well as its strategic investments in infrastructure and technology. The company has implemented advanced technologies and processes to streamline its operations, such as a port community system that allows for real-time tracking of cargo movements and digital documentation. APSEZ has also invested in expanding its capacity through the development of new ports and the acquisition of existing ones.

In addition to its port operations, APSEZ has also established multiple Special Economic Zones (SEZs) across India, which offer tax incentives and other benefits to businesses operating within their boundaries. These SEZs cover various industries, including IT, logistics, and engineering.

Overall, APSEZ's growth and success in the Indian port industry can be attributed to its strong focus on efficiency, capacity, and innovation, as well as its diversification into SEZ development.

3.12.1 Efficiency, Capacity, and Challenges

Adani Ports is the largest private port operator in India, with a market share of around 24% in terms of cargo volume handled. The company operates a diverse portfolio of ports and terminals across India, including the flagship Mundra Port, which is one of the largest commercial ports in the country. Adani Ports specializes in developing and operating world-class, state-of-the-art ports that are equipped with the latest technologies and infrastructure to handle a wide range of cargo types. The company is committed to providing efficient, safe, and reliable services to its customers, and has a track record of successfully executing complex port projects. Adani Ports has also been actively expanding its presence internationally, with investments in ports and terminals in countries such as Australia and Sri Lanka, making it a leading global port operator.
Adani Ports is known for its focus on efficiency and capacity in the operation of its ports. The company has implemented state-of-the-art technologies and processes to ensure smooth and efficient operations, which has contributed to its reputation as a leading port operator in India.

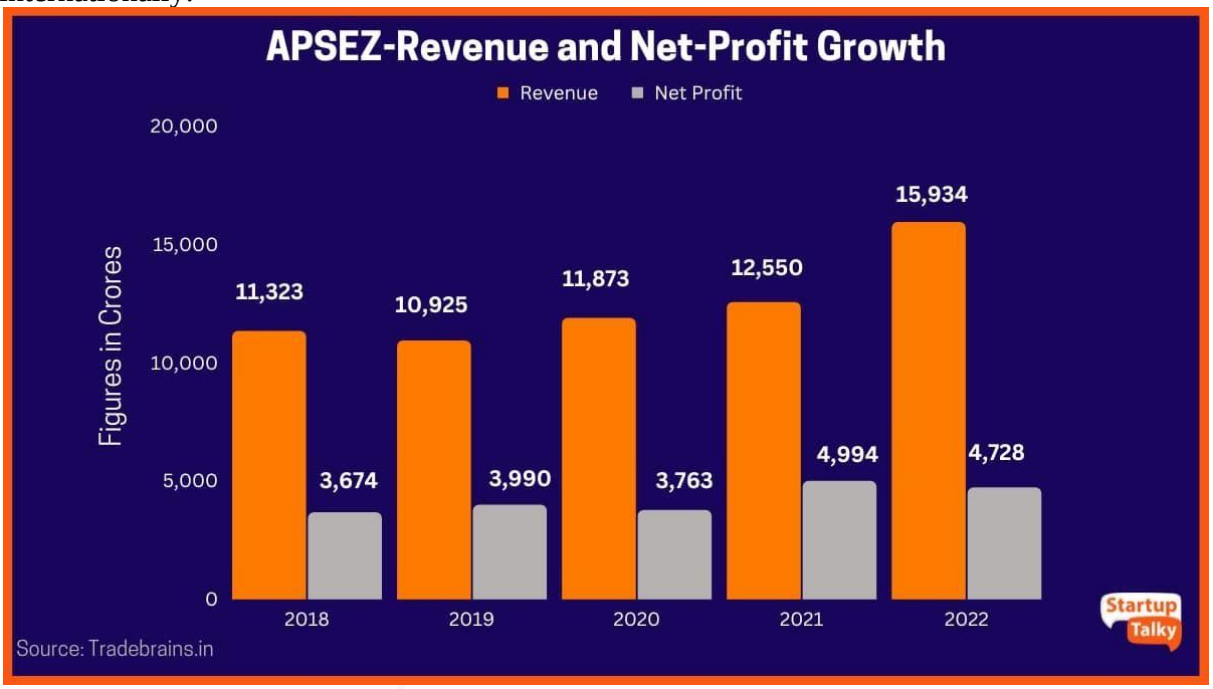
Adani Ports' commitment to efficiency is reflected in its use of automated container handling equipment, such as cranes, to reduce loading and unloading times. This has led to faster turnaround times for ships, which in turn has increased the port's capacity to handle more cargo. Additionally, the company has invested in digital technologies and analytics to optimize its supply chain management processes and improve overall operational efficiency.

In terms of capacity, Adani Ports has a diverse portfolio of ports and terminals across India, with a total capacity of over 480 million metric tons per annum. The company's flagship port, Mundra Port, has a capacity of 210 million metric tons per annum, making it one of the largest commercial ports in India. Adani Ports has also been actively expanding its capacity through the development of new ports and the acquisition of existing ports, both within India and internationally.

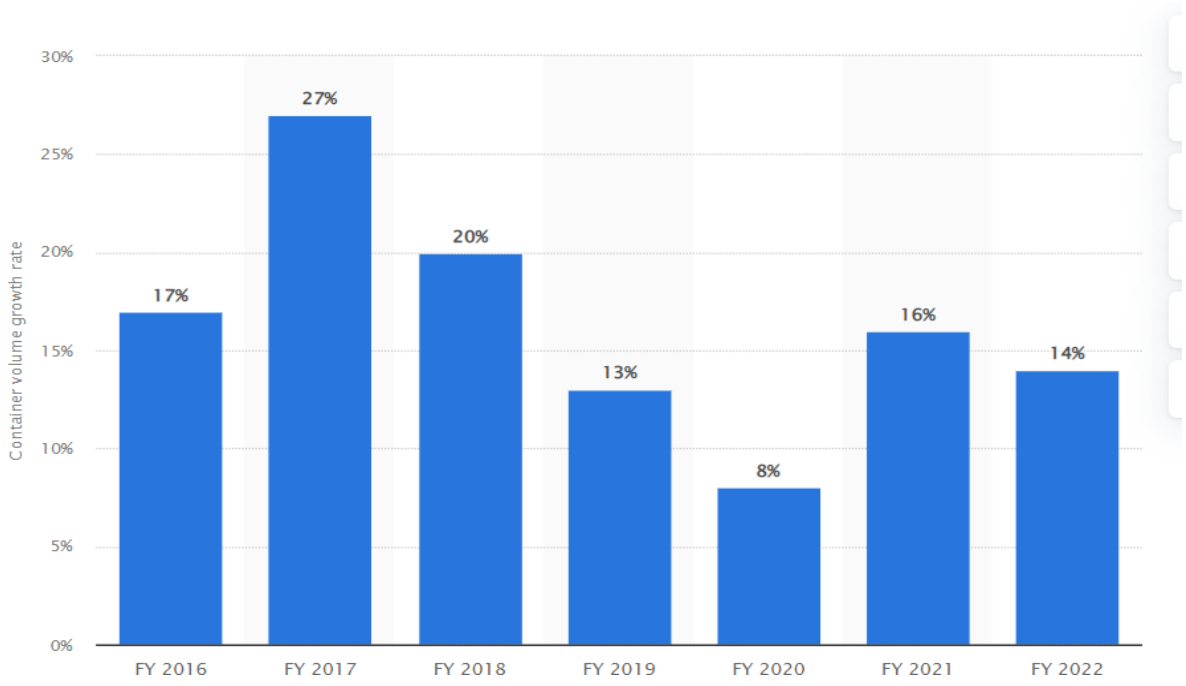
What sets Adani Ports apart from other port operators is its focus on sustainability and community engagement. The company has made significant investments in environmental protection and social initiatives, such as providing education and healthcare services to communities near its ports. Adani Ports has also been a pioneer in the use of renewable energy, with several of its ports using solar power to reduce their carbon footprint.

Overall, Adani Ports' focus on efficiency, capacity, sustainability, and community engagement has made it a leader in the Indian port sector and a competitive player in the global market.

Adani Ports faces several challenges in its operations as the largest private port operator in India. One major challenge is complying with various laws and regulations related to port operations, safety, and environmental protection. Adani Ports must constantly invest in upgrading and expanding its port facilities to meet growing demand and compete with other port operators. The company must also constantly innovate and differentiate itself to maintain its market share and attract new customers. Another significant challenge is the environmental impact of port operations, such as air and water pollution and disturbance to marine ecosystems. Adani Ports must invest in environmental protection measures and engage with stakeholders to mitigate these impacts. Additionally, Adani Ports operates in a complex geopolitical environment with potential risks related to trade policies, security, and political instability. Despite these challenges, Adani Ports has demonstrated resilience and adaptability in its operations, and continues to expand its presence both domestically and internationally.



Graph 3 - Adani Ports Revenue and Net-Profit Growth



Graph 4 - Container volume growth rate of Adani Ports and Special Economic Zone Limited from financial year 2016 to 2022

Chapter 4

Development of Port Infrastructure and Facilities

4.1 Competition in the Transhipment Market: Colombo Port and Other Key Players

Vizhinjam Port faces significant competition from Colombo Port, which is the largest transhipment hub in the Indian Subcontinent region. Colombo Port is strategically located on the main east-west shipping lanes that connect Europe to the Far East and Australasia, and it is a major hub for transhipment traffic from India. The port consists of three container handling terminals, namely Jaya Container Terminal, South Asia Gateway Terminal, and Unity Container Terminal, with a combined handling capacity of around 4.2 million TEU. However, this capacity can be increased to 15-16 million TEU per annum with the development of the South Harbour.

Over the last 10 years, Colombo Port has shown a compound annual growth rate (CAGR) of 8% in throughput, which indicates that it is a growing and competitive player in the transhipment market. Around 75% of the total container volumes at Colombo Port consist of transhipment traffic from India. However, the port lost market share in the mid-2000s due to port congestion, which resulted in hub ports outside the Indian Subcontinent region such as Singapore, Salalah, and Jebel Ali benefiting from Colombo's loss of market share.

With the commissioning of the South Asia Gateway Terminal and an increase in draft, Colombo Port has regained its market share in the transhipment market. The development of the South Harbour has further increased the port's handling capacity, making it an even more formidable competitor for Vizhinjam Port.

In terms of vessel traffic forecast, it is expected that the demand for transhipment services in the Indian Subcontinent region will continue to grow in the coming years, driven by the region's expanding economy and increasing trade volumes. This presents both opportunities and challenges for Vizhinjam Port in its efforts to capture a significant market share. The port will need to differentiate itself by offering superior services and establishing a strong brand reputation to compete effectively with established players such as Colombo Port.

In addition to Colombo Port, there are several other key competitors of Vizhinjam Port in the transhipment market in the Indian Subcontinent region. These competitors include ports in Singapore, Malaysia, and the United Arab Emirates, which have established themselves as major transhipment hubs for the region.

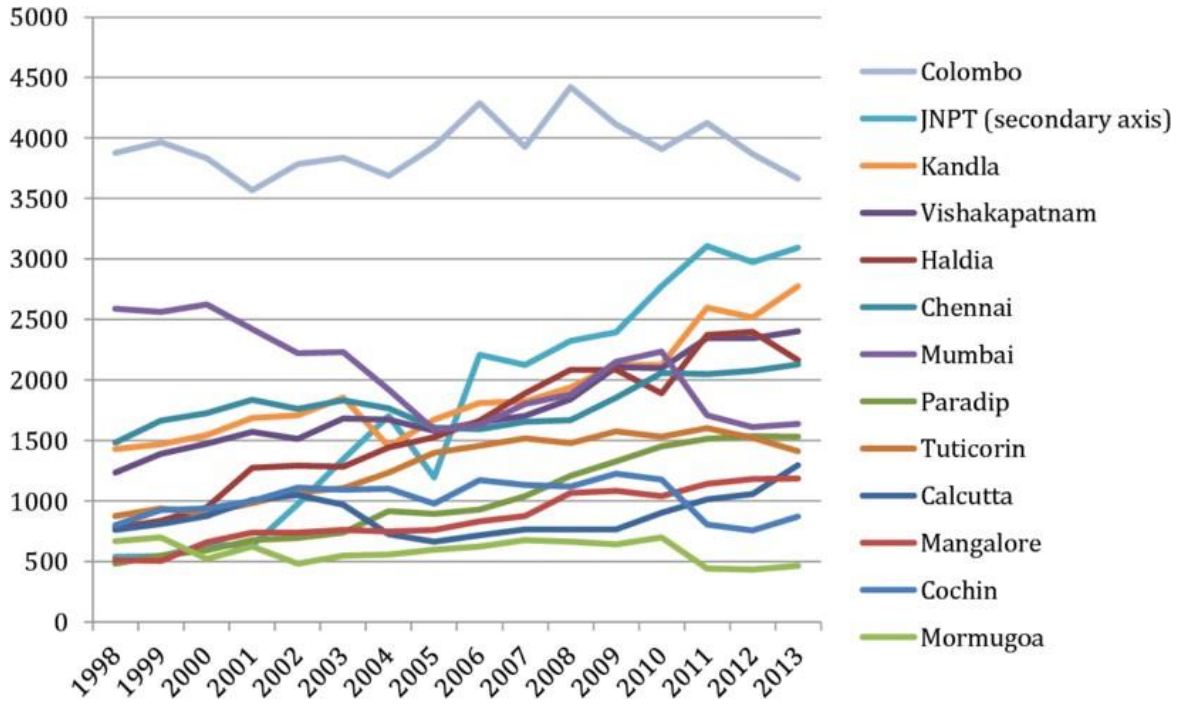
According to data from the Indian Ministry of Shipping, the transhipment market in the Indian Subcontinent region has been growing steadily over the past few years, with a CAGR of 6.2% from 2016-2020. In 2020, the transhipment volume at Indian ports was around 6.5 million TEU, which accounted for 26% of the total container volume handled by Indian ports.

Colombo Port remains the dominant player in the transhipment market in the Indian Subcontinent region, with a market share of around 45% in 2020. However, other ports such as Singapore, Port Klang in Malaysia, and Jebel Ali in the United Arab Emirates are also significant players, with market shares of 19%, 9%, and 6%, respectively.

Vizhinjam Port, which was commissioned in 2021, has yet to establish itself as a significant player in the transhipment market. However, the port has been designed to handle large container vessels and has a strategic location on the west coast of India, which could make it

an attractive option for shipping lines looking for an alternative to congested ports in the region.

In order to compete effectively with established players in the market, Vizhinjam Port will need to offer competitive rates, efficient services, and establish strong partnerships with shipping lines and other stakeholders in the logistics chain. The port's success will depend on its ability to differentiate itself and offer unique value propositions to customers in the highly competitive transhipment market.



Graph 5 - Total vessel traffic of ISC ports and Colombo port

4.1.1 SWOT analysis of Colombo Port

Strengths:

- Location on major East-West trade axis
- Successful introduction of private investors
- Concrete plans to increase capacity
- Competitive transhipment tariffs
- Strong growth over the past decade
- Large captive container traffic generated from its hinterland
- Rapid market share gain after capacity was increased

Weaknesses:

- Higher country risk than some competitors
- Single entrance channel and turning basin leading to delayed arrivals and departures
- Labour problems affecting productivity
- Old port infrastructure constrained by the city

Opportunities:

- Ideal transhipment option for shippers due to its location
- Trade growth in ISC

- Proposed Colombo Port Expansion Program (CPEP) to increase capacity and vessel turnaround times
- Congestion at Indian ports benefiting Colombo

Threats:

- Cheaper tariffs at ports like Kelang and Tanjung Pelepas
- Development of deep draft ports in ISC, particularly in India.

The transhipment container traffic market in the Indian subcontinent is the target market for both Colombo and Vizhinjam port. Bangladesh, Pakistan, and India are the key markets for both hubs. According to Drewry, the average growth rate for total transhipment volumes is 6.7% per annum for the period 2010-2015, which decreases to 5.8% per annum for the period 2015-2025, and then 4.3% per annum thereafter. In FY10, the various hub ports handled 7.1 million TEU of transhipment of ISC cargo, and Colombo had a 38% share. This share further increased in 2011 with the commissioning of the South Asia Gateway Terminal. Major hubs like Cochin, JNPT, Chennai, and Vizhinjam are expected to have a significant market share. Established ports like JNPT, Chennai, and Ennore are also expected to increase their share. Meanwhile, Singapore, Klang, and Dubai remain key players, and Middle Eastern hubs such as Dubai and Khor Fakkan are expected to lose market share with the operation of new hub ports at Sohar terminal, Middle East.

4.2 Vizhinjam port – Vessel Traffic Forecast

Summary of Colombo/ Vizhinjam Feeder Target Market	FY14	FY15	FY16	FY17	FY18	FY19	FY20	FY25	FY30	FY35	FY40	FY44
South coast India												
Cochin	175,325	156,112	113,434	119,320	125,503	133,492	137,699	179,215	184,025	164,250	158,186	145,595
Tuticorin	262,987	289,921	340,301	357,959	376,508	400,476	413,098	537,646	552,076	492,751	474,557	436,786
Other ports (e.g. Colachel)	0	0	0	0	0	0	0	0	0	0	0	0
East coast India												
Chennai	342,993	353,698	364,654	386,112	398,887	406,092	439,360	658,455	1,174,031	1,365,456	1,365,456	1,365,456
Other nr. Chennai (e.g. Ennore, Krishnapatnam)	0	136,912	195,577	261,090	324,460	384,732	436,621	389,100	598,937	1,107,070	1,665,946	2,142,474
Visakhapatnam	50,817	58,288	62,750	71,927	76,480	77,356	78,243	93,384	133,279	163,600	154,180	135,913
Other nr. Vizag	0	0	5,341	6,009	13,243	14,445	15,817	22,794	39,359	49,818	60,070	67,909
Paradip/Dhamra	5,098	8,804	13,912	18,456	77,252	101,118	129,174	302,603	472,162	529,835	555,049	551,241
Kolkata/Haldia/Kulpi	304,896	357,599	302,813	309,546	257,272	260,930	233,076	205,890	175,249	175,095	215,708	194,494
Bangladesh												
Chittagong/Mongla	359,496	398,410	438,977	481,851	498,975	505,961	508,848	620,318	810,633	1,022,878	1,207,408	1,407,149
Sub-total	*1,501,612*	*1,759,743*	*1,837,758*	*2,012,269*	*2,148,580*	*2,284,601*	*2,391,938*	*3,009,405*	*4,139,751*	*5,070,753*	*5,856,561*	*6,447,017*
West coast India & Pakistan	359,834	300,527	420,724	408,755	410,073	411,468	457,219	859,442	1,247,090	1,655,187	1,930,825	2,113,589
Total feeder volumes	1,861,445	2,060,270	2,258,482	2,421,024	2,558,653	2,696,069	2,849,157	3,868,846	5,386,841	6,725,940	7,787,386	8,560,605
Transshipment volume	3,722,891	4,120,540	4,516,963	4,842,048	5,117,306	5,392,138	5,698,314	7,737,693	10,773,681	13,451,880	15,574,772	17,121,211
Vizhinjam's Traffic Forecast	111,687	185,424	271,018	363,154	460,558	566,174	683,798	928,523	1,292,842	1,614,226	1,868,973	2,054,545
Vizhinjam's market share in available market	3%	5%	6%	8%	9%	11%	12%	12%	12%	12%	12%	12%

Table 5- vessel traffic forecast of Vizhinjam port

4.3 Tariff Authority for Major Ports: Ensuring Competitive Pricing and Improved Operations in India's Ports

The Government of India owns 12 major ports, while minor ports are under the jurisdiction of respective Maritime Boards of State Governments. The major ports are governed by the Major Port Trust Act of 1963, with the exception of Ennore, which is administered by the Companies Act. Tariff Authority for Major Ports (TAMP) approves the rates for services

offered by the major ports to ensure competitive and efficient pricing systems. Minor ports are allowed to set their own tariffs.

TAMP operates on a cost-plus basis, with a guaranteed rate of return to ensure that the pricing system is fair and efficient. The guidelines set forth by TAMP in 1998 include avoiding uniform rates for different ports, using a differential tariff structure based on marginal cost principle, using tariff charges to improve port operations, and initiating tariff proposals by port trusts, private operators, bulk operators, representative bodies of port users, directly or through port trusts. TAMP consults with other ports when determining tariffs, and tariff revisions are made every two years.

TAMP regulates the port operator's tariffs related to vessel, cargo, and leasing of property across port trusts and private operating companies. It sets the tariff ceiling for each terminal, allowing for a 16 percent return on capital employed.

When it comes to container handling in India, there are two types of charges to consider - those applicable to the vessel and those related to the cargo. There are various components that make up the cost of a port call in India, including port dues, berth hire, wharfage, pilotage, cargo handling charges, storage charges, as well as ancillary charges and services.

4.3.1 Vessel related charges (VRC) for container vessels

Port	Port Due Fee at Indian Ports (US$/GRT)					
	500 teu	**1,500 teu**	**2,500 teu**	**3,500 teu**	**5,500 teu**	**6,500 teu**
Nonmajor Port						
Mundra/Adani	778	2,489	4,356	6,533	10,656	12,444
Pipavav	540	1,728	3,024	4,284	6,576	7,680
Average Fee	659	2,108	3,690	5,409	8,616	10,062
Major Port						
Kandla Port	1,150	3,680	6,440	9,660	15,755	18,400
Mumbai	1,055	3,376	5,908	8,862	14,454	16,880
JNPT	951	3042	5324	7985	13024	15210
Mormugao	562	1800	3149	4724	7705	8998
New Mangalore	715	2,288	4,004	6,006	9,796	11,440
Cochin	1,280	4,096	7,168	10,752	17,536	20,480
Tuticorin	1,007	3,222	5,639	8,459	13,796	16,112
Chennai	1,150	3,680	6,440	9,660	15,755	18,400
Visakhapatnam	1,255	4,016	7,028	10,542	17,194	20,080
Kolkata /Haldia	1,500	4,800	8,400	12,600	20,550	24,000
Average Fee	1,063	3,400	5,950	8,925	14,556	17,000

Table 6 - vessel related charges (VRC) for container vessels

table presents a comparison of port dues applied at different ports that compete with Vizhinjam port in India. The charges levied by the ports can be compared based on the size of the vessel.

- 500 teu – 5,000 grt
- 1,500 teu – 16,000 grt
- 2,500 teu – 28,000 grt

- 3,500 teu – 42,000 grt
- 5,500 teu – 68,500 grt
- 6,500 teu - 80,000 grt

The tariff conversion for 40 feet containers can be assumed as 1.5 times of the 20 feet tariff while tariff for loaded containers (20/40) as 1.2 times of the empty container's (20/40) tariff.

4.3.2 Ports - container related tariffs

Shipping lines consider both tariff levels and operating costs when deciding to switch ports. Offering a competitive tariff is important for attracting potential customers, as higher tariffs can hinder traffic growth. However, lowering tariffs too much does not necessarily result in a significant increase in volume growth. To determine the charges that a port should levy, it is advisable to look at the rates charged by other major container handling ports in the region. Additionally, it is crucial that the new facility offers competitive rates for all ancillary and storage charges commonly found at modern container handling facilities. As a result, the container handling charges at Indian ports range from $31.5 to $66.5, with most ports charging similar rates for container handling.

4.4 The Revenue forecast

The revenue forecast for Vizhinjam Port from container operations is expected to be significant, given the port's strategic location and modern facilities. As per reports, the port is expected to handle about 1.8 million TEUs (Twenty-foot Equivalent Units) by 2023, and this figure is expected to increase to 3.3 million TEUs by 2025.

Based on the estimated container traffic volume, it is projected that the port will generate a revenue of around INR 800 crore (approximately $108 million) from container handling operations in the next few years. Additionally, the port is expected to create direct and indirect employment opportunities for around 20,000 people in the region.

Furthermore, the Vizhinjam International Seaport Limited (VISL), which operates the port, has signed several MoUs with leading shipping lines and logistics companies to promote container traffic. For instance, in 2020, VISL signed an MoU with Container Corporation of India (CONCOR) to enhance container operations at the port. Such collaborations are expected to further boost container traffic at the port and contribute to the revenue growth of Vizhinjam Port.
Colombo port offers a 20% discount on its published tariff rates for port and container handling charges to attract business from shipping lines. However, to provide a 10% cost benefit for a shipping line to switch its transhipment hub from Colombo to Vizhinjam, the port would need to offer a 30% discount on Colombo's tariff rates. This means that Vizhinjam would need to provide a minimum of 60% of the current published tariff at the Colombo port to meet the 10% cost-saving criterion required to attract mainline vessel calls.

According to Drewry, offering a 10% cost benefit is the minimum requirement for Vizhinjam to compete with Colombo and attract mainline vessel calls. Therefore, Vizhinjam needs to consider offering more competitive tariff rates to shipping lines to make it a viable alternative to Colombo port. This could involve exploring cost-saving measures and operational efficiencies to provide cost benefits to shipping lines, thereby making Vizhinjam a more attractive option for transhipment operations.

5 Port development

5.1 Assessing Port Capabilities: Site Conditions and Vessel Compatibility

Vizhinjam Port is situated on the western coast of India, at the southern tip of the peninsula, and is located about 10 nautical miles away from the international shipping route. Its strategic location close to the international shipping route makes it an ideal location for container transhipment traffic. The port is well-connected by the Southern Railway to Mumbai in the north and to the southern part of Tamil Nadu. Road connectivity to Vizhinjam is facilitated by NH47 (National Highway), which is located 8km away and connects Kanyakumari in the south to Mumbai in the north.

Vizhinjam's proximity to Kovalam Beach, a popular tourist destination located about 2km away, adds to the port's attractiveness. However, it is important to note that the proposed area for the Vizhinjam project is hilly and steep, which may pose some challenges in terms of port infrastructure development and operations.

Despite the hilly and steep terrain, the Vizhinjam port project has made significant progress in its infrastructure development. The construction of the breakwater, quay wall, and dredging of the channel have been completed, and the port is now equipped with modern container handling facilities. The port has also implemented advanced IT systems to improve operational efficiency and cargo tracking. The Vizhinjam port has the potential to become a major player in the container transhipment market, and its strategic location and modern infrastructure will make it an attractive option for shipping lines and other businesses looking to expand their operations in the region.

5.1.1 Climate

Vizhinjam has a tropical humid climate with hot summers and the region has two seasonal monsoons:

- The North-East monsoon between October to December
- The South-West monsoon from June to September

5.1.2 The temperature

The temperature at Vizhinjam Port is generally warm, with mean maximum daily temperature ranging between 29°C and 32°C throughout the year. However, the temperature tends to rise during the months of March, April, and May, which are considered to be the hottest months of the year. During this time, the temperature can reach as high as 33°C, making it uncomfortable for those who are not used to such high temperatures.

On the other hand, the mean minimum daily temperature ranges between 24°C and 30°C, with the lowest occurring in December. While this may still be considered warm by some, it can be a welcome relief from the scorching heat of the summer months. It is important to note that the temperature is just one of the many factors that need to be considered when assessing the viability of a port, and other factors such as weather patterns and potential weather-related disruptions should also be taken into account.

5.1.3 Humidity in the Vizhinjam area

The relative humidity levels in the region of Vizhinjam Port are generally high, with an average monthly relative humidity varying between 73% and 84%. However, during the southwest monsoon in June, the humidity level can rise to around 89%, making it quite uncomfortable for people who are not used to such high levels of moisture in the air.

It is important to consider the effects of high humidity levels when planning a port, as they can have significant implications for cargo operations and personnel health and safety. High humidity levels can cause cargo to become damp or even wet, potentially leading to damage or spoilage, and can also make it difficult for personnel to work efficiently and safely. Additionally, high humidity levels can contribute to the growth of mold and other harmful microorganisms, which can pose health risks to those working at the port.

Overall, while high humidity levels may pose some challenges for port operations, they can also be managed through proper planning and mitigation measures such as air conditioning and dehumidification systems. It is essential to assess the relative humidity levels in the region when considering the viability of a port and to develop strategies to mitigate its effects to ensure optimal port operations and personnel health and safety.

5.1.4 precipitation rate

Vizhinjam experiences a tropical climate with heavy rainfall and high humidity throughout the year. The average annual rainfall is around 1835mm, with most of the precipitation occurring during the southwest monsoon season from May to September. During this period, Vizhinjam receives an average monthly rainfall of over 220mm, with June being the wettest month with a maximum rainfall of 356mm.

After the southwest monsoon season, the dry weather sets in by the end of December and lasts up to May with an average monthly rainfall of around 27mm. The average temperature during the year ranges from 29°C to 32°C, with March, April, and May being the hottest months with temperatures rising up to 33°C.

Relative humidity is high throughout the year, with the mean monthly average varying between 73% and 84%. The highest relative humidity occurs during the southwest monsoon season, reaching up to 89% in June. These weather conditions are important to consider for port operations as they can affect the handling of cargo and the scheduling of vessels.

5.1.5 cyclones and visibility

Cyclones are not a common occurrence in the west coast of India compared to the east coast. Over the last century, only four cyclones have passed close to the Vizhinjam project location in the Arabian Sea, of which only two had any significant impact on the study region. This implies that the frequency of cyclones in the region is approximately once in 25 years, which may have implications for port operations during such rare events.

Visibility is not a concern in the Vizhinjam region, as there are no fog days throughout the year. This means that there are no restrictions on navigation due to poor visibility caused by fog. Good visibility is important for safe navigation of ships, especially during critical

manoeuvres such as docking and undocking. The absence of fog-related visibility constraints can be considered an advantage for shipping operations at Vizhinjam.

5.1.6 Factors Affecting the Size of Ships that can be Called at Vizhinjam Port

Several factors determine the size of ships that can be called at Vizhinjam Port. One of the key factors is the trading route and distance between Vizhinjam Port and origin/destination ports. The distance and route play a critical role in determining the cost and feasibility of calling at Vizhinjam Port.

The facilities available at the loading/unloading port, including the draft, also impact the size of ships that can be called at Vizhinjam Port. The availability of suitable ships in the market is another crucial factor. Vizhinjam Port would need to have the infrastructure to accommodate larger vessels, and such infrastructure investments must be justified by the expected trade volume.

Future availability of vessels on the market, including the "trickle-down" effects from mainline routes to secondary routes, is another factor to consider. The volume of annual traffic to be handled and the likely parcel size also play a crucial role in determining the size of ships that can be called at Vizhinjam Port.

The balance between capital costs for Vizhinjam Port development and freight transport costs is also essential. Larger ships offer economies of scale, but they require more substantial investments in port infrastructure, which must be weighed against the potential cost savings from larger vessels.

In summary, various factors, including the trading route and distance, facilities available, ship availability, trade volume, and cost considerations, influence the size of ships that can be called at Vizhinjam Port.

5.1.7 Trends in Container Shipping and Implications for Vizhinjam Port

The shipping industry has undergone significant changes with the rise of containerisation in the 1960s. Over the years, the trend has been towards larger and more technologically advanced vessels, which can carry more cargo and improve operational efficiency. As a result, it is expected that vessels in the range of 8,000 TEU will eventually "trickle down" to serve secondary or feeder routes in the future, while the ultra-large vessels serve the primary routes. This trend is supported by the order book of major shipping lines such as MAERSK Lines, Nord Capital group, Hamburg, Evergreen, K-line, and United Arab Shipping Company, who have been ordering and acquiring ultra-large container vessels.

The trend of larger vessels can benefit Vizhinjam Port, as it has been designed to handle the largest container ship of 18,000 TEU. With the lack of hinterland cargo, container transhipment is expected to be the primary business for Vizhinjam Port, and it can handle 18,000 TEU vessels from the Phase-1 development.

For direct vessel calls serving the import/export cargo, the design vessels considered for Vizhinjam Port are in the range of 1,000 TEU to 6,000 TEU. This means that the port will be

capable of accommodating a wide range of container vessels, from smaller feeder vessels to the larger mainline vessels. This will enable the port to handle a variety of cargo and attract more customers from different regions. Furthermore, the capacity to handle larger vessels will also increase the efficiency and cost-effectiveness of shipping operations, reducing the overall transportation costs and time required to move goods.

5.1.8 Handling General Cargo Vessels at Vizhinjam Port

General cargo vessels carrying commodities like fertilizers, raw cashews, and timber are expected to be handled at Vizhinjam Port using shore cranes or cranes mounted on the ship. The size of these vessels is typically between 25,000 DWT and 40,000 DWT. A maximum design size of 40,000 DWT is recommended for such ships at Vizhinjam Port.

5.1.9 Transhipment containers

With the lack of hinterland cargo, Container transhipment will be the primary business for Vizhinjam Port right and Vizhinjam can handle 18000 TEU vessels from the Phase-1 development.

5.1.10 Import/ Export Container Vessels

For the direct vessel calls serving the import/export cargo, the design vessels considered are in the range of 1,000 TEU to 6,000 TEU.

5.1.11 Multipurpose cargo

5.1.11.1 General cargo vessel

Ships ranging from 25,000 DWT to 40,000 DWT are expected to handle general cargo items like fertilizer, raw cashew, and timber. These commodities will be unloaded using shore cranes or cranes mounted on the ship. For effective port planning, it is recommended that the maximum design size of general cargo ships calling at Vizhinjam Port should be 40,000 DWT.

5.1.11.2 Cruise vessel

S. No	Commodity	Average parcel size	Design Ship Size		Overall Length	Beam	Loaded Draft
		TEU (DWT)	TEU/DWT		(m)	(m)	(m)
1.	Transshipment Containers	2,500 (23,000)	Min	9,000 (82,500)	350	46.0	14.5
			Max	18,000 (165,000)	400	59.0	16.0
2.	Import/Export Containers	1200 (11,000)	Min	1,000 (9200)	175	27.0	10.0
			Max	6,000 (55,000)	300	43.0	13.5
3.	Multipurpose Cargo vessels	(30,000)	Min	25,000	178	26.4	10.7
			Max	40,000	190	28.0	11.3
4.	Cruise	3000 pax (55,000)	Min	40,000	212	32	8.0
			Max	70,000	268	32	8.0

Table 7- size of the cruise Vessel

According to the Drewry report, the size of cruise ships is projected to range from 1200 passengers in Phase-1 to a maximum of 3000 passengers in the Master Plan.

5.2 Facilities requirements

The Phase-1 development of Vizhinjam port will mainly focus on the infrastructure needed for container cargo handling, including the number and size of berths, navigation requirements, terminal equipment, storage area, road and rail access for cargo transportation, as well as other necessary utilities and service facilities. Additionally, the port will also provide facilities for the Coast Guard and Indian Navy.

5.2.1 Requirements for Berth Length and Clearances

Berths must be long enough to fit the entire length of a ship with additional space on either end for mooring and clearance between ships. The clearance required at each end of the ship is dependent on the ship's size.

5.2.2 Factors Affecting Container Terminal Berth Capacity Analysis

The maximum capacity of a container terminal's berth depends on various factors, including the design size of vessels, the available length of the berth, the number of container moves per vessel call, the number of dock cranes assigned per vessel, the productivity of each dock crane, the maximum practical utilization of the berth, the operational time, unproductive time at the berth, and the peak/mean week seasonal demand.

Firstly, the size of vessels is a significant factor that influences berth capacity. Shipping companies are increasingly building larger vessels to gain the benefits of economies of scale, but larger vessels require a longer berth length to accommodate them.

Secondly, the number of containers moves per vessel call is limited to 1500 on average, and the number of dock cranes deployed per vessel call depends on the vessel size and the number of containers to be handled. For instance, for vessels up to 12,500 TEU, up to six dock cranes are deployed, while for smaller feeder vessels, two to three dock cranes are sufficient.

Thirdly, the productivity of each dock crane is critical in determining the berth capacity. An average productivity of 25 moves per hour is used during the initial development of the port. However, once the operation stabilizes, the productivity is assumed to reach 30 moves per hour.

Fourthly, the maximum practical utilization of the berth should be limited to avoid vessel queuing, as shipping lines expect a certain level of customer service. Although 100% berth utilization is possible, it is suggested to keep the berth occupancy up to 80% to avoid queuing. At the Port of Vizhinjam, during the Phase-1 development, two berths are available, and a 60% berth utilization is feasible for the operator.

Fifthly, the operational time of the port is crucial. It is assumed that the Vizhinjam Port will operate seven days a week for 365 days as an all-weather port. The port will operate round the clock in three shifts of eight hours each, with an allowance of one hour break between each shift, resulting in an effective working of 21 hours a day.

Sixthly, unproductive time at the berth can affect the overall capacity of the terminal. Activities like mooring, line fastening, unlashing prior to the first container move, administrative clearance, ship tie-up and untie time, and the time where the berth is physically occupied by a vessel but there is no crane activity are considered as unproductive time, which is assumed to be four hours per vessel call.

Finally, to calculate the peak/mean week seasonal demand of the berth, an additional 20% should be assumed over the normal demand.

5.2.3 Other Cargo Requirements

5.2.3.1 Cruise cum Multipurpose Cargo Berth

The Port of Vizhinjam proposes to build a 300m long berth in Phase-1 to handle both cruise and multipurpose cargo operations. This berth will serve as a terminal for cruise ships and will also be capable of handling general cargo such as containers, breakbulk, and project cargo.

5.2.3.2 Coast Guard

The Indian Coast Guard has requested a dedicated berthing space at the Port of Vizhinjam with a minimum length of 120m to accommodate its ships. The VISL and Kerala government have agreed to provide the required berthing space on a cost-sharing basis, considering the criticality of coastal security in the region.

5.2.3.3 Navy Berth

The Indian Navy has expressed interest in using the Port of Vizhinjam and has requested a dedicated berth that is 500m long with a loading ramp to allow for loading of vehicles through the bow ramps of Indian Naval Ships. The VISL and Kerala government have agreed to this proposal on a cost-sharing basis.

5.2.4 Water and Power requirements

The Port of Vizhinjam will have various water demands, including potable water for port personnel and passengers, as well as water for gardening and other uses. In Phase-1 development, the estimated water demand at the port is 0.5 million litres per day.

The port will be supplied with power through a 220KV main receiving station located near the truck terminal. The power requirement at the port will be for mechanized cargo handling equipment, lighting of the port area, offices and transit sheds, and miscellaneous activities. The electrical system will include a substation, monitoring and control systems, power cabling and fibre optic communications to the quay cranes, power cabling to the reefer area, power cabling to buildings and gate complex, and power cabling to terminal light towers.

5.2.5 Overview of Future Infrastructure and Facility Requirements for Vizhinjam Port

The Vizhinjam port has been designed with a futuristic outlook in mind, considering 18,000 TEU vessels as the design vessel for Phase-1. The port has a turning circle of 700m diameter, which can cater to the tug-assisted rotation of even the biggest futuristic vessels of 400+ m length. The draft available at Vizhinjam is about 18m, which will be deepened to 21m further, making it possible for even the biggest 18,000 TEU vessels like MAERSK EEE class to berth. Modelling studies have shown that the south breakwater is not required for maintaining tranquillity within the harbour, and it has been removed.

The master plan for Vizhinjam includes a total of five container berths, each 400m long. Phase-1 development will have a total berth length of 800m to accommodate two 12,500 TEU container vessels, while Phase-2 will add another 400m berth to accommodate up to three 12,500+ TEU container vessels. Phase-3 will add two additional 400m berths, bringing the total berth length to 2000m, which can accommodate up to five 12,500+ TEU container vessels or even 18,000 TEU vessels. Each berth will be equipped with four quay container cranes.

In addition to the container berths, there will be an additional fishery berth with a total berth length of 500 along the sea-ward side of the proposed north breakwater. A cruise berth will be constructed on the leeside along the northern breakwater to provide flexibility for phasing the cruise berths on a need basis without interrupting cargo operations. The master plan has two berths for cruise vessels, one 300m in Phase-1 and another 200m in Phase-3, along the northern breakwater. A provision of a 250m long berth for a dedicated liquid berth has also been made in the master plan. The berth will be used to import bunker fuel for the vessels calling at the Vizhinjam port and can accommodate a 60,000 DWT liquid bulk tanker.

Adjacent to the berths, around 100 hectares of container yard and support facilities have been planned to allow for the efficient transfer of containers from the yard to the apron. The container yard will have dedicated areas for full, empty, and reefer containers and will use Rubber Tired Gantry (RTG) Cranes in Phase-1 with the provision for upgrading to Electric RTG's in later phases. Side Pick cranes are proposed for handling empty containers.

The Vizhinjam port will have electrified railway lines with container handling facilities using Reach Stackers in Phase-1 and Phase-2, upgradable to RTG's or Rail Mounted Gantry's (RMG's) in Phase-3. The proposed port is essentially a transhipment container terminal with around 30% of gateway container traffic. The main terminal gate will be located at the east end of the port, consisting of a gate canopy with three entry and three exit lanes with one bypass lane and one lane for port vehicles on each side. The gate complex is designed for handling the master plan gateway traffic handled by trucks. In case of two or more terminal operators, gate complex will remain the same, and secondary check gates will be provided at terminal entry points.

5.3 Environmental Baseline Study for a Project Site in Vizhinjam

An Environmental Baseline was conducted to evaluate the impact of a proposed project within a 10 km radius of the project site. The study covered various aspects of the environment including land, water, marine, air, noise, biological, infrastructure, and public

utilities. In terms of the land environment, the project area consisted of marine water and coconut-covered land with some rock outcrops and lateritic cliffs along the shoreline. The area did not have any eco-sensitive areas such as mangroves or coral reefs. Inland, agricultural land and coconut plantations were present between human settlements. The Vizhinjam fishing harbour, a man-made harbour, was located on the northern side of the project site.

Regarding the water environment, there were three major water bodies present within the project area, namely the Karamana River, Neyyar River, and Vellayani Lake. The freshwater Vellayani Lake was the source of water for Vizhinjam, while the Neyyar River was located 10 km away from the project area. Groundwater in the Vizhinjam area was over-exploited through bore wells and dug wells, leading to water scarcity. However, the water gets recharged during the monsoon season from June to October, and the groundwater is generally free of pollution.

The marine environment was characterized by water depths ranging from 0.0 m to 22.5 m, with a gently sloping sea bed in a southwest direction. The northern part of the Vizhinjam harbour area was a natural deep bay, while the southern side was dominated by rocky outcrops. Waves approached mainly from two directions: South to South-West and West to South-West. The highest wave offshore of the proposed project area was approximately 4.0 to 5.0 m, while waves of about 1.0 m were most frequent, and around 20% of all waves in a year were between 1.0 m and 1.25 m. The predominant current direction was south-east from February to October, with the speed of the current being highest during the monsoon season. The direction of the current reversed during the post-monsoon period (November to January). The project area had three different types of seabeds, namely clayey/silty fine sand, fine to medium sand, and rock outcrops. Dredging was necessary to create a safe approach channel and turning space for ships to operate safely. The turning circle region consisted of medium dense to dense clayey sand with shell fragments and occasional silty sediment. The shoreline erosion problem had been a significant issue for Kerala since 1950, with coastal protection measures installed to protect the shoreline from significant erosion. The proposed site pocket beaches showed a medium erosion trend, and the north of Vizhinjam also showed an erosion tendency. Fill material would be required, apart from rocks, to reclaim land from the sea to develop the port area. In Phase-1, most of the fill material would be obtained from the dredged material itself.

The air environment in Kerala was influenced by its location between the Arabian Sea and the Western Ghats mountains. The dry winds from the North were shielded by the mountains, while the ocean breeze cooled the temperature around the coast. Kerala had four seasons, namely Winter, Summer, SW Monsoon, and NE Monsoon, with similar mean temperatures of around 27-28°C. During the summer and winter, a northeast wind was dominant, while the South-West and North-East wind dominated during the monsoon season, depicting the two different seasons of monsoon, SW and NE monsoon. Hard winds in the form of cyclones were rare in the Vizhinjam area.

5.4 Proposed Container Terminal Infrastructure and Equipment

The proposed container terminal will consist of two container berths that have a total quay length of 800m, allowing for a minimum of two container ships to be accommodated at any given time. To facilitate the efficient movement of containers, eight Rail Mounted Quay Cranes (RMQCs) will be provided on these berths. These quay cranes will have the flexibility

to be moved to adjacent berths, allowing for between two and five cranes to be deployed depending on the size of the ship being handled.

In addition to the quay cranes, 24 Rubber Tired Gantry Cranes (RTGCs) will be available in the Container Yard to aid in the handling of containers. A recommended quay crane to RTGC ratio of 1:3 will be maintained.

To handle containers being moved by rails, two Reach Stackers will be provided. Six Side Picks are proposed for the handling of empty containers. To enable the movement of containers between the quay, container yard, and rail yard, 55 Internal Transfer Vehicles (ITVs) will be provided.

In summary, the proposed container terminal aims to provide efficient handling of containers with the use of various equipment such as quay cranes, RTGCs, reach stackers, side picks, and ITVs. The terminal's design allows for flexibility in the deployment of quay cranes and caters to different sizes of container ships.

5.4.1 Ship-to-Shore Handling Facility (Rail Mounted Quay Cranes - RMQCs)

The Ship-to-Shore Handling Facility refers to a system of rail-mounted traveling cranes on the quay that are used for handling containers from the ship to the shore. These cranes have a front outreach of up to 65 meters and are capable of handling vessels with a capacity of 18,000 TEUs. However, stacking containers on the quay is not preferred except in emergency situations. These cranes are equipped with telescopic twin lift spreaders to efficiently handle containers.

5.4.2 RTGs or Rubber Tired Gantry Cranes

RTGs or Rubber Tired Gantry Cranes are the most commonly used equipment in container yards across the globe. These cranes are designed to operate on rubber tires and can move anywhere within the container yard. Typically, RTGs are powered by diesel but as Vizhinjam is a green project, the port authorities have provisioned for electric RTGs that produce zero emissions.

5.4.3 Reefer Load Container Storage

Reefer Load Container Storage refers to the storage of refrigerated loaded containers or reefers at the south end of the middle RTG stack row. The reefers are stored in multi-level racks that can stack up to five containers high and provide power and maintenance access. The ITVs are responsible for the delivery and retrieval of these reefers.

5.4.4 Empty Container Handlers

Empty Container Handlers are used for block-stowing empty containers in grounded rows, which can be stacked up to eleven containers wide by six to seven containers high. These rows are serviced by Medium-duty forklift trucks, Side-pick cranes, Top-pick cranes, and Reach-stacker cranes. The dedicated empty storage area is located at the eastern end of the container terminal between the RTG rows and the container terminal main access road.

5.4.5 Reach Stackers

Reach Stackers are used for handling containers within the container yard and intermodal operations. These stackers are capable of transporting containers over short distances and can stack them in various rows depending on their access. They are also used for stacking containers in small to mid-size ports and have gained popularity in container handling in rail yards due to their flexibility and ability to stack across rail tracks.

5.4.6 Internal Transfer Vehicles (ITVs)

Internal Transfer Vehicles or ITVs are used for cargo movement within the terminal area from the berth to the storage area and vice versa. Typically, trucks with a forty feet long trailer are used for container handling, and dumper trucks are used for bulk cargo. However, in upcoming terminals that focus on green and eco-friendly mechanisms, battery-operated ITVs are being used in place of diesel-based ITVs.

5.4.7 Railway connectivity of Vizhinjam port

Vizhinjam Port is located on the western side of an existing railway line that runs from Thiruvananthapuram Central Station to Nagercoil junction Station - Kanyakumari, within the Thiruvananthapuram division of the Southern Railway. This division has jurisdiction from Thiruvananthapuram to Kanyakumari, Nagercoil, and Mallapalayam Halt station in the southern direction, and to Kollam, Kottayam-Ernakulam junction, Vallathol Nagar, Thrissur Guruvayur Kochi Harbour terminus, and Kayamkulam junction, covering a route of 610km.

The broad-gauge main line passes through Nemom, Neyyatinkara, and Balarama Puram railway stations, which are approximately 10 km from the location of Vizhinjam Port. This single rail line runs between Thiruvananthapuram and Kanyakumari, while beyond Thiruvananthapuram towards the north, a double rail line exists up to Kayamkulam. Balarama Puram (Flag station) and Neyyatinkara (Block station) are situated on the southern side of the proposed rail alignment, while Nemom (Block station) is on the northern side. These three stations are located at a distance of approximately 9km, 13km, and 10km respectively from the port boundary.

The Ministry of Railways has granted Vizhinjam Port a "Rail Transport Clearance" to develop a private rail siding from the nearest hauling station to the port on the "Engine-on-load" (EOL) concept. This means that the port will have external and internal rail connectivity, enabling cargo movement within the terminal area from the berth to the storage area and rail yard, or vice versa. The private rail siding will facilitate the handling of containerized cargo and other goods through the use of rail-mounted equipment such as RMQCs and RTGs. This will not only reduce the turnaround time for ships but also provide an efficient and sustainable mode of transportation, reducing road traffic congestion and carbon emissions.

5.4.8 The container terminal infrastructure

The container terminal infrastructure is an essential component of any port, which is responsible for efficiently handling and managing the containers that are transported via the port. The infrastructure includes various components such as the container yard, container stack area, gravel stacking beds, RTG runways, reefer gantries, rail terminal, tugs, mooring launches, and pilot cum survey vessels.

The container yard is a designated area within the port where containers are stacked and stored. In this case, the yard area is approximately 25 hectares, and it is designed to accommodate stacking of containers up to 5 full container high stacks, with a density of 5.5 T/sqm. The yard area is made by consolidating reclaimed dredge material and levelling it out, followed by spreading and compacting of fill material for the base layer.

The container stack area is the space where containers are directly stacked on top of each other, and it is recommended to be surfaced with concrete block paving (CBP) for hard surfacing. In situations where ground conditions are favourable and major maintenance costs are relatively low, CBP is the preferred choice for hard surfacing. However, gravel stacking beds can offer a cost-effective solution for RTGs used to handle boxes to and from the stacks, with plain gravel beds successfully used for four-high stacking in other container terminals worldwide.

The RTG runways are reinforced concrete beams of 400mm thick, which are provided with sub-base layers for the movement of RTGCs. Turning pads with structural plates and inserts are provided for RTGCs, and electrical conduits and pits are installed in the container yard for cranes, HT electrical, general lighting, communications, and reefer arrangements.

The reefer gantries are structures planned in each slot of the container yard to accommodate the power plugs and carry out operations for reefer containers stacked up to 4 high. Under these platforms, the compact substation and the reefer power distribution panels are installed, and the power cable is laid for each reefer power plug.

The rail terminal is an area within the port that is designated for handling rail freight. In this case, the rail yard area is planned with a total outer dimension of 1,110m length and 62m width, and it will also be on reclaimed land. After consolidation of dredged material reclaimed, the yard area will be levelled and fill material will be spread and compacted for the base layer.

The terminal support system includes tugs, mooring launches, and pilot cum survey vessels. The main activity of harbour tugs is to provide assistance to vessels entering/leaving the harbour, turning of the vessel in the harbour, and the berthing/de-berthing operations. The mooring launches are small boats used to transfer mooring ropes between vessel and quay and transfer of mooring crew. Finally, pilot cum survey vessels are boats used to transfer pilots to and from incoming/outgoing vessels, and they are also used for hydrographic surveys and for buoy lights maintenance.

5.4.9 Security systems

To ensure the safety and security of the port, a comprehensive security system must be put in place. This system should be able to protect the port from potential threats such as sabotage, pilferage, thefts, encroachments by unauthorized persons, and trespassers. The security system should comply with the ISPS Code, which is a set of security measures designed to enhance the security of ships and port facilities.

To achieve this level of security, several proposals have been made. First, the port boundary will be protected by a 2.4m high rubble masonry wall with a 1m high barbed wire fence. Additionally, a perimeter fence CCTV system comprising high sensitivity colour cameras

will be installed. This will allow for continuous monitoring of the port perimeter to detect any potential threats.

To control access to the port, a security office and check post will be established at the entrance to the terminal. Watch towers will also be installed at suitable intervals to provide manual monitoring of the port area. In addition, adequate container scanners will be provided to scan a percentage of boxes as per the security plan. Radiation Portal Monitors (RPM) will be used to screen vehicles and cargo for detection of illicit sources.

An isolated area will be allocated for the storage of dangerous goods. This will help to prevent any potential harm to the port in case of an accident. Lastly, the lighting in the port area will be set to acceptable standards to ensure proper visibility at all times.

In summary, the security system of the port must be comprehensive and robust to protect against potential threats. The proposed security measures, including a perimeter fence CCTV system, watch towers, container scanners, and RPMs, will provide continuous monitoring and detection of any potential threats. The allocation of an isolated area for the storage of dangerous goods and proper lighting in the port area will further enhance the safety and security of the port.

5.4.10 IT systems

In order to increase productivity and efficiency in container handling, information technology (IT) is a vital component for the port. The IT Management System will be designed to include port planning, operations, administration, accounts, and internal and external communication. The system must have certain minimum functions available, such as ship-to-shore loading and discharge control, yard planning, gate delivery and receipt control, ship planning and dispatch including vessel stowage planning module, EDI abilities, RDT abilities, payment status and service billing, management information reports and statistics, and linking to shipping lines/agents.

The IT infrastructure will include various port functions, including planning operations and financial processing. The PC network will have workstations for all relevant port employees, communication devices such as RDT, internet links, servers, and storage capacity for the operational database and network management. Hardware, network, and communication systems will include provisions for data security and uninterrupted power supply.

A Vessel Traffic Management System (VTMS) will be installed at the new port, which will be built from a family of advanced maritime information applications and sensors. The system will be flexible and scalable, allowing for augmentation in functionality. The VTMS provided will allow it to be used as an aid to navigation (AtoN), ship reporting, Automatic Identification System (AIS), and voyage management. It will have features such as message and voice communications, multimedia logging, and replay. The system software will use a programming language that enables the software to be executed on virtually any kind of computer platform, reducing costs and ensuring a maximum system life-length. A VTMS control centre will also be designed and built to suit operational requirements.

Efficiency in a port container terminal is dependent on the information systems that drive and track the movement of containers, as well as act as an interface between the user, the vessel, and the terminal. A container terminal with a large amount of data generated requires

sophisticated IT infrastructure with connectivity to its users. The system provided is likely to have database servers, a large number of PCs, printers, UPS, terminal operation/planning software, and more. The Terminal Operating System should have ship planning, EDI, BAPLIE, external tracking, and billing modules.

A computer system for port operation takes the form of a central computer processor with hard disc storage on which information files are stored and updated. It is linked to a variety of terminals where operators can access, update, or supplement this information at any time. Developing specialized software, computerization of all operations including the management information system, etc. will be included in the capital cost. Overall, the implementation of IT systems is critical for the efficient and effective operation of the port.

5.4.11 The Fire fighting system

The Fire fighting system in the port needs to have the ability to control and put out fires effectively. Two types of systems will be installed: sea water and fresh water. The sea water system will have a fire water intake to draw water from the sea, pumps, nozzles for water curtains, hydrants and distribution networks. This system will cover container and car carrier berths. A centralized fire station with 2 mobile fire tenders, one of which will have a snorkel attachment, will be provided to attend to all fire calls. Fire Alarm Bells will be installed at strategic locations that can be heard by terminal operators, especially in buildings where the risk of fire and occupancy are high, such as the workshop and administration building. The fire alarm system will be activated by push buttons at strategic places in the terminal areas and around the port perimeter.

To elaborate, the fire fighting system in the port must be designed to ensure that it can manage fires and put them out quickly and efficiently. To achieve this, the system will have two types: sea water and fresh water. The sea water system will be responsible for providing water to control fires in the container and car carrier berths, and it will have a fire water intake to draw water from the sea. The system will also have a pump house with pumps, nozzles for water curtains along the front side of operating platform, hydrants, and distribution networks.

In addition to this, a centralized fire station will be provided for all fire calls. This station will have two mobile fire tenders, with one of them equipped with a snorkel attachment. This means that the fire tenders can reach fires in high locations, such as on top of buildings or on vessels.

To ensure that everyone can hear the fire alarm, Fire Alarm Bells will be installed at strategic locations within the terminal areas and around the port perimeter. Buildings that are at high risk of fire, such as the workshop and administration building, will have fire alarm bells installed. The fire alarm system will be activated by push buttons located at strategic places in the terminal areas and around the port perimeter.

Overall, the fire fighting system in the port will be well-equipped to handle any fires that may occur, with an efficient and effective sea water system, a centralized fire station, and a reliable fire alarm system.

5.4.12 Bunkering facility

The port will provide a facility to supply ships with fuel (Heavy Fuel Oil and Marine Diesel) through a pipeline laid in the berths. The pipeline will also be used to supply fuel to port crafts and vehicles. The plan includes building a fuel bunkering facility with a storage capacity of approximately 100,000 tons to meet the annual demand in Phase-1. Initially, mobile fuel tankers/trucks will transport the fuel from outside the terminal and supply it directly to the vessels. The master plan also includes allocating 2 hectares of land in the future expansion area for this purpose.

5.4.13 Pollution control

Pollution control is an essential aspect of any port operation, and the container terminal is no exception. Since containers are generally considered low hazardous cargo, there are no specific pollution control facilities required for a container terminal. However, various sources of pollution need to be monitored and controlled in the port, such as oil and bilge discharge from ships and crafts, cargo overboard, spillage during loading/unloading operations, industrial effluents, dust, and noise from vehicles and machinery.

To address these issues, several measures are proposed for pollution control at the port. A special drainage system will be installed to contain and clean oil spillage from fuel stations and the reefer wash down area. Additionally, a portable inflatable type oil spill containment boom and oil skimmer will be deployed to contain and clean oil spillage from vessels. High mast lights with shielding arrangements will be used to minimize light pollution, ensuring the port is a green port.

The port will also incorporate environmentally friendly features, such as the use of electric rubber-tired gantry cranes (e-RTGs) and hybrid internal transfer vehicles (ITVs), which will reduce fuel consumption and air pollution. Furthermore, the port is designed to be a world-class facility, with efficient systems that minimize processing times, ensuring a positive environmental impact.

Overall, the proposed pollution control measures and environmentally friendly features incorporated into the port's design will significantly reduce the environmental impact of the port and make it a world-class facility.

Chapter 5

Structuring and Financing Port Development Projects

6 Project Structuring Options

6.1 Considerations for the Successful Development of Vizhinjam Port Project

The Vizhinjam Port project faces several challenges due to the lack of significant gateway traffic and the high risk involved in relying primarily on transhipment traffic. To mitigate this risk, the project must be planned as a larger development that includes the development of an industrial and/or logistical hub near the port, providing opportunities for synergies between the port and the Kerala economy. The design of the port's civil works must be such that it can cater to the largest container ships of 18000 TEU capacity and support highly efficient operations. Private investors and operators must be involved in the planning, design, and construction of the port's civil works and given independence in deciding on the nature and timing of terminal capacity addition.

The management and operation of the port must be highly market-oriented, and strategic tie-ups with port operators, shipping lines, shippers, and other key players in the logistics value chain must be developed. Transhipment traffic is highly price-sensitive, and therefore, the project must initially offer substantial discounts to the transhipment tariff offered at Colombo port and match the tariff at Tuticorin port for bulk cargo and vessel-related charges. The project structure must be such that experienced private players that are able to develop strategic tie-ups with key players in the logistics value chain are involved in the project at an early stage and have a say in the planning, design, and construction of the port.

Moreover, the project faces intense competition from existing ports for transhipment traffic, and therefore, it must compete vigorously with ports such as Colombo and Vallarpadam. The project structure must set up the right incentives and checks and balances to ensure that design and construction of civil works and terminals are optimal from the viewpoint of efficient port operations and timing and extent of investments. Additionally, transhipment traffic demands disruption-free operations at the port, and strategies must be developed to counter the general perception of labour-related issues in Kerala. Some bidders consulted have suggested that the establishment of a Special Economic Zone at the port may give comfort to bidders and shipping lines that are potential customers for the transhipment traffic at the port.

In conclusion, the success of the Vizhinjam Port project depends on several factors, including the development of an industrial and/or logistical hub near the port, involvement of private investors and operators, market-oriented management and operation, strategic tie-ups with key players in the logistics value chain, and competitive pricing. The project structure must be such that experienced private players are involved in the project at an early stage and have a say in the planning, design, and construction of the port. Ultimately, the success of the project will depend on its ability to attract and retain transhipment traffic while providing efficient and cost-effective services.

6.2 Challenges and Financial Viability of Vizhinjam Port Project

Transhipment activities at Vizhinjam port are facing regulatory issues due to Cabotage law. According to the Merchant Shipping Act of 1958, Indian flag vessels and foreign flag ships need to obtain a license from the Directorate General of Shipping to carry on either foreign or

coasting trade. Non-Indian flag ships or ships not chartered by Indian citizens must seek a license to carry on coasting trade in India. The lack of regular feeder services between Vizhinjam Project and other ports in the Indian sub-continent region due to such short-term licensing may negatively affect transhipment traffic at the Project. The Ministry of Shipping has the power to exempt foreign flag vessels from the requirement of obtaining a license for carrying on coasting trade in India. However, this exemption is not guaranteed, and the risk is not entirely mitigated, as the Government of India may not provide an exemption to the project despite best efforts. To address this issue, the government of Kerala can seek a general order from the Ministry of Shipping to exempt all foreign or Indian flag ships calling at the port of Vizhinjam, along with any other ports in the Indian sub-continent, from the licensing requirement.

The construction of a world-class greenfield port at Vizhinjam requires heavy investment in civil works such as breakwater, dredging, reclamation, and quay walls. However, a project structure that puts the entire responsibility of financing civil works related investment on the private sector is financially unviable, as large investments are needed to construct a world-class port with meaningful spinoffs for the Kerala economy. Financial analysis suggests that the project has low debt capacity, and it will need a large infusion of equity to be financially viable. However, the return to equity investors is much lower than threshold returns required by investors. In addition, the life of these assets' ranges from 50 to 100 years, and depreciating them in the typical concession period of 25 to 40 years is not feasible. Therefore, substantial financial support from the government is required for the project to make it financially viable. This support is primarily needed to meet the capital expenditure for breakwaters, dredging, and reclamation, as well as external infrastructure such as road and rail linkages. Most potential bidders have indicated their inability to finance civil works, further confirming the need for government support.

6.3 Priorities and Objectives of Kerala Government in PPP Projects

The Government of Kerala (GoK) has set priorities for the development of a project on a public-private partnership (PPP) basis. One of the main objectives is to conduct a successful bidding process to select sponsors as early as possible, ideally by December/January 2010. To achieve this, the project needs to be positioned in a way that is financially viable and bankable for lenders and sponsors, and the bidding process should be fair, transparent, and competitive to attract the maximum number of competent and experienced bidders.

Another priority for the GoK is to reduce the total quantum of public expenditure on the project. The GoK prefers to defer its obligations to expend monies on the project over as long a period as possible and maximize the financial support available from the Government of India, subject to meeting financial viability and bankability considerations.

Additionally, the GoK aims to recover the money spent on the project and achieve a reasonable rate of return. To minimize the project risk that the GoK needs to bear, it wants to minimize its role in the construction, operations, and maintenance of the project and give the sponsors maximum flexibility to develop the project.

In summary, the GoK's priorities for the project are to conduct a successful bidding process, reduce public expenditure, recover the money spent on the project, minimize project risk, and give the sponsors flexibility to develop the project. These priorities are all subject to meeting financial viability and bankability considerations.

6.4 Exploring Infrastructure Concession Models for Port Development

The Landlord Model is preferred by foreign investors who are hesitant about greenfield project development and construction risks. Indian developers with construction arms may not be interested in the PPP bid. However, a modified version of the Landlord Model that includes additional geological tests and inputs from the Supra structure Concessionaire's business plan could still allow for construction works. The government of Karnataka (GoK) would retain control over the Master Plan, and VGF funding and multilateral funding could be pursued. While this reduces risks for the PPP partner and may lead to better bids, there is a risk of building a white elephant with large time and cost overruns. Indian developers would prefer to control the Master Plan, but GoK may need to undertake certain aspects of project development. The Modified Landlord Model may attract greater bidder interest, particularly from construction firm-led consortia, but there is a risk of over-design and gold plating of the EPC contract. The need for greater specification of EPC components in the PPP bid may affect bid timelines and innovation, and there is a risk of bidders abandoning the project after cornering construction margins. Bidders could also game the bid by asking for high EPC prices and a low grant or high revenue share for supra structure development and operation.

The government will provide financial support to the private entity responsible for constructing and operating the port. This support will be in the form of a capital grant during construction and payments during the operations period. The value of these payments will be calculated at a high discounting rate to encourage bidders to prioritize operations period payments over upfront construction grants. The government's credit risk and risk mitigation measures will also be considered by sponsors and lenders. If the private entity bids for operations period payments instead of an upfront grant, they will recover their investment and returns through payments during the operations period, which will incentivize them to provide high-quality services. The private entity will have full flexibility and control over the port's operations, maintenance, management, and tariff rates, while the government will have a statutory oversight function. The private entity will also have control over marine services and tariffs, allowing them to reduce costs to users. The VGF Scheme's restraints will not apply, and there will be no requirement to use certain documents.

Proposed Modifications to the Private Services Model for Infrastructure Concession have been suggested. The key points include:

- The availability payment model could be used to spread GoK funding over longer budgetary periods, while VGF could be available for the Supra Concession to reduce GoK funding.
- The risk of poor operational performance is mitigated by private investment being at risk.
- This structure may not be bankable because of the credit risk associated with long-term annuity payments by GoK for the Infra Concession.
- There is a possibility that GoK may consider this ineligible for VGF because two parallel concessions may be seen as an artificial split.
- In-principal approval for VGF before bids may delay the bid process, and the split structure may be tax-inefficient. Overall, this is not a preferable structure.

The Joint Venture BOOT Model is a possible structure that can be used for the development of the Port project, as it allows the maximum amount of VGF to be availed from the GoI.

However, it is not fully compliant with the conditions of the VGF Scheme, and certain clarifications will need to be sought from the GoI before implementing this structure.

Under the Joint Venture BOOT Model, all project risks will vest with the Concessionaire, while the GoK will retain a level of ownership over the Port assets that it has contributed funds towards. However, the structure may not be preferred by bidders due to its relative complexity and unclear eligibility under the VGF Scheme. Additionally, the requirement for complicated documentation between the GoK, the Sponsors, and the Concessionaire may constrain their operational and financial flexibility.

To use the Joint Venture BOOT Model, clarifications will need to be sought from the GoI regarding the treatment of capital contributions and VGF availability. This may take a long time and there is no guarantee that VGF will be available. Furthermore, even if VGF is made available, the market-based tariff may be insufficient to recover all costs incurred in developing the Port.

Overall, while the Joint Venture BOOT Model is innovative and prima facie compliant with the stated principles of the VGF Scheme, it may not be the preferred structure due to its relative complexity and bidder feedback.

6.5 The financial analysis

The financial analysis section provides insights into the various assumptions and scenarios related to the PPP project. The table outlines the responsibilities for each cost and revenue in the project, depending on the type of model - Landlord, Private Services, or Joint Venture. The costs and revenues are divided into categories such as Capital Expense, Operational Expense, Revenues, etc.

In the table, the International Finance Corporation evaluated more than 20 scenarios based on the broad structure of the Landlord, Private Services, and Joint Venture models. The analysis includes the impact of various factors such as the concession length, the Special Economic Zone (SEZ), upfront grant, annuity, and subordinated debt.

For example, reducing the concession length to 25 years would allow the Operator to utilize the Quay Cranes for the full 25 years, which would be more cost-effective than replacing them after 20 years. Additionally, while the SEZ does offer some benefits, the Government of Kerala's financial commitment to it is minimal, and the benefit to the sponsor is marginal. However, the SEZ is a requirement that many bidders have stated as necessary.

In the Landlord Model, the Government would fund the civil infrastructure, and an upfront grant or annuity may be needed to meet the viability gap for building and operating the supra-structure. In the Private Services Model, the upfront grant would be higher as the Concessionaire is responsible for both the supra-structure and the civil infrastructure.

The Government favours spreading its financial support over the term of the concession in the form of an annuity rather than giving it all upfront. This approach helps to manage risks associated with perverse incentives and spreads the financial load on the budget over several years. However, the appetite for operation period payments or annuity is limited, and investors may prefer upfront grants.

	Landlord	Private Services	Joint Venture
Capital Expense and Operational Expense - maintenance			
Dredging & Land Fill	Public Sector	Private Sector	Private Sector
Breakwater & Revetments	Public Sector	Private Sector	Private Sector
Quay Wall	Public Sector	Private Sector	Private Sector
General Port Superstructures	Private Sector	Private Sector	Private Sector
Container Terminal	Private Sector	Private Sector	Private Sector
Container Terminal Equipment	Private Sector	Private Sector	Private Sector
Marine Services	Private Sector	Private Sector	Private Sector
Utilities	Private Sector	Private Sector	Private Sector
Miscellaneous	Private Sector	Private Sector	Private Sector
OPEX-Energy & OPEX-Labor			
Energy	Private Sector	Private Sector	Private Sector
Labor	Private Sector	Private Sector	Private Sector
Revenues			
Port Dues	Public Sector	Private Sector	Private Sector
Berth Dues	Public Sector	Private Sector	Private Sector
CargoHandlingTariffs	Private Sector	Private Sector	Private Sector
Marine Service Dues	Private Sector	Private Sector	Private Sector

Table 8 - cost and revenue in the Vizhinjam project, depending on the type of model - Landlord, Private Services, or Joint Venture.

Finally, GoK had structured the financial support as an interest-free Subordinated Debt with a 10-year moratorium in the last bid. However, the bidders may expect a higher amount as debt repayment will take away from the financial support. The project's cash flows may not support the payback of a large government loan.

Chapter 6
Summary and conclusion

7 SWOT Analysis on Vizhinjam port as an emerging Transhipment port in India

SWOT analysis is a strategic planning tool used to evaluate the strengths, weaknesses, opportunities, and threats of a project or a business. The acronym SWOT stands for Strengths, Weaknesses, Opportunities, and Threats.
SWOT analysis is needed for Vizhinjam Port as an emerging transhipment port in India because it helps to identify the port's strengths, weaknesses, opportunities, and threats. This analysis provides valuable insights for the port's decision-makers to make informed decisions, develop effective strategies, and mitigate risks in order to achieve sustainable growth and success. Here are the strengths, weakness, opportunities and threats of Vizhinjam port.

7.1 Strengths

7.1.1 Strategic location

Vizhinjam Port's strategic location on the west coast of India, close to international shipping routes and major trade centres in the Indian subcontinent, provides a natural advantage for transhipment activities. It is situated in the southernmost part of India, making it an ideal location for transhipment of cargo from Europe, Africa, and the Middle East to East Asia and the Pacific. This location also makes it an attractive option for shipping lines, as it offers a convenient stopover point for vessels plying these routes.

7.1.2 Deep draft

The natural deep draft of 20 meters at Vizhinjam Port allows it to accommodate the largest container ships in the world. This gives the port a significant competitive edge over other ports in the region that may have draft limitations. With larger ships able to dock at Vizhinjam Port and unload a greater volume of cargo in a single call, it becomes an ideal hub for transhipment. This capability allows for the consolidation and deconsolidation of cargo from multiple smaller vessels onto fewer larger vessels, reducing the cost and time of handling cargo.

7.1.3 Modern infrastructure

Vizhinjam Port boasts state-of-the-art infrastructure and facilities, including container handling equipment, automated gate systems, and advanced IT systems. These modern facilities enable the port to handle large volumes of cargo efficiently and effectively, reducing turnaround times and increasing productivity. The port has also invested in well-equipped and modernized warehouses and cold storage facilities that provide value-added services to customers. This investment in infrastructure has been a critical factor in establishing Vizhinjam Port as an emerging transhipment hub.

7.1.4 Support from the government

Vizhinjam Port is a flagship project of the Government of Kerala, which has invested heavily in its development. The government's support provides the necessary political and financial backing for the port to succeed and achieve its potential as an emerging transhipment hub. The port is also backed by the Ministry of Shipping and the Sagar Mala Project, which is a national initiative aimed at boosting port-led development in India. This backing from the

government provides the necessary impetus for the port to overcome any challenges it may face and to compete effectively with other established transhipment ports in the region.

7.2 Weaknesses

7.2.1 Limited operational experience

While Vizhinjam Port has state-of-the-art infrastructure, it may lack the experience and expertise of established transhipment ports in the region. This could lead to operational inefficiencies, delays, and other challenges in handling large volumes of cargo.

7.2.2 Connectivity challenges

Although Vizhinjam Port is well-connected to major trade centres in India and the region, there may be challenges in providing seamless connectivity to the hinterland. For example, there may be inadequate transportation infrastructure, inefficient logistics networks, and regulatory hurdles that could impact the port's competitiveness.

7.2.3 Competition from established ports

Vizhinjam Port will face stiff competition from established transhipment ports in the region, such as Colombo Port in Sri Lanka, Jebel Ali Port in Dubai, and Singapore Port. These ports have a proven track record of success and may be able to offer better services, prices, and incentives to shipping lines and cargo owners.

7.2.4 Dependence on international trade

Vizhinjam Port's success as a transhipment port will depend on the growth of international trade and the ability of the Indian subcontinent to attract and retain cargo volumes. Any adverse changes in global trade patterns or economic conditions could impact the port's growth prospects. For example, a slowdown in the global economy, trade disputes, or geopolitical tensions could reduce the demand for transhipment services and impact the port's revenue and profitability.

7.3 Opportunities

7.3.1 Growing Transhipment Market

The transhipment market in India is growing at a steady rate due to factors such as increasing containerization, the need for supply chain optimization, and the growth of e-commerce. Vizhinjam Port's strategic location and modern infrastructure make it well-positioned to cater to this growing demand. In addition, as the only major transhipment port on India's west coast, Vizhinjam Port has the potential to capture a significant share of the market.

7.3.2 Increasing International Trade

India's trade volume is expected to grow at a robust pace in the coming years due to factors such as economic growth, a large consumer base, and favourable government policies. As a result, there will be a higher demand for transhipment services to facilitate international trade. Vizhinjam Port's location on the west coast of India, which is closer to key shipping routes, positions it well to cater to this growing demand.

7.3.3 Government Support

The Indian government has launched several initiatives to promote the development of ports, including the Sagar Mala Project, which aims to enhance the infrastructure of ports and increase their efficiency. Vizhinjam Port is a flagship project of the government of Kerala and has received significant financial support from the state government as well as the central government. This support provides an opportunity for Vizhinjam Port to secure additional funding and support for its growth and development.

7.4 Threats

7.4.1 Competition from Established Ports

One of the primary threats to Vizhinjam Port's growth is competition from established transhipment ports in the region, such as Colombo Port in Sri Lanka, Jebel Ali Port in Dubai, and Singapore Port. These ports have a proven track record of success, strong customer relationships, and may be able to offer better services, prices, and incentives to shipping lines and cargo owners. Vizhinjam Port must differentiate itself and offer unique value propositions to attract and retain clients.

7.4.2 Economic Uncertainty

Another significant threat to Vizhinjam Port's growth is economic uncertainty and market volatility. Global economic conditions, changes in trade policies, and geopolitical tensions can impact international trade and, in turn, the demand for transhipment services. Any adverse changes in global trade patterns or economic conditions could impact the port's growth prospects. Vizhinjam Port must be resilient and adaptable to changing market conditions and have contingency plans in place to mitigate risks.

7.4.3 Political Instability

Political instability in the region can also pose a threat to Vizhinjam Port's operations and growth prospects. Unforeseen political events, such as civil unrest, terrorism, or conflict, can disrupt port operations and scare off potential investors and clients. Vizhinjam Port must ensure that it has effective risk management strategies in place, including security protocols, crisis management plans, and insurance coverage, to protect its assets and ensure business continuity.

8 Summary

The Vizhinjam port project in India aims to become the country's deepest port, with a natural draft of 20 meters, making it capable of handling mega vessels with a capacity of up to 18,000 TEUs. The first phase of the project includes an 800-meter berth, a 3,180-meter breakwater area, and a 500-meter container yard. The master plan also includes a 500-meter fish landing centre, a 300-meter modern cruise terminal, and permanent base stations for the Indian Navy and Coast Guard.

The project is worth Rs.4010 crore and will be taken up under a public-private partnership on a build-operate-transfer basis. The Kerala government will develop the breakwaters, approach channels, road, and rail, and will also provide backup land for the port, while the BOT operator will build the port infrastructure such as berths, container yards, and cranes.

The involvement of both private and public sectors in port operations will prevent a monopoly and lead to more efficient operations. This is particularly important as there is a trend toward larger container ships, which require deeper berths and approach channels, higher capacity cranes, and more efficient turnaround times. Vizhinjam has an advantage over other ports in South Asia, such as Colombo, because of its deeper berths and approach channels of up to 20 meters, which have lower dredging and maintenance costs.

Vizhinjam has the freedom to fix its own tariff based on a competitive market environment, as it is a non-major port and comes outside the jurisdiction of the Tariff Authority of Major ports. This freedom makes it attractive to major port operators, as evidenced by the response of five major port operators to the global tender floated by Vizhinjam International Seaport Limited. This interest indicates the potential growth of Vizhinjam as an emerging transhipment hub for the Indian Peninsular region.

One important aspect to consider when discussing the development of Vizhinjam port as a transhipment hub is the potential environmental impact. While the project has received environmental clearance, it is important to ensure that proper measures are in place to mitigate any negative effects on the surrounding ecosystem. Additionally, the project should also prioritize the welfare of local communities and ensure that they benefit from the economic opportunities that arise from the port's development. It is important to strike a balance between economic development and environmental and social responsibility.

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