PLANNING AND OPERATION PROBLEMS OF INDIAN MAJOR PORTS WITH SPECIAL EMPHASIS ON COCHIN PORT

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Under the Faculty of Social Sciences

by

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DECLARATION

I hereby declare that the work presented in thesis entitled **"PLANNING AND OPERATION PROBLEMS OF INDIAN MAJOR PORTS WITH SPECIAL EMPHASIS ON COCHIN PORT"** is based on the original work done by me under the supervision of **Dr. M. Bhasi**, Reader, School of Management Studies, Cochin University of Science and Technology, Kochi. This work did not form part of any dissertation submitted for the award of any degree, diploma, associate ship or other similar title or recognition from this or any other institution.

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Abstract

Rapid changes in the technological environment of marine logistics and the increasing integration of waterborne, air and land transport systems have fostered a revolution in the design and operations of transport vehicles, cargo handling technology, and terminal facilities. This in turn has caused major changes in the functions of and uses of ports. From literature, it was found that these changes were very slow in case of Indian ports and the performances of port operations were poor when compared with similar ports in the same region. It was also found that a very few studies were conducted to identify the reasons for slow improvements in the performances of Indian major ports. In this thesis, an attempt is made to find out the operational problems of Indian major ports and to analyze the reasons for it. Some solutions have also been found out using management tools.

The study starts with the understanding the current status of operations and identifying the common problems of major ports in India. For this purpose, secondary data were collected from published report of Government of India, administrative report of ports, and the reports of the concerned ministry. Using this data, a comparative study of all major ports has been conducted using weighted score method. Then, the planning process of ports has been studied. For this purpose, the role of five-year plans in port development was studied using the plan reports and economic review of the five-year plan proposals. Problems in planning, allocation of funds and its utilizations were located. This analysis showed that Indian Ports are lagging behind as far as operational performance is concerned.

Since planning and operation problems differ very much from port to port, it is necessary to study problems from a firm level. Hence it was decided to conduct a detailed study of the operation problems of Cochin Port. The operation processes of the port were studied using flow processes chart, which was used to locate the delays in operations. Next, a survey-using questionnaire was conducted among the port users to identify the operational and the procedure and documentation problems. Observations from the survey are seen agree with the results obtained from the flow processes chart.

Profit generation in any organization is very much related to the operational efficiency. So operations study of any organization without considering its income and expenditure is incomplete. Hence, the income schedules and the expenditure schedules of the port are analyzed. The result showed that the financial position of the port is very poor due to the high expenditure; both operational and non-operational expenditure. This study also helped in finding out the critical operations among the three operational areas such as: Cochin Oil Terminal (COT), Container Terminal (CT) and Other Wharves operations. Cochin Oil Terminal is the most critical area, because the maximum income is generated with minimum expenses from here. The next important area of operation is Container Terminal because the trend in cargo handling has changed in to containerization. Hence further study has mainly concentrated on these two areas.

The reasons for low performances of the COT were studied and it was found that the COT operation is a bottleneck. A simulation model was developed and the best operation conditions of COT were found. The result showed that a system of bringing a few 55 thousand DWT tankers with majority of 35 thousand DWT tankers would be a solution suitable both for the port and the Kochi Refinery. Similarly, the operational problems of Rajiv Gandhi Container Terminal (RGCT) were identified using the data collected from the CT. Analysis showed that the ship side operations and the container yard operations were delayed due to the poor performance of handling equipment and the less space in the stacking yard. A simulation model was developed to study the *effect of turn around time on area of container yards and stacking high of the containers in the yard. The simulation results showed that the constraints of container yard resulted high turn around time. So, more handling facilities must be provided or the efficiency of the existing equipment must be improved for reducing the turn around time of the ships. The simulation models helped in quantifying the effects of congestion on performance.*

These studies have identified the overall operational problem areas of Indian ports. The problems related to planning and facility creation have also been brought out. At firm level, the problems related to operations of Cochin port have been studied. Detailed study has also been presented on the Oil and Container Terminal operations of Cochin port.

Key Words: Port Planning and Operations, Port performance, Bottlenecks, Oil Terminal, Container Terminal and simulation

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LIST OF ABBREVATIONS

AD	After Death-
AGV	Automated Guided Vehicle
AP	Andhra Pradhesh
APM	Administered Pricing Mechanism
B.E.P	Break Even Point
B/L	Bill of Lading
BEP	Break Even Point
BOT	Build. Operate and Transfer
C&F Agents	Clearing and Forwarding Agents
CAD	Central Accounts Department
CAS	Cargo Account System
CCHAA	Cochin Customer House Agents Association
CDS	Calcutta Dock System
CDU	Crude Distillation Unit
CFS	Container Freight Station
CHA	Customs House Agents
CISF	Central Industrial Security Force
CLP	Container Load Plan
CMIE	Center for Monitoring Indian Economy
CNTR	Container
COT	Cochin Oil Terminal
COT	Cochin Oil Terminal
CSAA	Cochin Steamer Agents Association
CT	Container Terminal
CVIA	Container Vessel Identification Advice
CY	Container Yard
D/O	Delivery Order
D/R	Dock Receipt
DBT	Declaration of Bonded Transportation
DGPS	Digital Global Positioning System
DLB	Dock Labour Board
DWT	Dead Weight Tonnage
e.g.	Example

E/D	Export Declaration
E/M Wharves	Ernakulam / Mattanchery Wharves
EA/IA	Export Application/ Import Application
EDC	Electronic Data Center
EDI	Electronic Data Interchange
EDO	Equipment Dispatch Order
EIR	Equipment Interchange Receipt
ENE	End Network Element
ETA	Expected Time of Arrival
FACT	Fertilizers and Chemical Travancore Ltd.
FCL	Full Container Load
GDP	Gross Domestic Point
GPM	General Purpose Mazdoor
HDC	Haldia Docking Complex
HOM	Higher Order Mode (fiber optics)
HRM	Human Relations Management
ICD	Inland Container Depots
IG Problem	Inert Gas Problem
IIPM	Indian Institute of Port Management
IP Service	Internet Protocol Service
ISO 9002	International Standard Organization 9002
IT	Information Technology
JICA Seminar	Japan International Container Association
JNPT	Jawaharlal Nehru Port Trust
Kms	Kilometers
KoDS	Kolkata Docking System
KPD	Kidder Pore Dock
KRL	Kochi Refineries Limited
LAN	Local Area Network
LOA	Length Over All
LPG	Liquid Petroleum Gas
LR1	Lloyd's Register Shipping 1
LR2	Lloyd's Register Shipping 2
m	Meters
MAUT	Multiple Attribute Utility analysis Theory
MBA	Master of Business Administration

MDPM	Market Determined Pricing Mechanism
MLO	Main Line Operators
MMT	Million Metric Tons
MMTPA	Million Metric Ton Per Annum
MOOT	Multi-objective Optimization Technique
MOST	Ministry of Surface Transport
MOU	Memorandum of Understanding
MR	Maritime Reconnaissance
Mrgs	Moorings
MT containers	Empty Containers
NCAER	National Council of Applied Economic Research
NH	National Highway
NIPM	National Institute of Port Management
NMS	Nautical Miles
NOR	Notice Of Readiness
NPA	National Port Authority
NRT	Net Registered Tonnage
NSD	Netaji Subhash Dock
NSICT	Nhava Sheva International Container Terminal
NTB	North Tanker Berth
OEE	Overall Equipment Effectiveness
OSTT	Off Shore Oil Tanker Terminal
P&O Ports	Peninsular and Oriental Ports
PCC	Pure Car Carriers
PMS	Preventive Maintenance Schedule
POB	Pilot On Board
POL	Petroleum Oil and Lubricants
PSA	Port of Singapore Authority
QC	Quay gantry Crane
RGCT	Rajiv Gandhi Container Terminal
RTG	Rubber Tyre Mounted Gantry
S/A	Shipping Application
SAC	Sagar Anchorage
SBM	Single Buoy Mooring
SCADA	Supervisory Control and Data Acquisitions

SCI	Shipping Corporation of India
SE	South East
Sq.Km.	Square Kilometer
STB	South Tanker Berth
TCP/IP	Transmission Control Protocol/Internet Protocol
TCS Ltd.	Tata Consultancy Service limited
TCs	Transfer Cranes
TEUs	Twenty feet Equivalent Units
ULA	Unloading Arm
UNCTAD	United Nations Conference on Trade And Development
USA	United States of America
VHF	Very High Frequency
Vizag	Visakhapatanam
VRS	Voluntary Retirement Schemes
VTMS	Vessel Traffic Management System
WAN	Wide Area Network

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CHAPTER 1

INTRODUCTION

Over a span of thousands of years, the introduction of sail, the invention of the compass, the development of steamship, the introduction of iron hull, and, in a such different vein, the recognition of the freedom of the seas have all been milestones for the shipping industry. The last few decades have witnessed tremendous changes in sea transport due to the growth of science and technology. The new economic policies such as globalization and liberalization of world market have further intensified the growth of shipping industry and world trade. Each of these breakthroughs had its impact on trade routes and on the rise and decline of seaports. The last five decades have experienced rapid changes in ocean transportation. International trade has been growing at a rate higher than the growth rate of world output. This higher growth rate of international trade is due to various strategies introduced worldwide. The strategies adopted are listed as follows:

- Move towards a market oriented economy
- Massive induction of foreign private capital and technology
- External sector liberalization and outward oriented policies enabled several developing countries like Taiwan and South Korea to achieve higher rate of economic growth and employment, and better export performance
- External liberalization effectively eliminated the state monopoly of foreign trade, reduced import restrictions and steps taken towards currency convertibility. Due to the impact of these strategies, the world trade will further expand in future.

1.1 Overview of trends in World Trade

The year 2001 witnessed an unexpectedly sharp downturn in the expansion of global output and a decline in world trade. World GDP, which in the preceding year recorded its highest annual growth rate of 4% in more than a decade, edged up to about 1.5%. World trade decreased by 1.5% after expanding 11% in the preceding year for the first time since 1982 world trade

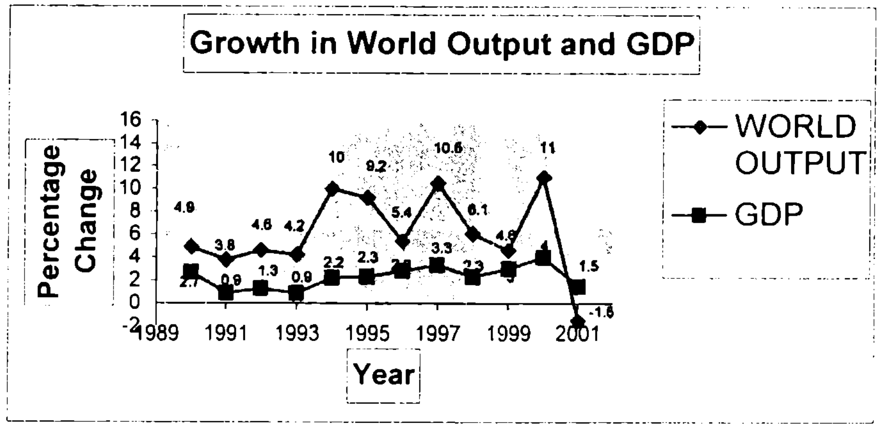

Figure 1.1 Trends in World Output and GDP

growth was negative. The slump in global output growth can be attributed to a decline in the major industrial country markets and the East-Asian economies with a high share of IT industries in their total output. Figure 1.1 shows the trends in growth of world output and GDP from 1990 to 2001.

The three large economies of the World-United States, Japan, and European Union- experienced simultaneous slowdown in economic activities from the third quarter 2000 onwards contributing substantially to the weakening trend in global economic activity. The bursting of the global IT bubble, the sluggishness of Western Europe's activity and to a lesser extends, the events of 11th September 2001 and after has contributed to the slowdown.

The economic slowdown in the major economies impacted trade flows across the globe. In contrast to the preceding year when world trade expanded appreciably in almost all the regions, the year 2001 witnessed large regional variations in trade and output growth. North America's merchandise export volume and import volume recorded the strongest regional decline in 2001 at 5.0% and 3.5% respectively. Latin America's moderate overall economic growth kept the volume of export up by 2.0% but the volume of import was down by 1.0%. The sluggishness of economic growth within Asia and in its major export markets (Viz. North America and Western Europe) caused for the first time a decline in Asia's exports in more than 25 years by 3.5%. Imports into Asia also declined by 1.5%. Western Europe's export and import volume slowed down markedly, with exports decreasing by 1.0% and imports declining by 3.0%. Trade expansion in Transition Economies however witnessed increase in merchandise export volume as well as in import growth, but the rates of growth were lower as compared to the previous year.

1.1.1 Trends in Sea borne trade

Expanding World Sea borne trade recorded its fifteenth consecutive annual increase in 2000, reaching a record of 5.89 billion tonnes. After recording increases for 15 consecutive years, World Sea borne trade stalled in 2001 at 5.83 billion tonnes of exported goods. The annual growth rate, calculated with the provisional data available for the 2001, was –1 percent, as is shown in Table 1.1.

Table 1.1 Development of International Sea borne Trade, selected years

Year	Tanker Cargo		Dry Cargo: Total		Dry Cargo: Of which main bulk cargo		Total (All Goods)	
	Billion Tonnes	% Change	Billion Tonnes	% Change	Billion Tonnes	% Change	Billion Tonnes	% Change
1970	1.442		1.124		0.448		2.566	
1980	1.871		1.833		0.796		3.704	
1990	1.755		2.253		0.968		4.008	
1997	2.172		2.781		1.157		4.953	
1998	2.072		3.526		1.170		5.598	
1999	2.057	-0.7	3.612	2.4	1.196	2.2	5.668	1.3
2000	2.115	2.8	3.775	4.5	1.288	7.7	5.890	3.9
2001	2.128	0.6	3.704	-1.9	1.303	1.2	5.832	-1.0

Source: Report by the UNCTAD Secretariat, "Review of Maritime Transport 2002"

The 2001 break down of exported goods by continent was as follows. Africa's share of world exports was 9.4 percent, while that of America reached 20.9 percent. Asia was by far the continent with the largest share of the total tonnage of sea borne world exports at 36.8 percent, Europe's share was the second largest at 25.5 percent, while Oceania's share was the smallest, only 7.4 percent of the world sea borne exports. Forecasts for the coming years have indicated that annual growth would probably be positive, while the distribution of world tonnage by continent was expected to be stable (Review of Maritime Transport [2002]).

In 2001 world shipments of tanker cargoes reached 2.13 billion tonnes, marked a growth by 0.6 percent during the year. About 77.5 percent of this tanker trades are in crude oil, and the rest in petroleum products. The dry cargo movement reached to 3.7 billion tonnes in 2001, declining to --1.9 percent during the year, which was 4.5 percent in 2000.

1.1.2 Demand for shipping services

As sea borne trade increased, the requirement for shipping services also increased. Eighty percent of the international cargo movement is through sea transport, which is the lowest cost mode of long distance bulk transport. The trend in demand of shipping services for selected years is shown in table 1.2. The demand for shipping service has increased from 10654 billion of ton-miles in 1970 to 17121 billion of ton-miles in 1990 and 22,682 billion of ton-miles in 2001, which was less by 1.5 percent compared with the 2000 figure. This decrease is larger than the 1 percent contraction recorded for cargo volumes and indicates a reduction in average transport distance for World Sea borne cargo. Haulage for crude oil and oil products resulted in tonnes-miles decreasing by 4.6 percent in 2001, which when compared to the modest of 0.6 percent increase for cargo volume, reflects increased shipments of crude oil from nearby sources (e.g., from the west coast of Africa to North America and from the Black Sea to Europe) as well as the intensive use of transshipment and the Submerged pipeline from the Red Sea to the Mediterranean.

For all dry cargoes, ton-miles increased by 1.2 percent, while tonnage transported decreased by 1.9 percent. Haulage of the five main dry bulks in ton-miles increased by a modest of 0.9 percent; slightly lower than the 1.2 percent increase in cargo volume, indicating that these cargoes were transported more or less along the same routes as before. However, ton-miles for the remaining dry cargoes, minor bulks and liner cargo, increased by 1.2 percent, while the cargo volumes transported shrank by 1.5 percent, indicating that these cargoes moved over larger distance during 2001.

Table 1.2 World Sea borne in Ton-Miles for selected years ***(billions of tonnes-miles)***

Year	Oil			Iron Ore	Coal	Grain	Five main dry bulks	Other dry Cargoes	World Total
	Crude	Products	Total						
1970	5.597	0.890	6.487	1.093	0.481	0.475	2.049	2.118	10654
1975	8.882	0.845	9.727	1.471	0.621	0.734	2.826	2.810	15363
1980	8.385	1.020	9.405	1.613	0.952	1.087	3.652	3.720	16777
1985	4.007	1.150	5.157	1.675	1.479	1.004	4.480	3.428	13065
1990	6.261	1.560	7.821	1.978	1.849	1.073	5.259	4.041	17121
1995	7.225	1.945	9.170	2.287	2.176	1.160	5.953	5.065	20188
1998	7.889	1.970	9.859	2.306	2.419	1.064	6.129	5.600	21588
1999	7.980	2.055	10.035	2.317	2.363	1.186	6.203	5.752	21990
2000	8.180	2.085	10.265	2.545	2.509	1.244	6.638	6.113	23016
2001	7.725	2.070	9.795	2.520	2.650	1.200	6.697	6.190	22682

Source: Report by the UNCTAD Secretariat, "Review of Maritime Transport 2002"

1.2 Sea Port Scenario today

The last five decades have experienced rapid changes in ocean transportation. Shipping has moved towards specialized vessels of larger size and higher speed. These modern vessels are of high cost and therefore in order to increase vessel utilization for journey there has been increasing pressure to reduce loading and unloading times at sea ports. Methods of cargo handling have therefore been modified from manual to automatic. In order to facilitate automatic handling, unitized packaging or containerization has been gaining popularity. About 60 percent of the bulk cargo movement is in containerized form today. Large container vessel capacity is in around 10000 Twenty Equivalent Units (TEUs) today, in place of less than 1000 TEUs in 1970s. Compared to conventional methods of bulk cargo handling, use of containers has several advantages, namely less product packaging, reduced damages and pilferage and higher productivity. The growth rate of container port throughput (number of movement in TEUs) has shown an increasing trend during the last few decades. Among the top twenty container ports, ten ports were from developing countries in 2001. The world growth rate for container port throughput (number of movements measured in TEUs) has increased by 15.4 percent in 2000. This was more than double the growth of the previous year, which was 7.3 percent, and reflects the booming trade condition that prevailed in 2000. Throughput for 2000 reached 225.3 million TEUs, an increase of 30 million TEUs from the 1999 level of 195.3 million TEUs.

The rate of growth for developing countries and territories was 14.5 percent with a throughput of 94.1 million TEUs, which corresponds to 41.8 percent of world total throughput. The recorded growth rate of developing countries is seen to vary from year to year. From the preliminary figures for 2001 for the leading 20 world ports handling containers, it has as seen that out of the leading 20 world ports, 10 ports were in developing countries and territories and socialist countries in Asia, with the remaining 10 located in market-economy countries. Of the latter, six ports were in Europe, three in the United States and one in Japan. Hong Kong (China) maintained its leadership. There were three new comers out of the top 20 world ports, all of them from Asia: Shezhen and Quingdao from China and Manila from the Philippines. The top four places on the list remained unchanged. The top twenty ports for 2001 recorded a total of 107.4 million TEUs in the year 2000, which was equivalent to 47.7 percent of the world throughput.

As the shipping demand increased, demand for servicing them at ports also increased, which have resulted in the development of a large number of new ports and up-gradation of existing ports. Ports function as an interface between the land and the sea, providing facilities to handle the cargo to and from ships. Ships typically spend around 20 percent of their time in ports. Any reduction in this time releases more time for journey, which is revenue generating. Hence the speed of service of ships at ports is very important. The performance of the ports have improved due to reasons such as, changing trade flows, competitive strategies of the vessel operations, pressure being exerted to cut costs, and provision of services for a new fleet of mega vessels. Port investment requirements have sky rocketed, overall container volume continues to grow and outlook for trade expansion appears favourable.

The chain reactions of growth in world trade, consequent to growth in sea borne trade, increase in shipping demand, and need for development of ports was noticed in India also. This demand for port development has further intensified after 1991 due to the new economic policy of globalization and liberalization implemented by India. The volume of traffic through Indian ports has increased from 23.11 MMT in 1955 to 152.67 MMT in1990 and to 271.92 MMT in 1999. Two years of impressive increase in container throughput were recorded in the Jawaharlal Nehru Port Trust (JNPT), which in 2001 celebrated its 12^{th} anniversary. In March 2001, JNPT was the first port in India to pass the 1 million TEUs mark, reaching 1.19 million TEUs, an increase of 33.7 percent from the previous year. In March 2002, after a 22.9 percent increase, it reached 1.46 million TEUs, of which 0.88 million TEUs was achieved in the Nhava Sheva terminal, operated by P&O Ports, and the remaining 0.57 million TEUs in the terminal operated by JNPT. The port, which has gained ISO 9002 Certification, is still deemed too expensive, and suggestions to merge the two terminals in order to achieve economies of scale have been voiced. The number of major ports increased from 5 at the time of independence to 12 in 2001. The performance of Indian ports is still poor when compared with other ports in the same region, such as Port of Colombo and Port of Singapore. Indian ports are facing problems related to facility up gradation, high manning scales, planning and operations.

In this thesis, Planning and Operation Problems of Indian Major Ports are studied in detail. The study was also gone into details of the Planning and Operations Problems of Cochin Port.

1.3 Work in this thesis

Initially the problem that was studied is briefly described. The objectives of the study are then described. The methodology used to solve the problem is explained and thesis plan is given at the end of this chapter.

1.3.1 The Problem

From the introduction, it is clear that Major Ports in India need improvement. The poor operational performance in ports could be due to either non-availability of adequate facilities or improper use of the same if available or both. Lack of adequate facility could be due to lack of funds, poor planning or poor plan implementation, or a combination of the above factors. There is need to analyze the planning and operation problems of all Indian major ports to find common problems related to policy and planning, common operation problems, and to find best operation practices that could be used. Since Planning and Operation problems differ very much from firm to firm there is need to study this from a firm level. As operation can be improved only by solving problems at firm level, it was found necessary to study the same and solve it for one port in detail. The problem at hand is therefore to find common planning and operation problems for Indian major ports at the macro level and then to study the planning and operation problems of a major port in detail at micro level. Solutions for some problems identified have also to be found out.

1.3.2 Objectives of the study

The objectives of the study are:.

1) To take stock of the current status of operations, compare the performances and identify common problems of major ports in India.
2) To find out the problems if any related to planning, allocation and utilization of funds in such ports.
3) To study the perceptions and views of port users regarding the operations of Cochin port.
4) To locate important areas of operations of Cochin port that needs improvement.
5) To analyze the important problem areas identified above and to find appropriate solutions.

1.3.3 Methodology

In order to take stock of the current status of operations of major ports in India, data were collected and analyzed from reports published by the Government of India and Administrative reports of all major ports. Other literatures regarding the operations of major ports were also used to locate the planning and operations problems. Allocation and utilization of funds for Major ports were analysed from first five-year plan to the ninth five-year plan to locate planning problems and recommend remedial strategies. A weighted scoring model was developed and all major ports were compared.

A detailed study was conducted in Cochin port to identify its operational problems. The study was conducted in four parts. In the first part, operation processes of Cochin port were studied using flow process charts and some problems were identified. In the second part, a survey was conducted using a questionnaire to understand the perceptions and views of the port users of Cochin port, regarding the operations of the port; their suggestions for improvement were also collected. Parato analysis was conducted on the results tabulated from the questionnaire survey to understand the severity of the problems.

In third part, the income and expenditure schedules of Cochin port were collected for a period of 12 years from 1989 to 2000. This data were used to calculate the gap between income and expenditure from different operations of the port. This was used to classify the operations based on volume of revenue and profitability. The effect of indirect expenditure was also studied. Break-Even analysis was done to compare the financial position of Cochin port in 1996-97 and 2001-02 and identified the basic reasons for the poor financial position of the port today.

In the final part, an in depth study was conducted at Cochin Oil Terminal (COT) and Container terminal (CT), which were identified in part 3 as the important areas of operations of Cochin port that needs improvements. Simulation models were developed and experiments were done to identify the bottlenecks and to evaluate de-bottlenecking alternatives. Work-study was conducted in Container Freight Station to fix the manning scale for stuffing and de-stuffing operations. Sensitivity analysis was conducted at COT and Container Terminal to find out the suitable operation parameters.

1.3.4 Scheme of the Study

This thesis is organized under nine chapters. In the second chapter presents a survey of literature relevant to the study. The third chapter discusses a comparative study of all major ports using weighted score method. The fourth chapter deals with anomalies and problems in port planning and plan implementation. The fifth chapter is dedicated to the study of operation problems of Cochin Port. The sixth chapter deals with the analysis of annual income and expenditure schedules of Cochin port to identify the important operation areas of the port. The chapter seven focuses on operational problems of Cochin Oil Terminal. The chapter eight discusses the operational problems of Rajiv Gandhi Container Terminal. In the last chapter, the summary of findings and recommendations and scope for further related works are presented.

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CHAPTER 2

LITERATURE SURVEY

2.1 Introduction

A wide variety of ports related studies were conducted all over the world during the 20^{th} century. Even before the beginning of the 20^{th} century, maritime geography had a strong maritime component. During 1950s the studies were shifted towards the location and layout planning of seaports. The operational system studies were conducted from 1970 onwards. Ownership and strategy management studies mainly started in 1990s. Now a large research is going on to improve the system performance using management tools and mathematical models. Many Universities in Netherlands, Japan, United States, Singapore, China etc. are conducting studies aimed at improvement of the operational efficiency of container terminals during the last decades.

2.2 Classification of port related literatures

For the purpose of presentation and discussion, the literature related to ports is classified under six areas, viz. 1) Geography, locations of ports and hinterland and transportation studies, 2) Operation planning, operation management, and operational improvement studies other than container terminal, 3) Container Terminal/port related Studies, 4) Crude Oil Terminal related Studies and 5) Studies based on Indian Major ports and 6) Studies based on Cochin Port. The important studies in each class are discussed in the following paragraphs.

2.2.1 Literature related to Geography, Locations of Ports and Hinterland and Transportation studies

Maritime geography has attracted the interest of at least a few researchers since the beginning of the twentieth century. Russel Smith [1905] had published a pioneering work in America on study of ocean commerce. Other significant contributions to the field of maritime geography were the studies by Sargant [1918] on the ocean trade routes of the British Empire, and on ports and hinterlands in 1938, and Seigfried's [1940] study on the Suez and Panama canals.

Since early 1950s, the number and variety of port and ocean transportation studies have increased. The recent works of geographers and economists on overland transportation on industrial location, and on urban and regional development add to the theoretical and empirical base for the study of maritime transportation.

In the field of ocean transportation and port geography, the researchers contributions might be divided in to two categories: empirical studies and theoretical or conceptual studies. There has been abundant research on the characteristics of single ports, or, in some cases, groups of competitive ports. These studies typically contain a brief history of the port, a description of the type and volume of cargoes moving through the port and of site and situation aspects, infrastructure and superstructure, and a definition of the hinterland. Among such studies are book of Walker on the Port of Buffalo [1939], Tavener [1950] on Southampton, Mayer [1957] on the Ports of Chicago and the St.Lawrence Seaway, Hance and Van Dongen [1958] on East African ports, and Bird [1963] on United Kingdom Ports These studies provide an insight into historical dynamics of contemporary changes in the systems of ports.

A number of empirical studies have concentrated on the delineation of port hinterlands. Sargent's [1918]} book is an early example. Then there are studies by Ullman [1943], Weigand [1956], Patton [1958], Draine [1963], Britton [1965], and Elliet [1969]. Most of these try to define the hinterland for one or two ports, based on an evaluation of the inland movement of cargoes. All of them emphasize the importance of hinterland analysis in the geography of ports. As Boerman [1952] has said: " No port structure can be understood when not seen together with its hinterland". Green's [1955] determination of the hinterland boundaries of New York and Boston in Southern New England, Patton's [1958] analysis of general cargo hinterlands of four United States ports, and Kenyon's [1970] research on the inter-port competition in the United States illustrate hinterland configuration on the eve of containerization, providing a useful basis for comparison with the contemporary picture. There is considerable emphasis, in the studies cited above, on complex and sometimes unique empirical cases; relatively little effort is made to conceptualize the phenomena of port regions, port rivalries or overlapping hinterlands.

The development of theory and of analytical frameworks for specific applications to port geography and ocean transportation has been very slow. This is a matter of recent concern in the literature. Robinson [1973] in his study indicates that traditional geographic studies of ports have failed to yield analytical methods suitable to the complexity of port systems; he concludes that there is "a desperate need for a more adequate framework for spatial analysis of ports." As Mayor suggests, even the traditional geographic concepts, such as those involving port-hinterland relationships, the nature and location of transportation links, and the dichotomy between marine and inland transportation, require re-examination in the light of technological changes in maritime transportation.

Many of the theoretical themes introduced over the past decades have been "borrowed" either from other disciplines such as economics and management sciences or from other branches of geography. Cooley [1894] discussed general concepts of transportation costs, rates, and competition as early as 1896. This important study also analyzed hierarchies of transportation centers and trade routes, as well as the interaction of land and water transportation modes, which is very relevant in the recent development of intermodal transportation systems. Bird [1973] suggests that a comprehensive treatment of port city geography requires a welding of central place, gateway, and agglomeration concepts, which is the concept of classical central place theory. Nevertheless, the hexagonal grid of external place theory has been used by Bird to formulate a theoretical port hinterland. The model is based on Isard's [1956] conception of a distorted hexagonal grid in the case of non-uniform distribution of population caused by transportation routes. This is an attempt to present a dynamic evolution of hinterlands from an initial stage of several ports (equal in size and evenly spaced along a coastline, sharing among them a given hinterland) to a final stage in which the entire area falls into the economic hinterland of only one port. The model, however, focuses upon the space organization of hinterlands, and the causes of such organization remain mostly unrevealed.

The notion that ports must be viewed within the framework of a wider system is recognized in many studies. Weigend [1958] points out that close relationships exist between port and hinterland on the one hand and between port and foreland on the other. Robinson [1970] carries this point further and argues that the separation, in previous academic conceptualizations, of the foreland and hinterland into two packages represents a false dichotomy.

Transport development in underdeveloped countries, with particular focus on port evolution is modeled in the well known Taaffe, Morrill and Gould [1963] article, which illustrate port development and the concentration of port activities as related to the development of a general transportation system. Rimmer [1967], in a discussion of the evolution of Australian ports, extends the Taaffe, Morrill, and Gould model to include not only the landward transportation network but also the seaward connections. This study of transport expansion is twofold: First, they view port development in a dynamic context; second, they consider ports as part of wider transportation systems. The above concepts though very helpful in understanding overall ports performance have limited use in the operational performance research that is undertaken in this thesis.

2.2.2 Literature of Operation Planning, Operation Management, and Operational Improvement studies

Robinson [1970] treats port as an operational system in order to establish a modeling framework with in which linkages, spatial structure and port capacity can be analyzed. Other studies use simulation models to analyze the varied and complex interrelated systems with in which port operates. Recently good amount of research has been accumulated world wide on port planning and operation strategies for improving the efficiency and effectiveness of the ports. A report by the UNCTAD Secretariat [1976], has described the importance of port performance indicators such as financial indicators and operational indicators. A number of performance indicators to assist port managements in the planning and controlling of port operations were discussed in this report. A method for the collection of the necessary information to permit the calculation of these indicators was explained with required set of interrelated files and registers. Another UNCTAD report [1993] has reviewed the strategies currently adopted by ports and the elements of strategic planning processes. They have done a comparative analysis of deregulation, commercialization and privatization of ports. It has also described various port problems and their causes.

The minimization of the total delay of ships is studied by Peterkofsky and Daganzo [1990]. Wan et.al [1992] have shown the application of information technology in the port of Singapore resulted in more efficiency and a higher performance. In Leeper [1988], has shown that, in order to achieve an improvement of productivity and reduction in investment costs, an advanced automated control technology is a necessary condition. Willekes et.al. [1995] have used computer simulation to select ship un-loaders for Indian ports. Park et.al [1987] have given an account of the use of a discrete event simulation model to simulate and study the future economic port capacity to meet the projected cargo demand. The first part of their model determines the effects caused by port capacity expansion. The second part evaluates the port economies due to changes in port capacity.

Edmond and Maggs [1978] have used queuing models to study and determine the number of berths that should be available at the quay. Imai et.al [1997] have looked into the problem of how to allocate berths to ships while optimizing the berth allocation. The introduction of a multi-objective approach is new in machine scheduling problems, according to Imai et.al [1997]. They developed a two objective non-linear integer program to identify the set of non-inferior berth allocations, which minimizes the dual objectives of overall staying time and dissatisfaction on order of berthing.

2.2.3 Literature of Container port related Studies

Literature review of container port related studies is mainly based on an article prepared and published by Iris.F.A et.al [2003]. The recent studies are discussed in this article in which the literature related to unloading and loading of the ship, transport of containers from ship to stack and vice versa, stacking of containers, inter-terminal transport and other modes of transport, and complete container terminal are separately discussed.

Harold M. Mayer [1975] argues that, because of increasing returns to scale, especially with the increased requirement for sophisticated capital intensive equipment for the handling of unitized general cargo, there is a tendency for port traffic to be concentrated at fewer but larger and more efficient ports. A study at the University of Wisconsin indicates that such a concentration will occur at " ports or other trans-shipment points in which traffic is consolidated for most efficient movement through highly capital intensive methods". Such ideas have been carried out to an extreme in a study predicts that " containers on the North Atlantic will mean an era of ship trading between one port on each side, with transshipment to all other ports and it seems likely that there will not be more than two major container ports on the east coast.

The European and International shipping Committees have also suggested the principle of concentration of container traffic in a limited number of terminal areas. A.L. Latham-Koenig [1970], in his evaluation of future trends and developments in the area of containerized transport in Europe concludes: "There will be an inexorable trend toward fewer main ports of call for container ships and more feeder services". As an example, he directs attention to the pattern of calls of the Sea-Land Company in Europe (Bremerhaven, Grangmouth, Felixstowe, Rotterdam), which indicates the probable shape of the future concentration of containerized shipping.

In a symposium at Bergen in 1973, E.Pollock, of the British Transport Dock Board, said that there is a limit to the number of ports that it would pay to link by direct services, not only because of ship size and availability of cargo, but most importantly because of turnaround time of ships in port.

In Shields [1984] a system is presented which can assist the stowage planning process of containers in the ship. The stowage problem was solved with the Monte-Carlo method. According to Wilson and Roach [2000], the container stowage problem is a problem, the size of which depends upon the capacity of the ships and the supply and demand of containers at each port. They proposed a suitable stowage plan using branch and bound algorithm and Tabu search method.

Later, many models were developed to improve the performance of container terminal operations using mathematical, financial and management tools due to the wide application of operations technologies and the advent of information technology. According to Agerschou et.al [1983], the use of containers has several advantages compared to conventional bulk namely less product packaging, less damaging and higher productivity. Daganzo [1989] discusses the static crane allocation problem in which a collection of ships is available at a berth to be handled at the start of the planning horizon and no other ships will arrive during this planning horizon. He developed a model using mixed integer program to minimize the total delay of the ships. The minimization of the total delay of ships is also studied by Peterkofsky and Daganzo [1990]. They found out an optimum departure schedule for the ships and a crane allocation scheme. Branch and Bound Algorithm was used to solve the crane-scheduling problem.

A number of research models were developed very recently in the area of transport of containers from ship to stack and vice versa. Baker [1998] proved that the use of straddle carriers instead of non-lifting trucks could mean improved QC productivity. According to his findings, multi-trailer system can be used to transport of multiple containers. In Steenken [1992], an optimization model was developed to determine the number of straddle carriers and their route. This problem is solved as a linear assignment problem. In Vis et.al [2001], a model and an algorithm are presented to determine the necessary number of AGVs at an automated container terminal. To solve the problem, a network formulation is given and a minimum flow, strongly polynomial time algorithm is developed. A complete review of the routing and scheduling of vehicles in general is given in

Bodin et.al [1993]. Steenken [1992] and Steenken et.al [1993] describe the more specific problem of the routing of straddle carriers at the container terminal to minimize empty - travel distances by combining unloading and loading jobs. Routing and scheduling systems are tested and integrated into a radio data transmission system of a real terminal. They formulated the problem using linear assignment method and network problem methods to find the optimum solution. In Kim and Bae [1999] mixed integer linear programming formulations and a heuristic method are given for dispatching containers to AGVs such that the delay of the ship and the total travel time of the AGVs are minimized. In Chen et.al [1998], an effective dispatching rule is given that assigns AGVs to containers. They have developed a greedy algorithm to solve this problem. Bish et.al [2001] extended the analysis, by integrating both the problems of dispatching vehicles to containers with the location problem of containers. In other words, in this vehicle-scheduling- location problem, each container has to be assigned to a location in the stack and vehicles have to be dispatched to containers such that the total time to unload all containers from the ship is minimized. They proposed a heuristic method to solve this problem. In Van der Meer [2000], the control of guided vehicle based internal transport systems like container terminals is studied. Results are presented that show how different vehicle dispatching rules behave in different environments. In Evers and Koppers [1996], the traffic control of large numbers of AGVs is studied. A formal tool to describe traffic infrastructure and its control is developed by using four types of entities: node, track, area and semaphore (i.e. a non-negative integer variable which can be interpreted as free capacity). The tool is evaluated with simulation. It can be concluded that the technique is a powerful tool for modeling transportation infrastructure and its control that the performance and the capacity of the area increases.

Several studies were conducted in the area of operations of stacking of containers: storing on a chassis and stacking on the ground. The distribution of empty containers to ports is a related problem. It is, for example, studied in Crainic et.al [1993], Shen and Khoong [1995] and Cheung and Chen [1998]. Various storage strategies are described in Chen [1999]. He concluded that higher stacking needs the improvement of all the other relevant conditions at the same time to reduce its possible adverse impact. Otherwise, large numbers of unproductive container movements are needed. Chung et.al [1988] developed and tested strategies that can reduce the unproductive movements of the stack crane during the loading process and as a result reduced the total container loading time. They propose the idea of using a buffer area, where a number of empty chassis are available to store export containers temporarily. A simulation model is developed to study the effect of this buffer area on the port's operation. De Castilho and Daganzo [1993] stated that for good configuration of the stack, methods are needed to estimate the number of moves to retrieve a container as a function of stack height and operation strategy. As a result, Holguin-Veras and Jara-Diaz [1999] developed a model to optimize the space allocation for containers in the stack.

Chen et.al [2000] developed a time-space network model to assist in assigning containers to storage locations in advance so as to minimize the total costs of operation. A test case and a real world case are solved with a branch and bound algorithm. In Kim and Kim [1999a] the storage space allocation problem is also studied, with decision variables stack height and allocation space. The objective of the problem is to minimize the number of reshuffles under the condition that the space requirements are met. Different arrival pattern of import containers such as: constant arrival rate, cyclic arrival pattern with the period of one week, and irregular arrival pattern. Linear program models are developed to solve these problems. The solution can be obtained by solving the dual problem and related sub problems by applying the sub gradient optimization technique. According to Cao and Uebe [1993] the repositioning of containers is closely related to the p-median transportation problem, namely the transportation problem of containers from rows to be emptied to p rows not to be emptied. In Taleb-Ibrahimi et.al [1993], results are obtained for long term and operational planning. They give a description of handling and storage strategies for export containers and quantify their performance according to the amount of space and number handling moves. Models are given that reflect the relationship between available handling efforts, storage space and traffic demand. In Kim et.al [2000], the problem of determining storage locations for export containers with a certain weight is considered. A dynamic programming model is formulated to solve this problem. For making real time decision a decision tree is given. The performance of this decision tree is evaluated by comparing its solution to the solutions of the dynamic programming model.

In Kim and Kim [1998] it is discussed how the optimal number of straddle carriers can be determined for import containers. A model is developed to solve the trade off between the storage density, the accessibility, investment and service to outside trucks analytically .The sum of all costs is minimized with respect to the number of straddle carriers and amount of space. Kozan and Preston [1999] use genetic algorithm as a technique to schedule the retrieval of containers from the stack. The objective is to minimize the time ships spend at the berth for the unloading and loading operation. The authors suggest that research should be done into the use of other techniques, like neural networks or tabu search, to see if they are more efficient than genetic algorithms.

Another area of research is related to inter-transport and other modes of transport in container terminals. According to Van Horssen [1996], new concepts and technologies have to be developed to handle the large numbers of containers expected in the future. Furthermore, research has to be done to the various transport systems by which containers can be transported between the terminals. One of the systems, the multi-trailer system is studied in Kurstiens et.al [1996]. This method is based on a technique, which tries to minimize the number of empty trips. To obtain the minimum number of trucks needed an integer linear problem model is developed.

One way of transporting containers to other destinations is by rail. In Kozan [1997a] an analytically based computer simulation model is developed to describe the container progress at a rail container terminal. The simulation model is combined with heuristic rules to describe the progress of containers in the system. Bostel and Dejax [1998] observe the allocation of containers on trains. Different models and solution methods are given and tested using realistic data.

It can be concluded that the number of container moves and the use and quantity of equipment can be decreased.

Another way of transporting containers to other destination is on the road by trucks. In Ballis and Abacoumkin [1996] a simulation model is developed that can be used in the design and evaluation of terminal facilities at the landside. Five heuristics are incorporated in the model to investigate the performance of the system. The comparison between different studies indicates that a shorter truck service time is feasible but that this leads to an increase of traffic conflicts in the internal transport network.

In the above section, only problems for individual types of material handling equipment in container terminals are discussed Within a container terminal it is obvious that in order to obtain an efficient terminal, it is also necessary to address all problems as a whole. For this purpose, several simulation models are developed at the end of the last century. In Gambardella et.al [1998], it is shown how operations research techniques can be used to generate resource allocation plans. Terminal managers to determine the best management strategies can use these plans. Ramani [1996] developed an interactive planning model to analyze container port operations and to support its logistics planning. It is assumed that all unloading operations are completed before loading operations are started. In the simulation model of Yun and Choi [1999], an object-oriented approach is used. Other simulation models for container terminals are developed in Merkuryev et.al [1998]. In Van Hee and Wijbrands [1988] a decision support system for the capacity planning of container terminals is developed. Several mathematical models, each describing parts of the complete process, are incorporated in this system. The system can support decisions at the strategic and tactical level. This decision support system is partially based on the system, for break bulk terminal, developed by Van Hee et.al [1988].

Analytical and simulation planning models for a complete terminal are compared by Kozan [1997b],. It is stated that containers arrive at the seaside in batches, namely on the ship, and not alone. Consequently, a batch-arrival multi server queuing model is developed and compared with a simulation model. In Kozan [2000], the problem examined is of the minimization of handling and traveling times of import and export containers from the time the ship arrives at the port until the time they are leaving the terminal and vice versa. The complete trajectory that containers go through from the ship to road or rail terminals via storage areas is incorporated into a network model. The objective of this model is to minimize total throughput time. It is explained that this model can be used as decision tool in the context of investment appraisals of multimode container terminals.

2.2.4 Literature of Crude Oil Terminal related Studies

According to UNCTAD Review of Maritime Transport [2002], 36.5 percent of world sea trade is of crude oil petroleum and its products during the year 2001. About 80 percent of the crude oil and its products are transshipped through seaports. This data itself shows how important crude oil terminal operations are in ports. Many models have been developed for improving the crude oil terminal operations. World over operations management is moving from thumb rule based decision making to data fed model-based decision-making especially in the area of logistics. Several techniques were used for crude scheduling process. According to Coulbeck et.al. [1988], most approaches in crude oil tanker schedule for oil refinery rely either on simulation or on pipeline sequencing per se, but Hane et.al. [1995] points out that these do not take into account of manufacturing complication such as Crude Distillation Unit (CDU) runs, tankages etc.

Shah [1996] adopted a mathematical programming model and used it for crude oil scheduling. In this model, several constraints were taken into consideration such as: pipeline capacity constraints, storage tank capacity constraints, CDU capacity constraints etc. The objective of the study was to determine the ship discharge details, port and refinery tank allocation, pipeline schedule and CDU schedule so as to reduce the economic penalties of poor scheduling and to enable the exploitation of opportunities, e.g., unexpected cheap cargoes on the high sea. The complex nature of the problem required a model that could effectively take into account, the queuing of tanker at sea, and the time for which a tanker would have to wait for the tide for movement to the berth, for optimization of the system. Deterministic event duration mathematical models fail to capture such complexity. Hence computer simulation model is most appropriate in such situations.

Hayuth et al. [1994] have described the development of simulation software for port operation with special emphasis on the considerations for choosing both the software and hardware; it also deals with coordination between terminals of more than one port. Kemthose et. al. [2001] developed a simulation based decision support system for selection of crude oil tanker schedule for an oil refinery. In their model, the tanker arrival schedule in equidistant intervals in time was considered and optimum number of tanker to be scheduled per month was obtained with in a tolerable limit of costs per metric ton for crude unloading.

2.2.5 Literature based on studies of Indian Ports

Literature has been found on studies of Indian Ports published very recently. Most of them are studies done by port executives and government agencies. Only a very few literature available are based on the studies done by academicians. At the same time, most of the studies are concentrated on projections volume of cargo handled in Indian ports. Also, it was noticed that most of the studies are based on a single port and only a few studies are based on two or three major ports in India.

Fotedar [1986] has discussed port development in India up to 2000. This is an empirical study conducted at major ports in India and projections of capacity and utilization and port traffic were done for 2000 A.D, based on past data from 1951-52 to 1985-86. Narain [1986] looked into inter-modal transport systems for the twenty first century. This study concentrated on container prospects in India and suggested strategies for development of containerization. Dayal [1986] also looked into the containerization perspective. Central Board of Excise and

Customs has published a report regarding the procedures and documentation problems relating to ports and customs in 1986.

In 1989, Planning Commission, Government of India published a report on " Perception planning for Transport Development". This report contains the status of major ports in India, projection of commodity wise capacity and traffic for 1989-'90 and traffic forecast for 2000 AD. It also discusses the port productivity of wet-bulk, iron ore other dry bulk, break bulk cargo and containerized cargo handling operations. The report has also looked in to the financial issues of major ports in general. The report concluded highlighting the need for strengthening National Port Authority (NPA) for integrated planning and development of ports.

Nehria [1990] submitted a project report on " Development of Major ports in India during the 1980s," clearly stating the process of plan allocation in transport sector as a whole and comparing it with the plan allocation in port sector, and other transport sectors. This study also discusses the percentage utilization of all ports in 1984-85 and 1989-90. It is seen that the capacity utilization has improved in 1989-90, when compared with the capacity utilization in 1984-85.

The India Infrastructure Report- Policy imperative for growth and welfare, volume 3 [1997] discusses issues such as growth of Indian ports, major problems faced by Indian ports, traffic and capacity expansion projection for 2005-06, finances of the port sector, cost estimates for different types of cargoes, and strategies for addressing the problems. The report also emphasizes the need for private sector participation and corporatisation, commercialization and competitive market strategy, restructuring the labour force, computerized cargo clearances etc.

Ramakrishnan [1997] has looked in to the overview of port developments in India. This study contains scenario off traffic, containerized cargo traffic, drawbacks and strategies and the measures desired in port sector. This study emphasizes the need of re-engineering concepts in the port sector. This study also emphasizes the need of bank finance, private participation and simultaneous developments of minor ports in India. A similar study was conducted by Chakravarthy [1998], highlighting the importance of private participation, and private investment in state sector. The study also reviewed the progress of private participation in Indian Port sector. Ramakrishnan [1998] again discusses the potential, problems and strategies for port development in India. In this study, a comparison on traffic handled in Indian ports with international ports were made and it was seen that the total traffic handled through Indian ports is less than the traffic handled through a single port of Rotterdam, and Port of Singapore. Strategies were also recommended for improvements of Indian ports. Similar studies were done by Ghosh [1998], Swaminathan [1999], De [1999], Ramakrishanan [1999], and Veeramuthumoni [2000].

Sinha [1999] has reported the relevance of project evaluation techniques in India port sector. The focus of the study was to reduce waiting time of container ships, reduce stay time of container ships at berth and maximize revenue earnings. This paper suggests various models for project evaluation such as: 1) Goal programming, 2) Multiple Attribute Utility Analysis Theory (MAUT), and 3) Multi-objective Optimization Technique (MOOT). Putatunda [2000] has reported a conceptual marketing model and its implication for Indian ports. The study highlights the importance of port marketing and a conceptual framework. Bose [2001] presented a case study on cargo handling of Major Ports in India. This paper attempts to analyze the performance of major ports in India taking into account the absolute cargo handled by them during 1951-52 to 1992-93. A particular focus of the study is the Calcutta-Haldia Port, with a view to determining the reasons for its deteriorating performance. Ghosh and De [2001] have studied about Indian Ports in the context of globalization. This study is concerned with the economics of Indian ports as one important phenomenon in Indian economic geography, and its relationship with regional development under the free market economy. A port performance index with the help of Principal Component Analysis of eight individual port performance indicators shows that traffic intensity is the most significant determinant of performance. The study concludes that with increasing openness of economy and absence of an integrated policy toward export transport network, there is a decline in export intensity and rising domestic coastal traffic in Indian Ports.

2.2.6 Literature based on Studies of Cochin Port

Even though many empirical and theoretical and analytical models were developed and applied in port sector world wide, the uses and its applications of these models in the Indian port sector are very less. Only some empirical studies were conducted in one port or two ports together. Some of the relevant studies conducted in Cochin Port are mentioned here. The study by Pankajakshan [1963] was one of the systematic studies carried out on Cochin port. Agarwal and John [1968] while doing their labour productivity study of major ports in India have covered the port of Cochin from the period from 1954 to 1966. The National Council of Applied Economic Research (NCAER) [1969] conducted a comprehensive survey of Cochin port in 1969. The study concentrated on traffic survey with limited objectives like, to forecast the likely traffic growth through Cochin port. The study of Sahai [1986] on the ports of India also covered the history, emergence, developments, utilizations of facilities, and the prospects of Containerization of the port of Cochin. The study of Anilkumar [1988] was an attempt to examine the causes for declining trends in port activities. Mohankumar [1994] has conducted a customer survey to study the perceptions of the quality of services rendered by Rajiv Gandhi Container Terminal (RGCT) of Cochin port in 1993-'94. Narayanankutty [1996] has developed a model for Human Resource Accounting for Cochin port.

2.3 Conclusion

Literature survey has been done for seaport related studies by classifying the studies in six categories namely 1) Geography, locations of ports and hinterland and transportation studies, 2) Operation planning, operation management, and operational improvement studies other than container terminals, 3) Container port related Studies, 4) Crude Oil Terminal related Studies and 5) Studies based on Indian Major ports and 6) Studies based on Cochin Port. From the literature, it is seen that the latest studies have shifted towards container terminals and their improvement This is because containerization has great scope in future. Operation planning, operation management and operational improvement studies of container terminals are also discussed under the category of Container Port concentration studies.

From the review of literature, it is clear that operational problems in the port sector have come because of the rapid increase in demand and increased service level requirements of specialized modern ships. Inability to change processes and operations with times has also resulted in inability of ports to cope with the problems. A few research studies have been reported use of operation management tools like modeling, simulation and work-study methods to improve the operational performance of Indian ports, even though a good amount of such studies have seen reported worldwide. The work in this thesis is an attempt to fill this gap in the planning and operation studies of Indian major ports.

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CHAPTER 3

A COMPARATIVE STUDY OF INDIAN MAJOR PORTS

3.1 Introduction

India has an ancient and glorious maritime history and tradition and, long before the Christian era; Hindus had crossed the waters of the Indian Ocean and not only penetrated many countries in South East Asia and the Far East, but also colonized several Pacific Islands. However, during the British rule, Indian shipping was suppressed for commercial and political reasons. The British practiced various strategies - to keep the British interests and to keep down Indian shipping ventures- such as relentless competitions, unfair practices and political persecutions before India got independence (Hariharan, [1970]).

At the end of 1947, a new shipping policy was announced. The Government of India, in their new shipping policy mentioned the need for active co-operation of the state with enlightened private enterprises. As a result, one Shipping Corporation was formed. The Scandia and the Government formed that corporation. This policy did not attract other Indian Shipping Companies. After 1956, the Government changed this policy. The second Shipping Corporation, which was started in 1956,was entirely owned, controlled, and managed by the government itself. This was the Shipping Corporation of India.

It is recognized by leading maritime nations that it is their prominent responsibility to so develop their ports as to enable them to provide for all the increasing modern needs and requirements of the trade that pass through and the ships that call at their ports. The fulfillment of this obligation is vital for the growth of economy and the effective Defense of the country. It is also imperative for a free and Sovereign India to maintain her strategic position in the Indian Ocean and to preserve and to develop her maritime strength.

In this chapter, a brief description of the development of all-major ports in India is given. A comparative study of all major ports carried out is also presented in this chapter. This enables one to understand and compare the present status of Indian major ports. Data used in this study was collected from various reports such as Basic Port Statistics of India from 1991 to 2001, Indian Shipping Statistics from 1995 to 2001, Administrative Reports of all Major ports in India from 1991 to 2001, Report of Economic Intelligence Service, 'CMIE' (Center for Monitoring Indian Economy Pvt. Ltd, 2002 January) etc.

3.2 Major Ports in India

Indian coastline, about 6000 Kms, is dotted with 12 major ports and 150 other ports. The location of all Indian ports is shown in Figure 3.1. Amongst the major ports, Kandla, Mumbai, Jawaharlal Nehru, Mormugao, New Mangalore and Cochin are located on the west coast and Tuticorin, Chennai, Ennore, Visakhapatanam, Paradip, and Twin Dock System (Calcutta Dock System & Haldia Dock Complex) at Calcutta are on the east coast of India. Calcutta is the oldest and Ennore is the youngest port.

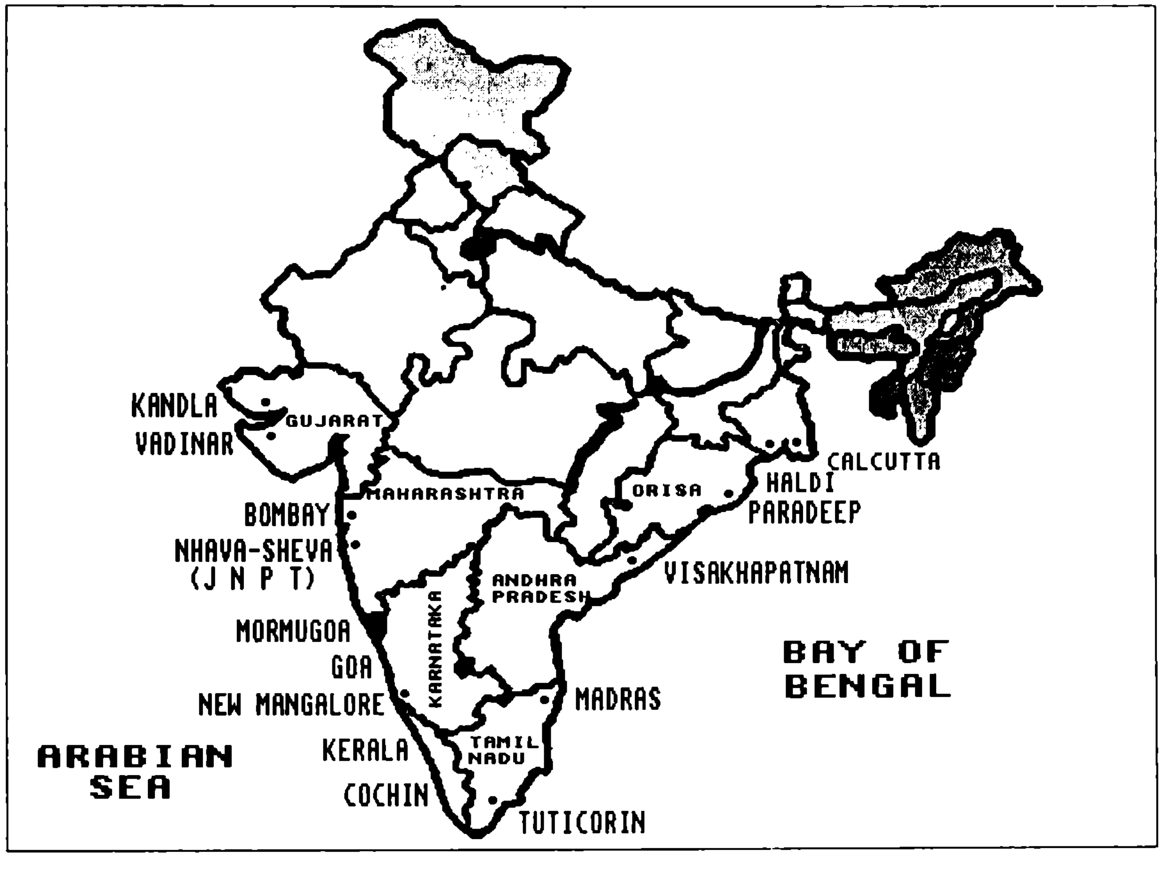


Figure 3.1 Location of Indian Major Ports

The major ports are under the administrative control of the Ministry o
Surface Transport (MOST) of the Government of India and are administerec through Board of Trustees constituted by the Government. The other ports are under the control of the respective maritime State Government of Gujarat Maharashtra, Goa, Karnataka, Kerala, Tamilnadu, Andhra Pradhesh, Orissa anc West Bengal and Andaman and Nicobar Islands Administration.

The Indian Ports Act, 1908 is applicable to both major and minor ports The other statutes, which have application to the Port Sector, are:

- The Indian Major Port Trusts Act, 1963
- Dock Welfare (Regulation of Employment) Act, 1948
- Dock Workers (Safety, Health and Welfare) Act, 1986 and
- The Merchant Shipping Act, 1958

Table 3.1. The States, Location and the type of Dock/Ports

Sl. No.	Name of Port	State	Location		Type of Dock/ Ports
			Latitude	**Longitude**	
1	Kandla	Gujrat	23^{0} 01' N	70^{0} 13' E	Estuary Port
2	Mumbai	Maharastra	18^{0} 54' N	72^{0} 49' E	Natural Harbour and Impounded Wet Docks
3	Jawaharlal Nehru	Maharastra	18^{0} 56.43' N	72^{0} 56.24' E	All Weather Tidal Port
4	Mormugao	Goa	15^{0} 24' N	73^{0} 48' E	Natural Harbour protected by a break water
5	New Mangalore	Karnataka	12^{0} 55' N	74^{0} 48' E	Artificial Lagoon port with open berth
6	Cochin	Kerala	9^{0} 58' N	76^{0} 16' E	Lagoon port
7	Tuticorin	Tamilnadu	8^{0} 47' N	78^{0} 12' E	Artificial Harbour
8	Chennai	Tamilnadu	13^{0} 06' N	80^{0} 18' E	Artificial Harbour with wet docks
9	Ennore	Tamilnadu	13^{0} 15' 30" N	80^{0} 21' E	Artificial Harbour
10	Visakhapatanam	Andhra Pradesh	17^{0} 41' N	83^{0} 17' E	Natural Harbour
11	Paradip	Orissa	20^{0} 15' N	86^{0} 40' E	Wet Dock
12	Calcutta Dock & Haldia Dock	West Bengal	22^{0} 06' 22" N 22^{0} 2' N	88^{0} 13.5' E 88^{0} 6' E	Riverine with impounded wet docks, river side jetty

There are other general enactments, which have a bearing on port working like Industrial Disputes Act, 1962. The Environment (Protection) Act, 1986 and the rules and regulations framed there under are relevant to port development and operations as well.

The State, location, and the type of Dock/Port are shown in Table 3.1. A brief introduction of all Major ports in India is given in the following paragraphs.

3.2.1 Kandla Port

Kandla port was founded in 1952 and declared as a major port in 1955 The Port is situated on the western shores of Kandla creek, which runs into the Gulf of Kutch at a point about 90 nautical miles from the Arabian Sea. It is al weather natural Port, its dry weather & mild monsoon minimizes loss of man-days as well as damage to cargo. Consistent, enlightened policies have enabled it to efficiently handle trade created by a hinterland that covers over a million sq km. from the North and North-West of India. This covers the highly productive granary and industrial belt stretching across Jammu & Kashmir, Punjab, Himachal Pradesh, Haryana, Rajasthan and Gujarat.

The contour depth along the shipping channel is around 10 meters. The total approach channel is 23 kms. The width of the channel varies between 200 and 1000 meters. Kandla is an all weather Port, well sheltered from the South West Monsoon. Necessary navigational aids are provided to facilitate day and night navigation. Night navigation is restricted to vessels of LOA 189 meters and draft up to 8.23 meters. Tankers for oil jetties are handled during daylight hours only. Ships having speed of less than 9 knots will not be moved in & out of Port during hours of darkness.

Vessels can anchor 1 mile South West of the position given under "Pilotage". Inside the harbour, Port Authorities allot anchorage. Vessels can however anchor more than 2 miles from Fairway Buoy but must pick up the Pilot, within 2 miles of Outer Tuna Buoy. Pilot boards vessel at Tuna Buoy at the mouth of Kandla Creek about 22 Km. from the signal station at the Kandla Port Tower.

The Port is directly connected to the National Highway No. 8-A. It is well connected with its hinterland comprising Northern Indian states by Meter Gauge as well as Broad Gauge railway system.

3.2.2 Mumbai Port

The Premier Port of Mumbai is strategically situated mid-way on west coast. It is gifted with a natural deep water Harbour of about 400 square kilometers protected by the mainland of Konkan on its East and Island of Mumbai on its West. The deep waters in Harbour provide ample shelter for shipping throughout the year.

As early as the beginning of the Seventeenth Century, in spite of a negligible trade, the natural advantage of Mumbai Harbour as a maritime base and haven for shipping on the western seaboard of India was realized. There was considerable maneuverings for its occupation. In 1652, the Surat Council of the East India Company, realizing the geographical advantage of the Port, urged its purchase from the Portuguese. Their wish was gratified nine years later when, under the Marriage Treaty between Charles II of Great Britain and the Infant Catherine of Portugal, the "Port and Island of Mumbai" were transferred to the King of Great Britain. After the transfer of the Port and Island to the East India Company by Royal Charter in 1668, development of the Port started. Various measures such as construction of a Custom House, a warehouse, dry docks, etc. were taken up by the Company to encourage trade. In 1813, an act of the British Parliament ended the Company's commercial monopoly. This resulted in a great spurt in the trade of that Port. The year 1858 witnessed the exit of East India Company and passing of Mumbai under the direct rule of the British Crown. In 1873, the present statutory autonomous Port Trust was set up for administering the affairs of the Mumbai Port. The opening of the Suez Canal in 1869 was the most decisive landmark in its growth. It shifted the whole trade scenario from the East Coast of India to the West to make Mumbai the commercial gateway of India besides the principal gateway of India that it already had become. Though traditionally designed to handle general cargo, over the years, the port has adapted to changing shipping trends and cargo packaging from break bulk to unitization/ palletization and containerization. It has also developed specialized berths for handling POL and chemicals

Round the clock navigation is allowed at the port. The main navigational Harbour Channel is, for the great part, a natural deep-water fairway. The Channel has been deepened to 11 meters. With a mean high water neap tide of 3.3 meters the Channel is adequate to meet the requirements of a large number of cargo vessels, passenger ships and deep drafted tankers. The approaches to the Harbour are well lit with the Outer Light Vessel (Mumbai Floating Light), visible 16 kilometers, the Prongs Lighthouse to the North, visible 27 kilometers and the Kennery Lighthouse to the South visible 29 kms.

The entrance of the Harbour, which has approaches from the Southwest, is between Prongs Reef and the Thull Reef lying off the mainland to the Southeast, a distance of about 9 kilometers. Kennery Lighthouse, which marks the Southern Boundary of the Port limits, is a light of the first order dioptric, group flashing white, and shows groups of two flashes with a visibility up to 25 kms in clear weather. The name of this lighthouse has now been changed to Kanhoji Angre Light House. Prongs Lighthouse marks a reef Southwards from Colaba Point and dangerous ground which extends for a distance of 1.6 kms from it. The light is of the first order dioptric and exhibits at night, every 10 seconds, and a white flashlight with a visibility up to 27 kms. There are three light buoys moored South-East of prongs Lighthouse, one flashing a green light every five seconds, the other flashing red light every 10 seconds and the third flashing red every 5 seconds. Prongs reef buoy is fitted with a radar reflector. Sunk Rock Lighthouse is about 3.2 km ENE off prongs Lighthouse. It is unattended and shows red light with white rays flashing every 6 seconds. There are other important subsidiary light including the Dolphin Rock Light and Tucker Beacon Light. Control Station and Port Signal Station, situated on the top of the tower at the Ballard Pier, monitor and control all ships that move in the harbour. It also hoists storm warnings. These stations are also equipped with VHF Radio sets on international frequency (Channel 12, 14 and 16). Four Lighted floating buoys to mark the approach channel, two jetty end beacons at mooring dolphins 1 and 4 and two leading lights have been provided for night navigation. In addition the Elephanta patch beacon has been upgraded to improve its range. Vessel Traffic Management System (VTMS), which also caters to JNPT.

Pilotage in and out of the harbour is compulsory for ships of 100 tons net and upward. The pilotage limits outward being delimited by a line drew East-West through the Prongs Light House.

3.2.3 Jawaharlal Nehru Port (JNPT)

Jawaharlal Nehru Port is situated along the eastern shore of the Mumbai Harbour, South East of Elephanta Island and approximately 10 nautical miles from the Gateway of India. JNPT shares a common channel with the Mumbai Port up to the point of entry of the South Elephanta Channel. This port was constructed and commissioned in May 1989. JNPT is the most modern port of India. It was planned with a view to decongesting Mumbai and serve as a hub port for this region. A common Vessel Traffic Management System (VTMS) is used for JNPT and Mumbai Port. Twenty four hour navigation is possible and pilotage is compulsory for all vessels above 100 N.R.T. All vessel movement is regulated by VTMS.

3.2.4 Mormugao Port

Mormugao Port is situated on the west coast of India at the mouth of river Zuari. The Port is approximately 370 km. South of Bombay and 575 km. North of Kochi. It is an open type harbour protected by a breakwater and a mole running parallel to the quay. The harbour is also protected from the southwest monsoon as it has been constructed on the leeward side of Mormugao Headland. It is the premier iron ore exporting Port of India with an annual throughput of around 16 million tons. The Port accounts for about 50% of India's iron ore export and ranks among the top 10 iron ore exporting Ports of the world. Though iron ore is the predominant cargo there has been an increase in liquid bulk and general cargo traffic since it was declared a Major Port on 2nd December 1963. Container traffic has also grown at quick pace.

Pilotage is compulsory for inward and outward movement of ships and between berths and moorings within the harbour. Pilotage services are provided round the clock with prior advice to the Harbour Master through agents.

3.2.5 New Mangalore Port

The Beautiful Coastal city of Mangalore has references in history and legend. Mangalore is mentioned in the manuscripts of the Great library at Alexandria, Egypt. Roman history describes it as a port on the mouth of the river Nitras (Netravathi). Ptolemy, a famous astronomer and explorer of the second century AD makes a mention of Mangalore in his journey record. Greek drama also alludes to the West Coast of India, in particular Udyavara and Mangalore (described as Mangala). During the time of the Vijayanagar Empire, Arab traders established a brisk trade route for silk and spices between Mangalore and West Asia. Tipu Sultan established an army attachment now known as Sultan Battery. Over the years Mangalore has grown rapidly into a rich industrial zone. The old port was unable to match the growing demands of modernization in the shipping industry; especially after the commencement of the five-year plans after independence. Therefore the necessity for a new port was felt and New Mangalore Port was formed.

The New Mangalore Port is situated on the West Coast of India in the state of Karnataka almost midway between the Major Ports of Mormugao and Kochi. The Port is 170 nautical miles south of Mormugao Port and 191 nautical miles north of Kochi Port.

The Port is provided with Railway sidings connected to trunk railways with adequate storage space and approach roads. The Port Users are directly contacting the Indian Railways for their requirement of wagons. New Mangalore Port is connected through the Konkan Railway to Maharashtra/ Goa and Karnataka. Tamil Nadu is also connected by Broad Gauge. Most of the Medium Gauge to Bangalore has been converted to Broad Gauge. With this New Mangalore Port will be directly connected to the ICD at Bangalore and the present container traffic to Chennai and Kochi will be routed through New

Mangalore Port. The National Highway 17 (NH 17) passes just outside the Port, thus making the Port easily accessible and linking it to large cities like Bangalore. Other Highways link it to Goa and Mumbai (Bombay) in the North, Calicut and Cochin in the South and to the main coffee and spice growing plantation areas of the hinterland. The nearest Airport, Bajpe (Mangalore Airport) is just 18 Kms. from the Port.

Twenty-four hours navigation is possible. Transit towers and buoys are all provided with lights for night navigation. Pilotage is compulsory for all vessels. Pilot station is located half mile off fairway buoy.

The Port is specialized in handling various types of chemicals like Phosphoric acid, Liquid ammonia, Styrene Monomer, Benzene, Cumene, Orthoxylene, Ethyl Dichloride, Cyclohexanone, Phenol, Acetone, Xylene etc. The Port has five separate tank farms for storage of chemicals, hazardous liquid cargoes, edible oil, molasses, POL products & LPG. The port has provided facilities to handle general cargo namely granite stones, wooden logs, sugar, plywood, wood pulp, machinery etc. It is also has facilities to handle the bulk commodities like iron ore concentrates, Iron ore pellets, finished fertilizers, raw materials for fertilizers, iron scrap, sponge iron, coal, and food grains.

The port has water spread area of 320 Acres, and land area of 2030 Acres comprising of a total area of 2350 Acres.

3.2.6 Cochin Port

The year 1341 saw the gigantic forces of nature culminate in the birth of a natural harbour. Centuries later the pioneering efforts of Sir Robert Bristow resulted in the modern Port of Cochin. The administration of the Port was vested with the Board of Trustees under the Major port Trust's Act, 1963. Kochi Port as it is now called, introduced containerized cargo handling way back in 1973. The introduction of house stuffing in 1992 and commissioning of the Rajiv Gandhi Container Terminal 1995 greatly contributed to its growth. This all weather port is strategically located to exploit the massive East-West ocean trade. There is only just 10 nautical miles from the direct sea route to Australia and the Far East from

Europe. This makes it the closest Indian Port to the maritime highway. Its proximity to the Kochi Airport and Railway Terminus gives it instant access to the world. The establishment of Inland Container Depots at different centers and the growth of containerization have stretched the hinterland of Kochi port to the whole of Southern India.

Pilotage is compulsory for all ships. 24 Hour navigation facilities are available in this port. Pilot boards vessel near Fairway Light Buoy. More details are included in chapter 5.

3.2.7 Tuticorin Port

Tuticorin was a small town with a rich maritime history. It was the center for maritime trade and pearl fishery. It was ruled by various dynasties like the Pandyas and Cholas, and then fell into the hands of the Portuguese and Dutch before finally coming under the administration of the British. The natural harbour and rich hinterland of Tuticorin Port prompted the East India Company to plan the development of the harbour. The lighthouse built in 1842 marked the beginning of the history of Tuticorin Harbour Development. On the 11 July 1974, Tuticorin Port was declared as the 10th Indian Major Port. On the 1st April 1979, the erstwhile Anchorage Port / Minor Port and the newly constructed harbour were merged into an Integrated Port Trust under the Major Port Trust Act 1963. From then on, Tuticorin Port has had two operational wings:

- Zone 'A' comprising of the new Major Port and
- Zone 'B' representing the old Anchorage or Minor Port.

Tuticorin Port is situated on the East Cost of India about 540 km southwest of Chennai. It is located in the Gulf of Mannar, with Sri Lanka on the South East and the large landmass of India on the West. The major Port of Tuticorin is created within a breakwater system jutting into the sea for about 4 km, one of the longest in the world. The Port was designed and executed entirely through indigenous efforts. Tuticorin Port is well sheltered from the fury of storms and cyclonic winds. It is strategically located very close to the major International sea routes. Navigation restricted to day light hours only. Pilotage is compulsory to all vessels.

Tuticorin Port is well connected to various trading centers within Tamil Nadu and the neighbouring states of Kerala, Karnataka and AP by National / State Highways. Regular bus services are available to several major cities throughout South India. The Port is linked to the broad-gauge railway system of the country. There is a daily express train service between Tuticorin and Madras and other connecting trains to Madurai. Tuticorin is connected by air to other major cities via. Madurai and Trivandrum. Journey by road from Tuticorin to Madurai takes 3 hours and Trivandrum 4 hours. Tuticorin is expected to be air linked after the newly commissioned Air Port is served by regular flight service.

The area of the water spread of Zone A is 960 Acres and of Zone B is 36.31 Acres. The land area is 2150 Acres and 365.88 Acres for Zone A and Zone B respectively. The total area of the port is 3512.19 Acres.

3.2.8 Chennai Port

Chennai Port is an artificial harbour on the Coramandal Coast in southeast India. The earliest recorded event in its creation was in 1639 when M/s. Cogan and Day founded a trading settlement on the site of the little fishing village, Chennaipattnam. The East India Company then started conducting all their maritime activities on this coast from here. Development of trade transformed the small fishing village to a modern port. The Capital of the state of Tamilnadu, Chennai as it was rechristened from the old name Madras is well linked & easily accessible by road, rail, water and air. Its climate is tropical with temperature ranging between 18° C-30° C.

Chennai Port is divided into 3 distinct zones namely:

1. Dr. Ambedkar Dock. (Inner harbour to handle passenger, general cargo & containers)
2. Jawahar Dock. (To handle coal, fertilizer other bulk and break bulk cargo)
3. Bharathi dock. (Outer harbour accommodates ore and oil handling system and a modern container terminal)

Chennai port railway is a member of the Indian Railway Conference Association and it is defined as a terminal shunting yard with abbreviation 'HOM'. Goods landed from vessels meant for dispatch to hinterland are taken by rail directly from the port and the goods to be shipped are brought from the various parts of the country to the railhead of the port.

In post-Independence period, the Port has developed into one of the most modern Ports, trying to match international standards, especially in container handling. The first modern container terminal in India was established at Port of Chennai in 1983.

Round the clock communication on Marine VHF channels is available. The Signal Station maintains continuous watch on Channel 16 at North Quay. VHF channels 12 & 14 are reserved for pilotage operations; channel 10 is available for communication with ships. A number of private launches ply day & night between the ships at anchorage and Shore.

The approach channel to the port has two sections:

1. The entrance channel within the protection of outer arm
2. The outer channel beyond the protection of outer arm.

The pilotage is round the clock and compulsory. Pilot boarding area 1 is about 2 Km. Northeast of breakwater for ships up to 230 meters in length and boarding area 2 is about 8 Km. Northeast of breakwater for ships over 230 meters in length. The anchorage is situated 'North Eastward' of the harbour in depths of 8 to 9 fathoms. The holding ground is good with coarse sand bottom. There is no limit on the number of ships that can be anchored. Vessels carrying explosives (which are of such nature that are permitted to enter the harbour) must anchor in the explosives anchorage eastward of the harbour. Such vessels should display Red Flag and Red Light by night.

The inner harbour water spread area is 220 Acres and the corresponding land area is 441 Acres. The water-spread area of the outer harbour is 200 Acres and its land area is 145.96 Acres.

3.2.9 Ennore Port

Ennore is situated on the Coromandal coast, north of Chennai in the state of Tamil Nadu. Ennore port, the 12th Major Port in the country is located at a distance of 24 km from Chennai port. Ennore Port was originally conceived as a satellite port to the Chennai Port, primarily to handle and meet the requirements of Tamil Nadu Electricity Board. The scope was widened, taking into account subsequent development plans of the Government of Tamil Nadu to set up:

1) An 1880 MW LNG power project in association with a private consortium
2) A Petro-Chem Park
3) A Naphtha Cracker Plant.

Ennore Port has been endowed with large chunks of land. The port has about 3500 acres of land its own. The port can provide all the infrastructure facilities required viz... water supply, electricity, transmission corridor, fire fighting services and environmental protection measures to the users of its facilities. The cost of Phase I of Ennore port has been estimated at Rs. 1058 crores. Government of India and Chennai Port Trust have contributed the equity capital of Rs. 300 crores and the balance dept portion is a loan met by Government of India and Chennai Port Trust. ADB has given a loan of USD 115 million to Ennore Port through Government of India.

The development of phase I of Ennore Port has been completed. The port was inaugurated and dedicated to the Nation by the Hon'ble prime Minister of India on 1.2.2001. Commercial operations were commenced with geared handymax vessels on 22.6.2001. Full fledged operations with deployment of self-unloading/gearless vessels of 65000/77000 DWT and shore based mechanical unloaders were started functioning very recently.

Ennore Port Limited (EPL) is the first corporatised port in the country. EPL as a landlord port would retain the port infrastructure and fulfill its regulatory function and envisages private sector to provide all other services. Development, operations and management of specialized terminals for dry/liquid bulk cargo would be concessioned to captive/private terminal operators for medium/long term durations based on capital investments. Operators would be required to construct berths, install topside and storage facilities at their cost. Also EPL would privatize marine services, maintenance dredging, bunkering services, container terminals, operation of bulk, warehouses, container freight stations, tank farm, cranage/handling equipment, dry dock and ship repair facilities.

3.2.10. Visakhapatanam Port

Visakhapatanam Port has played a prominent role in fostering accelerated growth in the region and significantly contributing to the country's trade & development. The Port was originally conceived in 1933 as an outlet for Manganese Ore exports. It progressed through planned infrastructure development in successive five-year plans and evolved itself to the ever-changing requirements of sea transportation systems. The Port comprises (i) Inner Harbour with 15 berths, (ii) Outer Harbour with 7 berths to accommodate deep draft vessels. One finger type jetty OB-1, OB-2 for ore carriers of size 1.50 lakh DWT, a general cum bulk cargo berth to accommodate vessels of size up to one lakh DWT and 14.9 m draft on Off-Shore oil Tanker Terminal (OSTT) to accommodate tanker of size up to 1.50 lakh DWT with direct discharge facility from the ship to refinery tanks and oil mooring facility for transshipments of crude oil from the mother tanker to daughter tanker, an exclusive jetty for LPG, a deep draft berth to accommodate post Panamax container vessels are the other service centers provided at Outer Harbour.

Visakhapatanam Port is strategically located between Calcutta and Madras on the East Coast of India in the state of Andhra Pradesh. A natural phenomena in the form of two massive rock hills; Dolphin's Nose on the south and Ross Hill on its North protect the Port from the regular cyclones that strike the East Coast of India. These two hills shelter a bay, which possess sufficient depth for ocean going vessels.

Pilotage is compulsory and round the clock navigation of vessels is possible. Embarkation Position is at roads about 1 nautical mile south east of fair way buoys. In respect of every vessel desiring to enter the Port, an application shall be made in advance in the form prescribed by the board, to Dy.

Conservator and Traffic Manager by the Master, Owner or Agent, stating the name of the vessel, cargo carried, or whether in ballast etc.

The total port area is 4369 hectares, of which 300 hectares are water spread area, 3882 hectares are total land area and 537 hectares are total reclaimed area. The Outer Harbour has a protected basin of about 200 hectares encompassed by a set of Break waters: North, South and East break-waters are 412 m., 1543 m., and 1070 m., respectively.

3.2.11 Paradip Port

Pandit Jawaharlal Nehru laid the foundation stone of the Port on 3rd January 1962. Construction work commenced in 19 November 1962 and dredging operations from 15th March 1964. During this period the Port was in the control of the Government of Orissa. The management was formally handed over to the Government of India on 1st June 1965. The Port was declared the eighth Major Port on 18th April 1966 making it the first Major Port in the East Coast commissioned in Independent India. The Port was opened to traffic in 1966. The main cargo handled was Iron Ore. Since then its cargo profile has greatly increased and from 1991, containers and transshipment of petroleum products were handled. It is located at 210 Nautical miles south of Calcutta and 260 nautical miles north of Visakhapatanam. The Port is connected with Broad Gauge Railway System of the South Eastern Railway. The Port is served by National highway No.5-A.

Pilotage is compulsory. ETA has to be given to Harbour Master not less than 24 hours before arrival of ships. Pilot boards vessel outside the breakwater SE of Fairway Buoy. No night navigation facilities available.

The Port has an artificial lagoon type harbour protected by two rubble mound "Break waters" and approached by the dredged channel. The North breakwater is 538 m. long on the North Eastern side of the Port and the South Break water is 1217 m. long on the South Eastern side.

3.2.12 Calcutta and Haldia Port

In 1690 the British anchored for the first time in the reach of the Hoogly River near the present day Kolkata. With the grant of trading rights to the British Settlement in Eastern India by the Mughal Emperor Aurangzeb, the city grew to become the premier port in British India. Its administration passed from the East India Company to the British Crown to be brought under the administrative control of the Government on 17th October 1870 with the appointment of a Port Commission under the Kolkata Port Act. By then the Kolkata jetties were fully operational. In 1886 a separate oil wharf was set up at Baj Baj. The impounded dock at Kidderpore (KPD) became operational in 1893. In 1925 four riverside jetties and a coal jetty were constructed at Garden Reach. In 1928 the second dock system, King George's Dock later renamed Netaji Subhash Dock (NSD) came up in the same area. The Port services the vast hinterland comprising the entire Eastern India including Bihar and Eastern Uttar Pradesh and the two land-locked Himalayan Kingdoms of Nepal and Bhutan. The Commissioners for the Port of Kolkata ran the port till January 1975 when Major Port Trusts Act, 1963, came into force.

Table 3.2 Docking systems of Calcutta and Haldia Port

Name of Docking System	Docks Provided	Facilities Provided
1. Kolkata Docking System (KoDS)	A) Kidderpore Docks (KPD)	18 Berths + 6 Buoy Mrgs. + 3 Dry Docks
	B) Netaji Subhash Dock (NSD)	14 Berths + 2 Buoy Mrgs. + 2 Dry Docks
	C) Baj Baj Oil Jetty	6 Petroleum Wharves
2. Haldia Docking Complex (HDC)	A) Haldia Dock	8 Berths + 1 under construction
	B) Haldia Oil Jetties	2 River berths
	C) Haldia Barge Jetties	2 River Oil Jetties for barges.
	D) Haldia Anchorage	For LASH vessels
3. Sagar Anchorage (SAC)	A) Diamond Harbour	Operational between 15th Sept. and 15th March every year
	B) Sagar Road	--

Kolkata port is the India's only riverine port has facilities developed over a stretch of 150 Km. of the Hoogly River. It comprises three major systems as shown in Table 3.2. All Docks are Impounded Docks System with Locks from River. 10 ship breaking berths are also available at CDS (KPD & NSD) subject to restrictions of length and beam.

The Kolkata Dock System is situated on the left bank of the river Hoogly, 145 Kms above the entrance to the river from the estuary off Sagar Island in the Bay of Bengal. The Haldia Dock System is situated 130 km. from pilotage station at Sandheads and at Latitude of 22° 02'.

The navigation channel leading to Kolkata and the river Hoogly can be divided into two parts:

1. Kolkata to Diamond Harbour, about 75Kms downstream of Kolkata.
2. Diamond Harbour to the Eastern Channel Light Vessel at Sandheads, about 157 Kms downstream of Diamond Harbour.

The maintenance of a navigational channel in a river with 17 sand bars is a challenging job. Vessel Traffic Management System (VTMS) was installed completely in April 1996 with a view to providing more effective and safer guidance to ship through radar surveillance. It has been taken up from the Sandheads to Haldia in the first phase and will be gradually extended up to Kolkata. The VTM system at Haldia acts as the main control station. The system at present is operational round the clock. Navigational aids like lighthouse, Automatic Tide Gauges, Semaphores, River Marks, Syledis Chain System and DGPS are provided.

Pilotage is compulsory for all vessels of over 200 NRT. The pilotage distance is 166 km. comprising 145 km. of river and 21 km of sea pilotage. The Pilot vessel always cruises on duty at Sandheads. She remains in the vicinity of the Eastern Channel Light vessel that marks the beginning of the inward pilotage. The river pilot embarks the inward bound vessels at Sandheads and proceeds up the river. On arrival at Kolkata (Garden Reach), the River pilot is relieved by a Harbour pilot who takes the vessel inside the lock at KPD or NSD or the river mooring as required. A Berthing Master guides the vessel to the nominated berth from the lock. For outward passage the process is reversed.

The handling of containers at 7 NSD (Netaji Subhash Dock) is fully computerized on on-line basis. For this purpose 20 modules are in operation. The Cargo Account System (CAS) for the remaining berths of NSD is ready for operation. Similar computerization schemes have been initiated for the Kidderpore Docks and at Haldia Dock Complex. Kolkata Port Trust is linked through Internet and NICNET. Implementation of EDI in CDS is in progress.

Anchorages are available for vessels in transit at Sagar Roads, Kalpi, Diamond Harbour, Royapur, Moyapur, Haldia, Uluberia and Garden Reach. The river mooring with capacity to accommodate 23 ships under favourable conditions of weather, tide, etc. extend from Howrah Bridge to Metiabruz. The length and draft for moorings and jetties vary subject to following restrictions:

1. During bore-tide periods no vessel over 152 meters is allowed to remain in the moorings in Kolkata and the draft is restricted to 5.5 meters.
2. At Baj Baj no vessel over 160 meters is allowed to remain in the moorings and the draft is restricted to 6 meters

3.3 Comparison of Indian major ports

A comparative study of all major ports has been conducted using the data collected from 1992 to 2001. The trend and the values of each performance indicators of all major ports are studied and compared with all the ports. The operational performance indicators, the financial performance indicators, Physical facilities available, manpower and its utilizations are analyzed and compared for all major ports. The performance of container terminals of the ports has also been compared with each other. Economic Intelligence Service 'CMIE', 2002 January and Basic Port Statistics of India 2001-02 were the main source of the secondary data used by us in this comparative study.

Weighted score method is used to compare the performance of each port. The four factors mentioned in the paragraph above are considered in this analysis. Each of the factors has sub-factors also. Scores are calculated based on the current values (data collected) of each factor mentioned above such that the best performance port gets score of 100 units and the worst port on that factor gets score of 0 units. This is done for all factors. Applying different weights to each factor consolidates the scores obtained by a port on different factors. The weights were determined by personal discussions and interview with experts of Cochin port. Now the weighted total score is obtained for all ports. The ranking is done based on decreasing order of the final score of each port.

3.3.1 Comparison of Operational performance Indicators of Major ports

The values of each operational performance indicator from 1994 to 2001 are collected and its trend is shown in Table 3.3. Straight lines with arrowheads in the table represent the trend. Curved lines represent approximately the fluctuation over the years. The value of each indicator for the year 2001 is also shown in the table. The following important operational performance indicators are considered for comparing the operational performance of each port. The value of operational performance indicators of each port for the year 2001 is used for this. The weights assigned for each factor is given in bracket. The operational performance indicators of Calcutta and Haldia are taken together, as it is being considered as a single major port.

1. Average turn around time (1),
2. Average pre-berthing time (1),
3. Average idle time of ships at berth (2),
4. Average output per ship berth day (3),
5. Capacity utilization of ports (2),
6. Average berth occupancy (3) and
7. Volume of cargo handled (1).

From the trend lines in Table 3.3, it is seen that the average turn around time of all major ports have improved. The turn around time of New Mangalore

Port and Cochin Port showed gradual improvement from 1994 onwards, whereas the JNPT showed fluctuation as shown in the table. The turnaround time of New Mangalore port is minimum (2.73 days) and maximum turnaround time is 6.55

Table 3.3 Operational Performance Indicators of Indian Major Ports

Name Of Port	Year 2001-'02	Operational Performance Indicators						
		Ave. Turn-round Time in days	Ave. Pre-Berthing Time in days	Ave Idle time at berth in Percent	Ave. Output Per ship berth day	Capacity Utilization In %	Ave. Berth-Occupancy	Volume Of Cargo In MT
1 Calcutta & Haldia	Value	4.36	0.745	37.35	4211	83.84	56.75	31.02
	Trend (1994-2001)							
2 Chennai	Value	5.25	1.96	36.3	6944	135.55	72.6	37.44
	Trend							
3 Cochin	Value	2.75	0.55	32.5	5979	95.17	63.6	12.8
	Trend							
4 JNPT	Value	2.98	0.92	10.4	7391	102.60	58.1	14.98
	Trend							
5 Kandla	Value	6.55	3.1	1.6	8016	118.72	79.8	46.3
	Trend							
6 Mormugao	Value	4.65	1,74	12.8	13576	95.58	74.0	18.23
	Trend							
7 Mumbai	Value	5.47	1.28	36.6	3944	99.70	58.5	30.41
	Trend							
8 New Mangalore	Value	2.73	0.76	32.8	12528	86.97	36.5	17.6
	Trend							
9 Paradip	Value	3.99	1.19	31.3	8831	106.15	69.5	13.64
	Trend							
10 Tuticorin	Value	4.11	1.58	34.4	3900	79.92	65.2	9.99
	Trend							
11 Visakhapatanam	Value	3.51	0.75	23.9	10772	128.28	66.8	39.51
	Trend							

days for port of Kandla. The average pre-berthing time of all ports showed an improving tendency except the port of Chennai and Mormugao. The best pre-berthing time is 0.55 days for Cochin port, the second one is the Calcutta &

Haldia port (0.745 days) and Visakhapatanam port is in third position (0.75 days). At the same time, there is high fluctuation of this value year by year for most of the ports. Average idle time at berth also showed improvement except the port of Paradip, Tuticorin and Visakhapatanam. JNPT, Mormugao and Kandla ports are first, second and third position respectively when the average idle time is concerned. All major ports showed improvement when the average output per ship berth day is considered. The highest output per ship berth day is 13576 tons for the port of Mormugao, and the port of New Mangalore is in the second position and the port of Visakhapatanam is in the third position. Six ports showed gradual improvement in average output per ship berth day over the years whereas the other five ports showed fluctuation in this value. Port of Chennai has maximum capacity utilization at the rate of 135.55 percent and port of Tuticorin has minimum capacity utilization of 79.92 percent. From the Table, it is very clear that the ports of Chennai, Visakhapatanam, Kandla, Paradip and JNPT have over utilized their capacity and other ports have under utilized their capacity. Hence necessary steps must be taken to increase the capacity of Ports of Chennai, Visakhapatanam, Kandla, Paradip and JNPT to reduce the congestion.

The trends of berth occupancy of all ports from 1992 to 2000 have been analyzed. The port of Cochin has shown an increasing trend in average berth occupancy from 1992 to 2000. All other ports showed a decreasing tendency of the average berth occupancy. There is high variability in average berth occupancy of all ports except Calcutta and Haldia over the years. Port of New Mangalore has lowest berth occupancy, followed by Calcutta and Haldia and JNPT. Kandla port has longest berth occupancy. The trend of the volume of total cargo handled in each port from 1993 to 1999 was studied. From the Table, it is understood that the volume of cargo handled through all ports have increased from 1993. But the variation is different for each port. Calcutta and Haldia, JNPT and Kandla showed gradual increase in volume of cargo over the years. All other ports showed fluctuation in volume of cargo handled. Port of Kandla handled maximum volume of cargo in 1999 followed by Visakhapatanam in second position and Chennai in third position. The port of Tuticorin and Cochin handled the minimum volume of cargo.

The weighted score of each operational performance indicators of all ports is shown in Table 3.4. From the table, it is very clear that the port of New Mangalore is operating with maximum operational performance followed by port of Visakhapatanam. JNPT and Mormugao are coming in the third and forth position respectively. The operational performance of port of Tuticorin is poorest when compared with other ports in India. From this analysis, it can be stated that the operational performance of the old ports (Calcutta & Haldia, Mumbai, Cochin and Chennai) are poor except the operational performance of port of Visakhapatanam when compared with the operational performance of new ports (New Mangalore, JNPT, Mormugao) except the port of Tuticorin.

Table 3.4 Weighted score and rank position with respect to Operational Performance Indicators

Sl. No.	Name of Port	Operational Performance Indicators (Weighted Score for each Factors)							Total Score	Rank Position
		Turn Around Time	Pre Berthing Time	Idle time at berth	Output per ship berth day	Capacity Utilization	Berth Occupancy	Volume of Cargo handled		
1	Calcutta & Haldia	9	12	0	3	4	39	13	80	IX
2	Chennai	5	6	2	21	44	12	17	107	VI
3	Cochin	15	13	10	15	12	27	2	94	VIII
4	JNPT	14	11	50	24	18	39	3	159	III
5	Kandla	0	0	40	30	30	0	22	122	V
6	Mormugao	7	7	46	66	10	9	5	150	IV
7	Mumbai	4	9	2	0	16	36	13	80	IX
8	New Mangalore	15	12	8	60	6	75	5	181	I
9	Paradip	10	10	12	33	20	18	2	105	VII
10	Tuticorin	9	8	6	0	0	24	0	47	X
11	Visakhapatanam	12	12	24	48	40	21	18	175	II
	Total Score	**100**	**100**	**200**	**300**	**200**	**300**	**100**	**1300**	

3.3.2. Comparison of Financial Performance Indicators of Major ports

There are several financial performance indicators to study the performance of a port. The trend of the financial performance was studied from the data collected from 1990 to 2001. Trend and fluctuations are indicated here also as done earlier in Table 3.3. The amount of operating income and operating surplus, operating ratio and ratio of net capital employed to the net surplus are the sub-factors used in determining the financial performance of the ports for the year 2001 The same is shown in Table 3.5.

From the table, it is seen that the operating income of all ports has shown a gradual increasing tendency from 1990 onwards. The ports of Chennai, Kandla and Mumbai have shown fluctuation in operating income over the years. The maximum operating income was generated by Calcutta and Haldia at Rs. 1146.93 million in 2001. The ports of Mumbai and Visakhapatanam have come in the second and third position respectively. The port of Tuticorin is in the last position; the operating income is only Rs.117.05 million in 2001. The operating surplus has also increased over the years except the ports of Chennai and Mumbai. High fluctuation is seen in all ports except the port of Calcutta and Haldia. From this, it is very clear that the operating expenditure is varying very much from year to year. The port of Calcutta and Haldia is in the first position (Rs. 449.87 million) and JNPT and Visakhapatanam are in the second and third position respectively, as far as operating income is concerned. The ports of Mumbai and Cochin are in eleventh and tenth position respectively. The operating surplus is only Rs. 17.16 million for Mumbai port and Rs. 31.33 million for Cochin port in 2001.The operating ratio of all ports exceed 50 percent except two ports viz. ports of JNPT and Tuticorin. These two ports are newly developed ports and have private participation in most of the operations in the ports. Port of Chennai, Cochin, Kandla and Mumbai have shown an increasing tendency of operating ratio. This is a serious matter that needs to be checked and controlled. Thus, it is very clear that the operating expenditure is very high for all old ports in India. Port of Chennai, Cochin and Mumbai are in ninth, tenth and eleventh position respectively in case of operating ratio is concerned. The ratio of net capital employed to the net surplus indicates the financial strength of the port. Table 3.5 also shows the ratio of net capital employed to the net surplus for the year 2001. The port of JNPT has minimum ratio (only 9), which indicates that the net surplus is maximum, and so the port of JNPT is financially stable. Port of

Chennai is in the second position as far as the ratio of net capital to the net surplus is concerned. Port of Cochin and Mumbai represent negative ratio (-587 and-91 respectively), which indicate the net surplus is less than the expenditure of the ports. This is a serious matter, which will affect the survival of the ports.

Table 3.5 Financial Performance Indicators of Indian Major Ports

Sl. No.	Name of Port	Value (2000-01) & Trend (1991-01)	Financial Performance Indicators			
			Operating Income (Million Rs.)	Operating Surplus (Million Rs.)	Operating Ratio in Percent	Ratio of Capital To Net Surplus
1	Calcutta & Haldia	Value	1146.93	449.87	60.78	861
		Trend				
2	Chennai	Value	339.7	58.88	82.67	177
		Trend				
3	Cochin	Value	187.06	31.33	83.15	-587
		Trend				
4	JNPT	Value	386.6	199	48.51	9
		Trend				
5	Kandla	Value	179.65	74.72	58.41	595
		Trend				
6	Mormugao	Value	187.57	54.84	70.76	2502
		Trend				
7	Mumbai	Value	438.12	17.16	96.08	-91
		Trend				
8	New Mangalore	Value	194.33	86.32	55.58	1137
		Trend				
9	Paradip	Value	297.2	96.3	67.6	2352
		Trend				
10	Tuticorin	Value	117.05	58.96	49.63	1113
		Trend				
11	Visakhapatanam	Value	394.98	171.34	56.62	1445
		Trend				

The operating ratio is positive for all ports, which mean that the operating expenditure is less than its operating income. When comparing the operating ratio and the ratio of net capital to the net surplus, it can be seen that the non-operating expenditure (indirect expenditure) is very high for the ports of Cochin and Mumbai. So the real culprit is the non-productive expenditure, which has to be contained in the case of Cochin and Mumbai. All ports except the port of JNPT and Chennai show that the financial position is not good enough for the future growth and development of the port. This is mainly due to the high expenditure incurred by the ports.

In this study, we have considered four important financial performance indicators namely 1) Operating Income 2) Operating Surplus 3) Operating Ratio and 4) Ratio of net capital employed to net surplus. The weight assigned to these indicators is 2, 1, 1, and 3 respectively. The weighted score and rank position of all major ports, when considering the four financial performance indicators altogether is shown in Table 3.6.

Table 3.6 Ranking of ports with respect to Financial Performance

Sl. No.	Name of Port	Financial Performance Indicators (Weighted Score of Each Factor)				Total Weight	Rank Position
		Operating Income	Operating Surplus	Operating Ratio	Ratio of Net Capital to Net Surplus		
1	Calcutta & Haldia	80	39	11	50	180	I
2	Chennai	18	4	4	70	96	III
3	Cochin	6	1	4	-90	-79	XI
4	JNPT	20	17	14	74	125	II
5	Kandla	4	5	12	56	77	V
6	Mormugao	6	3	8	0	17	IX
7	Mumbai	24	0	0	-78	-54	X
8	New Mangalore	6	6	12	40	64	VI
9	Paradip	14	7	9	4	34	VIII
10	Tuticorin	0	4	14	42	60	VII
11	Visakhapatanam	22	14	12	32	80	IV
Total Score		**200**	**100**	**100**	**200**	**600**	

From the table 3.6, it is very clear that the port of Calcutta and Haldia is the port having best financial performance indicators because they have generated maximum operating income and have maximum operating surplus when compared with other ports in India. JNPT has best operating ratio and best ratio of net capital employed to the net surplus. Hence, it can be said that the total expenditure (both operating and Non-operating) of JNPT is under their control. Chennai came in the third position as for as the financial performance indicators are concerned. The financial performance indicators of Cochin and Mumbai ports are in the last two positions (tenth and eleventh) respectively. From this study, it can be stated that the financial position of these ports became very poor because they have minimum operating income, operating surplus, operating ratio and ratio of net capital employed to the net surplus generated. This may be due to the cargo has shifted from Cochin to the nearby port of Tuticorin, and from Mumbai to its nearby port of JNPT. Cochin and Mumbai ports being the old ports, its operating and non-operating expenditures are very high, resulted bad financial position. Hence its operational efficiency has to be increased to compete with its nearby ports.

3.3.3 Comparison of Facilities available in Ports

A comparative study of all facilities available in each port has been done to rank the ports in India on this basis. For this purpose, the facilities available in the ports are classified into four groups:

- Berthing facilities
- Storage facilities
- Cargo handling facilities
- Capacity available to handle major commodity

These facilities are separately studied and the rank positions are determined by providing weight to each group.

3.3.3.1 Berthing facilities

Berthing facilities include the channel depth, Channel width, and total number of berth available in each port. The weights assigned to these factors are

2, 1, and 3 respectively. These factors are scaled and compared with other ports. The actual values of the factors are shown in Table 3.7.

From the table, it is very clear that the port of Chennai has maximum channel depth and Port of Calcutta and Haldia has minimum channel depth. The port of Calcutta and Haldia has maximum channel width and Cochin has a minimum channel width of 185 meters. The old ports have large number of berthing facilities. Port of Mumbai has 46 berths, Calcutta and Haldia together has 45 berths, Chennai has 20 berths, Visakhapatanam has 19 berths, Kandla has 15 berths and Cochin 14 berths whereas Mormugao has only 4 berths.

Table 3.7 Berth Facilities available in Major ports

Sl. No	Name of Port	Channel Depth (m)	Channel Width (m)	Total Berth (No)
1	Calcutta & Haldia	3+7	200+ 467	33+12
2	Chennai	19	244	20
3	Cochin	12	185	14
4	Jawaharlal Nehru (JNPT)	11	350	15
5	Kandla	5	200	15
6	Mormugao	13	250	4
7	Mumbai	11	366	46
8	New Mangalore	15	160	9
9	Paradip	13	160	9
10	Tuticorin	10	162	10
11	Visakhapatanam	10.7	122	19

3.3.3.2 Storage facilities

Storage facilities include the area of transit shed, area of warehouses and open area in each port. The weight assigned to these factors is 2, 1 and 0.5. The storage area available in each port is shown in Table 3.8.

From table 3.8, it is seen that port of Calcutta and Haldia together has maximum area of transit shed followed Port of Mumbai. The port of Mormugao has minimum area of transit shed. Port of Mumbai has maximum area of warehouses followed by port of Chennai. Port of Visakhapatanam has maximum open area followed by Port of Paradip and the port of Mumbai has minimum open area available. In general, we can see that the old ports have good storage facilities than port developed after independence of the country and the storage facilities provided for the newly developed ports are much lesser.

Table 3.8 Storage Area available in ports

Sl .No	Name of Port	Area of transit shed (m^2)	Area of ware Houses (m^2)	Open Area (m^2)
1	Calcutta & Haldia	178466	50000*	18475
2	Chennai	36000	65686 + 12600	325000
3	Cochin	28263	16356 + 10732	25000*
4	Jawaharlal Nehru (JNPT)	100630	75000*	630000
5	Kandla	17567	44622	578020
6	Mormugao	7700	17096	131532
7	Mumbai	133135	124951	25647
8	New Mangalore	23634	4380	57817
9	Paradip	11200	7504	650000
10	Tuticorin	10800	15060	72000
11	Visakhapatanam	25935	10482	1001663

* Data collected from the respective ports through telephone.

3.3.3.3 Cargo handling facilities

A comparative study of major equipment available in each port to handle the cargo inside the ports done is discussed in this section. The number of Wharf

Table 3.9 Cargo Handling Equipment available in ports

Sl. No	Name of Port	Wharf Cranes (No)	Mobile Cranes (No)	Other Back up Equipment (No)
1	Calcutta & Haldia	37	26	218
2	Chennai	26	10	176
3	Cochin	7	14	108
4	Jawaharlal Nehru (JNPT)	4	2	198
5	Kandla	16	5*	15
6	Mormugao	2*	1	11
7	Mumbai	52	27	95
8	New Mangalore	3	3	10
9	Paradip	4	4	23
10	Tuticorin	10	8	9
11	Visakhapatanam	10*	5*	45*

* Data collected from the respective ports through telephone

cranes, Mobile Cranes and all other back-up equipment available in each port was collected and is given in Table 3.9 The other back up equipment include

Forklift Trucks, Pay Loaders and Shovel Dozers, Tractors, Trailers, locomotives etc. The weight assigned in each category of equipment is 2, 1.5 and 1 for wharf cranes, mobile cranes and other backup equipment respectively.

From the table 3.9, it is seen that port of Mumbai has maximum number of wharf cranes and mobile cranes followed by port of Calcutta and Haldia together where as port of Mormugao has only 2 wharf cranes and 1 mobile crane. But the port of Calcutta and Haldia has maximum number of other back-up equipment followed by port of JNPT. The port of Tuticorin has only nine number of other back-up equipment. Again, we can see that the old ports have more handling facilities than port developed after independence of the country and the handling facilities provided for the newly developed ports are not sufficient.

3.3.3.4 Capacity available to handle major commodity

Another analysis was done based on the capacity available in each port to handle different types of commodities. The capacities of major commodity considered in this study are: Container Cargo Handling, Petroleum Oil and Lubricants, Fertilizer Cargo handling and Iron Ore Handling. The capacity available to handle the above four commodities for each port is shown in Table 3.10. Blank cells in the table indicate that no separate capacity is provided to handle the corresponding category of cargo. Equal weight of 1 unit is assigned to each factor for comparison purpose.

From table 3.10, considering container handling, JNPT, Mumbai and Calcutta and Haldia in the first, second and third position respectively. Kandla, Mormugao, New Mangalore, and Visakhapatanam ports have only negligible capacity to handle containerized cargo because these ports were not constructed and developed to handle containerized cargo. Port of Kandla has maximum capacity to handle POL cargo. Mumbai and Calcutta and Haldia are in the second and third position. POL handling capacity is not provided in JNPT. Mormugao and Paradip have only very limited capacity to handle POL cargo. Only four ports have capacity to handle fertilizer cargo. They are JNPT, Paradip. Cochin and Visakhapatanam. Similarly Iron ore handling capacity is provided in five ports. These ports are: 1) Mormugao, 2) Chennai, 3) Visakhapatanam, 4) New Mangalore and 5) Paradip.

Table 3.10 Capacity Available in ports to handle the Major Commodity

Sl.	Name of Port	Container	POL	Fertilizer	Iron Ore
1	Calcutta & Haldia	3300	20400	-	-
2	Chennai	2500	8300	-	8000
3	Cochin	1000	10500	600	-
4	Jawaharlal Nehru (JNPT)	15600	-	1500	-
5	Kandla	-	31000	-	-
6	Mormugao	-	1500	-	16500
7	Mumbai	5500	21000	-	-
8	New Mangalore	-	11500	-	7500
9	Paradip	3000	1500	850	3000
10	Tuticorin	1800	2300	-	-
11	Visakhapatanam	-	10800	500	8000

Now the weights obtained for the above four factors (berthing facilities, storage facilities, cargo handling facilities and the capacity available to handle the major cargo) were calculated and are shown in Table 3.11. The rank position based on the total score is also shown in the same table.

Table 3.11 Ranking of ports based on facility available

Sl. No.	Name of Port	Weights given to facilities					Rank Position
		Berth Facility	Storage Facility	Cargo Handling Facility	Capacity of Major Commodity	Total Weight	
1	Calcutta & Haldia	124	80	112	27	343	II
2	Chennai	76	34	68	34	212	IV
3	Cochin	40	14	39	29	122	V!
4	JNPT	52	64	27	26	102	III
5	Kandla	26	23	27	26	102	VII
6	Mormugao	30	5	0	39	74	X
7	Mumbai	109	82	122	35	348	I
8	New Mangalore	37	6	5	27	75	IX
9	Paradip	34	13	9	42	98	VIII
10	Tuticorin	29	5	21	8	63	XI
11	Visakhapatanam	43	24	20	42	129	V
Total Score		**600**	**350**	**450**	**400**	**1800**	

From table 3.11, based on overall weighted score for facilities for handling the four different types of cargo already stated, it is very clear that the Port of Mumbai comes first followed by Calcutta and Haldia. These two ports are very old ports in India. JNPT and Chennai ports have moderate facilities. Tuticorin, Mormugao and New Mangalore, which were developed after independence, come in the end based on facility criteria.

3.3.4 Comparison of Manpower available and its utilization in major ports

The trend of manpower in each port from 1990 to 2001 has been studied. The trend of change in manpower available and the value of manpower and the productivity are shown in Table 3.12. The manpower productivity was measured using the ratio of operating income to the total manpower available (operating income per man) and the ratio of volume of cargo handled to the manpower (tons per man) available. Hence the number of manpower available, operating income per man and tonnage per man has been considered for comparing the manpower productivity of ports. The weight assigned to these factors is 1,2 and 2 respectively.

From the table, it is clear that all ports have taken steps to reduce the manpower from 1990 except the port of JNPT and New Mangalore. But the rate of decrease is different for each port. Mormugao has almost steady staff strength during this period. JNPT has least manpower followed by New Mangalore and Tuticorin. All old ports have higher staff strength because, port sector was considered as an important employment sector after independence. Now the situation has totally changed. So the latest developed ports have less staff strength due to change in technology of material handling system. Old ports are now changing the technology towards automation. So it is very difficult to reduce their staff strength all on a sudden due to the resistance from all corners. Hence the rate of reduction of staff strength is very slow as shown in the table.

Class wise analysis of the staff strength has also been done. There are 77562 employees of all category in Indian Ports on 31-12- 2001. It is very interesting to see that in almost all ports, the number of Class I officers are more than the number of Class II officers except in the ports of Cochin, New Mangalore and Paradip. So the Class I officers are underutilized. Class II officers are over burdened due to their high span of control. The staff strength of Class IV employees is also seemed to be very high. Hence a total change in organization structure is essential for the effective utilization of the manpower. Table 3.13 shows the total staff strength and Class wise strength of officers and employees in all ports in India as on 31st December 2001.

Table 3.12 Value of manpower and manpower utilization

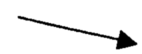
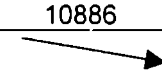
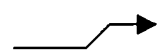
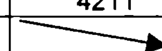
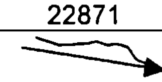
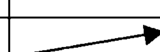
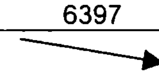
Sl. No.	Name of Port	Value On 31/12/2001	No. of Employees	Op. Income per Man in Crores	Tons Per Man
1	Calcutta& Haldia	Value	14036	0.08865	2397.5885
		Trend (1990-'01)			
2	Chennai	Value	10886	0.03317	3655.89298
		Trend			
3	Cochin	Value	4469	0.04587	3138.79353
		Trend			
4	JNPT	Value	1839	0.24345	9433.24937
		Trend			
5	Kandla	Value	4211	0.04460	11494.5382
		Trend			
6	Mormugao	Value	3816	0.05239	5092.17877
		Trend			
7	Mumbai	Value	22871	0.01957	1358.07431
		Trend			
8	New Mangalore	Value	2290	0.09227	8357.07502
		Trend			
9	Paradip	Value	3653	0.08822	4048.67913
		Trend			
10	Tuticorin	Value	3094	0.03996	6515.50132
		Trend			
11	Visakhapatanam	Value	6397	0.01957	11495
		Trend			

Table 3.13 Staff strength of Major Ports in India as on 31st December 2001.

Sl. No.	Name of Ports	Number of Officers		Number of Non-cargo Handling Operators			No. of Cargo handling workers		Casual Workers	Total
		CL I	CL II	CL III	CL IV	Oth-ers	CL III	CL IV		
1	Calcutta & Haldia	792	306	6177	6236	-	432	75	18	14036
2	Chennai	390	255	3262	2638	-	4341	-	-	10886
3	Cochin	153	238	2163	1000	-	880	35	-	4469
4	JNPT	205	46	353	125	120	990	-	-	1839
5	Kandla	104	79	1394	1697	22	773	-	142	4211
6	Mormugao	153	83	1685	1166	-	361	368	-	3816
7	Mumbai	440	39	4548	5879	-	7019	4946	-	22871
8	New Mangalore	75	109	846	317	-	345	598	-	2290
9	Paradip	90	194	1123	937	-	939	370	-	3653
10	Tuticorin	89	76	849	580	-	432	1068	-	3094
11	Visakhapatanam	200	133	663	1582	1008	1823	637	351	6397
	Total	**2691**	**1558**	**23063**	**22157**	**1150**	**18335**	**8097**	**511**	**77562**

Now the weights are assigned to the above three manpower related factors and the score obtained for each factor is shown in Table 3.14. From the table it is seen that the port of JNPT has maximum score followed by New Mangalore port. The manpower related performance of Port of Mumbai is very poor. Here again, the rank position shows that the old ports have comparatively poor manpower performances than that of the ports developed after independence.

Table 3.14 Ranking of ports based manpower related factors

Sl. No.	Name of Port	Weights given to facilities				Rank Position
		No. of Employees	Op. Income per man	Tons per man	Total Score	
1	Calcutta & Haldia	5	24	5	34	VII
2	Chennai	7	4	10	21	X
3	Cochin	11	10	8	29	VIII
4	JNPT	12	74	37	123	I
5	Kandla	11	8	46	65	III
6	Mormugao	11	10	17	38	VI
7	Mumbai	0	0	0	0	XI
8	New Mangalore	12	26	32	70	II
9	Paradip	11	22	12	45	V
10	Tuticorin	11	6	10	27	IX
11	Visakhapatanam	9	16	23	48	IV
Total Score		**100**	**200**	**200**	**500**	

3.3.5 Comparison of overall performances of Major Ports

The following four factors are considered for comparing the overall performance of major ports. A relative weight is also assigned to each factor, which are given in brackets. Scores are taken from the above analysis and are brought in a scale of 100 units. The weighted score is obtained by multiplying the score with the weight assigned to each factor. Table 3.15 gives the total weights of each port and the rank position.

A. Operational performance (2)
B. Financial Performance (2)
C. Physical Facilities (0.5) and
D. Man power (1.5)

Table 3.15 Comparison of Major Ports based on all Performance Indicators

Sl. No.	Name of Port	Weights obtained for Each Variables					Rank Position
		A	B	C	D	Total Weights	
1	Calcutta &Haldia	8	36	13	10	67	IV
2	Chennai	8	24	7	6	45	VIII
3	Cochin	20	0	3	9	32	IX
4	JNPT	30	28	8	37	103	I
5	Kandla	10	22	2	20	54	VI
6	Mormugao	34	12	1	13	60	V
7	Mumbai	0	4	12	0	16	XI
8	New Mangalore	34	20	1	21	76	II
9	Paradip	20	14	1	13	48	VII
10	Tuticorin	6	18	0	7	31	X
11	Visakhapatanam	30	22	2	14	68	III
	Total	**200**	**200**	**50**	**150**	**600**	

From table 3.15, it is seen that the best port in India is JNPT. The second and third best ports are New Mangalore and Visakhapatanam respectively. The first two ports were developed recently and the third port was developed before independence. The fourth best port is Calcutta and Haldia, where Calcutta was an old port and Haldia is a newly developed port. The fifth, sixth and the seventh best ports are Mormugao, Kandla, and Paradip respectively. From this study, it is also noted that the worst port is Mumbai, which is the oldest port in India. The recently developed port- the port of Tuticorin- is in the tenth position. Another very old port is Cochin, which is very poor in its overall performance and its rank is in the ninth position. Port of Chennai is another old port, whose position is in the eighth position. Cochin and Tuticorin are very close to each other; the competition between them is very high. Hence proper planning and development schemes must be evolved for success of the port of Cochin and Tuticorin. At the same time, a satellite port of Chennai called Ennore port started very close to Chennai port. This will be a major challenge to the existence of Chennai port in future. The overall performance of Mumbai port is very poor due to the emergence of JNPT very near to Mumbai with all modern technologies and facilities. Port of Calcutta could survive because of the timely decision of development of a new port; Haldia which is more convenient to the customers. It is seen that slowly the activities of Calcutta will come down and Port of Haldia will go up. Calcutta and Haldia and Kandla have the advantages of large area of port hinterland where most of the industries are developed and a good percentage of agricultural products are produced from here. Hence their position is very safe in the present condition. From this analysis, we can conclude that the overall performance of ports developed after independence of India is comparatively better than the port developed before independence. But the port of Visakhapatanam is an exceptional case.

3.3.6 Comparison of the performance of Container terminals of Major Ports

Container terminals being the trend in ports today, it was thought proper to compare these for different major ports of India. There are six major ports in India that has facilities to handle containers. The following five performance indicators are considered to compare the overall performance of container terminals. The weight assigned to each factor is also given in brackets below.

E) Volume of Container cargo handled (1)
F) Capacity of the Terminal (1)
G) Ratio of volume to capacity (2)
H) Availability of Equipment (1), and

I) Utilization of Equipment (1)

Table 3.16 shows the values of performance indicators of Container Terminals for the year 2000-01. From the table, it can be seen that the port of JNPT handled maximum volume of cargo during the year 2000, followed by port of Mumbai. The minimum volume is handled by Cochin port during the same period. Similarly the port of JNPT has maximum capacity to handle containers followed by port of Mumbai and port of Tuticorin has minimum capacity. The capacity. Capacity utilization is maximum for the port of Chennai followed by port of Mumbai. Port of Cochin has least capacity utilization during the same period.

Table 3.16 Performance Indicators of CT in India during 2000-'01

Sl. No	Name of Port	Volume in '000 tons in 2000-'01	Capacity in "000 tons in 2000-'01	Capacity Utilization in % in 2000-'01
1	Calcutta & Haldia	2551	3300	77.3
2	Chennai	3977	2500	159.08
3	Cochin	1247	1000	124.7
4	JNPT	10424	15600	66.8
5	Mumbai	70505	5500	128.19
6	Tuticorin	1633	1800	90.7

The availability and utilization QCs, TCs and Trailers are also considered for the comparison of Container Terminals in India. The percentage availability and utilization of key equipment is shown in Table. 3.17. From the table, it is seen that port of Tuticorin has maximum availability (considering the availability of all the three equipment together) of handling equipment followed by Mumbai. Port of Cochin has minimum availability for the equipment. Similarly, the utilization of equipment (considering the utilization of all the three equipment together) is maximum for the port of Chennai followed JNPT. Port of Mumbai has minimum utilization for their equipment.

Table 3.17 Availability and Utilization of Container Handling Equipment in 2000-01

Sl. No	Name of Port	QC/Similar Equipment		TC/Similar Equipment		Other Back up Equipment	
		Avail-ability in %	Utiliz-ation in %	Avail-ability in %	Utiliz-ation in %	Avail-ability in %	Utiliz-ation in %
1	Calcutta & Haldia	77.5	14.5	87.1	86.1	80.4	35.9
2	Chennai	81.9	75	90.4	58.5	88.7	55.5
3	Cochin	87.2	40.9	69.9	26.8	71.1	29.2
4	JNPT	89.4	54.4	89.9	64.7	76.4	65.4
5	Mumbai	93.1	32.7	86.1	18.5	89.7	6.9
6	Tuticorin	89.2	37.3	94.1	80	97.2	32.3

Now the relative scores are obtained on scale of 100 units. The total weight of each port is obtained by multiplying the score obtained with its corresponding relative weight assigned to each performance indicators. The ranking is fixed on the basis of total weights of each port as seen in Table 3.18.

Table 3.18 Weights assigned to each performance indicators

Sl. No	Name of Port	Weight obtained for Each performance factors					Total Weights	Rank Position
		E	F	G	H	I		
1	Calcutta & Haldia	7	10	8	10	15	50	VI
2	Chennai	14	6	74	18	26	138	II
3	Cochin	0	0	48	6	11	65	V
4	JNPT	47	62	0	17	25	151	I
5	Mumbai	30	19	50	22	4	125	III
6	Tuticorin	2	3	20	27	19	71	IV
Total		**100**	**100**	**200**	**100**	**100**	**600**	

From table 3.18, it can be stated that the best container handling port is JNPT, which has handled maximum volume of containerized cargo in 2000 and maximum capacity available. Port of Chennai is in second position. It has a maximum capacity utilization of 159.08 percent and its equipment utilization is also the highest. The port of Mumbai is in the third position. Mumbai has moderate capacity utilization when compared with other container terminals. Tuticorin is in the fourth position, which has highest availability and moderate utilization of equipment. Port of Cochin is in the fifth position, which has handled minimum volume of containerized cargo, minimum capacity available and minimum availability of handling equipment, but its capacity utilization is moderate. Calcutta & Haldia is in the last position, whose volume of cargo handled is not good, considering its capacity and the availability of number of equipment provided in the Container Terminal. Its capacity utilization and availability and utilization of equipment are very poor when compared with other container terminals in India. The volume of containerized cargo handled in JNPT is very appreciable when considering its limited number of equipment availability. Since port of Tuticorin and Chennai- are nearby ports of Cochin- have good equipment, there is high possibility of shifting of containers from Cochin to these ports. This is a new challenge to the port of Cochin. Same situation is there in the case of Mumbai port. Hence, immediate steps are necessary to improve the operational performance of Container terminals of Cochin and Mumbai.

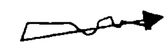
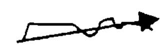
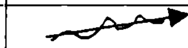
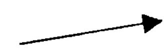
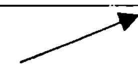
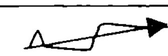
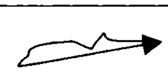
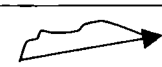
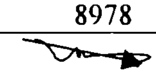
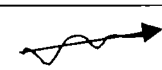
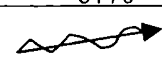
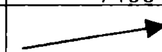
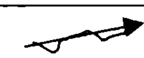
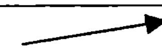
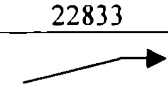
3.3.7 Study of Multi-commodity Handling Flexibility

Most ports in India have facilities to handle multiple commodities. This capability will also vary from port to port. In this section, we discuss the flexibility of different ports to handle various types of cargos. The trends in handling different types of cargo also studied and are discussed in the following sections.

3.3.7.1 Volume of Overseas versus Coastal Cargo

Analysis based on the volume of overseas cargo and coastal cargo was done to understand the trend of overseas and coastal movement from each port. The trend and the volume of cargo handled in 1999-'00 are shown in Table 3.19. From the table it is seen that there is a wide gap between the volume of overseas and coastal cargo handled in the year 1999 for all ports. The trend shows that the volume of overseas cargo has increased from 1991 for all ports. But some fluctuations in volume of both overseas and costal cargo are also to be seen. The same trend was seen in the case of coastal cargo also except the port of Mumbai. In the case of Port of Mumbai, volume of coastal cargo has reduced steeply from 117.41 MMT in 1991 to 89.8 MMT in 1999. From the table, it is also

Table 3.19 Trend in handling Overseas and Coastal Cargo through Indian Ports

Sl .No.	Name of Port	Position On 1999-'00	Overseas Cargo '000 tons	Coastal Cargo '000 tons
1	Calcutta & Haldia	Value	24156	6873
		Trend (1991-99)		
2	Chennai	Value	22776	14667
		Trend		
3	Cochin	Value	7806	4991
		Trend		
4	Jawaharlal Nehru (JNPT)	Value	14024	952
		Trend		
5	Kandla	Value	38102	8201
		Trend		
6	Mormugao	Value	17062	1164
		Trend		
7	Mumbai	Value	21434	8978
		Trend		
8	New Mangalore	Value	13885	3713
		Trend		
9	Paradip	Value	6170	7466
		Trend		
10	Tuticorin	Value	5761	4232
		Trend		
11	Visakhapatanam	Value	22833	16677
		Trend		

seen that the volume of overseas cargo is higher than that of the coastal cargo handled in each port except the port of Paradip. When considering both the volume of overseas and coastal cargo handled, Port of Visakhapatanam, Kandla and Chennai have come in the first, second and third position respectively. Port of Tuticorin is in the last position.

3.3.7.2 Import versus Export versus Transshipment Cargo

An analysis similar to the one above was conducted in the case of Import, Export and Transshipment cargo handled in each port. The volume of import

Table 3.20 Trend in Volume of Import, Export and Transshipment Cargo

Sl. No.	Name of Port	Position On 1999-'00	Import in '000 tons	Export in '000 tons	Transshipment in '000tons
1	Calcutta & Haldia	Value	20753	6018	4255
		Trend (1993-99)			
2	Chennai	Value	25946	10515	982
		Trend			
3	Cochin	Value	10608	2189	0
		Trend			
4	JNPT	Value	8818	5903	255
		Trend			
5	Kandla	Value	36034	3668	6601
		Trend			
6	Mormugao	Value	3285	14929	12
		Trend			
7	Mumbai	Value	19516	10003	893
		Trend			
8	New Mangalore	Value	8439	9148	14
		Trend			
9	Paradip	Value	4776	8860	0
		Trend			
10	Tuticorin	Value	7934	2059	0
		Trend			
11	Visakhapatanam	Value	17323	14359	7828
		Trend			

cargo was seen to be increasing over the years in each of the ports, but it showed fluctuation as shown in the Table 3.20. The volume of export cargo also increased in all ports except the port of Mumbai. The transshipment was increased in the case of Calcutta and Haldia, Kandla, Mumbai and Visakhapatanam, but it has decreased in the case of Chennai, JNPT, Mormugao and New Mangalore. Other ports have not handled transshipment cargo. From the table, it is seen that only three ports, Mormugao, New Mangalore and Paradip handled more volume of export than its import cargo. Also it is observed that there is a wide gap between import volume and export volume handled in the case of Calcutta and Haldia, Chennai, Cochin, Kandla, Mormugao, Mumbai, Paradip, and Tuticorin. This is not good to the ports because the vessels will be empty either in the forward or return trip. There must be a balance between export and import volume for better earnings to the port. When considering the combined effect of import, export and transshipment volume of cargo together, Port of Visakhapatanam, Chennai and Kandla came in the first, second and the third position. Port of Paradip is in the last position.

3.3.7.3 Break Bulk versus Conventional Dry Bulk versus Liquid Bulk Versus Mechanical Dry Bulk versus Container Cargo

A similar analysis has been done in the case of Break Bulk, Conventional dry bulk, Mechanical dry bulk and Container cargo handled in each port. The result is shown in Table 3.21. Break bulk cargo has increased in all ports except in the port of Chennai and Visakhapatanam. The increase in volume is fluctuating in most of the cases. The conventional break bulk cargo has also increased in all ports except in the port of Mumbai. In this case, the volume has increased steadily in most of the ports. The volume of containerized cargo movement has increased gradually in all ports. The movement of containerized cargo is negligible or absolutely nil from the port of Mormugao, Visakhapatanam, New Mangalore and Paradip. Volume of liquid bulk has increased in all ports except in the case of Mumbai port. Similarly the volume of mechanical dry bulk has also showed increasing tendency in all ports except from the port of Cochin and New Mangalore. Kandla and Mumbai have not handled the mechanical dry bulk cargo during this period. Mormugao has showed almost constant volume movement of cargo over the period. When considering all the different varieties of cargo movement, Calcutta and Haldia, Chennai, and Visakhapatanam are in a position of strength, followed by Mumbai and Kandla. Paradip and then Cochin have handled the least volume. Here again the old ports in India have handled maximum volume of the important cargo.

Table 3.21 Trend of Volume of Break Bulk, Conventional Dry Bulk, Liquid Bulk, Mechanical Dry Bulk and Container Cargo

Sl. No.	Name of Port	PositionOn 1999-'00	Break Bulk '000 Tons	Con. Dry Bulk '000 Tons	Cont-ainer '000 Tons	Liquid Bulk '000 Tons	Mech. Dry Bulk '000 Tons
1	Calcutta & Haldia	Value	2859	3277	2551	17677	4462
		Trend (1993-99)					
2	Chennai	Value	1230	14364	3977	11613	6250
		Trend					
3	Cochin	Value	588	386	1247	10217	359
		Trend					
4	JNPT	Value	147	691	10424	2171	1287
		Trend					
5	Kandla	Value	2944	4223	1134	38002	-
		Trend					
6	Mormugao	Value	373	2456	50	3505	14013
		Trend					
7	Mumbai	Value	4761	913	7050.5	18582	-
		Trend					
8	New Mangalore	Value	605	727	-	9589	6680
		Trend					
9	Paradip	Value	132	7846	-	3018	2640
		Trend					
10	Tuticorin	Value	1665	2129	1633	986	3580
		Trend					
11	Visakhapatanam	Value	1351	14745	262	15946	7206
		Trend					

3.4 Conclusion

A brief history of the development of all Indian major ports has been discussed as an introduction of this chapter. India has a long coastline of about 6000 km, with 12 major ports and 150 other ports. The locations, types of ports/docks, channel details and transport facilities to the ports were described in this chapter. A comparative study of all major ports has been carried out to understand the present status and trend in the growth and development of ports in India. The comparison between all major ports were done by making use of many variables related to port operations such as operational performance indicators, financial performance indicators, physical facilities available, and manpower available and its utilization. Weighted score method was used to rank major ports. The trend in growth and development of major ports over the last 10 years from 1991 to 2000 was also presented.

The main operational performance indicators considered in this study were the average turn around time of ships, average pre-berthing time, average idle time of berths in ports, average output per ship-berth day, percentage utilization of ports, berth occupancy and volume of cargo handled in ports. Ports of New Mangalore and Visakhapatanam have shown best operational performance indicators followed by JNPT and then Mormugao. The major financial performance indicators such as operating income, operating surplus, operating ratio and ratio of net capital employed to net surplus were taken to compare the major ports in India. From the study, it was seen that the port of Calcutta and Haldia had best financial performance. The port of JNPT and Chennai were in second and third positions respectively.

The physical facilities available in ports were classified into four groups a) berthing facilities, b) storage facilities, c) cargo handling facilities and d) capacity available to handle major commodities of each port. The channel depth, channel width, and number of berths available in ports were considered to compare the berthing facilities. The area of transit shed, area of warehouses and open area available in each port were used to compare the storage facilities. Number of wharf cranes, number of mobile cranes and all other back-up equipment were taken to compare the cargo handling facilities of all ports. The capacity available to handle the major commodities such as container cargo, POL, fertilizers and iron ore were considered to compare the availability of capacity of each port. From this study, it was seen that the best physical facilities are available in port of Mumbai followed by Calcutta & Haldia and JNPT.

In a comparative analysis of manpower and productivity of manpower, three factors were considered, which were number of employees, operating income per man and volume of cargo handled per man. Comparison based on the manpower available in all ports as on 31st December 2001 showed that the port of JNPT has minimum manpower performance, followed by New Mangalore and then Tuticorin. It was seen that the staff strength of all old ports was very high when compared with new ports. All ports have taken steps to reduce the staff strength due to new policy of Govt. of India. A class wise analysis of staff strength was also done. From the analysis, it is seen that the organization structure has to be changed for the efficient and effective utilization of the available manpower in ports. From the comparative study of manpower and their productivity, it was seen that the port of JNPT has best manpower productivity followed by New Mangalore and then Kandla.

Finally, all the above four performance indicators were consolidated for all major ports to know the present status. The analysis showed that the port JNPT is the best port in India among the eleven major ports. The port of New Mangalore is the second best and Visakhapatanam is the third best port in India. One of the oldest ports, Mumbai is in the last position. Similarly, the six Container Terminals were also compared using five important performance parameters, namely volume of cargo handled, capacity available, capacity utilization of the terminal, availability and utilization of container handling equipment during the year 2000-'01. This study showed that the JNPT was the best container terminal in India. Port of Chennai was the second best and Port of Mumbai came in third position. Among the six Container Terminals, RGCT associated with port of Cochin is in the fifth position. Port of Calcutta & Haldia was the last ranking container terminal in India.

When comparing the multi commodity handling flexibility of Indian Ports, it was seen that the old ports have better flexibility in handling multi-commodities like break bulk, conventional dry bulk, container, liquid bulk and mechanical dry bulk, import cargo, export cargo and transshipment cargo etc. The total volume of all types cargo have showed an increasing tendency from 1991, but there is fluctuation in volume over the years and from port to port. The trend also showed that the rate of increase of containerized cargo and liquid bulk cargo is more than that of other types of cargo. Hence, the newly developed ports like JNPT and

Tuticorin have more flexibility in handling containerized cargo than other cargo. The ports of Cochin and Chennai have planned to provide more facilities to handle liquid bulk and containerized cargo than to handle other type of cargo. As a result, Port of Cochin has developed the Cochin Oil Terminal (COT) to handle the liquid bulk cargo, and RGCT for handling containers; Chennai has increased their liquid bulk handling facilities and commissioned a new Container Terminal very recently.

The next chapter discusses the implementation of the five-year plans in India after independence with reference to port planning and development and tries to highlight the problems that occurred in the port sector while implementing the five-year plans.

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CHAPTER 4

PORT PLANNING AND PLAN IMPLEMENTATION

4.1 Introduction

Port planning is usually performed in a much more haphazard manner than planning for industrial development in general. The main reason for this appears to be the multitude of interest groups involved as shown in Figure 4.1. This complex network of interacting interests gives to major problems in port planning such as:

- Overt and concealed conflicts of interest that affect goal setting and planning procedures
- Planning funçtions that may be ineffectively allocated or required feedback rendered difficult, for extraneous reasons such as historical development
- Statistical information necessary for planning that may be dispersed, kept in several incomplete formats, and/or areas inadequately covered
- Conflicting values that may be embodied in the institution's framework of port planning
- A paramount body that is concerned with port planning possessed of the necessary stature to obtain information and cooperation from all parties does not always exist.

National and state governments impose their objectives, policies and constraints on the planning process. Today, in India, the 11 major ports are under the direct control of central government, the Port of Ennore, the 12th major port is under the control of a corporate management and the intermediate and minor ports are under the direct control of the respective state governments. The respective central or state governments take the policy, operation and development decisions of ports. Government's involvement in port planning may be regulatory, licensing or participatory in nature and also involving fund allocation for the development of ports. The involvement may include specification of both the planning objectives and the means to be adopted to realize them. Operational planning is left to the corresponding ports; there is usually government participation in the sense of legislative constraints on the planning process and scope.

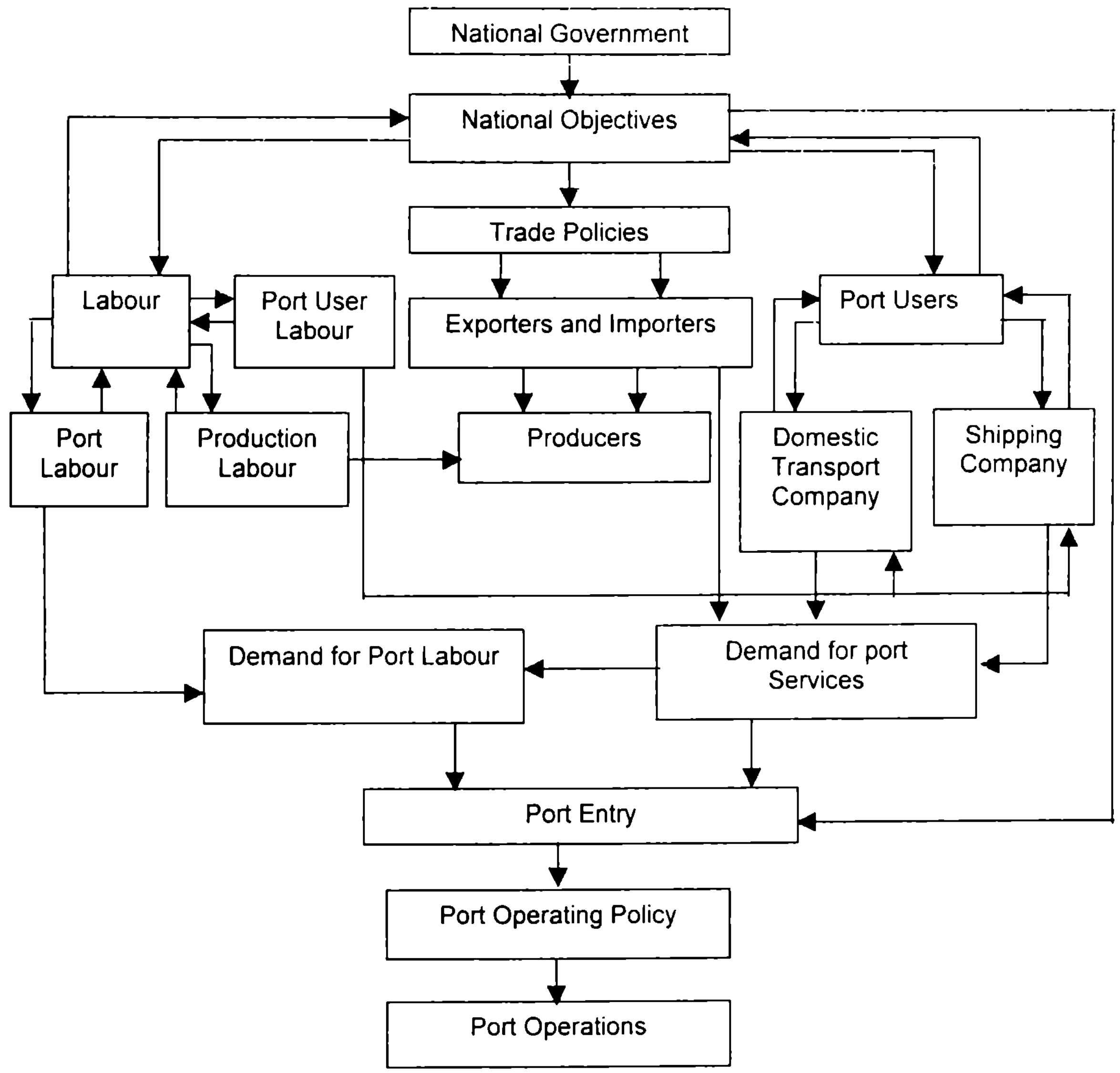

Figure 4.1 Interest groups affecting port planning

The main purpose of port planning is to design a port development program that will enable the port management to achieve its objectives in the most efficient manner. Port planning is essential to the development of ports for the following reasons:

1. The magnitude of investment required for port development is huge and efficient port planning can minimize the risk of waste of resources.

2. The port planning process scrutinizes all the available alternatives and finds the best and most economical method to meet objectives.
3. A formal port planning process provides port management with a basis for more systematic adjustment and adaptation to changes in shipping market conditions, transportation and other cargo handling techniques.
4. An efficient port planning approach makes it easier to formulate suitable compromise solutions that are acceptable to the interest groups involved. This is necessary because port development is often performed in a haphazard manner due to the fact that many interest groups are usually involved.
5. Port planning allows orderly and efficient implementation of port development without much delay or duplication.

In this chapter, it is planned to give an introduction of port planning in India after independence and review of five-year plans with respect to major ports is given. Ninth five-year plan proposals of the port sector will be reviewed in greater details since they pertain to liberalization era. Anomalies in planning and plan implementation will also be discussed in this chapter.

4.2 Port Planning Process

The whole port planning process can be divided in to pre-investment, investment and operational phases as shown in Figure 4.2. In the pre-investment phase, a two stage planning approach is usually followed. The first stage consists of aggregate or master port planning. Here, the main emphasis is on determining whether or not the port development is needed by first reviewing the current conditions and existing facilities and then by analyzing the results to evaluate if the projected requirements can be met.

The second stage consists of detailed port development planning. It starts with disaggregating the aggregate requirements found in the master planning

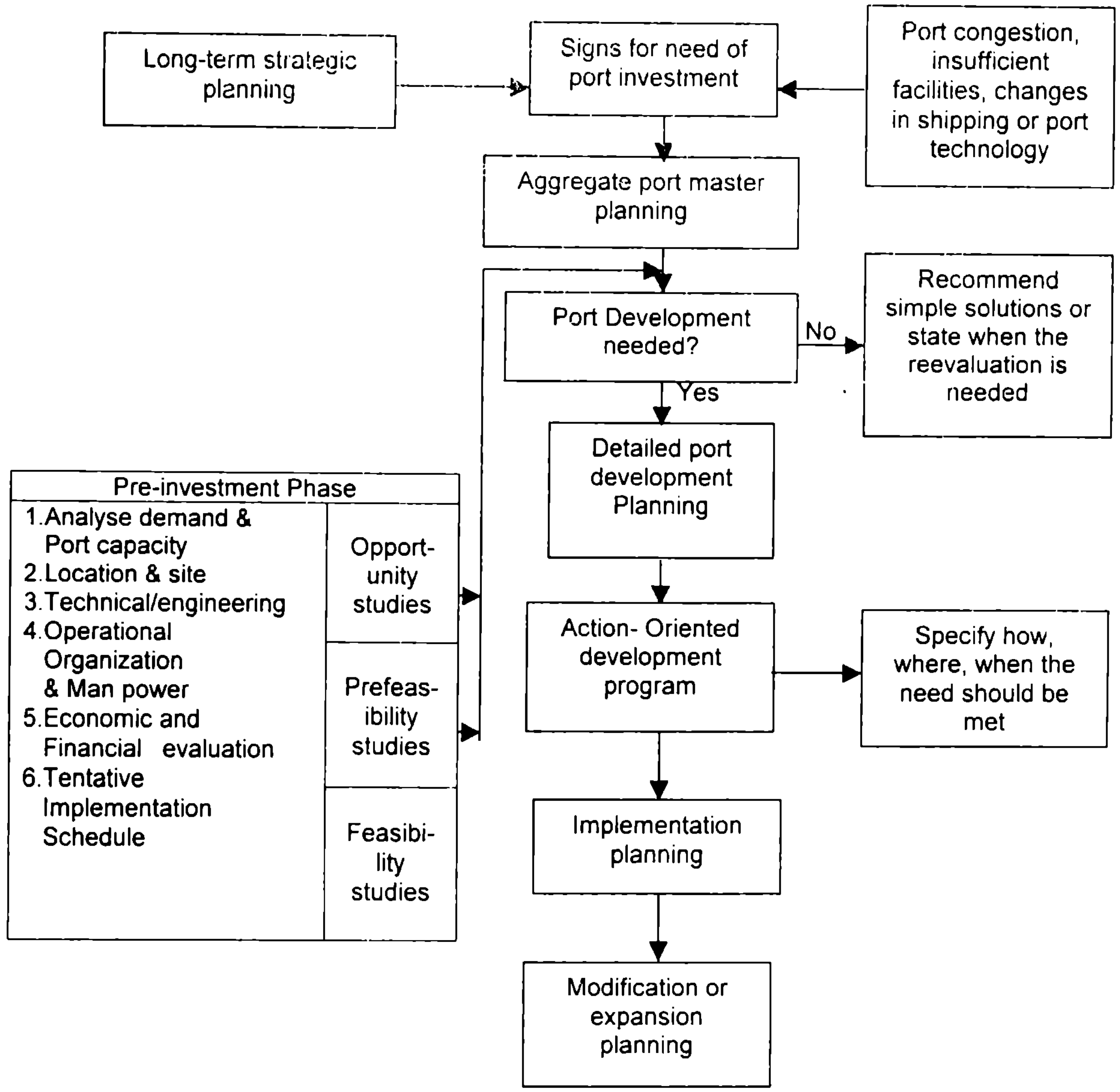

Figure 4.2 Port planning processes

process in to more detailed and identifiable problem areas. Then all the alternative methods that are available are identified that may solve these problems and are evaluated. Typical alternatives that are available to the port planners are institutional and operational improvements, modification or expansion of ports and its facilities and development of a new port. The results of port project evaluation on operational, technical, economic and financial aspects from the pre-investment feasibility studies are then incorporated to formulate a definite action-oriented port development program that specifies how, where and when the need should be met.

After the investment decisions are made for port development, implementation must be planned. Important factors to be determined are the construction scheduling, the procurement of technology, the equipment and materials, the rate of investment and organizing sufficient financial resources to ensure the on-schedule progress of the port development.

During the operational stage port modification or expansion planning may be required to meet efficiently any necessity of adjustment in port facilities or organization due to changes in market conditions or shipping and cargo handling technologies.

4.3 Port Development in India

There were five major ports in India prior to the first five-year plan period. They were Bombay, Calcutta, Madras, Cochin, and Visakhapatanam. The sixth major port was created at Kandla. It was held by an inter-departmental committee of the Government, appointed in 1945, that the existing facilities at the major ports were barely sufficient to meet the needs of the traffic that was then offering and that planning of additional facilities, for the growing trades of India and the new and modern requirements of shipping was, therefore quite essential. The volume of trade that passes through these five ports has steadily increased. It has risen from a little over 16.6 million tons in 1938-39 to more than 22.0 million tons in 1951-52. The volume of the trade passing through these five ports has thus witnessed a rise of nearly 33 percent during a period of 12 years. Moreover, it is reasonable to hold that, in view of the growing agricultural production and the increasing industrialization of the country, India's trade will, particularly with the export drive of the Government, witness a substantial upward march in the coming years. It is therefore; the duty of ports to take timely steps for effecting such developments as will enable them to cope with the steadily expanding volume of traffic.

The tonnage handled by the five major ports from 1938 to 1955 is shown in Table.4.1. It can be noted that, since India attained independence, the total volume of trade passing through these five ports has been on the increase from 1938-39 to 1951-52, the volume of trade to be carried has risen over 30 percent. It could be noticed that a little decline was registered in the following three years. It has however, witnessed a further increase in 1955-'56 and gone up to 23.6 million tons. The normal trade may, therefore, be taken at 22 million deadweight tons.

Table.4.1 Volume of cargo handled by the Major Ports from 1938 to 1955

YEAR	DEAD WEIGHT TONS (In million)
1938-'39	16.6
1948-'49	18.5
1949-'50	18.9
1950-'51	18.8
1951-'52	22.2
1952-'53	21.2
1953-'54	19.8
1954-'55	20.1
1955-'56	23.6

Source: - Dr.Hariharan, So I Rest on My Oars, Collection of Writing and Speeches of Master

In this situation, ports have to provide more facilities and services for the efficient functioning of trade and shipping. They have to be maintained and developed according to modern needs and standards both for national economy and National Defense. The government cannot, therefore, ignore their responsibility for building up these vital national services and for ensuring their efficient and economic functioning. The government was not in a position to allot to ports a substantial sum to enable them to develop their facilities and to maintain their services for meeting the growing needs and requirements of trade and shipping.

4.3.1 Need for Port Planning and developments of Indian major ports

According to the proposal of the first five-year plan, there was an urgent need for the development of our major ports after independence due to the following reasons.

- There was need for rectifying the consequence of partition and providing a natural outlet for traffic previously catered for by Karachi. It was mainly for this reason that the development of Kandla as a major port was recommended by the West Coast Major Port Development Committee. The recommendation was accepted by the Central Government and the project was taken up for implementation in 1949. Until the 31st March 1951, a sum of Rs.0.9 crores had been spent on this project.

- A large part of the equipment of port was intensively used during the Second World War and was antiquated and obsolete. The dock systems in the ports needed to be modernized. Postponement of renovation and modernization of these ports would result in slow turnaround of ships and economic loss of the country.
- The central government had undertaken to provide port facilities for the petroleum refineries proposed to be set up at Trombay (Bombay) by the Standard Vacuum Oil Company and the Burma shell Oil Company. As the refineries were expected to go into production before 1955, it was necessary to give a high priority for the provision of oil discharge facilities.

Based on the urgent need for the developments of major ports, plans were prepared as part of the national five-year plans/annual plans.

4.3.2 Plan procedure for port development

The Planning Commission is the apex national planning agency of the country. For each five-year plan, a working group for the port sector is constituted by the Planning Commission under the Chairmanship of the Secretary – Ministry of Surface Transport, comprising representatives from the user Ministries/Agencies (like Ministry of Commerce, Ministry of Energy, Ministry of Railways), port trusts, etc. and experts in the field. The working group is entrusted with the preparation of the five-year plan for the port sector. The terms of reference of the working group cover, inter-alia, the review of the physical and financial performance during the preceding five-year plan, finalization of traffic projections for the five-year plan period under consideration, identification of schemes of development to be taken up, requirement for funds, financing pattern etc.

The working group interacts with the various user interest groups and also takes into account the plan programmes drawn up by the ports. Based on these, the working group draws up the programmes for the five-year plan and submits its report to the Planning Commission. The Planning Commission after considering the inter-se priorities for the various sectors of economy and availability of resources, allocate outlays for the various sectors including the transport sector, which covers ports also. The five-year plan programme thus finalized is a broad blueprint for port development and forms the framework within which Annual plan are drawn up every year of the five-year plan period. In the annual plans, schemes of development are considered in a sharper focus and the Planning Commission approves the list of schemes

Only after the approval of scheme of annual plan from the Planning Commission, these schemes are processed by ports for investment decisions. Ports have been delegated power to take investment decisions on schemes costing up to certain monetary limits beyond which Central government's sanction is required. For the release of any foreign exchange involved in the cost of the schemes, Central Government's sanction is necessary.

4.4 The framework for Analysis of Planning Problems

The framework for analysis of port planning and plan implementation is discussed in the following four parts. The shortcomings in port planning and plan implementation are located using the analysis of data and by making use of literature.

1. Analysis of the challenges of Port Planners
2. Analysis of anomalies in strategic planning process for the developments of Indian Ports
3. Analyses of shortcomings in implementation of plan schemes suggested in 9^{th} five-year plan.
4. Strategies recommended for performance improvements of Indian Ports

4.4.1 Analysis of Challenges before Port Planners

When there are problems in the port, the infrastructure and the cargo handling equipment are often first considered to be at fault. However a recent UNCTAD survey in four African countries (Cote d'Ivoire, Ethiopia, Kenya and Senegal) found that "Investment in modern port facilities has been universally good, and although there have been some minor omissions there are no cases of serious infrastructure defects". If ports have the right infrastructure and necessary equipment, the cause of the problems may be lack of appropriate management or of modern management know-how. Principles of modern port management require that each port organization, department, workshop, team and staff member should have clearly described objectives and areas of authority and responsibility and be accountable for its performance. Modern management includes adequate rules and regulations, good statistical and information system, analytical accounting and cost control and human resource development etc. Today, in most cases, managers know these techniques well and many have been put in place. In fact, knowledge of modern port management has been disseminated in developing countries through various training activities during the last decades. In ports of developing countries, there are managers who have been trained abroad in modern port-management techniques, and thus the problem is not the lack of these techniques, but their implementation. Improved management is often unable to touch the roots of the problem.

4.4.1.1 Export-Import Ratio

During 1990's, a higher growth has been recorded in imports relative to exports resulting in a decline in trade surplus from the level of US $ 5.6 billions per annum in 1980s to about 2 billions in 1994-'95. In 1995-'96, trade deficit increased to around US $ 4.5 billions (Pederson, [2000]). A large number of policy measures, which were in use for the control of imports have been dismantled. Also a number of quantitative restrictions, which were imposed in the earlier protectionist regime, have been done away with. As a result, in India, '93 to 1999-'00 and the volume of export cargo has increased at the rate of 23.2

Table 4.2 Volume of cargo handled from 1992-93 to 1999-2000 through Indian ports

Year	Import Cargo (MT)	Export Cargo (MT)	Total Cargo (MT)	Ex-Imp Ratio (%)	Import Traffic Intensity (%)	Export Traffic Intensity (%)
1992-93	95.877	67.267	163.144	70.16	58.77	41.23
1993-94	96.673	76.606	173.279	79.24	55.79	44.21
1994-95	109.684	81.393	191.077	74.21	57.40	42.60
1995-96	120.265	95.416	215.681	79.34	55.76	44.24
1996-97	128.273	87.247	215.520	68.02	59.52	40.48
1997-98	142.168	94.764	236.932	66.66	60.00	40.00
1998-99	150.780	86.229	237.009	57.19	63.62	36.38
1999-00	163.432	87.651	251.083	53.63	65.09	34.91

Source: Economic Intelligence Service 'CMIE', January 2002

percentage for the same period. The Table.4.2 shows that the total volume of cargo handled from 1992-93 to 1999-'00, increased at a rate of 35 percent. When imports and exports are not balanced, the result is handling of empty containers in one direction which though takes almost the same time and effort as full container handling, pays only a fraction of full to the port. Therefore, imbalance of export and import is bad for ports.

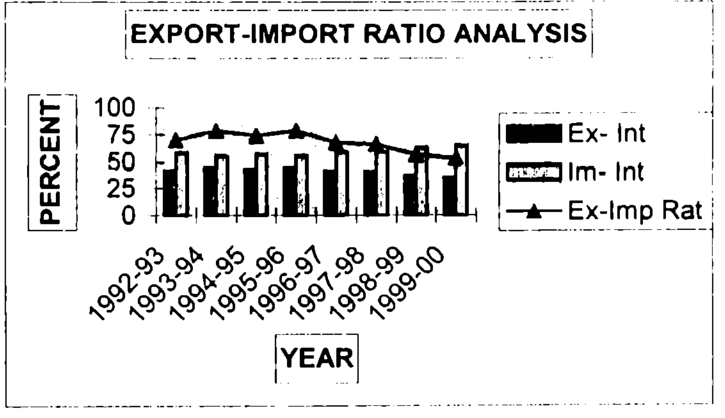

Figure 4.3 Export-Import Ratio

Figure 4.3 shows that the export intensity is reducing and the import intensity is increasing year by year. Thus, the ratio of export to import is reducing steadily. This means that larger part of import passed through overburdened the Indian ports. Hence, it is a clear indication that the authorities must take policy initiative to promote export trade to make the Indian ports financially strong and stable in the years to come for facing the threats and challenges since globalization and liberalization of economy.

4.4.1.2 Port Capacity adequacy

The port capacity and the traffic handled from the first five-year plan period to the beginning of the ninth five- year plan period is shown in Table 4.3. The urgent need for augmenting port capacity was felt in 1952 when utilization levels crossed 100 percent, steps to increase capacity were taken and till 1996 the capacity utilization remained below 100 percent. However, our port capacity utilization rate has again reached 105.60 percent in 1996-97. This indicates the inadequacy of port capacity.

Table 4.3 Capacity utilization of ports in India

Year	Port Capacity (MT)	Traffic Handled (MT)	Port Utilization Rate (%)
1951-52	20	21.75	108.75
1956-57	25	24	96
1961-67	36.67	33.01	90.02
1966-67	55	40.00	72.72
1971-72	59.55	59.19	99.39
1981-82	104.45	87.99	84.24
1984-85	132.73	106.73	80.41
1991-92	169.23	156.65	92.57
1996-97	215.21	227.26	105.60

The shortfall in port capacity will be a major concern in the coming years as liberalization gains further momentum incorporating the agricultural sector also. (In 1996-97, port traffic was 227.26 million tons, against the capacity of 215.21 million tons). Traffic further increased to 251.083 million tons in 1999-'00. The port utilization depends on the economic characteristic of the hinterland and or the type and modality of transfer linkage. Some ports are over utilized and some ports are underutilized due to the unbalanced growth of manufacturing belts as evolved over time across the country. . This is specifically true for the ports of Kandla, Mumbai, Chennai, and Vishakhapatanam that have been continuously suffering from supply side constraints (i.e. lower capacity) since liberalization. As a matter of fact, these are the country's top four ports according to their annual cargo throughput and output performance.

4.4.1.3 Change in Turn around time and output per ship-berth day

The output per ship-berth day and ship turn around time at major ports has worsened in the post liberalization period. This situation is aggravated in case of old ports, where average turn around time of more than a week is really serious. The situation appears much more serious when one considers costs. Given that international turn round time range between 3 to 10 hours rather than a week or more. Beyond the proximate causes, declining water draft and the riverine nature may be two main factors for the lower value of the performance. Table 4.4 shows the turn around time of Indian major ports from 1994-95 to 1999-2000. The average turnaround time of all old ports except Cochin, and Vizag is more than a week. The turnaround time of all ports except the port of Tuticorin shows a small improvement from 1994-95 to 1999-00. Still our turnaround times are very high when compared with the international standards of turnaround time.

Table 4.4 Turnaround time of major ports of India

Name of Port	1994-95	1995-96	1996-97	1997-98	1998-99	1999-00	Average Turnaround time in days
Calcutta	9.53	9.12	7.71	7.47	6.59	6.59	7.84
Chennai	7.97	8.18	8.30	7.12	7.50	6.80	7.65
Cochin	4.05	4.21	3.90	3.99	3.61	3.23	3.83
Haldia	7.18	6.83	5.98	5.30	4.73	5.21	5.87
JNPT	5.20	9.03	6.03	4.47	1.96	1.72	4.74
Kandla	9.74	14.88	9.00	8.98	8.61	6.16	9.56
Mormugao	6.88	6.29	6.28	6.32	4.81	4.30	5.81
Mumbai	9.35	10.10	7.68	8.37	7.01	5.60	8.02
Mangalore	5.75	5.21	4.37	4.09	3.72	3.80	4.49
Paradip	5.62	6.34	4.94	5.12	4.11	3.89	5.00
Tuticorin	5.42	5.99	5.09	5.05	4.87	6.39	5.47
Vizag	5.73	7.78	5.60	6.11	5.28	4.75	5.88

Source: Economic Intelligence Service,' CMIE', January. 2002

Table 4.5 shows the output per ship-berth day. Even though the output per ship berth-day shows an increasing tendency from 1994-95 to 1999-2000, the rate of increase is very less when compared with the international standards. The output per ship-berth day is very poor in Calcutta, Mumbai, and Chennai ports. The turnaround time and the output per ship-berth day of these ports indicate that necessity of taking appropriate steps to overcome the present challenges. It must be noted that the Government of India has invested maximum amount for the development of these three ports after independence of India.

Table 4.5.Average output per ship-berth day of major ports of India

Name of Port	1994-95	1995-96	1996-97	1997-98	1998-99	1999-00	Average output per ship-berth day in tons
Calcutta	1017	1164	1188	1285	1697	2157	1418
Chennai	4629	4732	5461	4800	5762	5886	5212
Cochin	4535	5771	5438	5420	4617	5952	5289
Haldia	5072	5842	5855	5902	5282	5599	5592
JNPT	2913	3585	2987	6209	6140	5905	4623
Kandla	4924	5233	7299	6556	8778	8740	6922
Mormugao	9107	8878	8540	10171	11076	11162	9822
Mumbai	2602	2516	2605	2530	2940	3876	2845
Mangalore	4564	5515	7176	7210	7507	9000	6829
Paradip	5584	5825	6406	6128	7012	7106	6344
Tuticorin	2589	2759	3026	2934	2984	2891	2864
Vizag	6027	5336	6696	6286	7057	7579	6497

Source: Economic Intelligence Service,' CMIE', and January 2002

4.4.1.4 High staff strength and Poor labour productivity

Labour productivity is one of the important indicators for measuring the performance of a port. An analysis of the average output versus the norm of various cargos handled fixed in 1990 reveals that this ratio varies widely from 50 percent to 200 percent. Secondly, this ratio in most of the cases is much above 100 percent which signify that the prescribed norms itself are at a low level [David Vandeveer, 1998]. The impact of post 1990 containerization has now created a need for the updating of these standards. In each plan period, maximum fund is allocated for automation of port operations; this results in displacement of manpower required for handling operations. The surplus manpower if not efficiently utilized for other purposes will result in lowered manpower productivity in ports.

Table 4.6 Port wise staff strength of major ports

Port	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	% Increase
ındla	4537	4633	4603	4976	4927	4677	4740	4451	4107	4486	3860	4128	-6.8
umbai	30987	30319	29349	28199	27327	25063	34696	32893	32789	32127	31416	31033	+0.15
IPT	-	-	1137	1187	1386	1507	1513	1549	1539	1550	1540	1557	+36.9
ormu-o	3683	3686	3614	3582	3668	3257	3612	3607	3588	3535	4290	4281	+16.2
anga-'e	1314	1312	1328	1330	1337	2401	2311	2303	2275	2258	2293	2289	+74.2
ıchin	5967	5868	5781	5533	5546	5546	5502	4872	4985	5021	5332	5213	-12.6
.ticor-	2286	2284	2270	2268	2250	2054	1998	2152	1941	1895	1875	1833	-19.8
ıennai	11469	11489	11346	11361	10318	10271	10357	10399	10314	10314	10207	10274	-10.4
zag	11013	10986	10848	11314	10227	10082	9772	9626	9450	9307	9198	8773	-20.3
radip	5590	5388	4841	4811	4834	4996	5241	4113	4229	4106	3892	3876	-30.8
lcutta	24873	24658	23643	23394	21292	19808	19296	18051	17357	16548	16265	15437	-37.8
'otal	**101719**	**100583**	**98760**	**97955**	**93112**	**89662**	**99038**	**94016**	**92574**	**91147**	**90168**	**88694**	**-12.8**

Source: Basic port Statistics of India 1999-2000

Table 4.6 shows the staff strength of the major ports. From the table, it is very clear that the old ports are over staffed and manpower has decreased at a slower rate when considering the change over from manual system to an automated system. The data indicate that the labour strength is only decreased at a rate of 12.8 percent at the middle of the ninth five-year plan. In many ports, the strength is increased during these periods.

An appreciable step has been taken in the ninth five-year plan period to reduce the staff strength by offering benefits of Voluntary Retirement Scheme (VRS). As is the case with most VRS schemes, the best employable staff utilized this facility to move off and the underutilized staff stayed on with the organization. This has resulted in acute shortage of skilled and experienced operators in certain critical operation departments.

4.4.1.5 Low utilization of facilities provided in ports

Equipment utilization has been low in most categories of equipment. Low productivity is mainly due to operational constraints, such as equipment break down, time spent on service and power failure etc. Over aging of installed equipment is another area of concern. Out of the total fleet strength, 88 percent of wharf cranes, 60 percent of mobile cranes and 31 percent of forklift trucks have crossed their economic life (Baird, [1997]). Port authorities are not taking timely action for the replacement of such equipment due to financial restrictions.

4.4.2 Analysis of Anomalies in strategic planning process for the development of Indian Ports

According to the Report of UNCTAD secretariat [1993], there are two planning activities which closely resemble strategic planning: (1) Corporate planning, which involves the preparation of a multi-year plan to guide a port management's decisions concerning the development of the different business activities of the port, and (2) Market planning, which produces a plan for the type of services to be provided to specify markets and the methods for promoting these services. Strategic planning attempts to bridge the gap by focusing on what the corporation is able to do to meet the requirements of the market. But, there are certain drawbacks seen in the process of preparation of a multi-year plan and its implementation to guide a port management's decisions and the type of services to be provided to specify markets and the methods for promoting these services for the developments of Indian major ports since independence.

4.4.2.1 Plan allocation based on past performance

The plan allocation is done based on the volume of cargo handled in each plan period. The capacity of each port is fixed on the basis of projection cargo for the next plan period. Since the plan allocation is done based on the past performance of each port, the ports like Calcutta, got maximum benefits for future development. A huge plan fund was utilized for the development of this port. The growth of this port is stagnant and the facilities provided in this port are under utilized and the investment made is non- productive. Plan allocation should therefore be based on future potential.

4.4.2.2 Random Port and Hinterland development

Port development and hinterland development are interrelated. The growth of hinterland will improve the development of the ports. Growth in hinterland in the past few decades has been more due to private entrepreneurship than because of government schemes or units. Thus, direct Government control on the process of hinterland development has reduced. However still governmental control over infrastructure facilities for hinterland development such as communication and transport is very important. Many a time, inadequate port facilities lead to shifting of industries to other suitable locations. Coordinated efforts for simultaneous port and hinterland development are yet to be seen.

4.4.2.3 Short fall in spending the plan outlays

The port development schemes are clearly defined in each port during the plan periods. But many schemes are not completed within the targeted period. There has been shortfall in expenditure during the plan periods. A study shows that in almost all ports, the plan outlay utilization is less than 50 percent and a few times it exceeds 100 percent. This is true in the post liberalization periods also. The plan outlays and its utilization of various major ports in India are given in Annexure (A). The main reason for the shortfall in actual expenditure is due to the delay in sanction and implementation of a number of projects. Another reason for the delay in completion of the projects within the targeted period is due to the insufficient budget provision for the implementation of the schemes. Now, many ports like Cochin, and Vishakhapatanam are not financially sound to repay the loans in time. In such cases, the financial support from the central government through the plan allocation is not sufficient to increase their port capacity.

4.4.2.4 Insufficient plan allocation

The plan allocation in the transport sector as a whole is very low and a very insignificant part of it is devoted to ports (Baird, [997]). Table. 4.7 shows the plan outlay of port sector in rupees and percent, and the total plan outlay at the transport sector. More over the share of transport sector in total plan has fallen from 22.10 percent to 13.10 percent during the eighth five-year plan (Ghosh & De, [2001]). It is surprising to note that such a crucial infrastructure sub sector like ports is the worst affected area in terms of both allocation and utilization of development fund during the post liberalization period.

Table 4.7 Plan Outlays of transport sector and port sector (Rs. in Crores)

Sector	Sixth plan (1980-1985)	Seventh plan (1985-90)	Eighth plan (1992-97)	Annual plan (1997-98)	Annual plan (1998-99)	Annual plan (1999-00)
Port (in Rs) In percent	647 (5.36)	1230 (5.43)	3557 (6.34)	1404 (6.79)	1000 (3.93)	1656 (6.11)
Total (in Rs)	12080	22644	56090	20675	25431	27104

4.4.2.5 Absence of effective project wing

The absence of effective research and development affected the progress and growth of Indian ports. The absence of the project wing with suitable manpower and knowledge in modern management systems affected the implementation of planned schemes in time. The modern operations tools are not used in port effectively for planning and implementing the schemes. There is scope for improved control and monitoring the schemes.

4.4.2.6 Absence of Training Department

There is no separate training department in many ports. The training departments those set up with some ports are not functioning properly. Such training departments associated with the ports lack continuous programmes and suitable and sufficient faculty members. In order to overcome these difficulties, Government of India has formed two Autonomous Institutes under the Ministry of Surface Transport- Indian Institute of Port Management (IIPM), Calcutta, and National Institute of Port Management (NIPM), Madras. These Institutions conducted several training programmes every year, but the port authorities are not making use this programmes properly due to the financial, and other constraints. The attendance in the programmes conducted at these institutions is very poor. Due to lack of training to port employees, they are not able to utilize the latest technology developments in their organizations and hence improvement is very slow.

4.4.2.7 Constraints of Cabotage law

A major constraint in the effective utilization of the modern container terminal at Chennai, JNPT, and Cochin port is the Cabotage law, which restricts coastal traffic movements to Indian vessel only. This prevents large foreign container vessels especially of the fourth generation category from using these ports as a base for transshipment of containers. This has resulted not only the under utilization of infrastructure at these ports but also in the diversion of traffic to nearby ports of Colombo and Singapore, depriving the country of foreign exchange earned through container handling operations. The delay in amending this law affected the overall performance of the container terminal operations in India. During the eighth plan period, Indian shipping fleet had hardly any container or cellular vessels, leave alone fourth generation vessels.

4.4.2.8 Lack of coordinated policy

There is an urgent need for a coordinated policy for regulating and encouraging investment from both public and private sector in ports. One may be surprised to note that although the Government of India controls all the major ports, it still does not have a coordinated port policy. It has only some guidelines issued from time to time on ad-hoc basis. Hence there is no doubt that the country needs a commercial revolution in the port industry. But to do these Indian ports need to go through a process of technological development, which demands monetary and fiscal policies, which are no less than revolutionary.

4.4.2.9 Absence of Transshipment terminal in India

Absence of transshipment container terminal in India has seriously affected the growth of Indian ports. At present, container traffic movement takes place through transshipment at Colombo, Dubai or Singapore. The extra transit time and additional cost incurred by Indian shippers are substantial. The cost of excessive ship waiting time in ports due to slow cargo processing in the case of bulk trades are passed on to the ultimate user thereby raising the price of imports unnecessarily and undermining the competitiveness of Indian exports in the international markets. A survey conducted by us among the port users of the Cochin port trust reveals that they will be able to save an average of $150 per TEU if a mother vessel call at the Cochin port (i.e. avoiding the transshipment operation at Colombo).

4.4.2.10 Delay in non-governmental sector participation

Private sector participation is one of the strategies included in the ninth five-year plan. This was with a view to bringing in global technology in port development and operations, it was envisaged to promote tie-up between Indian major ports and suitable foreign state ports like Singapore/Rotterdam etc under a Government-to-Government bilateral assistance programme. This ambitious strategy has not yet seen widespread implementation.

4.4.2.11 Delay in technical up gradation of equipment and systems

In the light of rapid technological changes taking place, in the maritime industry, the three major areas- Vessel Traffic Management System (VTMS), use of computers in container terminal operation and planning, and Electronic Data Interchange (EDI)- where automation was aimed at during the ninth plan. Unfortunately, the implementation of the programme has not progressed as per the target. In Cochin port, EDI utilization and computerization of the container terminal is partial. The VTMS operation is better and hence, the navigation process improved, still the optimum operational efficiency is not achieved. In container terminal operations, the yard planning, gate operation, allocation of equipments etc. are being done manually. The gate operations experience delays many times due to the lack of experienced computer operators attending the shift operations.

4.4.2.12 Bureaucracy

Bureaucracy and red tapism are another issues related to the allocation of outlays with in the time frame. Many times the plan outlay is sanctioned only after the middle of the plan period. The fund allocation is a lengthy process, as a tall hierarchy exits in its organization structure (different ministries at the center and the port trusts) and hence decision-making process is very tedious and time consuming. Port Trusts have only limited power and authority in the process of allocation of plan outlays. Every sanction is obtained from the center. This is a serious issue to be sorted out without delay.

4.4.3 Analysis of Shortcomings in implementation of plan schemes suggested in 9th Five-year Plan

The globalization process during 1991-'92 to 2001-'02 has enhanced the importance of international trade in the hitherto closed economy of India. Hence the government of India has taken several steps to meet the present requirement in the context of globalization of Indian economy in the eighth and ninth five-year plan period. During the ninth five-year plan, it was decided that the port development should keep in pace with the expansion in traffic and changes in the shipping scenario including the size of the ships, specialization and automation etc. Container facilities would need to be augmented at the ports in line with the developments abroad. Mechanical loading and unloading facilities would need to be developed at certain locations to handle the coal requirements of the existing and new power stations which are likely to be commissioned during the ninth five–year plan period. Efforts need to be made to improve the POL handling facilities at the ports by planning in such a way that the completion of tanker discharge/unloading operations is achieved within 24 hours. Night navigation facilities would need attention at all the major ports to improve the turnaround of tankers, other vessels, and berth utilization. Before embarking on any major investments in creation of additional infrastructure facilities, the developments and modernization of existing port facilities should receive priority to improve productivity at ports. Besides, the maintenance of port infrastructure would need to be improved. The port capacity would need to be adequately augmented in view of the projected traffic requirements of the plan period, with larger private sector participation. In order to augment the resource base for the development of ports as envisaged above, there are a number of other steps that must be taken including structural changes in the management of major ports. Some of the important proposals included in the ninth five-year plan schemes to augment the resource base are the following:

- Corporatization of ports
- Joint ventures
- Private sector participation
- Science and Technology and
- Manpower planning

4.4.3.1 Corporatization of ports

The provision of the Major Port Trusts Act 1963 do not allow operation of services by port Trusts on commercial lines. The approval of central government is required in a majority of decisions. Under this restrictive ambit, the ports are unable to operate in a market-oriented economy with flexibility in commercial operation. In order to overcome these difficulties, Government of India has decided to make the structural changes of management of the existing major ports during the 9th five-year plan period. But, the authorities could not initiate the structural changes of management of the existing ports as proposed in the 9th five-year plan period, even though they could set up the 12th major port in India – Ennore Port – under a corporation management. This is mainly due to the lack of political will of the Government and the failure of the authorities to convince the political and the trade union leadership the necessity of the proposed structural changes of the existing major ports.

4.4.3.2 Joint ventures

A scheme for formation of joint ventures between major ports and foreign ports, between a major port and a minor port(s), and between major ports and private companies has been approved. The objective is to attract new technology, introduce better managerial practices, expedite implementation of schemes, foster strategic alliances with minor ports for creation of optimal port infrastructure and enhance the confidence level of the private sector in the funding of ports.

The existing norms of productivity of labour and equipment will be stepped up and manning scales rationalized. Mechanical aids and cargo handling techniques will be introduced. The surplus labour under both cargo handling and non cargo handling categories will be identified, retrained for other trades where feasible and redeployed to the best extent possible for meeting the additional requirement of labour during the ninth plan period. Systematic and well designed training will be imparted to the port personnel to improve their skills and to prepare them for the switch over from conventional general cargo handling operations to more sophisticated container handling and also for bulk handling operations. The training will also be given to management officers to improve their managerial capability. Hence joint ventures in port sector were felt the absolute necessity, and thus Government proposed to implement this scheme during the 9^{th} five-year plan.

Some progress has noticed in the implementation of joint venture schemes in port sector. Authorities have taken initiatives in this regard. As a result, the ports of Nhava-Sheva Terminal in JNPT and Tuticorin are now functioning with the support of two foreign ports namely P&O, Australia and Port of Singapore Authority (PSA) respectively. Ports of Chennai and Vishakhapatanam have already signed MOU for foreign collaborations. More momentum should be created for implementing this scheme in other ports also in order to attract new technology, introduce better managerial practices, expedite implementation of schemes, and enhance the confidence level of the private sector in the funding of ports. Also all efforts should be taken to eliminate the multiplicity of agencies present in commercial cargo handling operations and ensure unified cargo handling labour with complete interchangeability between shore and ship. The start made in this direction at the Mumbai and Cochin ports for the merger of Dock Labour Boards (DLB) with port trust may be continued and extended to other port.

4.4.3.3. Private sector participation

The broad objectives of participation of private sector in port development have been to bring about an improvement in efficiency, productivity and quality of service as well as to usher in competitiveness in the provision of port services. In addition, the private sector is expected to mobilize adequate resources required for capacity augmentation and to introduce the latest technology and improved management techniques in the port sector. The government has already awarded the project for construction, management and maintenance of two berth container terminals on BOT basis at JNPT to a consortium headed by an Australian firm. The cost of the project is around Rs.

700 Crores to be spent in three years. The new terminal will augment the container handling capacity at JNPT to around one million TEUs annually. Other ports are also preparing/implementing projects to augment capacity through private investment. The Government for private participation in the port sector has identified the following areas:

- Leasing out assets of the ports.
- Construction and operation of container terminals, multipurpose cargo berths and specialized cargo berths, warehousing, storage facilities, tank farms, container freight stations, setting up of captive power plants etc
- Leasing of equipment for cargo handling and leasing of floating crafts from the private sector.
- Pilotage
- Captive facilities for port-based industries.

During the ninth plan, with a new view to bringing in global technology in port development and operations, it is envisaged to promote tie-up between Indian major ports and suitable foreign state ports, like Singapore/Rotterdam etc. under a government to government bilateral assistance programme, which would obviate the need to follow the tender route and help in the speedy implementation of various projects in the port sector.

Further, to make the system transparent and streamlined, an independent Tariff Authority for major ports has been set up to deal with tariff matters. The authority will fix and revise the various port charges and the charges to be collected by private providers of port facilities and publish the same from time to time. During the ninth plan, resources to the extent of Rs.8000 crores are likely to be available for development of ports. A major portion of this investment is expected from the private sector. The progress of this proposal seems to be slowly coming up in all major ports in India. This proposal is essential when we examine the financial states of the government and the major ports today.

4.4.3. 4 Science and Technology

In the light of the rapid technological changes taking place in the maritime industry, the three major areas, where automation will be aimed at during the ninth plan. The areas that require automation are as follows:

- Use of Vessel Traffic Management System (VTMS) to facilitate night navigation and help in safe pilotage of vessels at the port channels.
- Use of computer in cargo handling operations as without a well-developed database and computer system to monitor the operations, efficiency in container handling operations cannot be realized.
- Use of Electronic Data Interchange (EDI) for trade related document transactions to enable the ports and the port user community to usher in computer networking.

The progress of the implementation of this proposal during the 9^{th} five-year was examined. The review showed that they could not move too much with this proposal due to various reasons, such as: 1) Lack funds for automation, 2) resistance from the employees for computerization at initial periods, 3) failure of the management in convincing the employees the necessity of computerization, 4) lack of skilled and experienced computer experts in the port sector, 5) absence of Information Technology (IT) department, which were associated with other departments in all major ports etc.

4.4.3.5. Manpower planning

Initially, the handling of cargo in the Indian ports was done manually and was highly labour intensive. This scenario has changed with advent of technological development in the maritime transportation system. The emphasis has shifted towards carriage of goods in larger vessels, and mechanized loading/unloading. The cumulative outcome of all these has been handling a larger quantity of cargo with less number of workers at the Indian ports. The manning scales were evolved over a period of time based on local conditions and other factors that prevailed at individual ports. The existing norms of productivity of labour and equipment can be stepped up and the manning scales rationalized based on a more rationalized categorization of cargos, introduction of mechanical aids, and cargo handling techniques. Innovative efforts, including private sector participation in maintaining and leasing equipment need to be initiated to improve the productivity levels at ports.

The review of the progress of this proposal showed that the authorities have taken steps to reduce the manpower unscientifically. They proposed to reduce the existing manpower with out studying the actual requirements of manpower in each departments of the port. As a result of the implementation of the Voluntary Retirement Schemes (VRS), the skilled and knowledgeable employees utilized this facility to move off and the underutilized employees retained with the organization. This has resulted in acute shortage of skilled and experienced operators in certain critical operation departments.

4.4.4 Strategies recommended for performance improvements of Indian major ports.

Based on the points discussed above, the following strategies are recommended for betterment of Indian ports in the years to come. The implementations of these suggestions are essential to overcome the problems in the context of the liberalization policy of Indian Economy.

4.4.4.1 Corporate Structure

The provisions of the Major Ports Act 1963, didn't allow operations services by the port trusts on commercial lines. The approval of the Central Government is required in a majority of decisions. A corporate structure will impart administrative autonomy, which will directly improve the efficiency and viability of operations. As a corporate entity, Indian major ports would be able to raise resources through equity and debt from the market. Access to institutional finance will be easy since tangible assets will be available for use as collateral joint ventures with foreign ports and private sector will be smoother and more efficient in a corporate framework. Hence necessary steps must be taken to corporatise all Indian major ports as done in Ennore port at Chennai. This will enable ports to have Private sector participation with continuation of plan support from the Government. Under such setup ports can also go in for strategic alliance with minor ports, private sectors partners for joint projects as envisaged in the ninth five-year plan.

4.4.4.2 Project and Monitoring Wing

Professionally manned project wing must be formed in each port for development and implementation of plan schemes. Follow up and feed back systems are necessary for timely implementation of the plan. Proper Planning and monitoring has to be done to complete the projects with in the specified time. The present set up in the major ports is not sufficient to plan and monitor the proposed projects. Project financing has to be improved substantially. The possibility of setting up an agency like Engineers India Limited to take care of port project implementation can also be considered.

4.4.4.3 Training facilities

The training facilities provided at the port are not sufficient. In service training is essential for all operators of handling equipment of container terminals. Some motivation measures are to be taken to promote participation of officials in the training programme.

4.4.4.4 Rationalization of manning scales

The manning scales have evolved over a period of time based on local conditions and other factors that prevailed at individual ports. The existing norms of productivity of labour and equipment must be reviewed and the manning scales rationalized based on a more rationalized categorization of cargo, introduction of mechanical tools and cargo handling techniques.

4.4.4.5 Assessment of Indirect Manpower requirements

The overhead costs of the Indian ports are very high. An analysis revealed that the average overhead cost of Cochin Port is 51 percent for the last 10 years. This is due to high indirect expenditure, a major part of which is salaries and pensions. This has to be contained and reduced.

4.4.4.6 Formation of Information Technology department

A separate information technology (IT) department is to be set up in each port. Persons with the requisite education/training and experience must be recruited at operational levels. The head of the department should have sufficient knowledge in the field of operations management, statistical analysis and computer software and hardware. The IT employees should be capable of designing application software for port applications.

4.4.4.7 Installation of transshipment ports in Indian Sub-Continent

The extra transit time and additional costs incurred by Indian shippers, and installing a new transshipment port in Indian Sub-Continent should prevent the flow of dollars from our country to nearby countries. The location identified in Vallarpadam; Cochin is suitable for the installation of transshipment port. Government of India has taken primary steps to install the port, but due to various reasons its progress is very slow. There are many hurdles yet to be removed. Early completion of the proposed transshipment port will lead to the progress of all Indian ports, especially the growth of Cochin, Chennai, Tuticorin, New Mangalore, and Ennore port in future. Hence, the thrust for the tenth five-year plan should be for the completion of the transshipment port.

4.5 Conclusion

In this chapter, the process of planning and development of Ports in the country was discussed in detail. The process of fund allocation through five-year plans to the port sector was also discussed to understand the formalities involved in this process. The ninth five-year plan that has proposed many development programmes exclusively for port sector in the context of liberalization of Indian economy was reviewed. Various programmes such as corporatization of ports, joint venture and private sector participation in port sector, new developments in science and technology, and manpower planning were discussed. The problems faced by Indian major ports were highlighted. The problems related to planning, operations and plan implementation were discussed. Important suggestions for improvement cover, corporate structure for ports, better finance for projects, establishment of project department, rationalization of manpower both direct and indirect, improved training, and harnessing of IT. Implementation of project to establish a transshipment terminal at Vallarpadam (Cochin), during the tenth five-year plan is recommended.

The fact that Indian major ports are lagging behind, as far as planning and plan implementation is concerned, has been clearly brought out in this chapter. Actions for improvement have to be taken on war footing to make good the damage already done, have been presented.

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CHAPTER-5

OPERATIONAL PROBLEMS OF COCHIN PORT

5.1 Introduction

In this chapter, a brief description of the historical development of Cochin port and the facilities available today are given. Recording of the present operations of the port using flow process chart are done to identify problems related to operations. Work-study techniques have also been used to identify some operational problems. Results of a survey using questionnaire have been analyzed to understand the views and perceptions of port users regarding the operations of Cochin port.

Cochin has a very interesting history. It was here that an ancient colony of Jewish settlers was established and even today there exists in Cochin a small colony of white Jews whose origin is lost in antiquity. In more recent times, the Portuguese Admiral Cabral brought his fleet into the Harbour in 1500. Vasco De Gama also arrived in 1500. One of the first European buildings in India was built near Cochin in 1504. In 1663, Cochin passed from the Portuguese to the Dutch and in 1795 the British took it over from the Dutch.

In the following sections, presents the history and development of Cochin port, organization structure and layout of Cochin port, Natural advantages of Cochin port, present facilities available in the port, followed by process study and analysis.

5.2 History and Development of Cochin Port

Cochin was the seat of the ancient Chera Kingdom. Cranganore, twenty miles north of the modern port of Cochin was an important port of India, even in the Pre-Christian era. This port was known as "Muziris" to Ptolemy and other ancient writers. This historical port naturally attracted the sea-faring nations from Europe to the East and the first European settlement in India was here.

In 1340 a severe flood in the river Periyar brought enormous quantity of silt and blocked the passage to Muziris Port, situated in the mouth of the Periyar. The Muziris harbour was silted up and therefore it lost its importance as a port. This flood also opened up a channel on which Cochin Port is located.

Cochin port's modern history started with the advent of the Portuguese more than 500 years back. The Portuguese built their fort in Cochin in 1503. They operated from Cochin to gain and retain control over the Arabian Sea and the Indian coastal ports. It remained the headquarters and main port of the Portuguese till 1530 when they made Goa as the capital of their settlements in India and East Indies. In 1658 a dissatisfied section of the family of Raja of Cochin sought Dutch help for his ascendancy to the throne. In 1963, the Dutch defeated the Portuguese and gained control over Cochin. They lorded over Cochin till 1795, when the British attacked Fort Cochin and captured it. The efforts in gaining mastery over Cochin were for monopolizing the pepper producing areas surrounding Cochin and for control of trade and commerce through the Port of Cochin.

The development of Cochin into a modern port is a romance of work and vision. It could not until three decades back take its rightful place as a modern deep-sea port because of rock-like barrier of sand, which blocked the approach to the port from the sea. For centuries the Harbour was only a roadstead and boats and lighters took cargo to ocean-going steamers waiting outside and brought back rice, the principal import and other goods. For more than a hundred years, there were proposals of developing the port by cutting a deep channel for ships to enter and come inside. Probably no dredging proposition since the days of the Suez Canal project had aroused so much technical interest as the opening up of the Cochin harbour. For seventy years one engineer after another discussed the process, but there was no agreed solution. At last what the first thought was an illusory dream was brought within the realms of reasonable hope.

After many daring experiments and surveys the cutting of an approach channel from the deep sea across the bar to the harbour was accomplished. The work was made possible by using a suction dredger "Lord Willingdon" with pipeline. The performance of this dredger had created a world record for speed, low cost and continuity of work. In three working seasons, by 1926, the approach channel, 450 feet wide and three and a half miles long was cut across the bar, connecting the Harbour mouth with the deep sea. During 1930-'31 the port was thrown open for vessels up to 30 feet draft.

Then began the conversion of the Harbour into a Major Port. This development was done in four stages. The first stage consisted of all preliminary works of investigative nature before 1920 when Mr. Bristow (later Sir. Robert Bristow), the pioneer architect of the Port was appointed for development of the Harbour. The second stage consisted mainly of foreshore protection, a part of the reclamation wall and the experimental dredging inside and outside, which cost 0.9 million. The third stage consisted of the major dredging operations inside and outside the moorings, a few residences, a large area of reclamation and a dry dock. Of this reclamation of about 780 acres in area across Willingdon Island is the nerve center of port activities. It cost about Rs. 7.9 million. The fourth stage included all works necessary to convert Cochin into a first class modern port, like the provision of bridges, wharves, quay berths, cranes, ware houses, transit sheds, offices, a reserve light and power plants, residences, port railway, water supply and a number of small works. Its cost came to nearly Rs. 11.7 million.

In 1936, Cochin Port was declared as a Major Port and the Government of India took direct control of its administration. The end of 1939 saw completion at the provisions of facilities of a first class terminal port. The first ship came along the new wharf on 2nd June 1939.

At first the port started with 2 wharf berths and due to the intervention of the Second World War, improvements had to be temporarily kept in abeyance. However, one more berth was added during the war period. As part of the Post-War Development Scheme, the wharf was extended by another berth. By 1951, the port had four berths capable of accommodating four vessels of 450 feet in length in addition to the Boat, Train Pier that was meant for passenger ships and as a coal berth. 13 stream moorings were constructed in the Mattanchery Channel in the Western side and three stream moorings were built in the Ernakulam channel in the eastern side. The stream moorings in the Ernakulam channel were mainly intended for use of oil tankers and the rest for steamers carrying general cargo.

It is at this stage of development that the National Five Year Plans work at the port commenced. Plans and schemes were developed during each plan period based on the cargo handled during the previous plan period.

The Indian seaports entered the containerized era by receiving the first containership in Cochin port in 1973. Ever since, the containerized traffic of the port has been steadily increasing. Quays 8 and 9 of the Ernakulam Wharf have been developed into a container-handling terminal with modern equipment

5.3 Organization Structure

A Board of Trustees constituted by the Government of India manages Cochin port. The Board of Trustees consist of a Chairman from Indian Administrative Services, a Deputy Chairman from the port and representatives of the Government of Kerala, Ministry of Surface Transport, Customs department, Defense Service, Indian Railways, Marine products Exports Development Authority, Kochi Refineries Limited, Indian National Ship Owner's Association, Cochin Chamber of Commerce and Industry, Indian Chamber of Commerce and Industry, South Western India Shipper's Association and labour union leaders.

The organizational set up of the port as on 31-03-2001 is shown in Fig. 5.1. This figure shows only the top-level management structure of the port. There are nine departments in Cochin port. Engineering (Mechanical), Traffic and Marine departments are the three important operations departments of Cochin port. All other departments are supporting departments for the operations departments for the efficient functioning of Cochin Port. The operations of equipment for handling cargo including container handling, maintenance of these equipment, and functions of the workshop and dock systems are under the control of mechanical engineering department. All wharves related operations are controlled by the traffic department. Ship related operations, dredging operation, fire and safety operations, conservation of backwater and land are under the control of Deputy conservator in the Marine department.

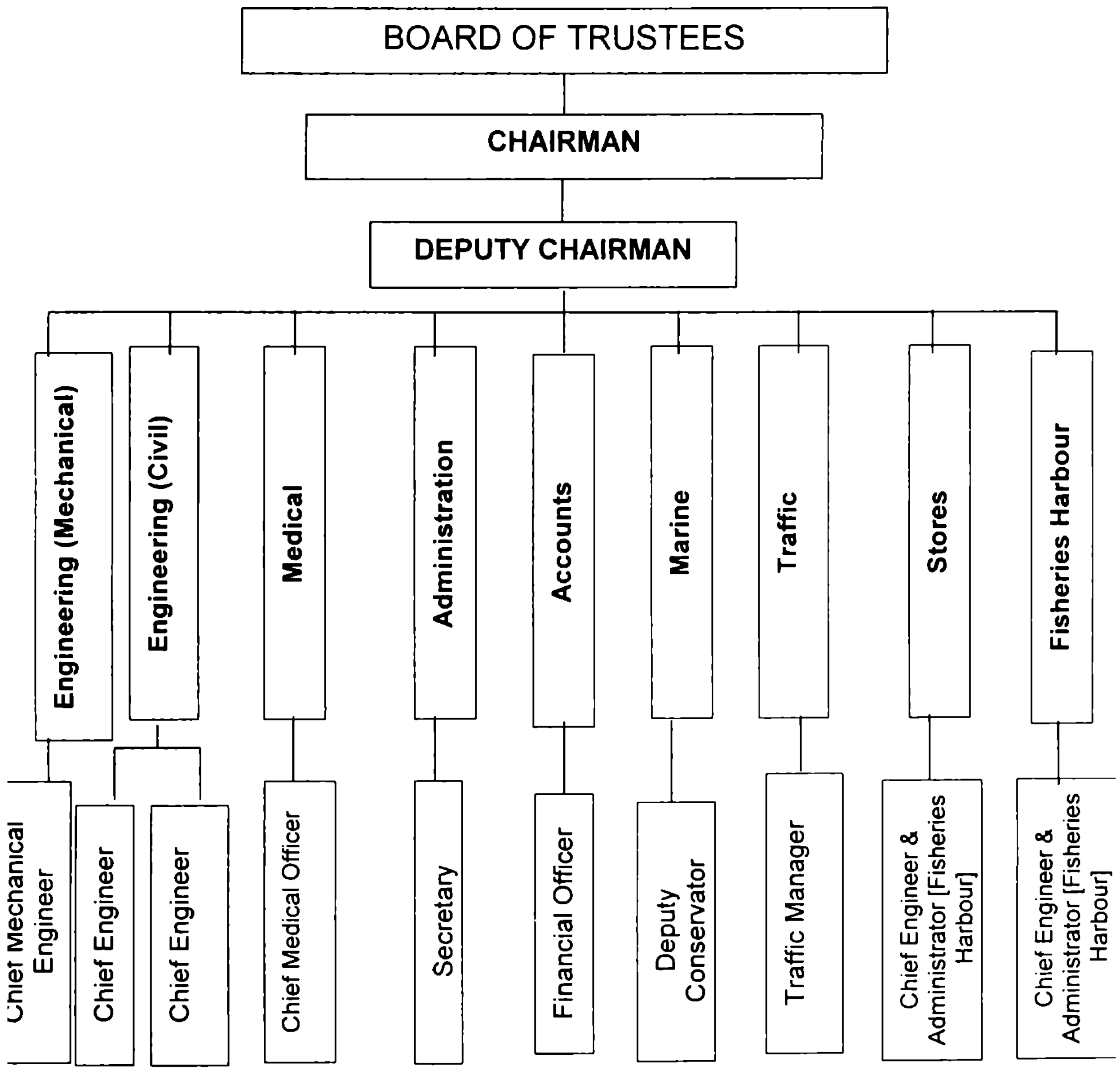

Figure 5.1 Organization Chart of Cochin Port

The total staff strength as on 31-03-2001 was 6328. . The following Table.5.1 shows the staff strength of various departments on 31-03-2001.

Table 5.1 Staff Strength of Cochin Port as on 31-03-2001.

Departments	Class I	Class II	Class III	Class IV	Total Staff Strength
1. Administration	14	12	153	69	248
2. Accounts	14	25	294	19	352
3. Traffic	18	39	1473	56	1586
4. Medical	16	2	157	144	319
5. Marine	47	11	609	385	1052
6. Civil Engg.	29	16	442	372	859
7. Mechanical Engg.	25	29	1225	495	1774
8. Stores	2	5	52	19	78
9.Fisheries Harbour	2	3	41	14	60
TOTAL	**167**	**142**	**4446**	**1573**	**6328**

The Table 5.1 reveals that the Mechanical Engineering Department has the highest staff strength followed by the Traffic Departments. Of the 6328 staff, 4446 are class III staff and 1573 are class IV workers including shore labourers.

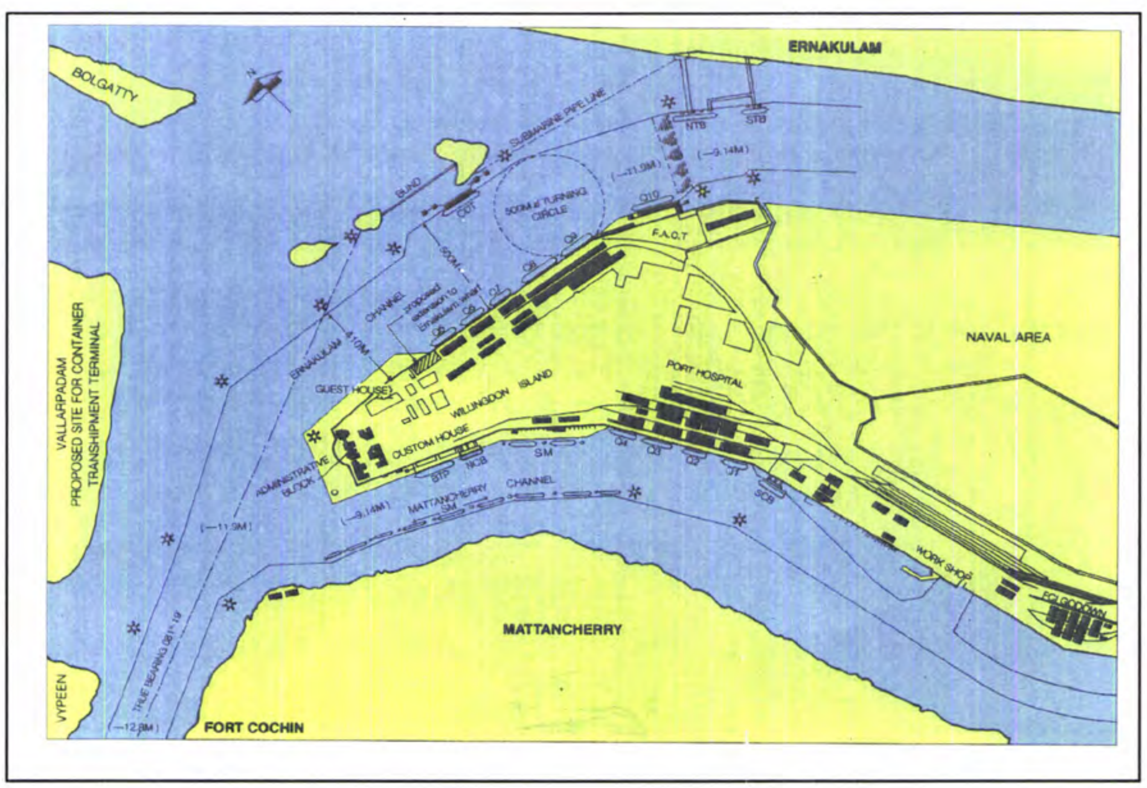

Figure 5.2 Layout of Cochin Port

5.4 Layout of Cochin Port

Port of Cochin is located on the Willington Island at latitude 9^0 58' north longitudes, 76^0 14' east on the south west coast on India about 930 KM south of Mumbai and 320 KM north of Kanyakumari. The layout plan of Cochin Port is shown in Figure. 5.2.

5.5 Natural Advantages of Cochin Port

In view of its beautiful scenic background and the lagoons and backwaters surrounding it, Cochin has been rightly called the "Queen of the Arabian sea". The port comprises all the water area in the sea and the backwaters bounded on the north by 10 degrees north latitude which is 2 miles north of Harbour entrance, on the east by the Ernakulam foreshore and on the south by a parallel of latitude about 3 miles south of the entrance, extending on the western side up to the fairway buoy. It includes the Willingdon Island, which has been reclaimed from the backwater and where the deep-water wharves are situated. The Harbour entrance between Cochin and Vypeen is 440 yards wide and gives access to about 125 sq-miles of navigable backwater. The Vypeen foreshore on the north side and the Cochin foreshore on the south side of the entrance form natural backwaters, Vessels can lie comfortably in the Harbour and carry on landing and shipping operations even in the monsoon weather.

The modern port of Cochin is lying on the direct route to Australia and the Far East from Europe. It is open for deepwater traffic in the worst monsoons and provides a splendid anchorage at all times of the year. Any ship having up to 30 ft. draft can enter the port even in the roughest weather. It serves a vast hinterland of industrial and planting areas comprising the states of Kerala, Tamilnadu, Andhra Pradesh, and Karnataka. Foreign and coastal steamers touch the port regularly. It is connected by railway to all-important cities of the country. It is also linked by airlines to Bombay, Bangalore and Chennai. The route to the port forms part of the National Highways leading to the planting districts of

Anamalais and to the planting areas and rich forest tracts of the High Range Hills of Travancore.

5.6 Present Facilities

Cochin port is an all weather port. A draft of 35 feet is maintained in the Ernakulam Channel along with berthing facilities, which enable the port to bring in larger vessels to the port. In the Mattanchery Channel a draft of 30 feet is maintained. The port provides round the clock pilotage to ships subject to certain restrictions on the size and the draft of the vessels. There is a network of railways, roads, waterways, and airways, connecting the port with the hinterland centers spread over the state of Kerala, Tamilnadu and Karnataka. Facilities for supply of water and bunkering to vessels are also available. The facilities available at Cochin port are given in the following sections. The berths available in the ports are classified in to four categories according to the type of cargo handled, which are as follows.

1. Dry Bulk Cargo Handling Berths
2. Liquid Cargo Handling Berths (Oil Berths)
3. Container Handling Berths and
4. Fertilizer Handling Berths.

A brief description of all these berths is given in the following sections.

5.6.1 Dry bulk Handling Berths

There are seven berths available in Cochin to handle dry bulk cargo. Quays Q_1, Q_2. Q_3 and Q_4 are four berths located at the Mattanchery Wharf. Coal and Cement are the two major cargoes handled in this wharf. Other three quays Q_5, Q_6, and Q_7 are located at Ernakulam Wharf. The passenger ship berths at Q_6 and/or Q_7. When the frequency of container ships are more, then some container ships also berthed at Q_6 and/or Q_7 depending up on the availability of Quays.

5.6.2 Liquid Cargo Handling Berths (Oil berths)

The North Tanker Berth (NTB) and the South Tanker Berth (STB) are two old berths located on the foreside of the Ernakulam channel to bring crude oil, the raw material of Kochi Refinery Limited and export of their products. As the capacity of the refinery increased, this facility became inadequate to meet the requirements. Hence the port expanded its capacity by creating a new terminal in 1984 in Ernakulam channel, known as Cochin Oil Terminal (COT) to accommodate tankers up to 1,15,000 DWT. Now this terminal is used to discharge the crude oil from tanker to the storage tanks provided at the Kochi refinery site. This sophisticated terminal constructed to service the increased traffic in crude oil and refined petroleum products consequent on the expansion of the refining capacity of Kochi Refinery has an optimum capacity of 7.5 MMT per annum.

5.6.3 Container Handling Berths

Quays 8 and 9 (Q_8 & Q_9) of the Ernakulam Wharf have been developed into a container-handling terminal with modern equipments. In addition to this, the berths have been deepened for providing a draught of 10.7 meters. At present the terminal (stevedoring) operations are undertaken by private stevedores on behalf of Shipping Agents. The Container Terminal (CT) of Cochin Port has a handling capacity of 1,00,000 TEUs per annum.

5.6.4 Fertilizer Handling Berths

The fertilizer berth (Q_{10}) located in the Ernakulam wharf, is a facility created to cater to the increased import requirements of fertilizer raw materials. The mechanical un-loader erected at this berth by the Fertilizers And Chemicals Travancore Limited (FACT) is in full operation. The fast mechanical un-loader at the berth is capable of discharging at the rate of 600 tons per hour thereby helping to reduce the turnaround time of fertilizer vessels at the port.

Table 5.2 Berthing Facilities of Cochin Port

SL. No.	Particulars	No	Specifications	Location	Remarks
1	**Wharves** Mattanchery Wharf Ernakulam Wharf	1 1	Length: 670.50 m Draft: 9.14 m Length: 917 m Draft: 10.67 m	Western side of the Island. Eastern side of the Island.	No. Of along side sheded berths: 7 Nos
2	**Fertilizer Berth**	1	Length: 207 m Draft: 10.67 m	Ernakulam Wharf	Handling Rav materials of FACT
3	**Coal Berth** North Coal Berth	1	Length: 182.88 m Draft: 8.5m	Mattanchery Wharf	--
	South Coal Berth	1	Length: 192.02 m Draft: 8.5m	Mattanchery Wharf	
4	**Boat Train Pier**	1	Length: 182.88 m Draft: 9.14 m	Mattanchery Wharf	--
5	**Tanker Berths** North Tanker Berth (NTB)	**3** 1	Length: Ships up to 231.36 m Draft: 9.14 m	Eastern side of Ernakulam Wharf	Accommodat ship size of 30,000 DWT
	South Tanker Berth (STB)	1	Length: Ships up to 198 m Draft: 9.14 m	Eastern side of Ernakulam Wharf	Accommodat ship size of 18,000 DWT
	Cochin Oil Terminal (COT)	1	Draft: 11.7 m	Eastern side of Ernakulam Wharf	Accommodat ship size of 115000 DWT
6	**Stream Moorings**	**11**	Length: 60.96 m to 171.21 m Draft: 4.57 m to 9.14 m	Mattanchery Wharf	--
7	**Low Wharf & Shallow Wharf**	**2**	--	Mattanchery Wharf & Fort Cochin respectively	Meant for lighters and sailing vessel

Table. 5.3 Storage Facilities available at Cochin Port.

Location	Particulars	No. Of Sheds	Area Available (m^2)
I. Mattanchery Wharf	1. Ware Houses	4	12237
	2.Overflow sheds	5	9429
	3.Transit sheds	4	17463
	4.Hazardous sheds	2	205
	TOTAL	**15**	**39334**
II. Ernakulam Wharf	1.Warehouses	3	7272
	2.Warehouses at EDC	1	540
	3.Overflow Sheds	2	3156
	4.Transit Sheds	3	10800
	5.Hazardous Sheds	1	103
	6.Carbide Sheds	1	61
	TOTAL	**11**	**21932**
III. Fort Cochin Low Wharf	1.Warehouses	1	223
	2.Hazardous Shed	1	61
	3.Transit Sheds	3	1750
	TOTAL	**5**	**2034**
IV. Container Freight Station	1.Storage shed	1	10000
Grand Total		**32**	**73300**

Table 5.4 Cargo Handling Facilities at Cochin Port

SL. No.	Particulars	No	Specifications	Remarks
I. Rajiv Gandhi Container Terminal (RGCT)				
1	Berths Q_8 & Q_9	2	Length: 414.10 m Draft: 10.70 m	1.Container ships also handled at Q_6 & Q_7
2	Container Stacking Area	--	Area: 6.5 hectares.	
3	Container Parking Yard	--	936 ground slots.	2. Adequate lighting with average illumination level of 20 LUX
4	ICD Yard	--	90 slots for containers and 438 slots for empty containers.	
5	Plug Points	111	440 volts for 96 plugs and 208 volts for 15 plugs	
II. Equipment Available for Container Handling				
1	Transfer Cranes	5@	35.5. Tons	@ One transfer crane is on BOT basis
2	Gantry Cranes	2	40 Tons	* For handling trailer chassis
3	Reach Stackers	2	40 Tons	
4	Heavy Duty Tractors*	22	--	
5	Fork Lift Trucks	25	3 Tons	** For handling MT Container
6	Reach Stackers**	2	8 Tons	
7	Heavy Duty Top Lift Trucks***	4	25 to 35 Tons	
8	Light Duty Top Lift Trucks****	2	5 Tons	*** Lifting loaded containers
9	Heavy Duty Mobile Crane	3	--	
10	Spreaders	3	40' Containers	
11	Spreaders	3	20' Containers	
12	Trailer Chassis	9	20'	**** Lifting MT containers
13	Trailer Chassis	26	40'	
III. Equipment Available for cargo handling other than container cargo				
1	Electric Wharf Cranes	14	3 to 10 Tons	1.Available in Q_1 to Q_7 berths.
2	Mobile Cranes	7		2.Electric Wharf Cranes include light And heavy duty and Grab cranes
3	Fork Lift Trucks	22		
4	Heavy Duty Tractors	7		
5	Reach Stackers	2		
IV. Flotilla				
1	Tugs for Shipping	4		
2	Grab Hopper Dredger	2		
3	Excavator	1		
4	Dump Hopper Barge	1		
5	Pilot Launches	2		
6	Mooring Launches	5		
7	Other Tugs/Launches	14		
8	Fire Float	1		
9	Floating Crane	1		

The list and specifications of the facilities available in Cochin port are shown in the Tables 5.2, 5.3 and 5.4.

5.7 Process Study and Analysis

When a ship arrives at the outer sea, the pilot from the port receives the ship at the outer sea and brings it in the assigned berth. The berth allocation is done at the berth committee meeting chaired by Traffic Manager. The representatives of the steamer agents and Port officials will be present in the berthing committee meeting. When the ship reaches the berth, it has to moor at the quay. Now unloading and loading of cargo from/to ship will be done with the help of cranes. Unloading and loading processes are done based on a plan prepared in advance. The unloaded cargo has to be transported to its storage space provided in the port premises. The export cargo has to be transported from the storage space to the hook point to load it into the ship. After completion of the unloading/loading of cargo, the ship has to be un-berthed from quay and the pilot will accompany the ship up to the outer sea. The processes at the port premise are schematically shown in Figure 5.3. In each operation, many decisions have to be taken at operational and tactical levels.

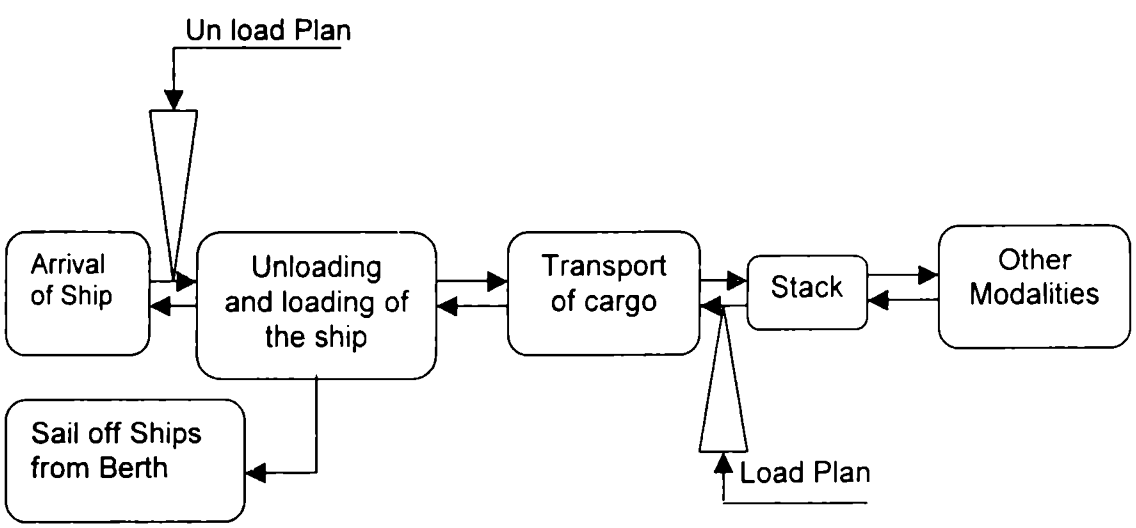

Figure 5.3 Processes at a port

Depending up on the type of cargo handled, the operations of Cochin Port can be mainly classified in to three groups such as:

- Container Cargo Operations
- Liquid Bulk cargo operations
- Solid Bulk Cargo operations

Again the operations of Cochin port can be classified according to the berth used in the port such as:

- Container Terminal Operations (Q8 and Q9)
- Oil Terminal Operations (COT, NTB and STB)
- Other Terminal Operations (Q1 to Q7 and Q10)

Systematic studies of all these operations were done by making the Flow Process Charts. Some operational bottlenecks were also identified using the flow process charts. Each operation was divided in to small elements of operations. The container terminal operations are divided in to following small elements processes.

- Berthing of Ships at Container Terminal
- Receiving loaded containers for export
- Containers arriving by rail for export
- Reefer Containers for export
- Loading of export containers to ships
- Discharging of import containers from ship
- Temporary landing/loading of containers from/to ships
- Planning and Execution of ship work
- Export containers – planning and stacking at reach stacker yard
- Receiving empty containers (MT Containers) for export
- Handling of export cargo/cargo for stuffing
- Un-berthing of ships from Container Terminal.

The liquid bulk cargo operation procedure has been explained in chapter 7 with the help of a block diagram. The solid bulk cargo operations are also divided in to sub processes such as:

- Berthing of ships

- Planning and execution of ship work
- Handling of bulk cargo at the wharves
- Handling of import (General Cargo) and cargo de-stuffed from containers.
- Un-berthing of ships

The berthing and un-berthing operations are same irrespective of the different type of cargo operations. The flow process diagrams were drawn for all process to make a detailed study of the procedure and operations of port. Important issues related to the operations were also noted on the flow diagram. The flow diagrams are self-explanatory and hence its procedures are not explained in detail. The flow process diagrams drawn for all sub processes listed above and have been shown in Annexure (B).

Various operational delays identified in process study using flow charts are: 1) Delay in bringing the ships in to the berth, 2) delay in registration of loaded containers for export, 3) delay in stacking of loaded containers at parking yard due to want of unloading equipment, 4) delay in getting the gate pass, 5) delay in off-loading the containers in the rail track, 6) delay in off-loading the reefer containers from truck, 7) waiting for loading of export containers to ships, 8) delay in execution of ship work after berthing, 9) delay in starting the unloading of containers from ships,10) delay in removal of cargo at wharf, 11) delay in getting the containers from CFS for loading to the ships, 12) cargo waiting for loading in vehicle, 13) delay in un-berthing the ships after completing the ship work, and 14) waiting of ship at Fair Way.

Physical movements and operations related to cargo for both import and export are related to processing of documents and paper work. The delays in paper work therefore have adverse impact of movement of cargo.

5.8 Port Users Survey

The perceptions of various port users are important in understanding the operational problems of ports. As a service industry, the port has to market its customers in tune with the modern marketing concepts, customer needs have to be met effectively and efficiently. Customer satisfaction has a crucial role in the existence of an organization in the present competitive world. Therefore, it should be the management's endeavor to bridge the performance gaps by understanding the needs of its customers. Survey using questionnaire is a tool in practice to understand the views and perceptions of port users regarding the operations of port.

Port acts as a facilitator and provides services to their users. By port users, we mean those agents who come in to direct contact with port for availing various services provided by the port and then contributing revenue. Port users can be classified according to their functions and operations, namely shipping agents/steamer agents, Customs House Agents (CHA)/ Clearing and Forwarding Agents (C & F Agents), Stevedores, Main Line Operators (MLO), Shippers (Exporters and Importers) etc. Table 5.5 shows the functions of port users. According to the ship schedule, the shipper will prepare their cargo for export. The shipper will contact their CHA/ C&F agents to collect the cargo and they will receive the cargo and keep it in the port premises after completing all port and customs formalities. Shipping agents will prepare the load plan and send the copy to port authority. The stevedores will load the cargo in to the ship according to load plan. The port provides necessary facilities, for handling cargo inside the port premises.

Table 5.5 Functions of port users

Sl.No.	Name of Port Users	Functions of port users
1	Steamer Agents	Responsible for bringing the ships to the port for loading and/or unloading cargo
2	Customs House Agents or (CHA)/ C&F Agents	Responsible for transferring cargo from port premises to their importers and transferring cargo from exporters to the port premises.
3	Stevedores	Terminal operators at the port and loading and unloading of cargo from/ to the ship.
4	Main Line Operators (MLO)	Agents of a particular line, and not the agent of vessels
5	Shippers	The actual custodian of the cargo. Exporters export their cargo to his customer and Importers import the cargo from their supplier.

5.8.1 Objectives of Port Users Survey

The objectives of this survey were as follows.

- To understand the perceptions of the users of Cochin port regarding the operations and the performance of the port.
- To identify the critical operation problems of the port.
- To collect suggestions for improving the performance of the existing system.
- To recommend strategies for implementation on the basis of data and information collected from the port users.

5.8.2 Preparation of questionnaire

Prior to the preparation of questionnaire, discussions were held with selected officers in middle and operation level managements to understand the various operations of port. Discussions were also held with a few port users from each category. Office bearers of the associations like Cochin Steamer Agents Association (CSAA), the Cochin Customer House Agents Association (CCHAA), and Cochin Chamber of Commerce were also interviewed with a view to gather information relating to operation of Cochin port and problems faced. Using the information collected from interviews and discussions with port users and port officers, a questionnaire was framed. The questionnaire contained two parts viz. part A and part B. Part A was exclusively prepared for CHA/C&F agents, to identify the problems with the procedure and documentation formalities of port operations. Part B was again subdivided in to three groups viz. the container terminal operations, cargo operations at Ernakulam/Mattanchery wharves, and general questions related to Cochin port operation. The objective of part B was to identify the problems of container terminal operations; issues related to cargo operations at Ernakulam and Mattanchery wharves; and the general operation problems of the port based on the perceptions of different types of port users. Many questions were objective type with multiple choices of answers. The respondents were asked to rank the listed responses according to importance.

The respondents were also given choice to add relevant points to answers to each question, if necessary.

After preparing the draft of the questionnaire, it was sent to a small sample of port users to test the questionnaire. It was noted during test survey that most port users were worried more about container related operations since this was a growing segment of business. Thus more responses and suggestions were obtained relating to this area. The final questionnaire was modified accordingly to give more thrust to container terminal operations. The sample of the final questionnaire is given in Annexure (C).

5.8.3 Survey

This part of the study rests on the foundations of a customer survey designed to gather information from the port users about the services provided by the port. The port user's views were used to understand the critical operational problems of Cochin port. For the purpose of survey, responses from 64 users of various categories as shown in Table 5.6 were collected. There are about 229 port users registered with the port. Out of the 229 registered port users, there is only 93 active port users have regular business with Cochin port. Category wise, the number of registered port users and active port users is also shown in Table 5.6.

Table 5.6 Category of port users participated in the survey

Sl. No.	Category of port users	No. Of Respondents	No. Of Registered Port Users With Cochin Port	No. Of Active Port Users With Cochin Port
1	Shipping agents	24	76	40
2	CHA/C&F agents	21	127	35
3	Main Line operators	7	16	10
4	Stevedores	8	10	8
5	Shippers	4	--	--
Total		**64**	**229**	**93**

The profile of port users, who participated in the questionnaire survey based on the duration of business experience, is shown in Table 5.7

Table 5.7 Category of port users based on business experiences with Cochin port

Category	Duration of business experience	No of respondents
A	< 2 years	1
B	2 to 5 years	3
C	5 to 10 years	5
D	> 10 years	33
	Total	**42**

In Table 5.8, shows the multi port experience profile of the respondents. This clearly indicates the capability of the respondents to compare the performance of Cochin port with other ports in India.

Table 5.8 Port users of Cochin port have business with other ports of India.

Sl.No.	Name of ports	No. of organizations having business
1	Tuticorin	27
2	Chennai	26
3	New Mangalore	15
4	Vizak	16
5	Kandla	12
6	Mumbai	16
7	Calcutta	13
8	Mormugoa	13
9	Nava Sheva	12
10	Haldia	11

The questionnaire was designed to collect responses in the following category of operational problems, which came to light in the test survey.

- Equipment related problems.
- Procedure and Documentation problems.
- Container handling problems in container terminal.
- Cargo handling problems in Ernakulam/Mattanchery wharves.
- Other general problems of Cochin port.

5.8.4 Results from analysis of the survey responses

The analysis of the survey responses was done after the scrutiny and tabulation of the responses received from the port users. The tabulated data are shown in Annexure (D), in which the response ratings are plotted in graphs. From the graph, the gravity of the problems was found out and it was known how much one factor was deviating from other factors of the same problem. From the data collected, the problems are classified in to various groups as mentioned in the section above. The critical problems in each group were identified by use of Parato analysis. The suggestions of the port users to improve the existing operational performances are also studied to determine the most common ones. The critical problems are discussed with management experts in and outside the port and strategies were formulated for improving the operational problems of Cochin port.

5.8.4.1 Equipment related problems

From the data collected from the respondents, it was seen that the technical problems of equipment are very serious resulting in the poor performance of container terminal operations. The reasons in decreasing order of importance for poor equipment performance are given in Table 5.9.

Table 5.9 Reasons for poor performance of equipment in container terminal

Sl.No.	Reasons for poor performance of equipment	Criticality of the reasons
1	Outdated equipment	Critical
2	Insufficient equipment	Critical
3	Operators efficiency and lack of training	Important
4	Improper maintenance plan	Important
5	Improper planning of containers in the yard	Less important

5.8.4.2 Procedural and documentation related problems

75 percent of the port users of Cochin opined that the procedures and documentation formalities are more cumbersome when compared with other ports in India. The problems in this class are:

- Procedural problems in filing of shipping bill.
- Problems in filing of Export/ Import Applications (EA/IA).
- Problems in customs procedure and documentation.

The major difficulties that are faced in each of the above areas are given in the following Tables 5.10,5.11, and 5.12.

Table 5.10 Procedural problems in filing of shipping bills

Sl.No.	Reasons/Difficulties	Criticality of the reasons
1	No strict time schedule to the staff	Critical
2	Lack of control over the staff	Critical
3	No work target to the office staff	Important
4	No follow up from the officers	Important
5	Lack of training to employees of the CHA	Less important

Table 5.11 Procedural problems in filing of EA/IA

Sl.No.	Reasons/Difficulties	Criticality of the reasons
1	No strict time schedule for employees at EDC	Critical
2	Too much procedure	Critical
3	Bureaucratic approach at office	Important
4	Inefficiency of staff in the section	Important
5	Delay in collecting port charges	Important
6	Lack of coordination between EDC & CCHA	Less important

Table 5.12 Problems in customs procedure and formalities

Sl.No.	Reasons/Difficulties	Criticality of the reasons
1	Too many steps in documentation	Critical
2	Officers seated at different places	Critical
3	Lack of computers and printers	Critical
4	Poor coordination between port and customs	Important
5	Duplication and repetition in procedures	Less important
6	Lack of delegation of powers	Less important
7	Repetition in inspection process	Less important

5.8.4. 3 Container handling problems in Container Terminal

According to the opinion and views of port users, the performance of stuffing operation at the container terminal is better when compared with other container terminals of major ports in India. The port charges and rates are also reasonable in Cochin port. But the services from equipment and labour, and port procedure and documentation are very poor. Storage facility at the container terminal is comparatively good and delays in ship operation are less when compared with the operational parameters of other container terminal in India. Many factors are responsible for low performance of the operations at RGCT, which are shown in Table 5.13.

Table 5.13 Factors responsible for low performance of Container Terminal

Sl.No.	Responsible Factors	Criticality of the reasons
1	Technical problems of equipment	Critical
2	Labour related	Important
3	Poor planning at container yard	Important
4	Management lapses	Important
5	Trade union attitude	Important
6	External factors	Less important

The weights given for each factor is shown in Figure 5.4. From the graph, it is seen that the technical problems of equipment (1) are very crucial, and so need immediate attention. The next four factors (2,3,4 &5) are important, which also require necessary improvements. The external factors (6) have only less influence on the performance of container terminal operations.

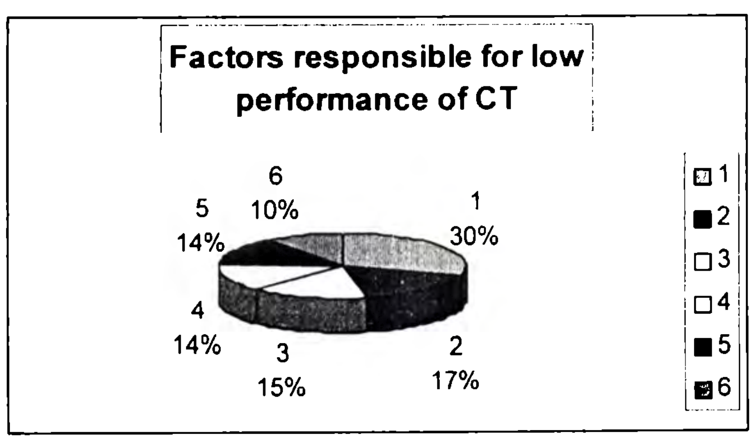

Fig.5.4 Factors responsible for low performance of CT operations

The response of the port users to the question asking them to rank the performance of different container terminals of major ports gave the result shown in Table 5.14 below.

Table 5.14 Comparative performance of Container Terminal Operations in India

Sl.No.	Name of Port	Weightage given	Rank Position
1	JNPT (NSICT)	631	First
2	TUTICORIN	630	Second
3	CHENNAI	442	Third
4	JNPT (GOVT. TERMINAL)	411	Fourth
5	RGCT, COCHIN	345	Fifth
6	MANGALORE	186	Sixth

The reasons for high turn around time of vessels that called at the container terminal were studied from the responses of the port users. The most critical reason is related to the performance of the equipment in CT. Poor planning of containers at the stacking yard, poor labour productivity, and customs related problems are equally responsible for the high turn round time. The other reasons are ship related problems, General Purpose Mazdoor (GPM) related delays, and pilotage related delays, which have less influence on the turn round time of vessels calling at CT.

The problems in handling of reefer containers at CT were studied. Poor supervision, frequent power failure, and insufficient number of plug points and equipment are the critical issues now faced in handling and storage of reefer containers. Uneven surface of the reefer container yard affected the life of the sophisticated instruments of the container on many occasions.

Poor implementation of computers and frequent changes of its operators at the gate office resulted delays in getting the Equipment Interchange Report (EIR).

5.8.4.4 Cargo handling problems in Ernakulam/Mattanchery wharves

The responses regarding the high turn round time of ships calling at E/M wharves are analyzed. Table 5.15 shows different reasons for high turn around time of ships, according to the weights given by the respondents to the factors.

Sl.No.	Responsible Factors	Criticality of the reasons
1	Poor performance of equipments	Critical
2	Poor performance of GPM gang	Important
3	Insufficient storage facilities	Important
4	Customs related issues	Important
5	Ship related problems	Less important
6	Pilotage problems	Less important

The reasons for poor performance of equipment are discussed above. According to the views of port users, the reasons of pilotage problems are: 1) restrictions in full night pilotage; 2) draft restrictions; 3) Availability of pilot, tugs, mooring boats, and crews; 4) tide restriction; and 5) monsoon weather.

Table 5.16 General problems of port operations and the percentage respondents.

Sl.No	General Problems.	% Of Respondents
1	Business through Cochin port is expensive when compared with other major ports in India	96
2	Cochin port could not compete effectively with the port of Colombo as a transshipment port with the existing facilities	92
3	Cochin port shall function as a transshipment center in Indian subcontinent	89
4	Port's performance should improve if the port brings under the Companies Act	82
5	Convenience of Filing of shipping bill using Computers rather than manual system	78
6	Unsatisfied GPM operation at the Container terminal of Cochin port	71
7	Stevedoring charges, hiring charges of equipment, pilotage charges, bribes, ground rent, and charges outside ports are very high or high	67
8	Satisfaction with gate operation at CPT	66
9	Inconvenience due to the terminal operations controlled by three departments viz. Mechanical, traffic, and the finance departments	56
10	Satisfied with the existing storage facilities in the E/W wharves	50
11	"Cut Off Time" provided at Cochin port is necessary	44

5.8.4. 5 General problems of Cochin port

The problems that are not discussed so far are included in this section. There are many other bottlenecks in the smooth functioning of Cochin Port, according to the views of the port users. The important issues are studied and are listed in Table 5.16.

5.8.5. Summary Analysis of Problems from Survey Responses

The summary grouping of various categories of problems from survey responses is given in the following Table 5.17.

Table 5.17 Summary Analysis of Problems from Survey Responses

Category of Problems	No. Of Problems
1.Facility Design and Installation	1.Out dated/Insufficient equipment 2.Improper yard planning 3. Insufficient storage facilities 4.Insufficient number of computers and printers 5.Lack of automation
2.Maintenance Problems	1.Poor maintenance plan for equipment
3.Operation and Skill Related Problems	1.Poor Efficiency of operators/staff 2. Poor performance of equipment 3.No time schedule to the staff
4.Manpower Related Problems	1.Lack of training to the Operators 2.Lack of coordination 3.Attitude of trade unions 4. Poor performance of GPM Gang
5.Procedure or Documentation Related Problems	1.Lack of control over the staff 2.No work Target 3.No follow up from the Superior 4.Manual filing of EA/IA 5.Lengthy procedure 6.Delay due to multiple window system
6. Other problems	1.Lack of coordination B/W Port and customs officers 2.Offices at different location 3.Customs related issues 4.Business through Cochin Port is too much expensive

5.8.6 Suggestions of Port Users

The port users of Cochin port have long experience in sea trade. During the survey they have given some suggestions for overcoming the present day operation problems. The customers of port have no role in planning and formulating the development schemes for the growth of the ports in India. Now

Table 5.18 Suggestions for reducing the number of bottlenecks in operations of CPT

Suggestions for simplifying the procedure and formalities	***Suggestions for improving Gate operations***
• Better inter/intra department coordination between ports, customs and other related officers. • Proper training to employees of port • Strict time schedule and control on employees. • The existing forms must be simplified. • Fix the daily target (quantum of works) to both employees and officers. • Keep transparency in office procedure and documentation. • Avoid duplication	• Provide network facility between port and customs so as to enable the port users to know the details regarding the delivery of containers. • Multiple department inspections to be avoided. • Provide a weigh bridge at port premise • Implement online activity at gantry hook point, and TC stack with gate operation • Provide more number of computers at gate office to avoid delay in getting EIR. Centralized gate operation
Suggestions for promoting business through Cochin port	***Suggestions for improving port's CFS operation***
• Trade meeting at various locations of hinterland • Speedy port and customs clearance for export cargo • Cut off time on merit basis. • Full computerization and automation • Avoid bribes. • Building of Vallarpadom Container Terminal • Reduce the port operating cost. Encourage more marketing strategies.	• Privatize the CFS operation • Provide separate equipment and crew • Avoid gang booking systems and appoint labours permanently • Introduce one more shift. • Increase the stacking space • Stuffing to be carried out on chassis during the peak period.
Suggestions for avoiding delay in Customs formalities	
• Boarding formalities for vessels coming from other Indian ports must be dispensed with. • Provide facilities for collecting customs levy and port charges at a single window. • The long hierarchy in the process of getting clearance from customs must be dispensed with, by delegating powers. • Unified customs procedures and formalities in all Indian ports. • Dispense off Customs Preventive officers.	• Avoid delay in communication between customs officers in wharf area and the main office. • Holidays for port and custom office must be matched with it days, and working time also must be the same. • Better coordination between port and customs official. • Permit direct loading to private vehicle from/to ships. • Single door clearance for EA/IA.

with high competition due to liberalization and globalization, all providers of goods or service are focusing on customers. Hence ports also should do the same. It is in this context that the suggestions of the port users should be valued and considered seriously. Their important suggestions are listed in Table 5.18.

5.9 Recommendations

Based on the findings, and considering the needs of the port users of Cochin port, some important recommendations are listed in the following paragraphs for overcoming the existing problems in the operations of Cochin port.

- ***Single Window Clearance***

A single window system for port and custom clearance is recommended as implemented in the port of Tuticorin.

- ***Better Market Strategy***

In the context of globalization of Indian economy, competition between ports increased to a great extent. Trade has also increased considerably. The balance between export and import cargo got disturbed. Hence, necessary steps must be taken to increase the volume of export cargo through the ports. Offering good incentive scheme can attract more exporters. Priority must be given to handle export cargo at the ports.

- ***Unified customs formalities***

Unified customs procedure and formalities must be followed at all ports in India. All unnecessary documentation must be dispensed off. Strengthening the relationship between customs, ports and other port users is very desirable.

- ***Better labour/equipment productivity***

Equipment and labour productivity are two very important issues of all Indian ports that need to be sorted out. The existing manning scales must be reviewed in the context of automation of port operations, and a revised manning scale must be introduced for increasing the labour productivity. A large number of critical equipment is outdated, and are in poor state of maintenance. A detailed study is recommended to measure the performance of critical equipment such as gantry cranes, transfer cranes, electrical cranes etc. Necessary steps must be taken to improve the overall equipment effectiveness (OEE).

- ***Install Transshipment Container Terminal at Vallarpadom***

Port authority must take initiative to bring all port users, political leadership in the state, trade unions, and state govt. under a single umbrella to remove the existing hurdles for the installation of the proposed transshipment container terminal at Vallarpadom. This is very much essential for the future growth of all ports in India, especially the port of Cochin. This will prevent the flow of dollars from India to Colombo, Singapore, and Dubai, which will strengthen the economic position of India.

- ***Joint sector/Private sector participation***

Huge capital is required for modernization of the existing port facilities and it is also time consuming. Efficiency and capital are important factors concerned with modernization. Hence Joint Sector and or Private sector participation is essential for generating huge funds and bringing high efficiency needed in port operations. The port authority must take initiative to identify the areas where the private/joint sector participation is possible and necessary steps must be taken to modernize the existing facilities.

- ***Harnessing the Advantages of Information Technology***

Automation is an important concern in the modern world. The advantages of computerization and use of information technology are limitless. Cochin port is already very late in harnessing the advantages of such systems. Immediate steps must be taken for making use of benefits of computer automation in port operations.

- ***Transparency in Documentation and procedure***

Transparency in procedure and operation documentation will curtail the bribes at various levels. The bribes at Cochin port are comparatively high, when compared with nearby ports. If bribes reduce, the total expenditure for the customer will reduce, as bribe is a factor of high operating cost of port users in Cochin port. (The above is based on customer survey)

- ***Attitudinal changes of all concerned***

Having lived and developed for a long time under licensee and control regime, customs and port find it difficult to change its orientation to customer. They find it difficult to change from "powerful permission granting authority" to "service providers to facilitate business". Under the protective blanket of government control they still follow red-tapism and bureaucracy. This has to be changed. To change this, an attitudinal change must be evolved in employees of the ports and custom department from top to bottom. The attitude of the trade union leadership must also be changed according to the needs and cry of port users, and their employees. This attitudinal change is necessary for all concerned to overcome the present challenges and threats facing the operation of Cochin port.

5.10 Conclusion

Created by nature in 1341 A.D., visited by international travelers and administered by colonial conquerors through the centuries, which followed and developed by Sir. Robert Bristow in this century against far too many odds and despite the cynicism of far too many people, Cochin Port today is indeed the "Queen of the Arabian Sea" as prophesied by the then Diwan of Cochin Sir.Shanmugham Chetty who coined that expression more than 60 years ago. From a mere roadstead until the beginning of this century, it has today grown in to a Major Port. Cochin port lies on the direct route to Australia and Far East from Europe and can accommodate 26 vessels at a time. It has a rich hinterland and good transportation facilities. Cochin port has two wharves, good storage facilities, a full-fledged container terminal and cargo handling facilities. It is managed by a Trust, the members of which are appointed by the Government of India representing the central ministry, state ministry, public sector companies, labour unions, chamber of commerce, Port Users etc. There are nine departments with a staff strength of 6328 on 31-03 2001. Cochin port contributes greatly to the economic development of Kerala and the neighboring states.

Flow process charts were made to understand the operations of the port. The port operation is classified in to three groups as 1) Container Terminal operations, 2) Oil Terminal operation and 3) other Terminal operations. The operations in each classification were divided in to sub process and its flow process diagrams were made. The various delays were identified from the flow process chart. The important delays thus noted were: 1) delay in bringing the ships in to the berth, 2) delay in registration of loaded containers for export, 3) delay in stacking of loaded containers at parking yard due to want of unloading equipment, 4) delay in getting the gate pass, 5) delay in off-load the containers in the rail track, 6) delay in off-load the reefer containers from truck, 7) waiting for loading of export containers to ships, 8) delay in execution of ship work after berthing, 9) delay in starting the unloading of containers from ships,10)delay in removal of cargo at wharf, 11) delay in getting the containers from CFS for loading to the ships, 12) cargo waiting for loading in vehicle, 13) delay in un-berthing the ships after completing the ship work, and 14) waiting of ship at Fair Way.

Physical movements and operations related to cargo for both import and export are related to processing of documents and paper work. The delays in paper work therefore have adverse impact of movement of cargo performance.

A survey was conducted among the port users of Cochin port to study the problems that they are facing with the operations of the port. Responses were collected, using questionnaires focusing on problems classified in to five groups viz. Equipment related problems, procedure/documentation related problems, Container terminal operation problems, Ernakulam/Mattanchery wharves operation problems, and other general issues and comparison with other major ports in India. Parato analysis was done to prioritize the problems coming under each category. A summary analysis of problems from survey was done and the problems were categorized in to six, which are: 1) facility design and installation problems, 2) Maintenance problems, 3) Operation and skill related problems, 4)

Manpower related problems, 5) procedure and documentation related problems and 6) Other problems. The problems in each category were identified and actions were suggested for improvement. Some important recommendations are: single window clearance system, market focused strategy, unified custom formalities and procedures, better labour and equipment productivity, building of a transshipment container terminal at Vallarpadom, Joint/Private sector participation, and harnessing the advantages of automation using computers.

Using process charts, problems were identified from material flow point of view. Using user survey, the problems from documentation process and service point of views were also collected. There was agreement to be seen between results of the two methods for problem identification. The problems identified have to be solved quickly. Some solutions have been suggested here. In the later chapters some important problem areas identified here are studied in greater detail.

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CHAPTER 6

STUDY OF FINANCIAL STATEMENTS OF COCHIN PORT

6.1 Introduction

This chapter deals with the analysis of the financial statements of Cochin Port for a period of 12 years from 1989 to 2000. The income and expenditure schedules were collected and analyzed to identify the important operational problem areas of Cochin Port. An important area of operation is the functional area where the maximum revenue is generated. Break-Even analysis is done to compare the financial position of Cochin port in 1996-97 and 2001-02.

In the case of a service provider such as a port, understanding the overall organizational efficiency is important. UNCTAD report deals in detail on how port authorities should collect and use a set of performance indicators concerning both operational and financial aspects of port operation. All indicators have been selected with a view to providing assistance to port management in medium term planning and control [UNCTAD Report, 1976]. Analysis of financial reports gives a good indication of the trend and the current financial situation from total organizational point of view. This is especially so in case of a Government owned and controlled set up where changes are budget and finance driven.

6.2 Rationale behind the Study

In chapter five, several operational problems were identified using flow process charts and a survey conducted among port users. The operational problems thus identified came under the three operational areas of Cochin Port, which are:

- Container Terminal operations,
- Oil Terminal operations and
- Other Wharves operations.

To find out the solutions of all problems is beyond the scope of this work. So it was decided to find solutions to a few important operational problems identified. The first task is therefore to identify critical operational problem areas. The financial impact of the operational problem studied is important to determine its criticality. Thus financial analysis is used to identify the critical areas of operations.

Profit in any organization is very much related to the operational efficiency. When the operational efficiency is more, the profit generated will be higher and the operational expenditure will be lower. Hence operations study of any organization with out considering its income and expenditure is incomplete. This study of financial statements of Cochin port was therefore undertaken to find critical operation problem areas.

6.3 Analysis of Data collected

Financial statement analysis is a useful tool for understanding a firm's performance. According to Prasanna Chandra [1995], financial statements, such as the income-expenditure statement, the profit and loss accounts, and the position statement or the balance sheet are indicators of two significant factors: (i) the profitability, and (ii) financial soundness. The annual income-expenditure statement is the accounting report that summarizes the revenue, expenses and the difference between them for an accounting period. While analysis based on a single set of financial statement is helpful in understanding current problems, it may often have to be supplemented with analysis of such statements for a larger period of time to get better insight in to a firm's performance and change in condition over a period of time. Hence the income and expenditure schedules of Cochin Port were collected and analyzed. The sections that follow present the analysis.

6.3.1 Analysis of Income- Expenditure statements

In this study, revenue accounts (Income Schedule and Expenditure Schedule) from 1989 to 2000 are analyzed. The accounts were examined to understand the gap between annual operating income and expenditure (referred to Gap Analysis hence forth) over the last 12 years.

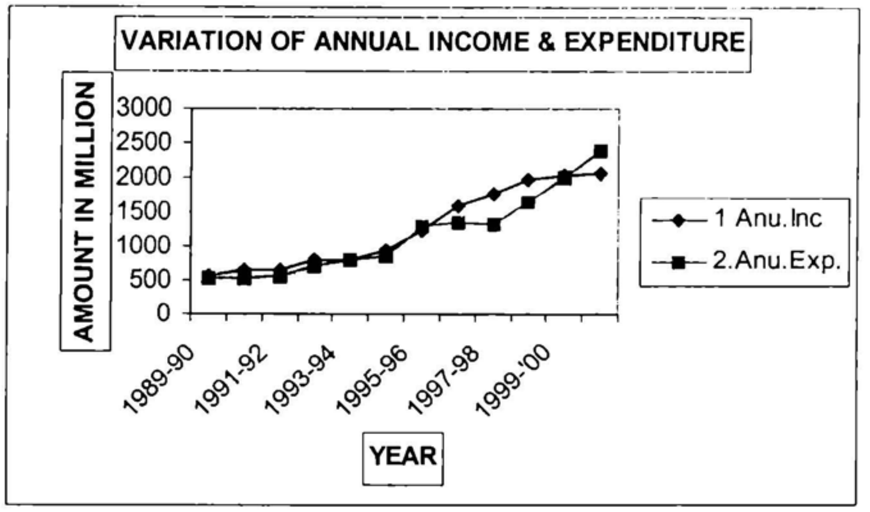

Figure 6.1 Variation of Annual Income and Expenditure

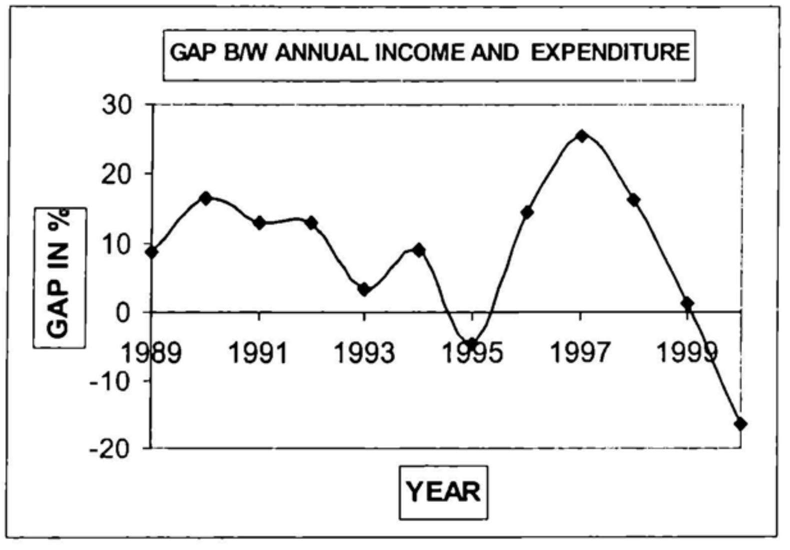

Figure 6.2 Variation of gap between Annual income and Expenditure

In these accounts the annual income includes both direct and indirect income and the annual expenditure includes both direct and indirect expenses of the firm. Figure 6.1 shows the variation of annual income and expenditure and Figure 6.2 shows the variation of gap between annual income and expenditure in percentage over the years. It is seen that the gap between annual income and annual expenses reduces from 1989 to1995 (9% to –4.5%) and the gap increased up to 1997 (25 %) and again reduced from 1998 onwards. From the year 1999 onwards the annual expense is found to exceed the annual income and it stands 16% above income at year 2000. This clearly indicates that the organization is sinking.

6.3.2 Direct Income Versus Direct Expenditure

In order to explore the cause of the poor situation, analysis was done to study the gap between annual direct income and expenses of the firm. Figure 6.3 shows the variation of direct income and direct expenses. Initially the gap was less but has increased from 1994 onwards and the same trend continued up to 1997. Again from 1998 onwards the gap decreases, but direct expense never exceeded direct income.

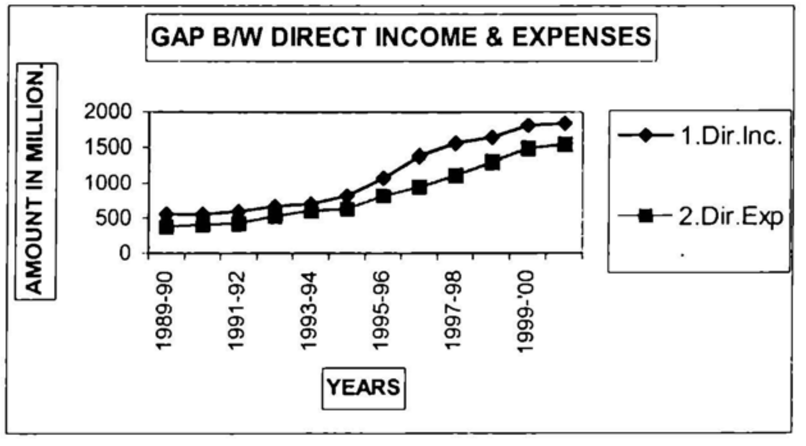

Figure 6.3 Variation of Direct Income and Direct Expenditure

The accounts were explored further to find out the reasons for decreasing gap between annual direct income and expenditure. The direct income is generated from three sources, which are: (1) Cargo handling and storage charges, (2) Port and dock charges, and (3) Estate rentals. Table 6.1 shows the average contribution in percent of each item to the direct income. From table, it is seen that the cargo handling and storage operation is the most important source of direct income.

Table.6.1 Sources of Direct Income and its Contribution

Serial No.	Description	Average Income in Percent	Remarks
1	Cargo Handling& Storage Charges	67	Gradually increased up to 1994,appreciable increase from 1995 onwards.
2	Port & Dock Charges	26	Gradually Increased over 12 years and approximate linear variation
3	Estate Rentals	7	Gradually increased over 12 years and approximate linear variation.

Figure 6.4 shows that the port and dock charges and the estate rentals have gradually increased over the last 12 years and have shown an approximate linear variation. Therefore, a sudden increase of income from these two sources cannot be expected. The income generated from cargo handling and storage

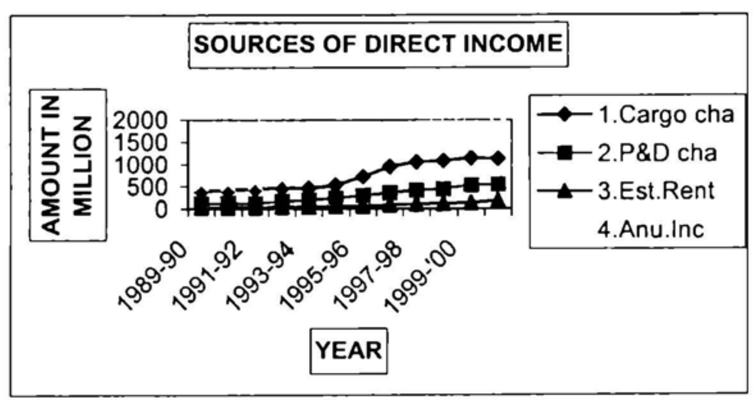

Figure 6.4 Variation of sources of Direct Income

operation gradually increased up to 1994, from 1995 onwards there is an appreciable increase in this. The total income also increased gradually up to 1994, the increase was at a higher rate from 1995 onwards because of the higher rate of increase of income from cargo handling and storage operations. This reconfirms that the cargo handling and storage operation is a critical activity of the port as far as income is concerned.

Since cargo handling and storage operation is a critical activity of the port, further analysis was carried out to identify the various sources of income obtained from this operation. This operation include (1) the handling and storage charges of general cargo, (2) crane hire charges, (3) Petroleum, Oil and Lubricants (POL) handling charges, (4) demurrage on general cargo, (5) wharfage on containerized cargo, (6) hire on equipment for container handling and (7) miscellaneous charges. Table 6.2 shows the average contribution in percent of each of the item of the cargo handling and storage operation.

Table 6.2 Sources of Cargo Handling and Storage Operation and its Contribution

Serial No.	Description	Average Contribution in percent	Remarks
1	Handling and Storage Charges of General Cargo	15	Related to General Cargo Operation
2	Crane Hire Charges	1	Related to General Cargo Operation
3	Petroleum, Oil and Lubricants (POL) Handling Charges	61	Most critical operation
4	Demurrage on General cargo	3	Related to General Cargo Operation
5	Wharfage on Containerized Cargo	6	Related to Container Terminal Operation
6	Hire on Equipments for Container Handling	13	Related to Container Terminal Operation
7	Miscellaneous Charges	1	Very negligible amount

Table 6.2 shows that an average of 61 percent of income is collected from POL handling operations (source 3), 19 percent of income (source1, 2 & 4) is related to general cargo operation, another 19 percent (source 5 & 6) is related to containerized cargo operations and the remaining 1 percent from miscellaneous account (source7). A further analysis shows that on average from every rupee earned from general cargo handling and storage, 95 paise is spent there itself. Similarly, an average of 25 paise per rupee earned is spent for the storage and handling of containerized cargo. At the same time, only 5 paise from every rupee earned from POL handling operations is spent for the same. Since POL operation contributes 61 percent of direct income with minimum expense, it is a very profitable activity in cargo handling and storage process of this port. Hence, POL operation must be done with maximum efficiency and the customer should be kept satisfied to maintain a safe financial position of the port. The bottleneck of POL operations from the customer point of view and their search for alternatives has been discussed in detail in a study given by (Bhasi [1999]).

Therefore, this undue reliance on POL operations by the port is not a good strategy. General cargo operation is less profitable when compared with containerized cargo operations and POL operations

Table 6.3 shows that an average of 24 percent of expenditure is on account of cargo handling and storage expenses. About 40 percent of expenditure is on account of port and dock facilities including pilotage expenses. Only 4 percent is on account of maintenance expenses of rental land and building. The remaining 32 percent is on account of management and general administration expenses. The port and dock facilities for shipping including pilotage expenses, management and general administration expenses and cargo handling and storage expenses are very critical as far as direct expense is concerned. These critical expenses are very much related to the operational efficiency of the system and the productivity of the staff of the port. The port and dock facilities including pilotage expenses are very high. This is due to the high expenditure incurred for dredging and marine survey operations. Possibilities of

Table 6.3 Account of Direct Expenditure

Sl. No.	Particulars	Average Expenses in Percent	Remarks
1	Cargo Handling and Storage Expenses,	24	High
2	Port and Dock facilities including Pilotage Expenses	40	Very High
3	Maintenance Expenses of Rental Land and Building	4	With in the budget control
4	Management and General Administration expenses	32	Very high
5	Railway Working Expenses	0	Absolutely Negligible

reducing this dredging and marine survey expenses have to be found out. The management and general administration expense is also very high due to the high overhead expenses of the port. This definitely has to be contained and then reduced to sustainable levels. The cargo handling and storage expense is high due to the high maintenance cost of handling equipment, storage sheds and wharves. Therefore, more effective and efficient ways of doing this have to be implemented.

The ratio of annual direct expenses to the direct income was also computed for 12 years. Figure 6.5 shows the variation of the ratio of direct expenses to the direct income. Its value is seen to vary from 68 percent to 86 percent with an average of 76 percent. This higher value is a clear indication of the poor financial position of the port. The direct expenses are very high when compared with the income generated. The result of this study also clearly advocates firstly, better control on expenses and secondly, the need for increasing the income.

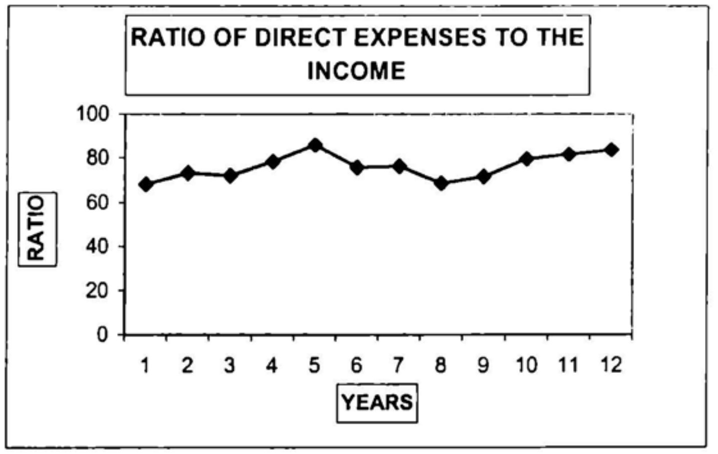

Figure 6.5 Variation of ratio of Direct Expenses to Direct Income

6.3.3 Indirect Income versus Indirect Expenditure

Another analysis was done to study the gap between the indirect income and indirect expenditure for 12 years from 1989 onwards. The resulting variation between the indirect income and the indirect expenditure is shown in Figure 6.6. The indirect income is increased gradually from 1989 to 1998 and reduced from 1999 onwards. But high variability is shown in case of indirect expenditure and it is always greater than direct income except in 1998 due to the nonpayment of interest on loan during this year.

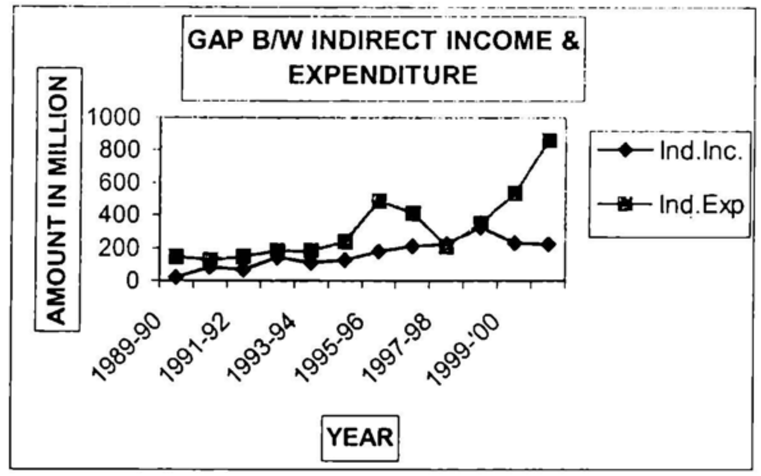

Figure ``6.6 Variation of Indirect Income and Indirect Expenditure

The variation of indirect income is shown in Figure 6.7. Various sources of indirect income are: 1) interest on investment, Fixed deposit and cash balance, 2) profit on sale/redemption of investment/ capital assets, 3) miscellaneous income and 4) items relating to previous years. From the graph, it is clear that the interest on investment, fixed deposit and cash balance (line 1) has increased

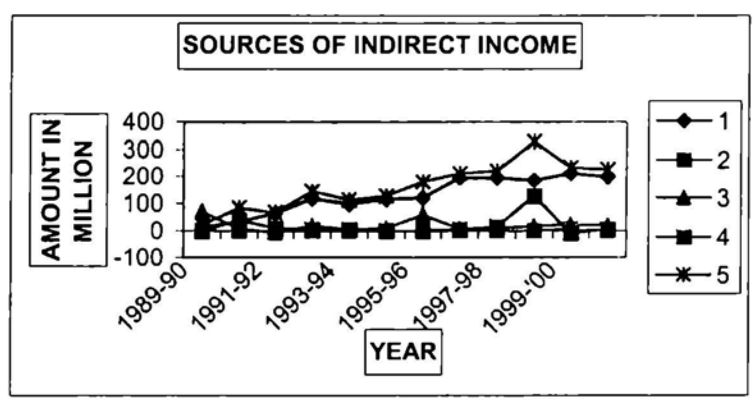

Figure 6.7 Sources of indirect income and its variation

steadily over the years and profit on sale/ redemption of investment/ capital assets, miscellaneous income and the items related to the previous years (line 2, 3 and 4 respectively) are almost constant over the years and these amounts are comparatively less when compared with the indirect income generated from the first source of income. The total indirect income (line5) has increased gradually up to 1998 and then reduced. From this analysis, it is seen that this indirect income has limitations to increase further.

The ratio of indirect expenditure to the indirect income is very high and is increasing dramatically over the years. The variation of ratio of indirect expenditure to the indirect income is shown in Figure 6.8. It is seen to have varied from 96 percent to 675 percent of indirect income. The variation of the

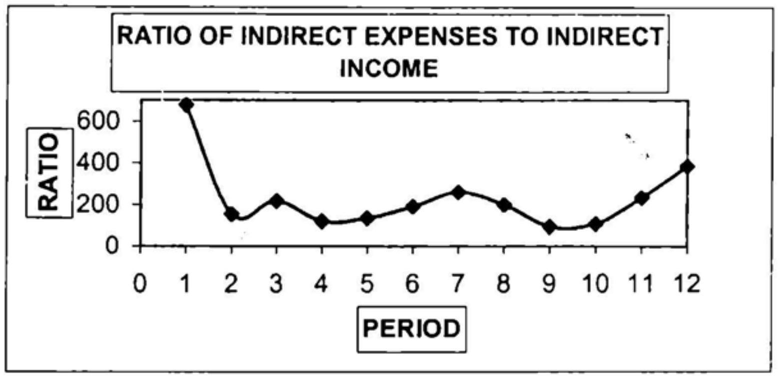

Figure 6.8 Variation of Ratio of Indirect Expenditure to Indirect Income

ratio is inconsistent but is always very high. From the above, it can be stated without doubt that the indirect expense is the culprit, which is greatly responsible for the current poor financial state of the port. So these higher indirect expenses must be contained.

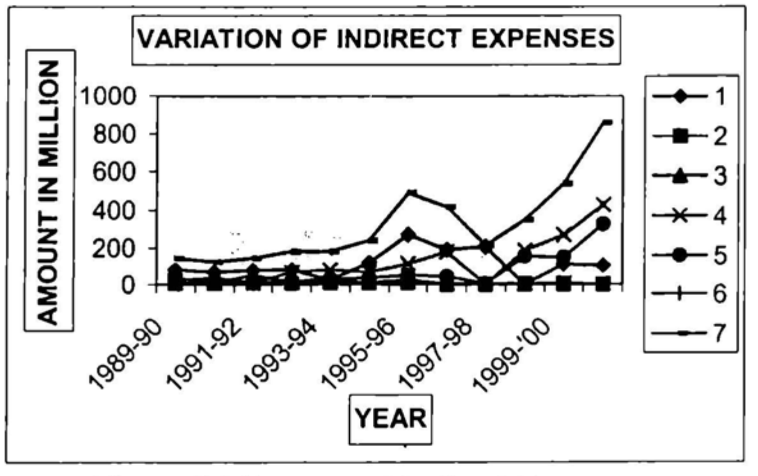

Figure 6.9 Sources of Indirect Expenses

A further analysis was conducted to find out the reasons for high increase in indirect expenditure. The indirect expenses are: (1) Interest on loan and bank commission, (2) Refund of loans, (3). Retirement Gratuities. (4) Pension payment, (5) Items relating to previous year, and (6) Voluntary Retirement scheme 1992. The variation of average expenses of each item is shown in Figure 6.9. From the figure, it is very clear that the interest on loan- both government and other loans- and pension payment are very high and all other expenses are negligible. Hence the actual culprit for high indirect expenditure are: (1) interest on loan, and (2) payment on pension. These expenses have to be contained and then reduced. Three options that come to our mind are: (1) renegotiate old high interest loans in light of lower interest regime prevailing now, (2) create a pension fund to manage pension payment, and (3) re-examine the other non-statutory benefits provided to pensioners.

6.3.4 Analysis of Overhead Expenses

High overhead is a problem with most Government run organizations. Analysis was done to find out the variation of the annual overhead expenditure of the port. The annual overhead expense is the Management and General Administration expenses after depreciation, which includes Management and Secretariat expenses, Medical expenses, Stores Keeping, Accounting and Auditing, expenditure on Head Office Building and Telephone, Engineering and Workshop Administration, Overhead and Sundry expenses, and new Minor Works. Overhead expenditure was calculated from the income and expenditure schedule of the port.

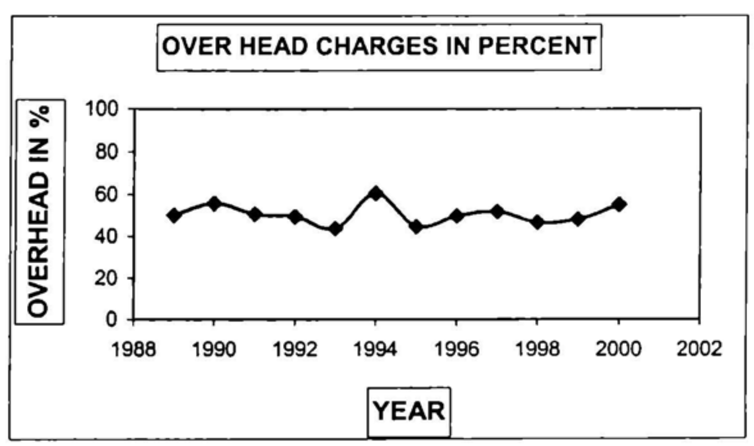

Figure 6.10 Variation of Overhead expenses over the total expenditure

Figure 6.10 shows the variation of annual overhead expenses in percent of the total annual expenses after depreciation over a period of 12 years. It is seen to vary from 43.8 percent to 60.7 percent of the total expense with an average overhead expense of 51 percent. This expense is indeed very high. This was found mainly due to high staff strength of the organization. Data regarding the staff strength of the port for the last 11 years (from 1991 to 2001) is shown in Table 6. 4 (a) and 6.4 (b).

Table 6.4 (a) Staff Strength of Cochin Port from 1991 to 2001

Sl. No.	Categ-ory of Employ-ees	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
1	Class I	164	166	161	157	157	155	153	164	167	167	167
2	Class II	69	71	68	75	77	85	93	112	129	140	142
3	Class III	3944	3969	3820	3696	3652	3600	3548	4460	4438	4438	4446
4	Class IV	2449	2436	2243	2178	2245	2083	1920	1742	1600	1585	1573
	TOTAL	**6626**	**6642**	**6292**	**6106**	**6131**	**5923**	**5714**	**6478**	**6334**	**6330**	**6328**

Table 6.4 (b) Class wise Staff Strength of Port

Serial No.	Description	Staff strength as on 31.03.1991	Staff strength as on 31.03.2001	Average Staff strength	Staff Strength in Percent
1	Class I Officers	164	167	160	3
2	Class II Officers	69	142	108	2
3	Class III Employees	3944	4446	3913	63
4	Class IV Employees	2449	1573	1932	32

From tables 6.4(a) and 6.4(b), it is very clear that the organizational hierarchy is against the basic principles of management (in that it is not triangular, more Class I other than Class II). The span of control of class I officers is very narrow and the span of control of class II officers are relatively wide. A specific study is necessary to look into this problem. Conducting work-study in each department and accordingly fixing the manpower required will be appropriate.

6.4 Break-Even Analysis

In the previous sections, the financial statement of the port was analyzed and the reasons for the present poor financial state of the port were found out. Here, an analysis of the financial statement of the port in 1996-97 and 2001-02 is one and compared using break-even analysis. Again the reasons for the poor financial state of the port are found.

According to Hingorani and Ramanathan [1988], break-even point is that level of activity where total cost equals total revenue so that the firm neither earns profit nor suffers any loss. At this stage the firm is said to be break-even. This is the point at which the total contribution is just equal to the fixed costs; hence no profit or loss is earned. Or, the total revenue is equal to the total cost. No firm would be content to reach only this point; but this represents a point which one must reach before one goes further to earn a profit. If one does not reach this point, one has suffered a loss. By determining this point, the firm can very well assess how far away it actually is from that point. If the firm is actually at a level far higher than the BEP, it means that it is profitable.

From the financial statements, the fixed income, variable income, fixed expense and the variable expenses were calculated. Fixed income and fixed expense are taken on the basis that these do not change with the volume of cargo handled. Variable income and variable expenses are taken on the basis that these are directly related to the volume of cargo handled in the port during the given time. The elements of income and expenditure divided into fixed and variable components on the above basis are shown in Table 6.5. The elements shown in the table cannot be segregated into strictly fixed and variable income or expenses due to the aggregation of income and expense elements into heads already without considering the fixed and variable classification aspect. However best efforts have been taken to do this classification with the aggregated data available now. In order to illustrate this point, consider estate rental. This is taken as variable income because major portion of income is obtained from the rental of buildings, sheds and depots used to keep the cargo. Its maintenance and repair charges are at the same time taken as one of the elements of variable expenses.

Table 6.5 Elements of Income and Expenditure

Sl.No.	Particulars	Elements of Incomes/Expenses
1	Fixed Income	1. Finance and Miscellaneous Income
2	Fixed Expenses	1. Management and General Administration Expenses. 2. Finance and Miscellaneous Expenditures.
3	Variable Income	1. Cargo handling and Storage Charges 2. Port and Dock Charges 3. Estate Rentals.
4	Variable Expenses	1. Cargo Handling and Storage Expenditure 2. Port and Dock Facilities for Shipping including Pilotage Expenses. 3. Railway Working Expenditure 4. Maintenance of Rental land and Buildings.
5	Total Income	1. Fixed Income 2. Variable Income
6	Total Expenses	1. Fixed Expenses 2. Variable Expenses

The fixed income, variable income, total income, fixed expense, variable expense and the total expenses for the year 1996-97 and 2001-02 calculated from the annual income and expenditure schedules of port and are tabulated in Table 6.6. The volume of cargo handled during the same period is also noted in the table.

Table 6.6 Values of Volume of cargo handled, Income and Expenses

Year	Volume of Cargo handled in MMT	Fixed income in Rs. Crores	Variable Income in Rs. Crores	Total Income in Rs. Crores	Fixed Expenses in Rs. Crores	Variable Expenses in Rs. Crores	Total Expenses in Rs. Crores
1996-'97	0	20.9	0	20.9	44.37	0	44.37
	11.74	20.9	137.76	158.66	44.37	65.16	109.53
2001-'02	0	14.37	0	14.37	129.20	0	129.20
	12.06	14.37	187.06	201.43	129.20	107.10	236.30

Now separate graphs were plotted for each year and the variations of total income and total expenditure with respect to the volume of cargo handled in the port are shown in Figures 6.11 and 6.12. From figure 6.11, it is clear that financial position of port during 1996-97 is very safe, as the BEP is nearly at 3.3MMT whereas port is operating with a volume of 11.74 MMT. The port is operating about 255 percent of volume of cargo higher than the BEP. Since the firm is operating at a level far higher than the BEP, it means that the firm is very profitable.

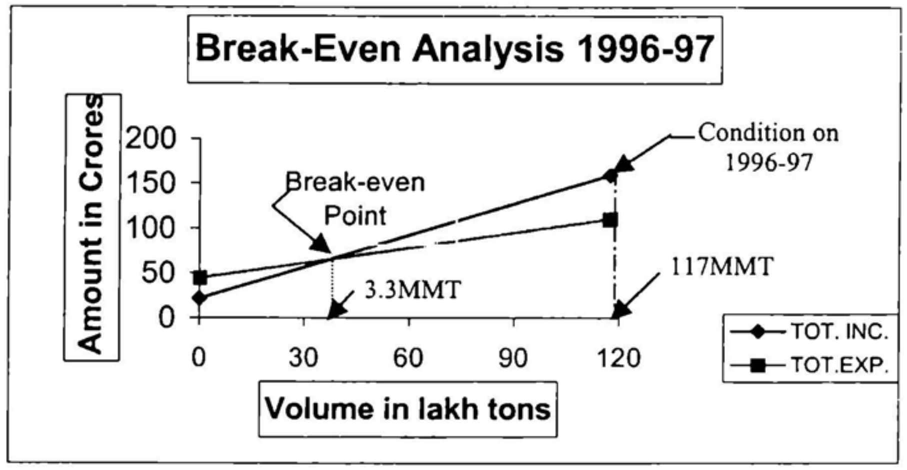

Figure 6.11 Break-Even Analysis for 1996-97

Figure 6.12 shows that the financial position of port during 2001-02. This is very poor because the firm operates far below the BEP. Now it was assessed that the port is operating at 36 percent of the volume of cargo level lower than the BEP (Extrapolated). Hence the total expenditure is higher than the total income of the firm at the present operating condition and thus the firm has suffered a loss.

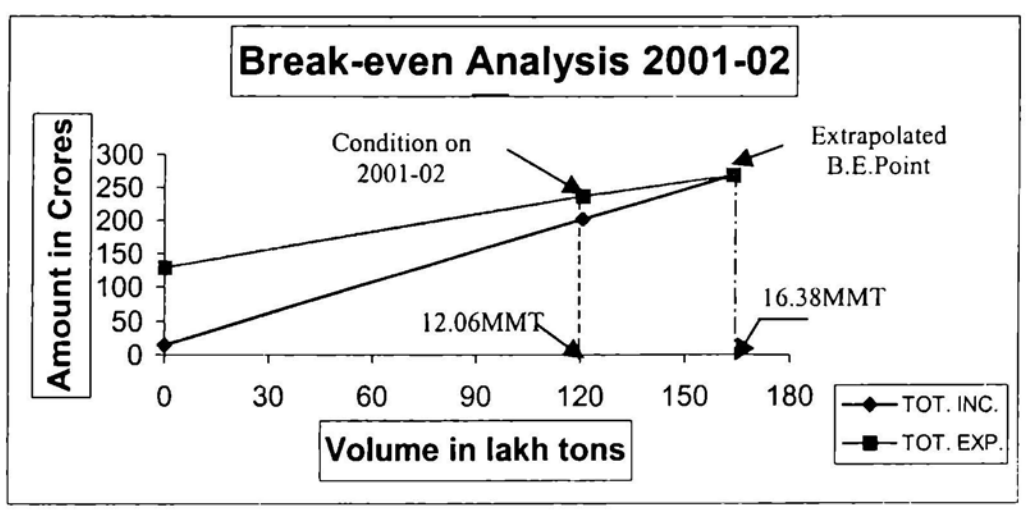

Figure 6.12 Break-Even Analysis for 2001-02

The summary of the result of break-even analysis is shown in Table 6.7. From the table, it is seen that as the volume of cargo has increased by 3 percent from 1996-97 to 2001-02, the fixed income has reduced by 31 percent and the variable income has increased by 36 percent. At the same time the fixed expense has showed an enormous increase of 191 percent and the variable expense has increased by 64 percent. Similarly the total income has increased by 27 percent and total expense has increased by 116 percent. From the analysis, it is very clear that there is no control on fixed expenses and variable expenses. In the present situation, the income cannot be increased due to the constraints of limited capacity of cargo handling at the port. So it is not possible to increase the volume of cargo to the level of extrapolated BEP (16.38MMT). Then the only way to overcome the present financial condition of port is to have strict control over the expenses. The fixed expenses have to be reduced substantially and actions taken to reduce the variable expenses as much as possible.

Table 6.7 Summary of Break-even Analysis

Particulars	Year		Percentage Increase (Approx)
	1996-97	2001-02	
Volume of cargo (MMT)	11.742	12.059	3
Fixed Income (Rs. Crores)	20.9	14.37	-31
Variable Income (Rs. Crores)	137.76	187.06	36
Total Income (Rs. Crores) A	158.66	201.43	27
Fixed Expenses (Rs. Crores)	44.37	129.20	191
Variable Expenses (Rs. Crores)	65.16	107.10	64
Total Expenses (Rs. Crores) B	109.53	236.30	116
Surplus (A-B) (Rs Crores)	49.13	-34.87	-171

This analysis clearly indicates that the major reason for the present sorry state of financial condition of the port is the undue increase in fixed expenses. The Management and General Administration expenses and the Finance and Miscellaneous expenses have increased at a high rate with in the last five years. The main elements of these expenses are overhead and sundry expenses, management and secretarial expenses, medical expenses, Engineering & Workshop administration. accounting and auditing expenses, interest on Govt.

loans, payment to Pension Fund towards expenditure on pension and payment contribution to fund etc. Another reason for the poor financial condition of the port is the high rate of increase of the variable expenses such as dredging and marine survey expenses, handling and storage of general cargo, handling and storage of container expenses, Towing, berthing and mooring expenses, administration and general expenses at wharves, estate maintenance etc which are coming under the accounts of cargo handling and storage expenses, port and dock facilities for shipping expenses, rent for land and building. It is worth noting that the same reasons have come out from the analysis reported in section 6.3 above. A medium and long-term strategy of the port should involve finding and implementing measures to convert as much of fixed expense to variable expense as possible.

6.5 Findings

(1) The total annual expenditure exceeded the total annual income due to the higher amount of indirect expenses. The indirect expenses have increased due to the higher interest burden of loan and the payment of pension benefits and contribution to the employees.

(2) An average 67 percent of income is generated from cargo handling and storage operation. So it is a very critical operation. 26 percent of income is collected on account of port and dock charges.

(3) In cargo handling and storage operation, 61 percent of income is collected from POL operations. At the same time only 5 percent of the income generated here needs to be spent for this operation. Thus this is the operation that generates maximum surplus income. This operation has to be performed efficiently and the customer has to be retained by the port at any cost.

(4) Between container operations and general cargo operations the former is more profitable for the port. The world trend also shows increase in containerization. How ever, these customers have greater flexibility of operations and can easily shift to other ports if service becomes poor. Therefore it is

important to give adequate attention to maintain customer good service levels in container terminal operations.

(5) An average 40 percent of the direct expenses is spent for port and dock facilities for shipping including pilotage operation, 32 percent for management and general administration and 24 percent is used to meet the cargo handling and storage operation. Of the above 32 percent for management and general administration appears to be high and therefore the same need to be controlled.

(6) The ratio of direct expenditure to the income also showed the increasing financial weakness of the firm. About 76 percentage of direct income is used to meet direct expenditures. This leaves a surplus of only about 24 percentages, which has become grossly inadequate to meet the increased indirect expenditure.

(7) The current overhead expenses are at a very high level of 60.7 percent. The higher overhead expenses are due to high staff strength of the port.

(8) Break-Even analysis also shows that the enormous increase of fixed expenses and the high rate of increase of the variable expenses are the two basic reasons for the sorry state of the financial position of the port today. It also shows that only capacity utilization and operations improvement will not solve the problems of Cochin port. Financial discipline is required urgently.

6.6 Suggestions and Conclusion

This study using the annual financial statement of the port for a period of twelve years clearly showed the eroding strength of the organization. The fact is that over the years total expenditure has increased, and from the year 1999 has overtaken the total income, pushing it into red. This has happened because of the following reasons: (a) the surplus generated from operations (money left over from direct income after meeting the direct expenditure) has steadily decreased over the years, (b) the indirect expenditure head has also increased dramatically during this period. This double crisis has resulted in such a bleak financial position of the port.

The other important observations made in this chapter relate to the high dependence on POL operations by the port, the high cost of operations and maintenance, and high staff strength of the port. The main causes of high indirect expenditure have been identified as interest payment and pension payment. The suggestions made to tackle this are: (1) renegotiate old high interest loans in light of lower interest regime prevailing now, (2) create a pension fund to manage pension payment, and (3) re-examine the other non-statutory benefits provided to pensioners.

This study revealed the scope for more work in the area of excess staff strength problem. The port operations also need to be studied separately in order to find ways of improving service levels, efficiency, and to reduce the direct expenses involved.

This study also showed that the POL operation is the most critical area of operation, which has high dependence on income generated in the port. Another area of importance in operation is the Container Terminal, which has further scope of growth because only less than 45 percent of the cargo is moving in containerized form in India today. The third area of operation- other wharves operation- is very expensive and it has limited further growth in future because the trend has changed towards containerization of cargo. Hence a micro level study of POL Operations and Container Terminal Operations is necessary, which are presented in the next two chapters.

Break- even analysis was done to compare the financial position of ports in 1996-97 and 2001-02. The analysis revealed that the financial position of the port in 1996-97 was very comfortable and the financial position in 2001-02 was very poor. The analysis also revealed the reasons for the poor financial position of the port today. The main reasons are the uncontrolled increase of the fixed expenses during the last five years and high rate of increases of variable expenses during the same period. The comparison of the findings of break-even analysis with the previous analysis showed that the reasons for the poor financial position of the port today are one and the same.

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CHAPTER 7

STUDY OF COCHIN OIL TERMINAL OPERATIONS

7.1 Introduction

This chapter deals with the operations of Cochin Oil Terminal (COT). An exploratory study was conducted to identify the operational bottlenecks. The influence of the various parameters such as size and number of tankers bringing crude, the rate of crude oil discharge, and the draft availability on the operational performance of COT are analyzed, using data pertaining to year 2000-2001. A few choices of tanker size and schedules have been suggested for de-bottlenecking the operations of the system.

The Cochin Oil Terminal (COT) is an infrastructure facility provided by Cochin Port Trust for handling crude oil, the raw material for Kochi Refineries Ltd. Kochi. The COT was commissioned in 1984. The capacity of Kochi Refinery has already been increased from 4.5 MMTPA to 7.5MMTPA and now there are plans to increase the capacity to 10MMTPA. India imports more than 80 percentage of its crude oil requirement, which is transported by sea. About 80 percentage of its domestic production is also from river delta or offshore oil wells; this is also transported through sea or pipelines. Performance of operations of Oil Terminal has great impact on the efficient operation, for refineries that depend on movement of crude oil through ports. At the port under consideration, the refinery has had periodic capacity expansions without parallel expansion in crude handling facility at the port. The port is interested in fully utilizing the facility already available and saturating it before investing in additional capacity. This is specially so when the present facility though a little stressed can meet current requirements.

Phased dismantling of Administered Pricing Mechanism (APM) and related changes in government regulations have resulted in drastic changes in policies and operations of refineries. Refineries have started focusing on cost reduction measures that was earlier not very relevant, since they were operating under a pattern that provided fixed assured return of investment provided the quantity targets were met. The introduction of Market Determined Pricing Mechanism (MDPM) has brought focus on cost control; since reduction in costs directly show up as increased margin, extra emphasis has given on reducing operating expenses and cost of procurement of their raw material (crude oil). About 95 percent of the total direct cost of a refinery is represented by cost of crude oil. The refinery understanding the limited expandability of the crude handling facility of the port is contemplating on setting up a Single Buoy Mooring (SBM) facility. Setting up of a separate Single Buoy Mooring by the refinery will result in great loss of earnings to the port (Bhasi, [1999]).

This decision is a new challenge to the Cochin Port Trust, because the crude oil requirement of Kochi Refineries Limited is presently moved through the Oil Terminal of the port. Oil terminal operation of any port is very critical because it is a major source of income with a minimum operating cost. In chapter 6, an analysis showed that an average of 67 percent of income is obtained from cargo handling and storage operation, 26 percent of income from port and dock charges and the remaining 7 percent from estate rentals. Out of the 67 percent of income obtained from cargo handling and storage operation, 61 percent of income is on account of the POL handling charges. The annual cargo handling and storage expense is 24 percent of the total annual expenses of Cochin port. Out of the 24% of the annual handling and storage expenses, the POL handling expenses is only an average of 5 percent. The ratio between POL handling expenses to the corresponding income is very low (12 percent). The manpower required for operation of the oil terminal is also very low when compared with other operations like container handling operations and general cargo operations. This shows clearly the crucial role played by POL operations in Cochin Port. The need for improvement of performance of this important operation, in the present condition of customer dissatisfaction, is therefore clear.

7.2 Cochin Oil Terminal processes

When the crude carriers come, they have to be received, berthed and crude unloaded as required and the tanker sent off. This is done at the COT; the sequence of operations here is shown in Figure 7.1. Different steps in the operation process and the issues related to the operations are discussed in the following sections.

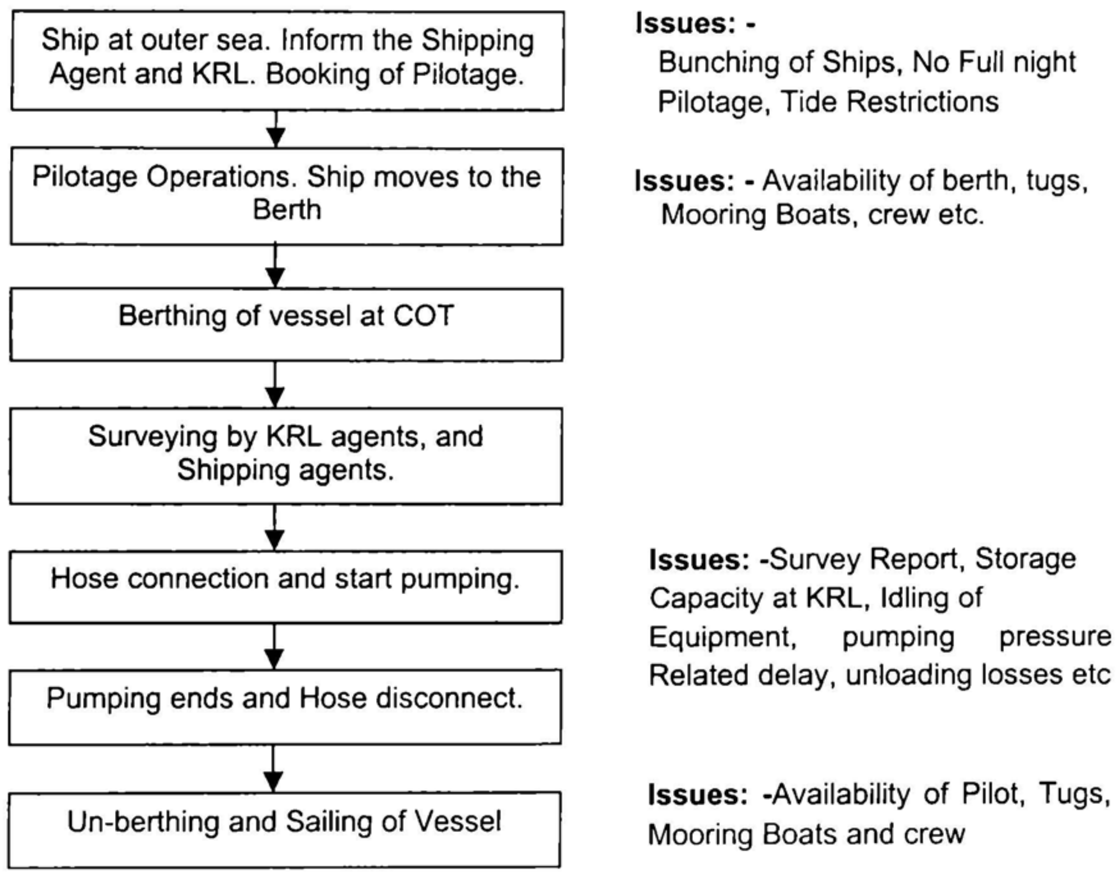

Figure 7.1 Block Diagram of COT Operations and the related issues.

7.2.1 Operations Procedure of COT

The operational procedure followed in COT operation is described below.

- Once the ship arrives at the outer sea, it contacts its shipping agents and KRL officers at the Jetty. The shipping agents then contacts KRL for instruction regarding berthing. NOR is issued by the ship.

- The berth allotment is done in the Berthing Committee Meeting to bring the vessel at COT, if the berth is vacant. The berth allotment is done on the basis of first come, first served/or priority given by KRL.
- The shipping agent then book in pilot for tanker to berth. The mooring crew is also booked. The port personnel are also requested to be ready to receive the tanker.
- The in pilot boards the ship in outer sea and navigates it through the channel to the berth. At the mouth of the channel at Fort Kochi two to three tugs approach the vessel and these tugs help the vessel to move through the channel and berth safely at COT. Once the mooring crew fastens the tanker at the Jetty, the tugs leave.
- The first activity after berthing is lowering of the gangway on to the jetty by the tanker crew. The in pilot now leaves the vessel. In case the vessel is carrying imported cargo or a foreign vessel, customs have to board the vessel first and only on getting customs clearance, KRL and other personnel can board the vessel.
- The surveyor appointed by KRL boards the vessel. In addition, there are surveyors of Shipping Corporation of India (SCI) and Shipping Agent also board the vessel. The boarding officers meet the Chief Officer and receive the Notice of Readiness (NOR). He also collects the Bill of Lading and other documents and request for a tank survey to be done.
- The Ship's crew deputed by the chief does the tank survey while the surveyor deputed by KRL, SCI and Shipping Agent's representative observes the same and make note of the readings.
- On completion of the tank dip readings, each of the surveyors use the calibration table for tanks and do calibration separately to arrive at the tonnage of crude carried by the vessel. Simultaneously three chicksuns of the unloading arm (ULA) are to be connected by the port personnel.
- Now after completing all procedural formalities such as agreeing on the ship to shore communication, emergency signals and safety formalities,

the KRL officer advises the chief to start pumping of crude, keeping the discharge pressure below 8 kgf/cm^2 at KRL manifold.

- The quantity discharged as per ships figure and as per KRL tank readings are also verified periodically (about every 4 hours). If the discharge pressure is very low, results in lower discharge of crude from the tanker and therefore more time at the berth.
- When the pumping is completed, the chicksuns are disconnected and a survey of the tanks is done once again. The chief signs the statement of facts and the tanker is ready to sail off.
- The out pilot who has been booked earlier boards the vessel and navigates it through the channel to the outer sea. Tugs help the vessel to move after the moorings have been removed. The vessel then is turned with the help of the tugs and then it sails off through the channel.

7.2.2 Issues related to Operation processes

The main problem that occurs here is the restriction put on vessel size due to draft limitations, due to which more economical larger vessels cannot be used to bring in crude. Delay in berthing of vessels or in their sailing out also occur at times due to lack of full night navigation facilities and the dependence on tide for sailing in. The main problem in planning occurs due to bunching of vessel arrivals, creating a situation when there are many vessels waiting for berthing. This results in demurrage payments by the user to the shipping companies, creating user dissatisfaction. There are also times when the berth is unoccupied and the crude handling facilities are idling.

7.3 Analysis of Vessel turnaround time

Operational time element data was collected from the logbooks of Cochin Port Trust and KRL for the year 2000. The data was tabulated and graphs were drawn. From the analysis, the bottlenecks in the operations and the reasons for poor performance of COT were identified.

A key performance measure, the vessel turnaround time, is found to be high. The reasons for this are analyzed below. Bottlenecks in the operations of COT are identified and strategies for improving the performance of operation and satisfying the customer are recommended. The vessel turnaround time is the time between the Notice of Readiness (NOR) and the time of reaching of the tanker from COT to outer seaway after discharge of the crude oil. The vessel turn around time is made up of smaller time elements, which are shown in a Pie chart in Figure 7.2.

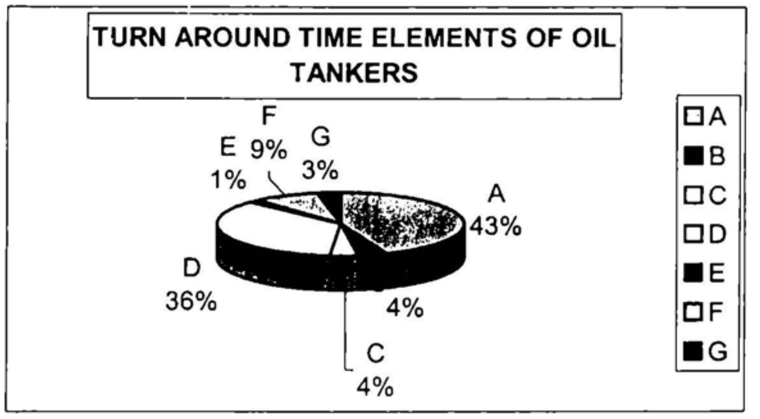

Figure 7.2 Time elements of Turn around time of vessels at COT

From Figure 7.2, it can be seen that 47 percent of turnaround time, is the time between the Notice of Readiness (NOR) and the Pilot On Board (POB) (A&B), whereas the pumping time (D) is 36 percent. The corresponding percentage is 4 for berthing to start of pumping (C), 1 percent for end of pumping to hose disconnection (E), 9 percent for hose disconnect to sail off (F) and 3 percent for sail off to reach outer sea (G). The two highest time elements were analyzed further to find reasons for their high values.

The characteristics of turnaround time of crude tankers arriving at Cochin Oil Terminal and its time elements were studied and its effects are discussed next.

Figure 7.3 shows the minimum, mean and maximum values of the turn-around time of crude tankers for one year. It is worth noting here that the minimum does not vary much from month to month, however the mean and the maximum times are higher in months when more ships come. When the monthly arrival pattern of tankers studied, it was also seen that the number of tankers arriving at oil terminal during April, May and June were less because the crude requirement is very low due to the shutdown maintenance usually planned during these months.

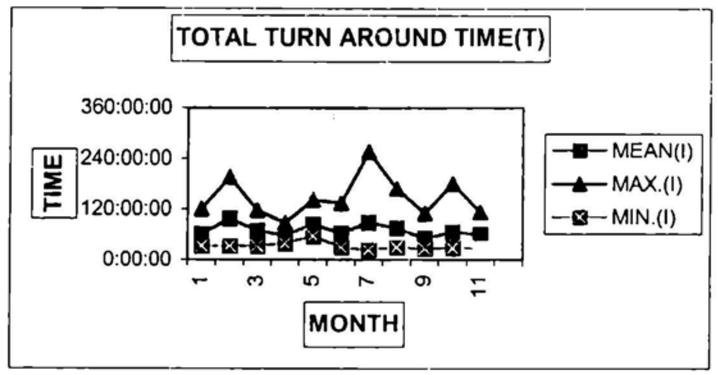

Figure 7.3 The characteristics of turn around time of tankers

The impact of high turnaround time is the resulting overstay of tankers at the Port and the consequent demurrage incurred by KRL. The normal time permissible for oil tankers at Cochin port trust is only 36 hours from NOR to Hose disconnect. The tankers that stay more than 36 hours have to be paid demurrage charges by KRL. The data shows that on an average of 72 hours of waiting time is there for the tankers at CPT. This time is very high.

7.3.1 Vessel Turnaround Time increase due to activities before discharge of crude

The first and most important time element of the turnaround time is the time between Notice Of Readiness (NOR) and berthing. Its variation on month basis is shown in Figure 7.4. Here again, it is seen that the minimum does not vary much from month to month, however the mean and the maximum times are higher in months when more ships come.

Since turnaround time and the time between NOR and berthing show the same characteristics, it is worth noting that any reduction in time from NOR to berthing will cause the reduction in turnaround time of tankers. The time between NOR to POB is very high due to various reasons such as (1) the berth occupied by another vessel, (2) restriction on full night pilotage, (3) tide dependent navigation, (4) delay for in-pilot and (5) delay in arranging tugs, mooring boats and crew.

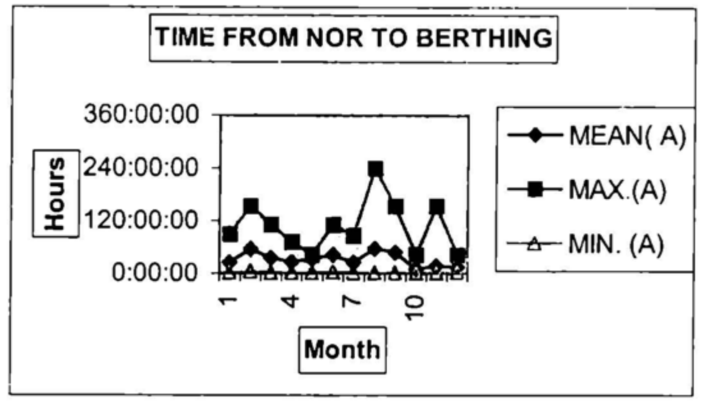

Figure 7.4 Variation of time between NOR and berthing

The next time element is the time from berthing to commencement of discharge. Its variation is shown in Figure 7.5. This time element is only 4 percentage of the turnaround time. It is seen that the minimum and mean time

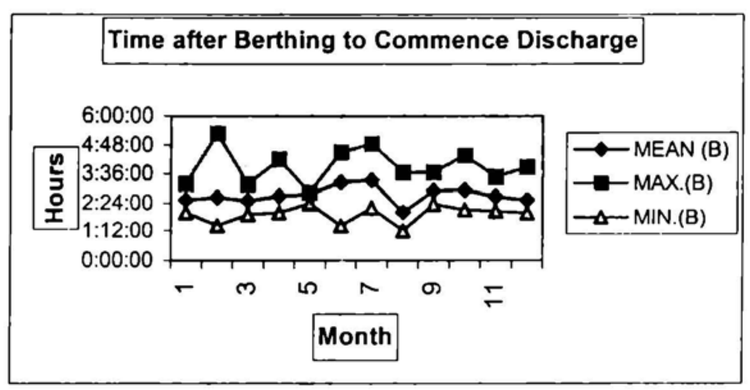

Figure 7.5 Variation of time element from berthing to commencement of discharge

are closer when compared with the maximum time. The maximum time comes around 5 hours in five months. This is mainly due to delay in getting survey reports from all concerned and getting clearance from the user. Here the delay on port account is very low and hence port has less control on this time.

7.3.2 Vessel Turnaround Time increase due to time for discharge of crude

The next important time element is the time for discharge of crude. Discharge of crude is done using pumps on board the tankers; the performance of this is tanker dependent. There is also constraint of maximum allowable pressure in the pipeline of 8 Kgf/sq cm, due to old age of the pipeline. Figure 7.6 shows the time for discharge in various months and it can be seen that the maximum time for discharge is high in the months of January through August except the month of May. This being a bottleneck resource, the high maximum time should be reduced. The curves of minimum, mean and maximum should be close to each other. The discharge should be maintained at highest levels to reduce the discharge time. The ways of maintaining a higher level of discharge is by keeping higher pressure rating at the shore and the line and by minimizing disturbances in continuous pumping.

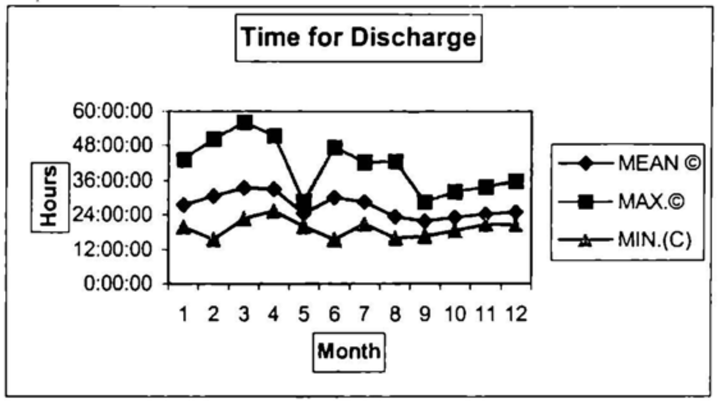

Figure 7.6 Variation of time of discharge of crude.

The pumping time is also high due to the combined effect of one or more of reasons such as (1) poor discharge pressure of tanker pumps, (2) low holding pressure of the pipe line from port to KRL and (3) high variation in pumping rate. The variation in pumping rate is due to inert gas (IG) problem, boiler problems of the vessel, Ullage problems of the storage tanks at KRL, leakage in line and in unloading arm, and very low pressure of the pumps. This variation in continuous pumping alone causes an average time loss of 1 percentage, which is significant considering the large amount of time, spent on pumping.

7.3.3. Vessel Turnaround Time increase due to time after the discharge of crude

The time between completion of discharge and hose disconnection from unloading arm was noted. Analysis of this time element shows that the minimum, mean and maximum times are very close as shown in Figure 7.7. The time for hose disconnection is about 1 hour. This is the last point in time up to which KRL is charged demurrage. Hence, the processes after this point have to be done by the Port without the follow-up of KRL. This creates tendency for delay since port is used to follow-up from users for doing work.

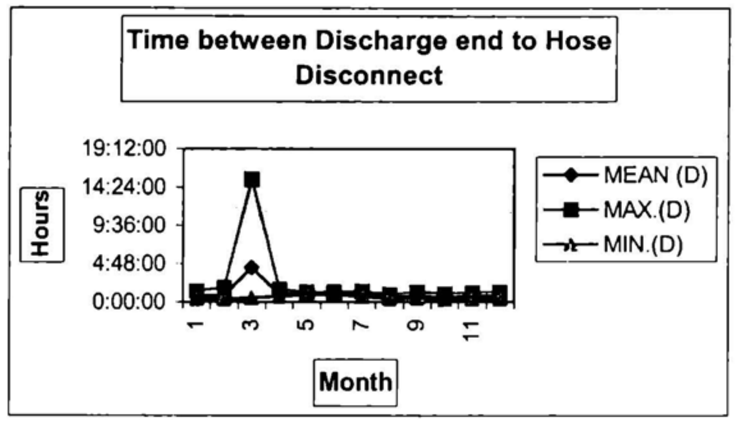

Figure 7.7 Variation of time between pumping ends to hose disconnect

The variation of time after the hose disconnection to the time of the sail off tanker from the berth accounts for 9 percentage of the turnaround time. The variation of time between pumping end to hose disconnect is shown in Figure 7.8. Here the minimum and the mean time are very close to each, showing that most of the times there is no undue delay here. But the maximum time has variation from month to month and it becomes very high at the last three months

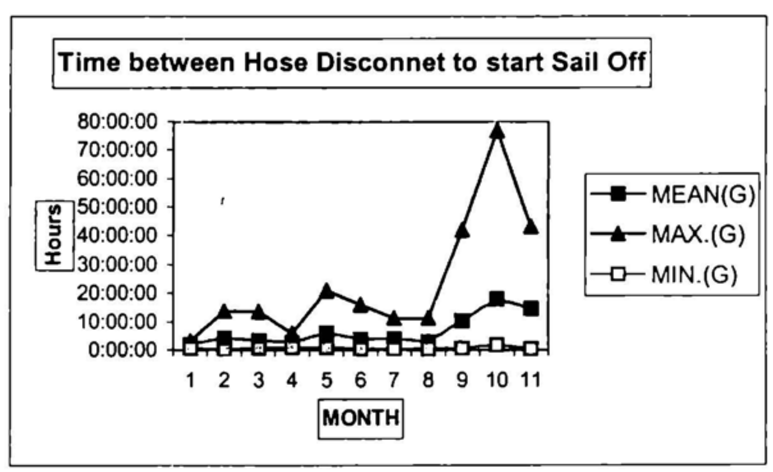

Figure 7.8 Variation of time between hose disconnect to sail off tanker

of the financial year, this is a negative sign and shows that there are cases where undue delay occurs. The occurrence of these undue delays has to be brought down to reduce the turnaround time. KRL has interest in sailing off the tanker only when another vessel is waiting for the berth. The reasons for delay are (1) no follow up from the user, (2) want of pilot, (3) delay in arranging tugs, mooring boats and its crew, and (4) full night pilotage restrictions.

From Figure 7.9, it is seen that the variation of the minimum, maximum and the mean time between unberthing and sail off time are minimum. It takes 3 percentage (2 hours and 25 minutes) of the turnaround time. This is reasonable when compared the time for berthing of ships that takes 4 percentage of the turnaround time

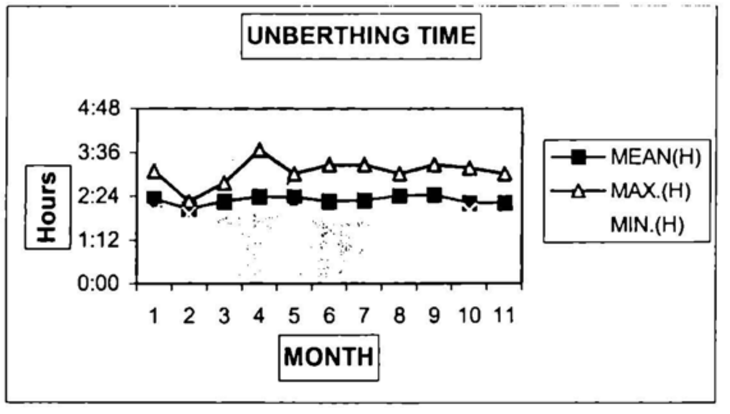

Figure 7.9 Variation of unberthing time

7.4 Rate of Discharge-Bottleneck effect

The refinery brought 2.7668 million metric tones (MMT) of Bombay high and 3.8819 MMT of imported crude during the period 2000-2001. This results in the requirement to handle an average of about 13 crude tankers per month with minimum of 3 tankers in May to maximum of 19 tankers in September. The parcel size of these tankers varied from 18836 MT to 72594 MT with the mean of 44028 MT. The monthly crude arrival and size was always more than 40,000 MT except in May. The crude arrival during non-monsoon months is high, and very high in the pre-budget months. The requirement of crude oil is limited in May due to the shut down of the plant.

It may be noted that though the allowable pumping rate is 2500 MT per hour, this was achieved only in the case of one tanker in the year under study. From the data collected, it is seen that the actual pumping rates for the ships vary from 335 to 2500 MT per hour with the average being 1712 MT per hour. This being the case, a simple calculation given below shows that about 50% time of the year if crude pumping is done, it will be enough to meet the refinery's crude requirement. Considering the fact that monsoon limits operations to 50% of normal levels during four months of the year in the other month's average required pumping utilization rate becomes 60.83 %. If the fact that about 150 tankers have to be handled per year is considered, and that pumping of crude cannot take place during 12 hours gap that comes between pumping from successive tankers is taken into account, the crude pipeline utilization goes up to 81.12 %. But when the berthing time allowances is 24 hours (instead of 12 hours) between ship departure and a berthing, the crude pipe line utilization goes up to 121.67 %. This creates an impossible situation; the bottleneck effect of this critical parameter is evident. The only way of de-bottlenecking this is by increasing the average pumping capacity of the crude from the tankers.

Table 7.1 Calculations for the Utilization levels of the crude pipeline

Hours of pumping required per year = Refinery capacity/ Average pumping rate = 7500000/1712 = **4380 hours.**
A. Therefore, Percentage of pumping time required = (Hours of Pumping/ Hours in a year)*100 = (4380*100)/(365*24) = **50%**
B. Percentage of pumping time with monsoon limits = 4380/(24*30*8+12*30*4))*100 = **60.83 %**
C. Percentage of pumping time with monsoon limits and berthing time allowance of 12 hours between a ship departure and a berthing = (4380/{(24*30*8+12*30*4- 150*12)}/*100) = **81.12%**
D. The same calculation as **C**, but with inter ship time of 18 hours instead of 12 = (4380/{(24*30*8+12*30*4-150*18)}/*100) =**97.33%**
E. The same calculation as **C**, but with inter ship time of 24 hours instead of 12 = (4380/{(24*30*8+12*30*4-150*24)}/*100) =**121.67 %**

Based on the calculations shown in Table 7.1, a sensitivity analysis has been done to show the effect of change in average pumping rate from 1000 MT per hour to 2500 MT per hour and inter ship gap in berthing on the need for utilization of crude lines from jetty to KRL, keeping all parameters constant. The summary of the result is shown in the Table 7.2. The results clearly indicate that with 1750 MT per hour pumping rate and 12 hours gap between tanker berthing approximately 80 % crude pipeline utilization exists which is very high and is near maximum limits.

Table.7.2 Analysis showing the effect of change in pumping rate and inter ship gap in berthing (feasible scenarios are indicated in **BOLD** Numbers)

Average pumping rate in MT	1000	1250	1500	1750	2000	2250	2500
A. Normal crude pumping in %	85.62	68.49	57.08	48.90	42.80	38.05	34.25
B. With monsoon limits in %	104.17	83.33	69.44	59.52	52.08	46.30	41.67
C. With monsoon limits+12hrs in %	138.89	111.11	93.59	**79.36**	**69.44**	**61.73**	**55.56**
D. With monsoon limits+18hrs in %	166.67	133.33	111.11	95.24	**83.33**	**74.07**	**66.67**
E. With monsoon limits+24hrs in %	208.33	166.67	138.89	119.05	104.17	92.59	**83.33**

7.5 Types of tankers arriving at COT and study of its discharge

The above discussions have clearly shown that discharge time is a key-limiting factor in performance improvement of COT. This time is primarily dependent on the tanker pump discharge pressure and its variability. This being the case, the pumping performance of different tankers bringing crude for KRL to COT was examined. During the period under study about 150 different tankers came. It was seen that some vessels owned by Shipping Corporation of India (SCI) come frequently with Crude for KRL. There are about 12 tankers coming between 5 to 10 times per year and 5 tankers coming above ten times per year. A tanker was seen to have come even 24 times in a year. These frequent visitors have to be selected considering their crude pumping performance. Data revealed that the average discharge rate of 6 number of these frequent tankers were below the average of 1700 MT per hour. These tankers unnecessarily choke up the crude unloading system, and therefore they should be avoided. The analysis of the discharge pressure shows that only once the pumping is performed with the allowable pressure of 8 Kgf/cm^2. It is clear that the performance of the pumps is poor; this is due to old age and poor maintenance of the pumps. This point is supported by secondary data of the Indian and Foreign ships which reveals that 24.28 and 27.31 percent of the respective ships are more than 20 years old [Indian Shipping Statistics, 2000].

7.6 Draft Restriction

The draft available at COT is 11.7metres.The required draft for different class of tankers that reached at KRL is shown in Table 7.3. It is seen that the dead weight tonnage (DWT) load for KRL has varied from 18,836 tons to 72595 tons of crude oil. It can be seen from Table 7.3 that tankers do not bring full load to Cochin and this is mainly due to fear of draft availability. At times lower parcel size is brought because of joint loading for Mangalore and Kochi Refinery and unloading at Mangalore first.

Table.7.3 Draft requirement for different types of Tankers

TYPE	DWT Capacity	Max.Pumping Rate (T/Hr)	DWT Load for KRL	Draft Requirement in meters (Full)
MR	40,000	2040	37,000	10
LR1	63,000	2720	49,000	12
LR2	87,000	4080	58,000	14
SUEZ MAX	1,47,000	6125	80,000	16

The LR2 vessel with 87,000 DWT capacities can be brought to COT, if they utilize the high tide facility available at Cochin Port. To understand the tide advantage for bringing high capacity tankers at COT, the tide table for the Cochin Port Trust 2001 has studied. Table 7.4 shows the month wise average high and low tides. An average 0.9 m high tide is available. But the high tide is greater

Table.7.4 Average tide Height of Cochin Port Trust in 2001

Month	High Tide (m)	Low Tide (m)	High Tide (m)	Low Tide (m)
January '01	1.169	0.37	0.945	0.752
February '01	1.026	0.47	1.018	0.523
March '01	0.916	0.414	0.963	0.426
April '01	0.86	0.458	0.845	0.269
May '01	0.812	0.339	0.836	0.371
June '01	0.831	0.356	0.822	0.342
July'01	0.831	0.355	0.798	0.307
August '01	0.802	0.31	0.758	0.281
September '01	0.787	0.293	0.752	0.291
October '01	0.827	0.339	0.779	0.358
November '01	0.9	0.456	0.918	0.423
December '01	1.01	0.564	1.013	0.489
AVERAGE	**0.90**	**.39**	**0.87**	**0.10**

than 0.9m in December (1.01m), January (1.169m), February (1.026m), and in March (0.916 m). In all other months, the tide height is less than 0.9m, and it is minimum in September (0.787m). Hence, the tanker schedule has to be arranged according to the availability high tide to get maximum benefits. The high capacity tanker has to be scheduled during the month of January, February, and December, and low capacity tanker has to be scheduled in other months. If so possible, the number of tankers can be reduced and hence the bunching of tankers can be reduced, and thereby reducing the turn around time of tankers, which reduces the demurrage charges substantially.

Table.7.5 shows the frequency of arrival of three different classes of crude tankers at COT for a period of one year. Since at least 12 hours on an average is lost between uses of berth by consecutive tankers, decreasing the number of tankers can increase the total discharge. This can be done keeping the annual crude requirement the same only by bringing larger parcels in larger tankers. A major constraint in doing this is the draft available now. A formula of sharing the benefits gained by KRL from this step, with Cochin Port to take care of the additional expense incurred by them for dredging will have to be worked out before this becomes possible. A study to determine the cost-benefit of dredging and finding the optimal dredging depth is the next necessary step recommended.

Table.7.5 Frequency of arrival of crude Tankers

CLASS	PARCEL SIZE IN TONNAGE	FREQUENCY OF ARRIVAL
A	Less than 50,000	115(75%)
B	50,000-70,000	36(24%)
C	Greater than 70,000	2(1%)

7.7 Crude Tanker Selection using Simulation Model

World over operations management is moving from thumb rule based decision making to data fed model-based decision-making especially in the area of logistics. Several techniques were used for crude scheduling process. Most approaches in crude oil tanker schedule for oil refinery rely either on simulation (Coulbeck, [1988]) or on pipeline sequencing per se, not taking account of manufacturing complication such as Crude Distillation Unit (CDU) runs, tankage etc. (Indian Shipping Statistics, [2000]).

7.7.1 Problem Statement

Oil terminal operation of any port is very critical because it is a major source of income with a minimum operating cost for the port. The refinery wants flexibility in tanker capacity choice, and would like maximum flexibility in scheduling the tanker arrivals at the port so as to minimize its inventory holding requirements and crude transportation and handling costs. The port on the other hand would like to have the facilities already available used to the maximum before putting up extra capacities at additional capital expenditure. The increased utilization of the COT puts restrictions on flexibility of crude tanker scheduling and results in demurrage payment to tankers since most of the times tankers have to be kept waiting at outer sea to ensure their availability for unloading whenever berth is free. The analysis in section 7.3 shows that 44 percent of the turnaround time is the time between the Notice of Readiness (NOR) and the Pilot on Board (POB) clearly indicating that tankers have to spend a lot of time waiting for berth resulting in demurrage.

Figure 7.10 shows the hours of overstay of oil tankers at Kochi. From the graph, it is seen that the minimum time is almost same, but the maximum time is high except in May and October.

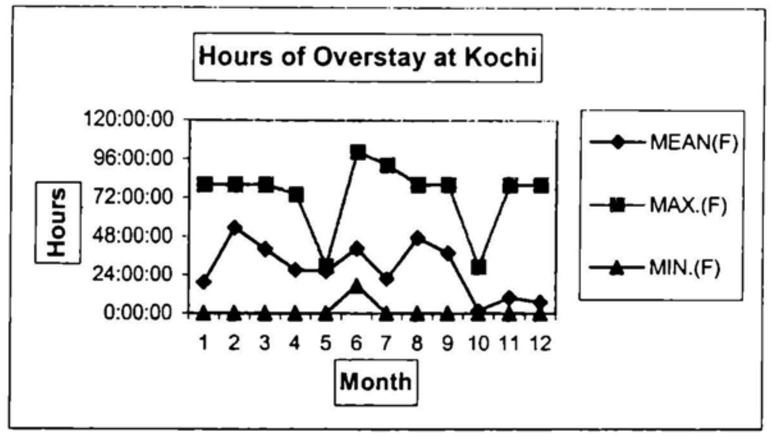

Figure 7.10 Month wise overstay of tankers at CPT

Like all river mouth port, Cochin port also suffers from silt accumulation problem resulting in limited draft availability. Due to this, more economical larger vessels cannot be used to bring crude. COT being the bottleneck must be used the maximum. COT is not being used in the time between the departures of a tanker after unloading, to the time of berthing of the next tanker. This idle time during the month has to be minimized. One way of doing this is by reducing the number of tankers arriving during a month. This has to be done keeping the tanker size and numbers large enough to meet the crude requirement. Another factor influencing this decision will be the tanker availability, its hire charges and port charges. The actual parcel size of these tankers is currently seen to vary from 18836 MT to 72594 MT with an average of 44028 MT.

The tanker occupies the COT while discharging crude. This time is seen to be high due to the combined effect of one or more of reasons, which are: 1) poor discharge rate of the tanker pumps, 2) low holding pressure of the pipeline from the port and 3) high variation in discharge rate. The study of data of 150 tankers that used COT during August 2000 to July 2001 showed that pumping pressure varied from 2 Kgf/cm^2 to 7.8 Kgf/cm^2 with an average of 5.57 Kgf/cm^2. The corresponding rate of discharge varied from 335 MT per hour to 2500 MT per hour, with an average of 1712 MT per hour. There is therefore clear need to keep the discharge rate high and reduce variations in the same. There is restriction on the maximum safe holding pressure of the crude pipeline in this case due to its old age and because it passes through the heart of a busy city.

The problem at hand is to find out the optimum choice of tanker size and number required each month to bring in crude oil to the refinery under consideration. The crude oil discharge rate that these tankers must maintain for optimum performance is also to be found out. The hire cost of the tankers and their port related charges are inputs to the problem. The problem has to be solved using tankers subject to draft restriction and discharge rate subject to maximum safe pipeline holding pressure.

7.7.2 Methodology and Model

The problems above are characterized by the presence of probabilistic time elements for activity duration, and parallel multiple activity occurrences. Such real life problems are modeled well by discrete event computer simulation. The methodology used here involved the development of a basic simulation model to represent the tanker arrival, waiting at outer sea, berthing, discharging crude oil and then sailing off. The occurrence of day and night and change in tide are also incorporated in the model. The model uses as input tanker arrival schedule, crude discharge rate and tanker hire and port charges. The output from the model are: (1) monthly total cost, (2) tonnage discharged, and (3) minimum, mean and maximum time of stay of tanker at port.

Considering safe holding pressure of the crude pipeline, working discharge rates of 1250, 1500, 1750, 2000, 2250 and 2500 MT/hour were the options examined by using the simulation model. Taking into account the draft restrictions at the port tankers of size 35, 55 and 70 thousand DWT were onlyused in the model. It was assumed that enough numbers of the tankers of each of the above size are available. It was also assumed that for the above tanker sizes there would be no tide restriction for movement in and out of the harbour. Discharge is assumed to take place continuously at the constant rate given to the model. Breakdown of equipment, which is very rare in practice, is assumed to be negligible. Tankers are scheduled and arrive at the outer sea at equal intervals during a month. The flow chart showing the logic used in the simulation-based model is given in Figure 7.11.

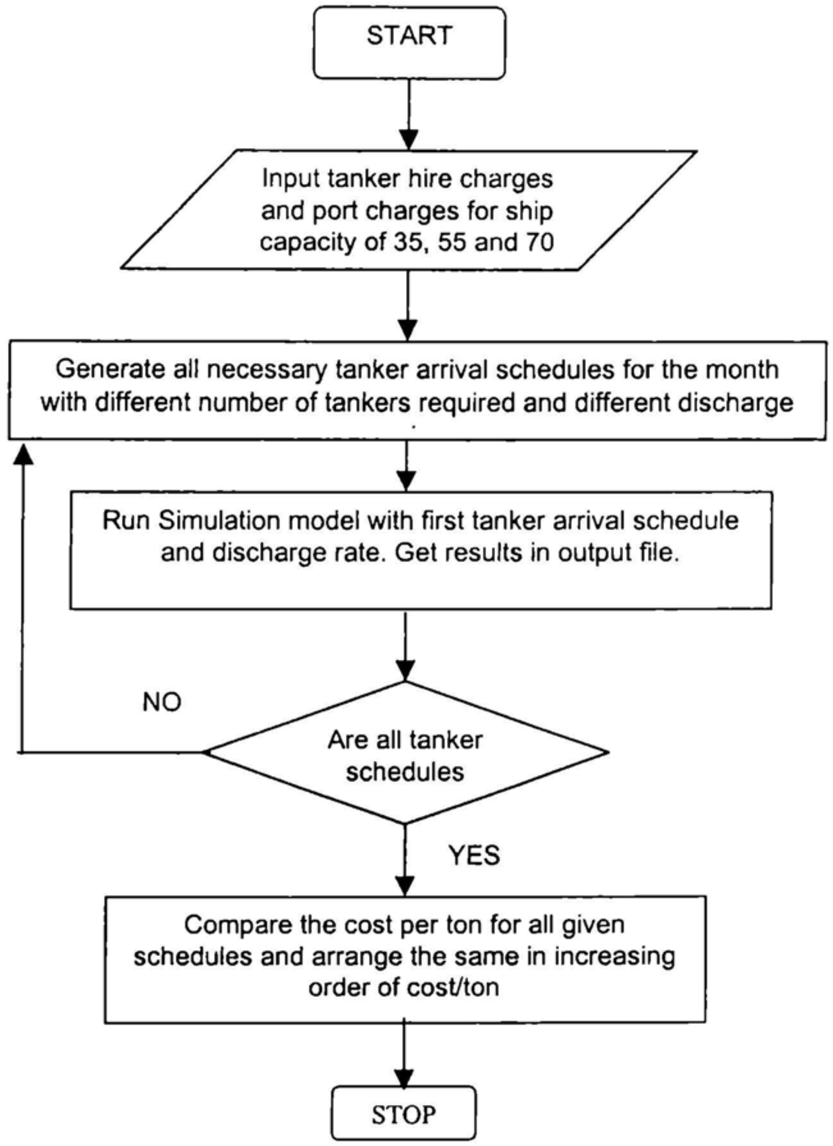

Figure7.11 Flow chart of the model

A simulation model was developed the using SIGMA, of which the details are available in Schruben, [1995]. It is a commercially available discrete event simulation package based on event graph representation of models. This event graph concept is useful in recording, development, and debugging of the simulation model. The model so developed converted into PASCAL and the other input-output modules are added for use and faster execution. The event graph of the crude tanker operation at the port is shown in Figure 7.12. The description of the events in the event graph is given in Table 7.6.

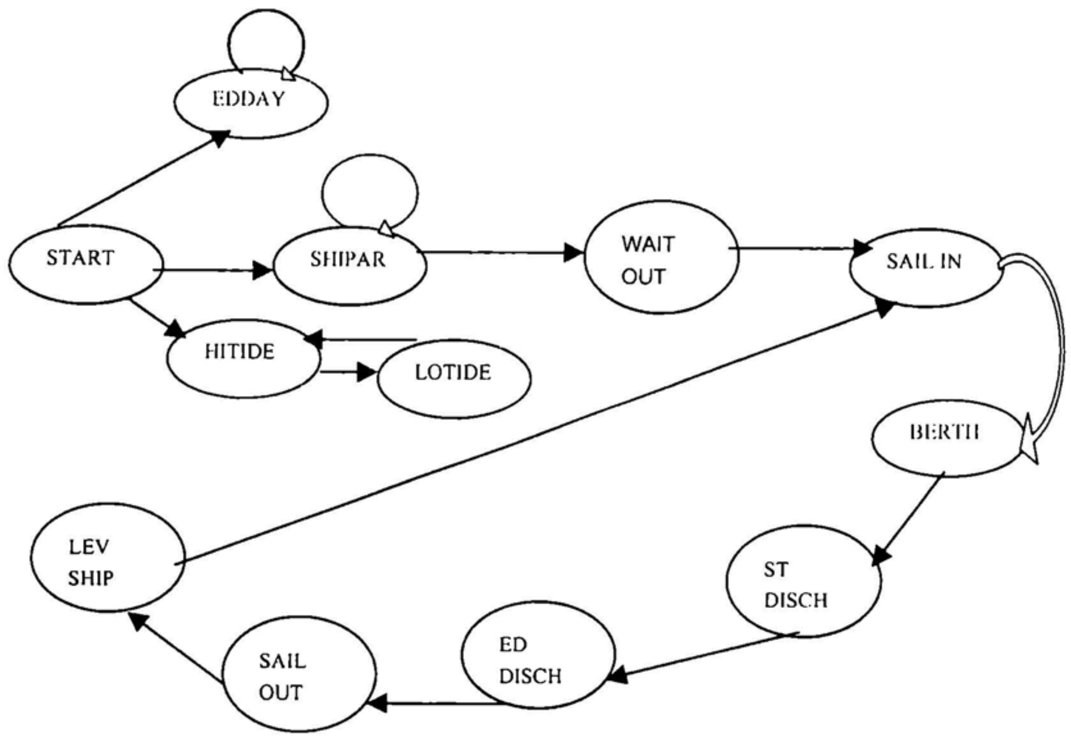

Figure 7.12 Event graph of the simulation model

Table 7.6 Description of events in event graph of the simulation model

Node Name	Description
START	Initialization of variables and start of simulation
EDDAY	Event of end of day occurs
HITIDE	High tide occurs and schedules next low tide occurrence
LOTIDE	Low tide occurs and schedules next high tide occurrence
SHIPAR	Next tanker carrying crude oil arrives at outer sea
WAIT OUT	Tanker joins Queue of waiting ships at outer sea for berth.
SAIL IN	Tanker starts sailing in to harbour for berthing
BERTH	End of berthing of Tanker
ST DISC	Start of crude oil pumping from berthed tanker
ED DISC	End of crude oil pumping and Hose disconnected
SAILOUT	Tanker leaves berth
LEVSHIP	Out-pilot leaves tanker at outer sea.

The model was modified the tanker loading and unloading rules were incorporated to get a basic crude tanker unloading simulation model that formed the base of model to find the monthly cost per ton, minimum, mean and maximum days of each tanker in the berth for given tanker schedule.

The white box method was used for validation of the model. In this method, the actual logic of operation was compared with that followed in the simulation model to make them the same. For this, the detailed schedule of tanker unloading for the month was compared with what would happen in reality for both sequence of events and their times of occurrence and the model were validated.

7.7.3 Results from the experiments using the Simulation Model

Figure 7.13 shows the variation of total cost/MT for a 35000 DWT tanker when the discharge rate is varied from 1250 to 2500 MT/hour. Each curve on in the figure represents the case of 8 tankers arrival per month to 25 tankers arrival per month. From the figure it can be seen that the lines for tankers 8 to 18 arriving in a month are bunched together, indicating that there not much cost difference per ton between them. Since 18 tankers of 35000 DWT are required per month to satisfy the crude oil requirement of the refinery, the same is therefore recommended. It is also worth noting that in case more than 18 tankers are brought in special attention should be given to maintain discharge rates at 2250 MT/ hour, at least 1750 MT/hour should be definitely maintained to prevent cost escalation.

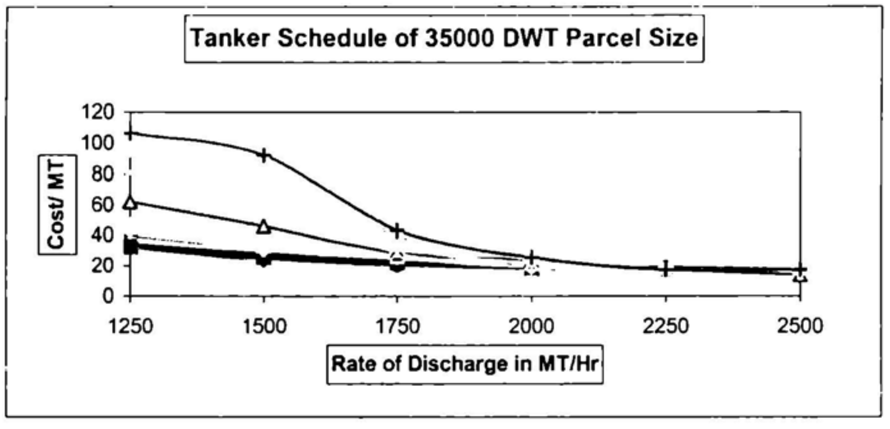

Figure 7.13 Variation of Cost/ MT and rate of discharge for the tanker of 35,000 DWT

Similar to the above, Figure 7.14 shows the variation of total cost/MT for a 55000 DWT tanker when the discharge rate is varied from 1250 to 2500 MT/hour. From the figure it can be seen that the lines for tankers 8 to 12 arriving in a month are bunched together, indicating that there not much cost difference per ton between them. Since 12 tankers of 55000 DWT are required per month to satisfy the crude oil requirement of the refinery, the same is therefore recommended. Unlike the case in Figure 7.13 in this figure the lines do not meet at all, this is because when more number of these medium size tankers arrives some have to wait for unloading. It is also worth noting that in case more than 12 tankers are brought in special attention should be given to maintain discharge rates at 2250 MT/ hour, at least 2000 MT/hour should be definitely maintained to prevent cost escalation.

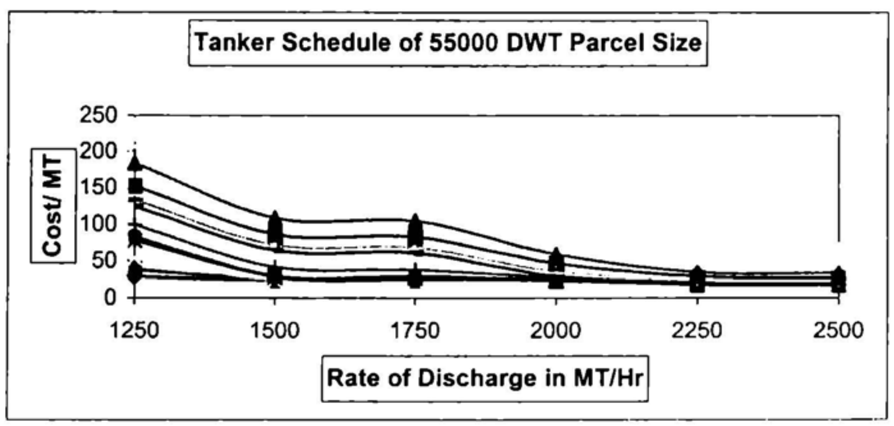

Figure 7.14 Variation of Cost/ MT and rate of discharge for the tanker of 55,000 DWT

Similarly, Figure 7.15 shows the variation of total cost/MT for a 70000 DWT tanker when the discharge rate is varied from 1250 to 2500 MT/hour. From the figure it can be seen that the lines for tankers 8 and 9 arriving in a month are bunched together, indicating that there is not much cost difference per ton between them. Since, 9 tankers of 70000 DWT are required per month to satisfy the crude oil requirement of the refinery the same is therefore recommended, and discharge is to be kept at 2000MT/hour. Unlike the case in Figures 7.13 and 7.14, in this figure, the lines are all separate at the beginning when discharge rate is low, they come closer only near 2500 MT/hour discharge rate. But even at this rate they do not all meet. It is also worth noting that in case more than 9 tankers are brought in special attention should be given to maintain discharge rates at 2500 MT/ hour, at least 2250 MT/hour should be definitely maintained to prevent cost escalation.

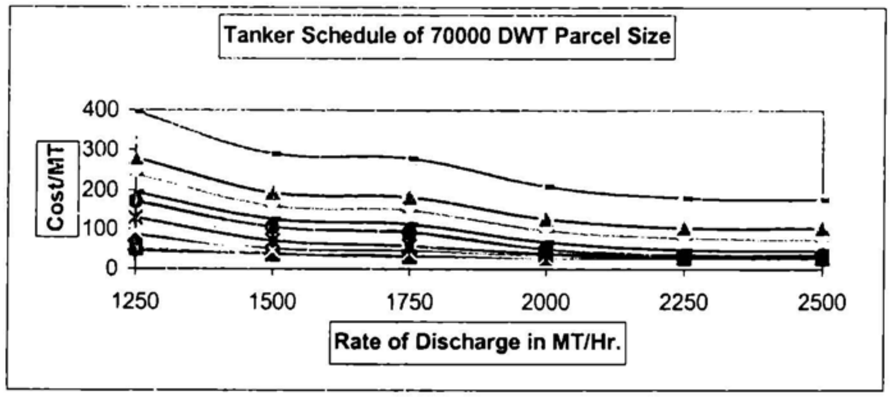

Fig.7.15 Variation of Cost/ MT and rate of discharge for the tanker of 70,000 DWT

In the above analysis, it was separately examined and the number of tankers to be brought every month and discharge rate to keep in the case of tankers of 35, 55 and 70 thousand DWT capacity were found out. The comparison between options of using the three different tanker sizes has to be now recommended. A comparison of the best alternative for each tanker size is given in Table 7.7.

Table 7.7. The best result that obtained from the simulation output for each parcel size

Choices	Parcel Size in MT	No. of Tankers in each month	Rate of discharge in MT/ Hour	Ship Hire Charges/ MT in Rs.	Handling Charges/ MT in Rs.	Total cost per MT in Rs.	Qty Handled in MT	Minimum, Mean, and Max. Days of Stay at Kochi		
1	35,000	18	2250	17.14	12.93*	30.07	630000	0.8	1.1	1.2
2	55,000	12	2250	17.73	13.67*	31.40	660000	1.3	1.4	1.6
3	70,000	9	2000	28.57	14.45*	33.02	630000	1.8	2	2.1

* Source: Published data from' Indian Ports', Vol.XXX1, July'99 [6]

The first alternative is the best choice for the refinery because the total cost per MT is least at Rs. 30.07/MT. There is no demurrage charge under this alternative because the maximum days of stay of the tanker are only 1.2 days where as the permissible day is 1.5 days without demurrage charges. The excess time available can be effectively utilized for the scheduled maintenance of the handling facilities at COT. One major drawback of this alternative is the lengthy procedure and documentation formalities due to larger number of tanker calling in the same month. If the number of tankers is less, the effort for completing the procedure and the documentation will be less.

The second alternative is a better choice for port when compared with the first alternative because the handling charge is higher than that of the first choice. This is a better choice for refinery also because of three reasons. First, there is need only to hire, plan and schedule lesser number of tankers every month, and there is lesser variability in the system. Second, the effort for completing the procedure and other formalities are less due to small number of tankers that call at the port. Finally, larger size tankers are seen to have better pumps for discharge of crude. But the cost per MT is slightly higher when compared with the first alternative.

The third alternative is the best choice for port because their earning will be maximum, and it is the worst choice for refinery among the three alternatives due to the highest cost per MT of crude oil. This cannot be therefore recommended.

7.8 Conclusion

In this chapter, focus was on the critical operational parameters of Cochin Oil Terminal. The bottlenecks in the operation of COT were identified and effects of key parameters on its performance were studied. Pre berthing delay was found to occur due to the following reasons: (a) berth occupied by another vessel, (b) full night navigation restriction, (c) want of pilots, tugs, mooring boats and its crew and (d) delay in getting of survey report. A key parameter, discharge time, was found to be high due to the poor performance of the discharge pumps in the tanker, and low allowable pressure of the old crude pipe line from COT to KRL. The time after finishing of discharge to sail off was also to be seen high in the case of some tankers. COT is clearly a bottleneck and de-bottlenecking can be done by either increasing average discharge rate from tankers or by bringing fewer tankers with larger parcel size. The later can be done only after dredging the channel deeper, which requires huge capital investment. An arrangement for sharing the gains by bringing larger tankers between KRL and Cochin port trust will have to be worked out for this. A study to find the viable depth of dredging is also recommended.

The discrete event based simulation model of the Oil tanker berth operations was successfully developed and used for finding the size and number of tankers to use to bring in the crude for the refinery. The least cost alternative for the refinery was found out and recommended. Besides cost per ton, there are other factors such as volume of paper work and other work generated, requirement of time for maintenance, etc that have to be considered when determining the tanker size to use. Considering all the above, it is suggested that a system of bringing a few 55 thousand DWT tankers with majority of 35 thousand DWT tankers would be a solution suitable both for the port and the refinery.

In this simulation model, tankers were made to arrive at equally spaced intervals; this is not true in real case where clubbed tanker arrivals do take place making the situation worse. There could be the case of arrival of different size tankers in the same month schedule. This basic model can be used to test this and other effects of different tanker arrival schedules on the system and check the impact on Cost per tonne and other performance measures.

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CHAPTER 8

STUDY OF RAJIV GANDHI CONTAINER TERMINAL

8.1 Introduction

A container terminal is the point where sea and land operations of containers meet. It requires large facilities for the extensive functions it has to perform when compared with conventional mooring facilities. Being the hub of the whole container transport system, it is charged with the important functions such as planning and performing orderly loading/unloading of ships and storage, handling and delivery of containers in the terminal, while always collecting all necessary information concerning ships' schedules, booking position, land transport situation, progress of jobs in the container yard (CY) and the container freight station (CFS), demand and supply of containers, delivery schedules, etc., to organize the smooth flow of containers through all segments.

Containers are large boxes that are used to transport goods from one place to another. Several transportation systems can be used to transport containers from one place to another. Transport over sea is carried out by ships. On the other hand, trucks or trains can be used to transport containers on land. To transship containers from one mode of transportation to another, ports and terminals can be used. Containers were used for the first time in the mid-fifties. Through the years, the proportion of cargo handled in containers has steadily increased. As a result of the enormous growth in container traffic, the capacity of ships has been extended from 200 to 8000 TEUs and more. Furthermore, the importance of ports and terminals has grown. With the introduction of larger ships, small terminals have changed into large terminals. To ensure a fast transshipment process, at large terminals a high degree of coordination is necessary. These terminals can be operated by using, among other things, information technology and automated control technology. As the result of use of new technology and automation, efficiency of container terminals have improved along with enormous increase in the volume of cargo from 0 TEU in 1964 to 225.3 million TEUs in 2000.

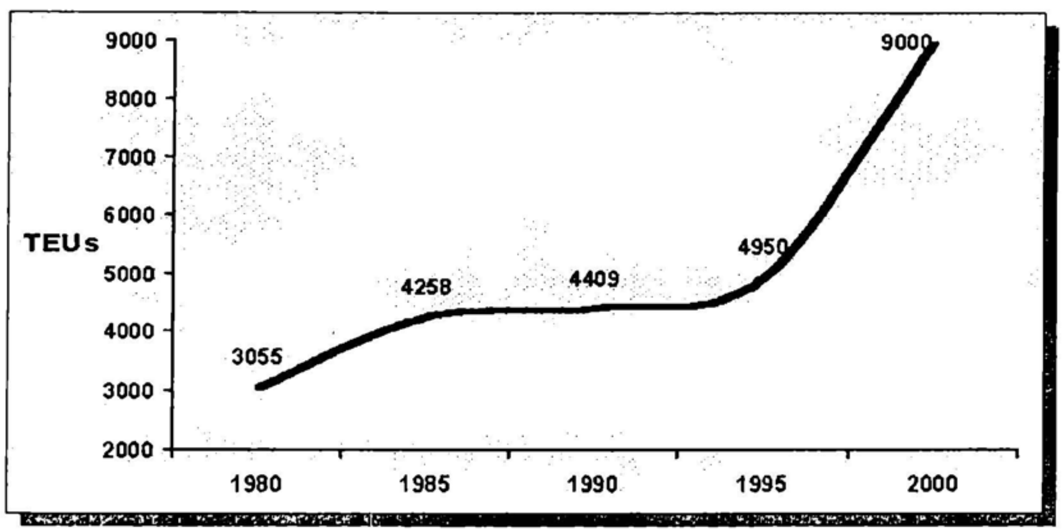
This chapter discusses the history and development of containerization worldwide, followed by the development of containerization in India. An outline of containerization of Cochin port is incorporated including the export and import processes of Rajiv Gandhi Container Terminal (RGCT). An analysis is done to identify the operational problems of RGCT. Work-study method is used to improve the stuffing and de-stuffing operations of the Container Freight Station (CFS). A simulation model is developed to study the effect of congestion in the container yard and the increase of existing area of stacking yard on turnaround time of ships.

8.1.1 History and Development of Containerization

Land containers, were developed and introduced by the United States' railroads in the 1920s. These were then widely adopted by the European and Japanese railways after the Second World War, as the bearer of rationalization of cargo transport by rail. With the advent of international sea/land through transport in the 1960s, rail containers provided a chassis for this transport. In sea transport also, the development and use of 'lift van', fairly comparable to today's containers, could be traced back to the 1920s. However, the U.S.Army first introduced the original marine containers in the military sealift during the Second World War.

Through in the 1950s, ocean transport of general (dry non-bulk) cargo used break-bulk (i.e. on pallet) methods; pallets were moved, generally one at a time, onto a truck or rail car that carried them from the factory or warehouse to the docks. Then each pallet was unloaded and hoisted by cargo net and crane of the dock and on to the ship. Once the pallet was in the ships hold, it had to be positioned precisely and braced to protect it from damage during the ocean crossing. This process was then reversed at the other end of the voyage, making the ocean transport of general cargo a slow, labour intensive, and expensive process.

All of this began to change in 1955. Malcolm McLean, believing that individual pieces of cargo needed to be handled only twice -at their origin when stored in a standardized container box and then at their destination when unloaded. He purchased a small tanker company, renamed it Sea-Land, and adapted its ships to transport truck trailers. The first voyage, to Puerto Rico, of a sea-land began from Newark, New Jersey, USA, on April 26, 1956. Confrontations with shipping lines, railroads, and unions, however delayed the company's maiden international voyage to Rotterdam until McLean's Sea Land inaugurated the first transatlantic container service between Port Elizabeth and Rotterdam in 1966. Things changed, the service was successful and the turning point was made. Further, containerization as something to replace conventional liner trades with full containership capable of loading numerous containers was initiated in 1966 by the utilization of the converted containership 'Fairland' by the Sea-land Service Inc. in the North Atlantic. In mid September 1968, Japan NYK introduced first special purpose deep-sea vessel outside US, 752 TEUs, Hakone



Source: Drewry Shipping Consultants and ECLAC (forecast for the year 2000).

Figure 8.1: The Capacity of Large Container Vessels

Maru in service. Containerization had then become international. From 1970 onwards container throughput has increased enormously. As the container throughput increased, the capacity of the containerships also increased accordingly. The increase in capacity of container ships over the years is shown in Figure 8.1.

In the years that followed, standardized containers were constructed, generally twenty and forty feet long without wheels, having locking mechanisms at each corner that could be secured to a truck chassis, a rail car, a crane, or other containers inside a ship's hold or on its deck. The use of standardized containers also meant that intermodalism of international trade, the movement of cargo from an origin in one country to a destination in another by more than one transport mode, became commercially feasible.

To handle the containers from the ship to shore and vice versa, either the ship should have its own crane (geared vessels) or those should be improvised crane system in the wharf. With the innovation of container cellular vessels, cranes in the ships have vanished; the port-in berth should have crane system for handling the containers. Individual improved shore cranes cannot reach all the stacks in cellular vessel. Hence, the need to have quay gantry cranes with the sufficient reach to handle the container became evident. These are again automated with a single operator, which was one of the milestones in the development of modern container terminals.

8.1.2 World Scenario Today

As stated earlier, McLean's effort to sail a vessel in US on 26 April 1956 with 58 containers on board made a beginning of containerization of Ocean borne cargo traffic. The effect of containerization on international ports was seen only by 1974. In 1970, the containerized traffic was hardly 6.3 million TEU. By 1995, it had grown to 130 million TEU. By 1997, about 75 to 80 percent of break bulk has containerized internationally. The process of concentration in ports and shipping has gained force in recent years. Regular liner shipping companies are merging, alliances being formed and container ship sizes are increasing substantially. Private international port operators have established themselves and are acquiring a growing market share as a result of privatizations and the growing volume of trade. Hub ports are experiencing strong growth based on the increase in container transshipment. The latter is linked to the development of global service networks by shipping lines and the increasing difference in size between large and medium-sized vessels, which makes it economically viable for freight to be transferred from a feeder to a larger vessel for the greater part of the journey. Table 8.1 shows the volume of containerized cargo handled and the percentage of total traffic over the years from 1985 onwards.

Table 8.1 Container traffic

Year	Quantity Handled in Million TEUs	Percentage of Total Traffic
1985	54.58	--
1990	86.53	--
1995	144.53	--
1996	157.39	8.9
1997	174.36	10.8
1998	190.75	9.4
1999	209.66	9.9
2000	225.30	18.7

Source: Review of Maritime Report 2002 by the UNCTAD Secretariat.

As the volume of world traffic increased, the capacities of shipping lines also simultaneously increased. Table 8.2 shows the capacity of the 10 major shipping lines in 2001. Each of the 7 leading lines already has an accumulated carrying capacity in excess of 200000 TEU. The capacity of these lines is about

Table 8.2 Major Alliance of Shipping Co.

Sl.No.	Major Shipping Companies	Country/Territory	Number of Vessels	Capacity (TEU)
1	Maersk Sea-Land	Denmark	293	693237
2	P&O Ned Lloyd	UK/Netherlands	147	380009
3	Evergreen Group	Taiwan province of China	131	348650
4	Hanjin/DSR-Senator	Republic of Korea/Germany	87	299490
5	MSC	Switzerland	150	296064
6	NOL/APL	Singapore	85	244848
7	COSCO	China	130	228060
8	CMA-CGM Group	France	72	176278
9	NYK	Japan	78	169921
10	CP Ships Group	Canada	81	160206
WORLD TOTAL				**7057915**

Source: Review of Maritime Report 2002 by the UNCTAD Secretariat.

38 percent of the world fleet capacity. Table 8.3 shows the available capacities of container ships region wise for the year 2002, of which 76.6 percentage is the contribution of developed countries and the remaining 23.4 percentage is the contribution of the remaining countries of the world.

Table 8.3 Capacity of Container ship by Region in 2002

Region	Capacity of Container Ships in TEUs	Percent of the world capacity of container ships
1.Developed Market Economy Countries	1785609	33.3
2.Major open Registry Countries	2317543	43.3
Total of Developed Countries	**4103152**	**76.6**
3.Countries of Central and Eastern Europe including former USSR	24590	0.5
4.Socialist Countries of Asia	105344	2.0
5. Developing Countries of which:	984024	18.6
a) Africa	10674	0.2
b) Americas	273893	5.1
c) Asia	708883	13.2
d) Europe	574	0
e) Oceania	0	0
6.Other, unallocated	129540	2.4
World Total (2002)	**5356650**	**100**

Source: Review of Maritime Report 2002 by the UNCTAD Secretariat.

Container ships are generally classified into generations, having characteristics typical of certain stages in development and container ship building. The capacity has been growing enormously; thus 5th generation vessels

Table 8.4 Physical Characteristics of Container ships

Generation	Year	Container Capacity	DWT	Overall Length (LOA) (m)	Overall Width (m)	Draught (m)	Speed
1st Generation	1968	750	14000	180	25	9.0	20.6
2nd Generation	1969	1500	30000	225	29	11.5	21.6
3rd Generation	1972	2500-3000	40000	275	32	12.5	26.0
4th Generation	1985	4200	--	290	33	11.6	18.0
5th Generation	Late 1990	6800	--	368	47	12.0	16.5

are put in to service in late 1990, which can carry 7000 TEU. The physical characteristics of container ships are shown in Table 8.4. Now mega-ships of about 14000 TEUs capacity have been built very recently. Realizing the draft limitation, the trend is to go with larger LOA (Length Overall) and beam width.

Thus it can be said that containerization is there to stay and grow all over the world in the coming years.

The rate of growth of containerization in 2000 for developing countries and territories was 14.5 percent with a throughput of 94.1 million TEUs, which corresponds to 41.8 percent of world total throughput. The growth rate was better than that of 1999-10.9 percent- when developing countries' throughput was 82.1 million TEUs. Places with double-digit growth in 2000 and 1999 were Argentina, Bangladesh, Brazil, Colombia, Egypt, Hong Kong (China), India, Indonesia, Malaysia, Mexico, Morocco, Oman, Panama, the Philippines, Senegal, Trinidad and Tobago and Yemen. The leading 20 world ports handling containers for the year 2000 and 2001 is shown in Table 8.5.

Table 8.5 Top 20 container terminals and their throughput, 2001 and 2000 (TEUs)

Sl.No	Container Terminal	TEUs 2001	TEUs 2000	Growth Rate 2000-2001	Growth Rate 1999-2000
1	Hong Kong	17900000	18100000	-1.10	11.70
2	Singapore	15520000	17040000	-8.90	6.90
3	Bussan	7906807	7540387	4.90	17.10
4	Kaohsiung	7540524	7425832	1.50	6.30
5	Shanghal	6340000	5613000	13.00	33.30
6	Rotterdam	5944950	6275000	-5.30	-1.10
7	Los Angeles	5183519	4879429	6.20	27.40
8	Shezhen	5076435	3993714	27.10	34.00
9	Hamburg	4688669	4248000	10.40	13.60
10	Long Beach	4462967	4600787	-3.00	4.40
11	Antwerp	4218176	4082334	3.30	13.00
12	Port Klang	3759512	3206428	17.20	25.70
13	Dubai	3501821	3058886	14.50	7.50
14	New York	3316275	3006493	10.30	5.00
15	Bremerhaven	2896381	2712420	6.80	24.40
16	Felixtowe	2800000	2800000	0.00	3.80
17	Manila	2796000	2867836	-2.50	33.60
18	Tokyo	2770000	2960000	-6.40	9.80
19	Quingdao	2640000	2120000	24.50	37.00
20	Gloia Tauro	2488332	2652701	-6.20	17.70

Source: Containerization International, March 2002 and Port Development International, April 2002.

From table 8.5, it is very clear that the growth rate throughput for the year 2001 is less than for the year 2000. It is also seen that the growth rate of throughput for all container terminals is less in 2001 except the container terminal of Dubai and New York when compared with the growth rate of throughput in 2000.

The list included 10 ports in developing countries and territories and socialist countries in Asia, with the remaining 10 located in market-economy countries. Of the latter, six ports were in Europe, three in the United States and one in Japan. Hong Kong (China) maintained its leadership even though it reported a drop of 1.1 percent in growth rate. The top four places on the list remained unchanged. The top 20 container ports for 2001 recorded a total of 107.4 million TEUs, equivalent to 47.7 percent of the world throughput.

8.1.3 Containerization in India

The Indian seaports entered the containerized era by receiving the first containership in Cochin port in 1973. Ever since, the containerized traffic of the port has been steadily increasing. Quest for economy in transportation and reducing the labour content were the prime reasons for containerizing the cargo in the developed countries. While in international scene about 75-80% of the cargo is containerized, in India it is presently about 45% (Ramakrishnan [1999]).

Table 8.6 Growth of Container Traffic in Indian Ports

Year	Million TEUs
1980-81	0.13
1985-86	0.407
1990-91	0.681
1995-96	1.45
1996-97	1.70
1997-98	1.89
1998-99	1.92
1999-2000	2.21
2000-01	2.47
2001-02	2.89

Hence, there is enough scope for further containerization of the cargo. The container traffic has been recording impressive growth particularly since 1992-93, in line with the increasing use of containers for all types of cargoes in international trade. The aggregate Container Traffic handled in the past twenty five years in Indian ports is shown in Table 8.6. In 1980-81 the container traffic handled was only 0.13 million TEU and it has increased to 2.89 million TEUs in 2001-2002.

Six Indian ports namely Calcutta/Haldia, Chennai, Cochin, Jawaharlal Nehru Port (JNPT), Mumbai, and Tuticorin have been increasingly handling the containers. At present, the operations of Port of Tuticorin and JNPT are privatized and in all other ports, the container operations are partially privatized. With respect to the contribution of different container handling major ports to the total container traffic for 2001-02, JNPT continues to be the leading port in India accounting for a share of 54.52% of the container traffic in 2001-02. As compared to 1990-91, all the major container-handling ports, except JNPT and Tuticorin, have seen their respective shares decline. The share of Mumbai port has seen a dramatic decline from 47.61% in 1990-91 to 8.81% in 2001-02 due to diversion of container traffic to JNPT, while the share of JNPT has increased from 8.02% to 54.52% during the same period. A look at the growth trend of container traffic over the period 1990-91 to 2000-01 reveals that JNPT is the fastest growing major port for containers during the period.

As the container traffic has recorded impressive growth during the last decade, the capacity of container terminals, size of the ships that called at the ports and the facilities to handle the containers were improved. Over the years cargo handling capacity of major ports has steadily increased to cater to the growing volume of internal and external trade. The capacity of the ports, which was 169.23 million tons at the end of 1991-92, has increased to a level of 291.45 million tons at the end of 2000-01 and to 343.95 million tons at the end of 2001-02.

Container handling performance of Indian ports are very less when compared with other Asian ports. Table 8.7 clearly justifies this argument.

Keeping the aspect of availability of Quay crane/efficiency and speed of handling in view, main line vessel call such ports and transit the container. Feeder vessels then call at such port for re-handling and transporting in small vessels. It is sad that in Indian ports, the containers are transshipped from Srilanka/Dubai or Singapore. Hence the need for creation of adequate facilities enables calling of main vessel at Indian port.

Table 8.7 Container handling performance of selected Indian and Asian Ports

Ports	Average Containers handled per Ship Hour
Haldia	6 to 7
Calcutta	7 to 9
Mumbai	8 to 10
Chennai	10 to 12
JNPT	25 to 30
Colombo	35 to 45
Bangkok	40 to 45
Singapore	75 to 85

The liberalization and privatization concepts have induced better productivity norms in the ports and the concept of competition and commercialization. Concepts of intermodalism and rail movements are showing an increasing trend: yet more facilities, faster and fixed schedule movement of trains is essential for better transportation and promptness.

8.2 Containerization in Cochin Port

Cochin was one of the major ports identified for development of container handling facilities by the Government of India. In the first phase of the development scheme, two rubber tyre-mounted transfer cranes to handle loaded containers and for stacking them in the yard and two forklift trucks with side spreaders to handle empty containers were procured and commissioned in 1985-86. Hard surfaced area of 15,500 m^2 was provided for storing containers. The above facilities provided were expected to cater to about 30,000 TEUs per annum.

The second stage development was undertaken in 1988. Existing two wharf berths (Q_8 and Q_9) were converted into a full-fledged container terminal to handle a projected traffic of 1,00,000TEUs. The berth side channels have been deepened to a draft of 10.7 meters from 9.14 meters. Two quay side gantry cranes for ship- to- shore and vice versa operations, two additional rubber tyred gantry cranes, 19 tractor heads, 16 semi-trailers and 15 forklift trucks were also provided. Computer facilities were also installed at the terminal. A Container Freight Station (CFS) of 10,000 m^2 was built. 7,000 m^2 of additional hard stacking

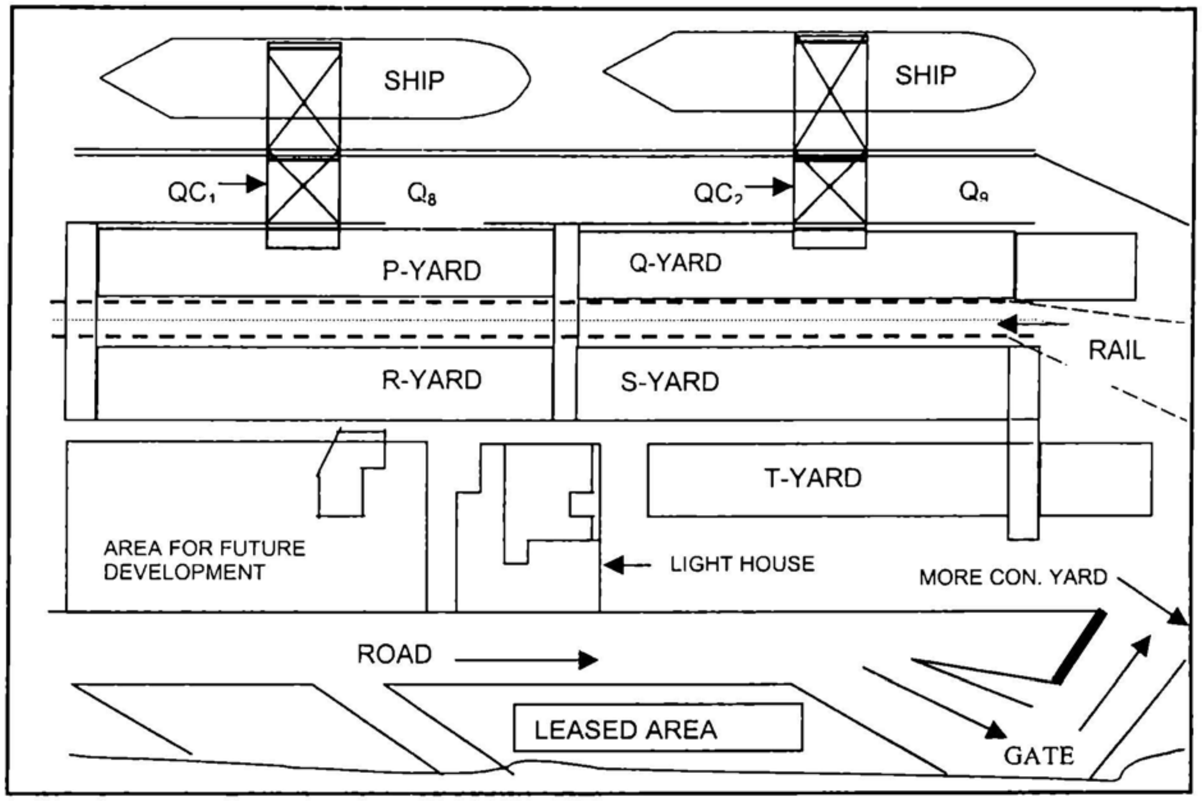


Figure 8.2 Layout of Rajiv Gandhi Container Terminal

area was created for storing containers. The Rajiv Gandhi Container Terminal (RGCT) was commissioned on 28th January 1995. Two reach stackers for stacking/de-stacking of containers and two reach stackers for handling empty containers were also procured later. In 1998, one rubber tyred gantry crane was arranged on lease in the stacking yard to meet the additional requirements due to increased demand for container handling operations.

The layout of the Rajiv Gandhi Container Terminal is shown in Figure 8.2. At present the container operations of RGCT are controlled by three departments viz. the traffic department, which controls the container traffic and the related operations, the mechanical engineering department, which operates and maintains all the key equipment needed for container handling and the finance department, which makes all the bills and collect all data related to terminal operations.

8.2.1 Container Terminal Infrastructure

Rajiv Gandhi Container Terminal has good road connectivity to all main cities of the country. NH 47, NH 17 and NH 49 connect the terminal with its hinterlands. Cochin Harbour Terminal railway station is situated on the same Island at a distance of only 500 meters. The container terminal premise is connected to this railway station, which makes the transportation of containers by rail faster. Nedumbassery international airport is only 35 kilometers away from the container terminal. There is river interface through Vembanattu backwater, and sea transport interface with RGCT.

The customs office, the central health administration office, office of the CISF, offices of users of the container terminal such as: CHA/C&F Agents, Steamer agents, MLOs, Stevedores, shippers etc, and office of the Cochin chamber of Commerce are located on the Island. The Southern Command Headquarters of the Indian Navy is very close to the Terminal.

A small repair shop is located in the premises of the Container Terminal for minor repairs of the handling equipment. A major workshop is located in the port for major maintenance of the equipment. Dry docking facilities are also available in the port. Moreover, one major shipbuilding and repair shop in the country namely Cochin Shipyard Limited is located in the opposite bank of the Vembanattu backwater. Therefore, any type of ship repair (Major or Minor) is possible. Many private container stuffing and de-stuffing stations are also located near the container terminal.

8.2.2 Container Handling System

The handling methods currently employed in container terminals include the following three basic types.

- **Chassis (Sea Land) system:** All the movements of containers in the terminal are done on chassis. Containers are discharged from containership by quayside gantry crane or shiptainer on board and placed directly onto chassis alongside. Containers on chassis are transferred by tractors to the marshalling yard and are lined up in the shape of trailers.
- **Straddle Carrier (Matson) System:** Stacking or transfer of containers inside the terminal is performed by straddle carrier. First employed by Matson at Diamond Head Terminal in Honolulu, this system discharges containers by crane from the containership direct on to the apron, transfers them to the marshalling yard by straddle carriers and, in principle, places them directly on the yard.
- **Transtainer System:** Multi-tier storage is performed by using transfer cranes in the marshalling yard, with a view to combining the advantages of the chassis and straddle carrier system. Under this system, containers discharged from containerships are placed onto yard chassis and carried to the marshalling yard to be stored by transfer cranes.

In RGCT, transtainer system is used to handle the containers in the terminal. Containers are stacked in the yard by means of Rubber Tyre Mounted System (RTG). This system enables mobility by yard chassis and three to four-tier stacking of containers in the marshalling yard, having the advantage over the straddle carrier system of efficient use of limited yard space. However, the containers stowed underneath multiple tiers must be taken out through repeated handling, which results in lower handling efficiency. It appears that in mechanized terminal operations, this system is more adaptable to automation and computerization.

8.2.3 Trend in container traffic

There is an appreciable container traffic growth from the last decade through Cochin port. Table 8.8 shows the number of containers handled in the terminal in TEUs. It is seen that the number of import and export containers have increased steadily from 1992. The total number of containers handled also showed an increase to 151829 TEUs during the year 2001-2002 from 143115 TEUs handled in the preceding year indicating an increase by 6 percent. Similarly the number of container ships that called at Cochin Ports has also increased from 225 in 1992 to 433 in 2001. During the year 2001-2002, the tonnage of container cargo handled recorded an increase of 15.7 percent to 1.44 million tones from 1.24 million tones in the preceding year. Exports in containers also showed an increase by 19.5 percent during 2001-2002 to 0.975 million tones from 0.815 million tones in the preceding year and import in containers showed an increase by 8.4 percent to 0.464 million tones from 0.428 million tones in the preceding year. Table 8.8 shows the trend in container traffic from 1992 to 2001.

Table 8.8 Trend in container traffic from 1992 to 2001

Year	1992 -93	1993 -94	1994 -95	1995 -96	1996-97	1997-98	1998-99	1999-00	2000-01	2001-02
Import (TEUs)	27589	33980	40740	45736	54222	58574	62594	61972	67857	71757
Export (TEUs)	28003	36850	45710	50308	57923	63075	66318	68085	75258	80072
Total (TEUs)	55592	70830	86450	96044	112145	121649	128912	130057	143115	151829
No. of Container ships	225	267	275	265	279	312	377	359	347	433

8.3 Computer System for Container Terminal Management

This section presents the Management models and Systems used to manage a modern container terminal. The models discussed here are based on those used in container terminals in Japan. This discussion is necessary to understand the complete container terminal system i.e., facilities and the management system used to run it. In the early stage of containerization, operations were controlled manually in most terminals. But the manual control is considered to be difficult if the annual throughput of the terminal exceeds 60,000 TEUs. In such cases, a container operational system using computers is recommended. However computers are applied only for terminal planning

Table 8.9 Load based recommendation for computerization of Container Terminals

Step	Annual Container Volume (TEUs)	Control Planning and Documentation	Handling equipment
I	Up to 60,000	Manual	Manual
II	60,000-1,50,000	Computer	Manual
III	1,50,000	Computer	Computer for key equipment
IV	Above 1,50,000	Computer	Computer for all equipment

Source: Study materials of Indian Institute of Port Management, Calcutta, used in the training programme on "Management of Container Handling Operations" (July 30-August 03,2001) organized at Cochin Port.

system and related documentation. This means that individual container handling equipment in the container terminal is manually driven based on work order sheets, which are obtained from computers before hand. This is not a complete real time planning and control operation using computers. In accordance with increase of containers handled, real-time system to plan and control container handling equipment will be essential in order to improve the productivity based on right and timely information. In other words, some of the container handling equipment also will be integrated in to the network of computer system, in order to perform in a highly efficient, full proof and labour saving manner. This type of a system is referred to as an automated container terminal. The load based recommendations for computerization of container terminal is shown in Table 8.9.

At present, RGCT is partially computerized. Yard planning and container handling equipment operations are manually controlled. According to the above table, it is already late to computerize the whole operation including the handling equipment operations since its annual container volume has exceeded 1,50,000 TEUs. Hence a fully computerized system is recommended in RGCT.

8.3.1 A Model for Container Terminal Computerisation

A model for fully computerized system recommended in the above section is discussed here. This model is based on literature obtained from the proceedings of JICA seminar conducted on 23rd January 2002, at Japan. This is a model designed and implemented in a container terminal of Japan. The system consists of an Application server with Internet connectivity, Gate control system,

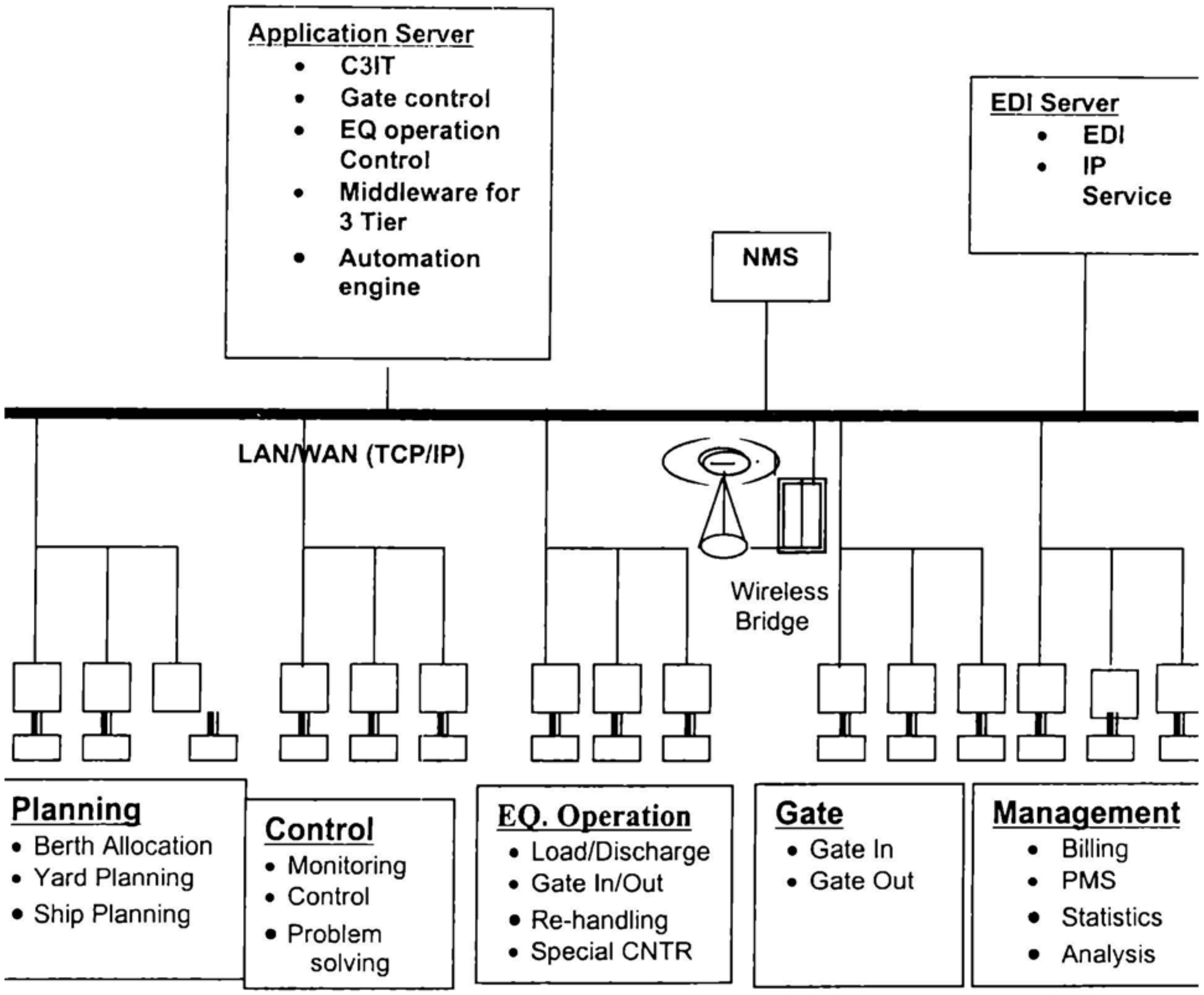


Figure 8.3 Model for computerization of a container terminal

Equipment operation control, Middleware for three Tier and automation engine. An EDI server with EDI connectivity and IP service is also required. Different workstations are integrated in the system as shown in Figure 8.3. Wireless bridge is provided to communicate through satellite to different work centers of the terminal. Digital Global positioning systems (DGPS) are also integrated with the system to identify the location of containers in the yard.

The Terminal Operation system has three sub systems, which are: Planning System, Operation System and Management System. The software module diagram and its configuration are shown in Figure 8.4. The main functions of each system are also shown in the diagram.

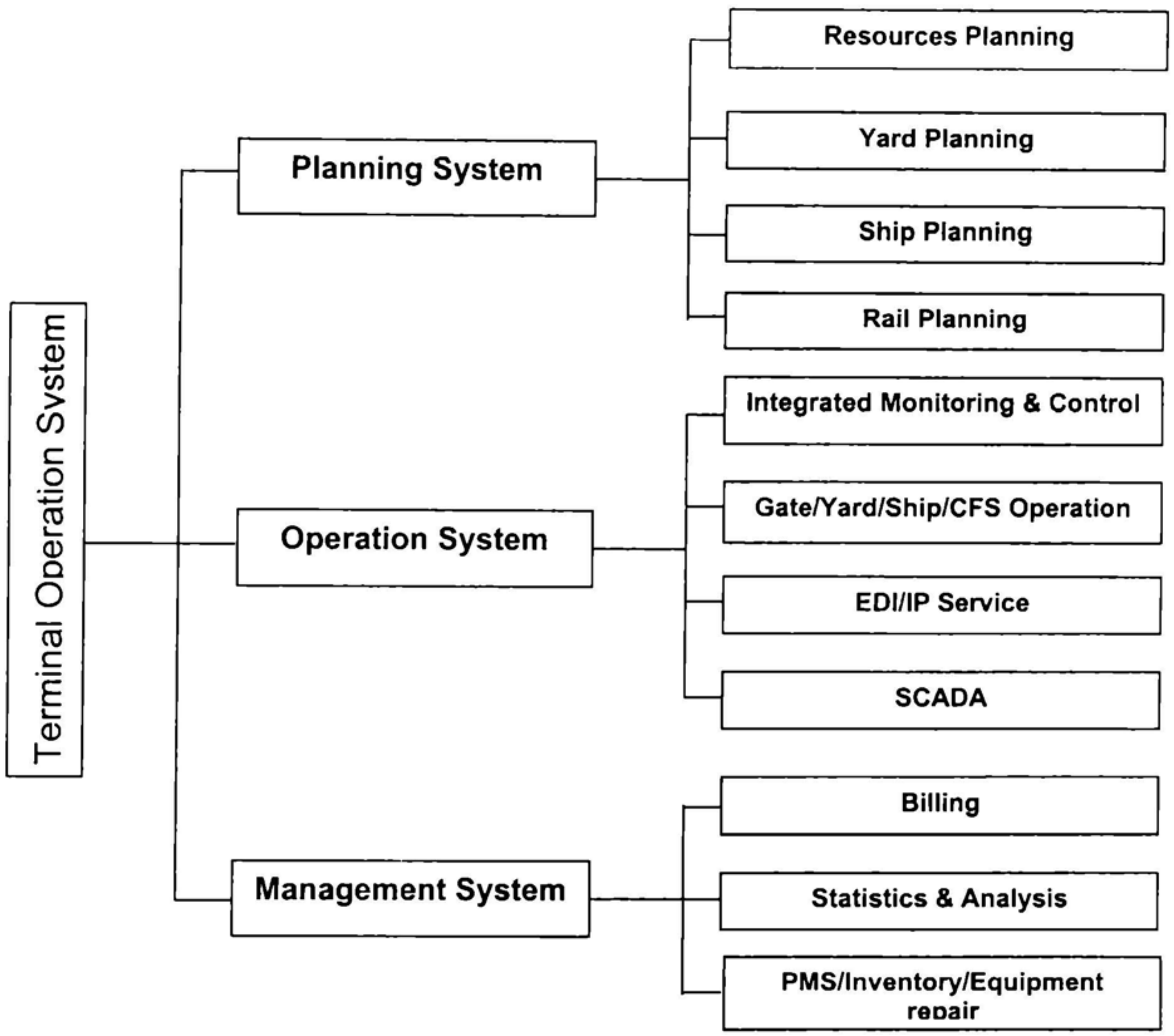


Figure 8.4 Terminal Operation Systems

The planning system has four sub-systems, which are: 1) Resource Planning system, 2) Yard Planning System, 3) Ship Planning system and 4) Rail Planning system. The decomposition diagram of the planning system is shown in Figure 8.5. Similarly the decomposition diagram of operation system and management system are shown in Figure 8.6 and Figure 8.7 respectively. From the figure, we can see that there are four sub system for operation systems such as C3IT, SCADA, Operation and EDI/IP and the management system has three sub systems namely Management Analysis, Billing, and PMS/Inventory management. The decomposition diagram clearly shows the functions of each sub systems.

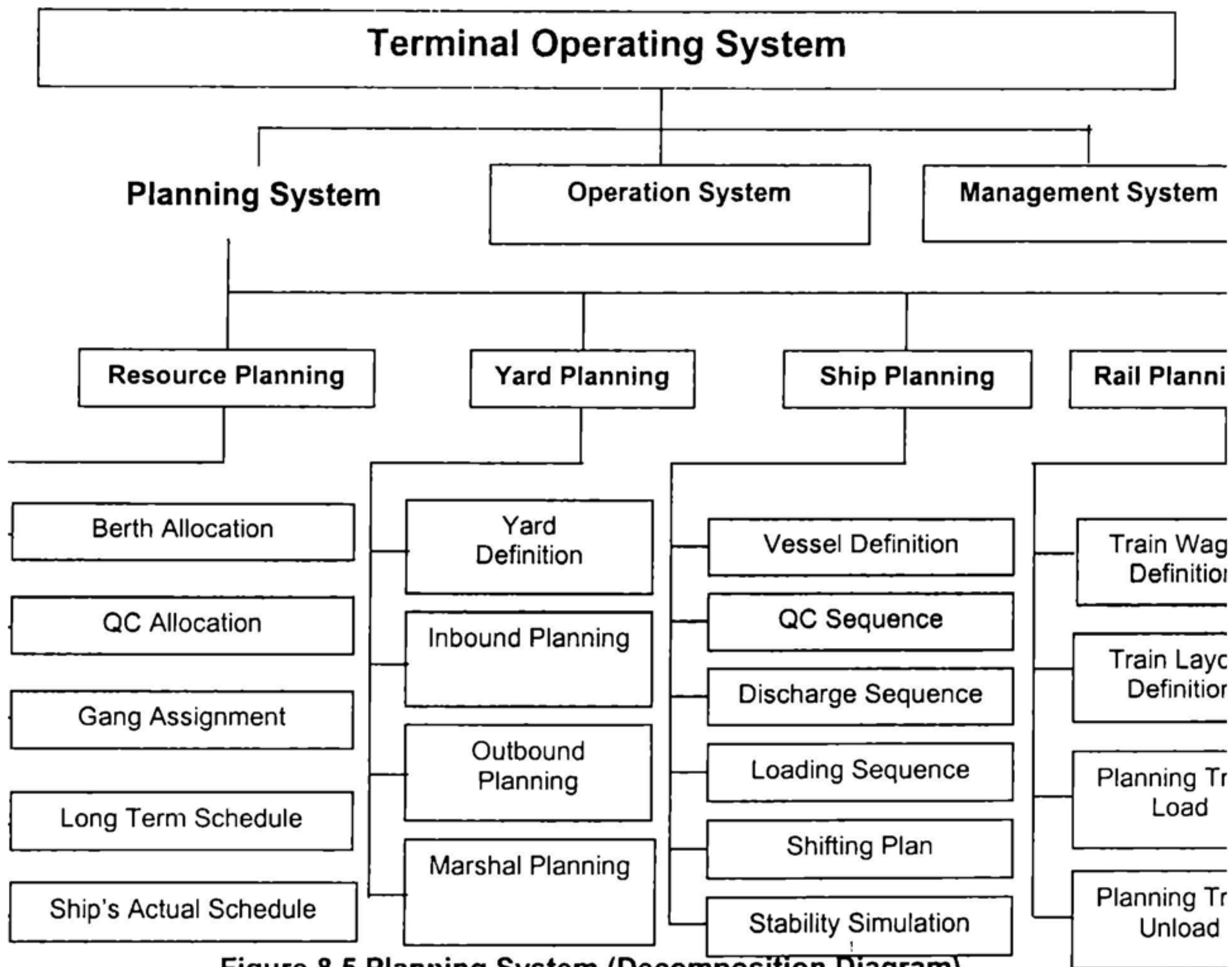


Figure 8.5 Planning System (Decomposition Diagram)

8.3.2 Electronic Data Interchange (EDI)

Electronic Data Interchange (EDI) is the electronic transfer of business documents from one computer application to another computer application without human intervention. EDI starts with an agreement between two organizations or groups of organizations. Joint decisions are made about the standard to be used during the interchange of data, the information to be exchanged, the network carrier and when the information will be sent. A decision is created in the business application of one of the participating organizations. The document is automatically reformatted by the EDI translator into the agreed-upon EDI standard. The translator wraps the reformatted document in an electronic envelope that has an ID for the organization that is to receive the document.

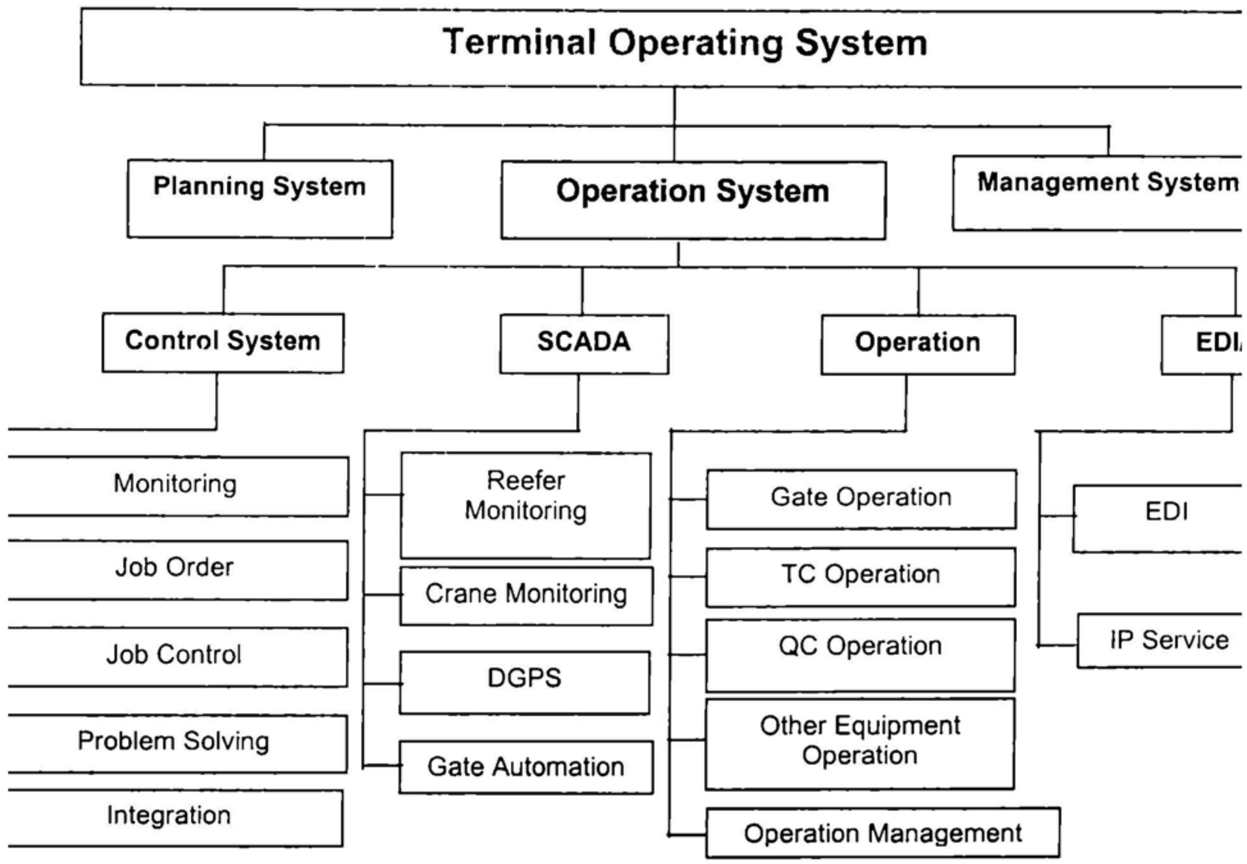


Figure 8.6 Operation System

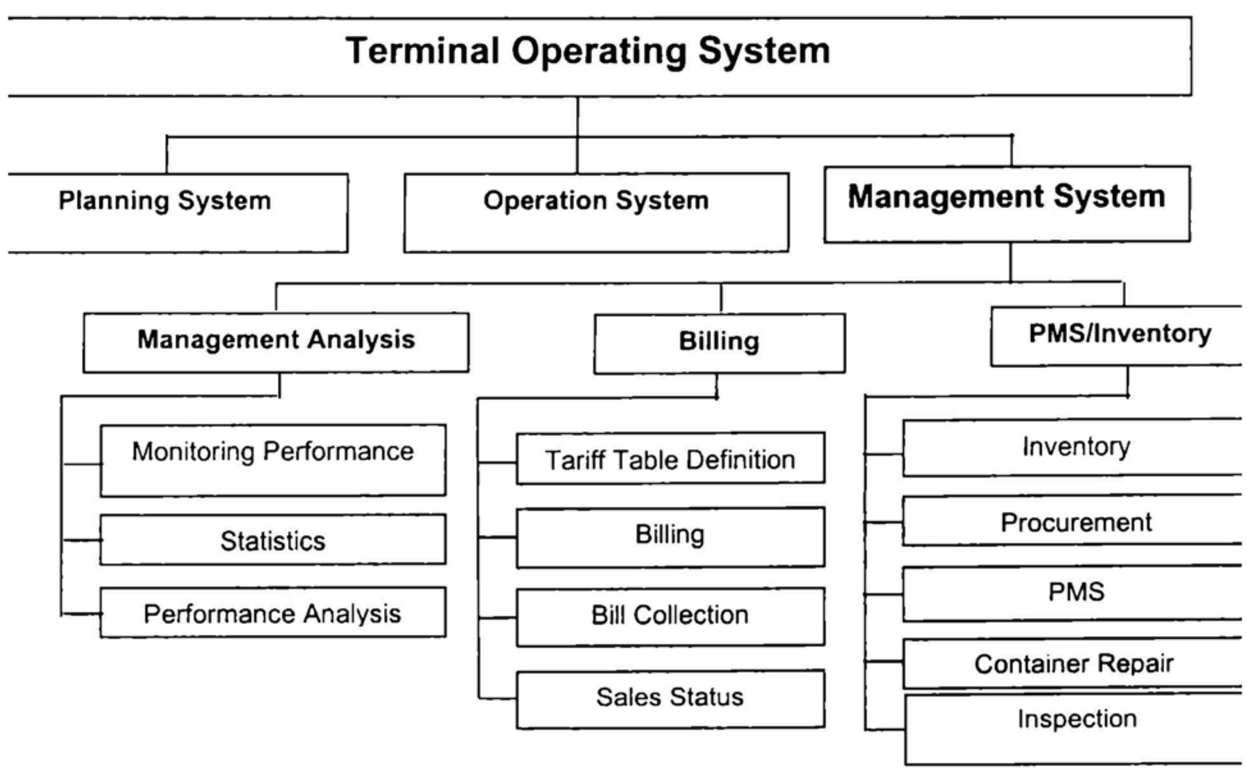


Figure 8.7 Management Systems

It was the development of containerization that led to the introduction of EDI into the international logistics. Each contract of carriage involved large numbers of units which, led shippers and carriers to use computers to record the information necessary for an efficient transport service. The Electronic Data Interchange function provides the means to exchange freight and other information between shippers and their carriers using computers connected with another computer by telephone.

The container world is no longer feasible without EDI, has become a necessity for the container terminals and shipping agents in order to facilitate the operational aspect of handling goods. The volume and the velocity of the container business render EDI absolutely necessary. Currently most container terminals send more than 80% of their reporting regarding containers to their clients through EDI.

The various major ports in India are opting for EDI to improve the port's efficiency. Cochin port trust has started implementing EDI as an initial step has launched EDI for a few messages with vessel agents, container agents, and main line operators, with customs and also for port billing system. The Cochin Port being a forerunner in implementing EDI in container operations in India does not have the advantage of learning from the experience of another Indian port. The Cochin Port is on the way of implementing EDI stage by stage.

With the increase in the container traffic, EDI was introduced at Rajiv Gandhi Container Terminal of Cochin Port. It is being introduced especially for the containers because of multiplicity of interfaces and faster handling needs. The cargo in the containers may be of different types as well as having different ownership. Also the ownership of containers in the same vessel may vary. Shipping containers is a daily continuous activity. EDI helps a lot in shipping containers, as a lot of messages are to be sent and received for the containers between various agencies.

The following EDI messages are already implemented in the container terminal.

- CALINF: - Vessel Calling information
- COPRAR: - Container Discharge or Loading Order Message
- COARRI: - Container Discharge or Loading Report.
- INVOIC: - Invoice
- DEBADB: - Debit Advice
- CREAVE: - Credit Advice

The following Export related messages are send between customs and port through flat file.

- Shipping bill details
- Shipping bill items details
- Entry of goods into port
- Stuffing report
- Let export order
- Details of shut out cargo (for containers as well as for other of cargoes)
- Grant of entry outwards
- Grant of port clearance
- Vessel Sailing report

8.4 Container Terminal Operations

Terminal operation is the cycle of jobs performed before and after a ship's loading and unloading. The cycle of jobs covers the interchange of loaded or empty containers with shippers at the Container Yard (CY), packing or unpacking of cargo into/from containers at Container Freight Station (CFS), their receipt and delivery from shippers or to consignees, and other related jobs.

Notably terminal operation work is done in the limited space of the terminal, in an integrated manner with large-scale mechanization and a limited use of manpower. Accordingly, port operations have been much more rationalized than in the conventional trade, and punctual, rapid and rationalized terminal operations have led too much improved handling efficiency in addition to the all-weather feature of container handling.

Container terminal operation is an integrated operation of the following activities and functions shown in Table 8.10.

Table 8.10 Elements of Container Terminal Activities

I. Terminal Administration and Management	II. Container Yard Operations
1. Strategic Decision Making 2. Administration of the Terminal 3. Coordination of operations 4. HRM	1. Yard Plan 2. Marshalling Plan 3. Gate Operation 4. Security in CY
III. Ship side Operations	**IV. Pilotage Operation**
1. Stowage plan 2. Re-handling 3. Lashing/Unlashing 4. Gang Composition	1. Tug Operation 2. Mooring Operation 3. Berthing of Ships 4. Unberthing of Ships
V. Handling equipment Operations	**VI. Container Freight Station Operations**
1. QC operation 2. RTG Operation 3. Other Backup equipment operations	1. Stuffing of Container 2. De-stuffing of Container 3. Gate Operation
VII. Repair and Maintenance Operations	**VIII. Computer Operation**
1. Equipment Maintenance 2. Yard maintenance 3. Wharf Maintenance 4. Maintenance of offices and Building 5. Maintenance of Reefer Container Yard	1. Billing 2. Data collection and Analysis

The above-mentioned operations can be broadly brought under two classifications, which are: 1) Operations related to Export containers and 2) Operations related import containers. Job descriptions for handling the export and import containers are discussed in detail in the following sections.

8.4.1 Export Container Operations

Export container movement from the ship at the berth to the customer is shown in Figure 8.8. In performing terminal operations, the handling plan must be set out so as to correspond to every movement of the cargo and containers in close and up-to-date communication with the shipping lines, shippers/consignees and forwarders. The information must flow instantly to each division of the terminal and the outcome must be fed back to the parties concerned so that the smooth flow of containers is ensured. Figure 8.7 also shows the flow of documentation related to export containers. The functions and the information flow shown in the figure are self-explanatory and hence the details are not explained here.

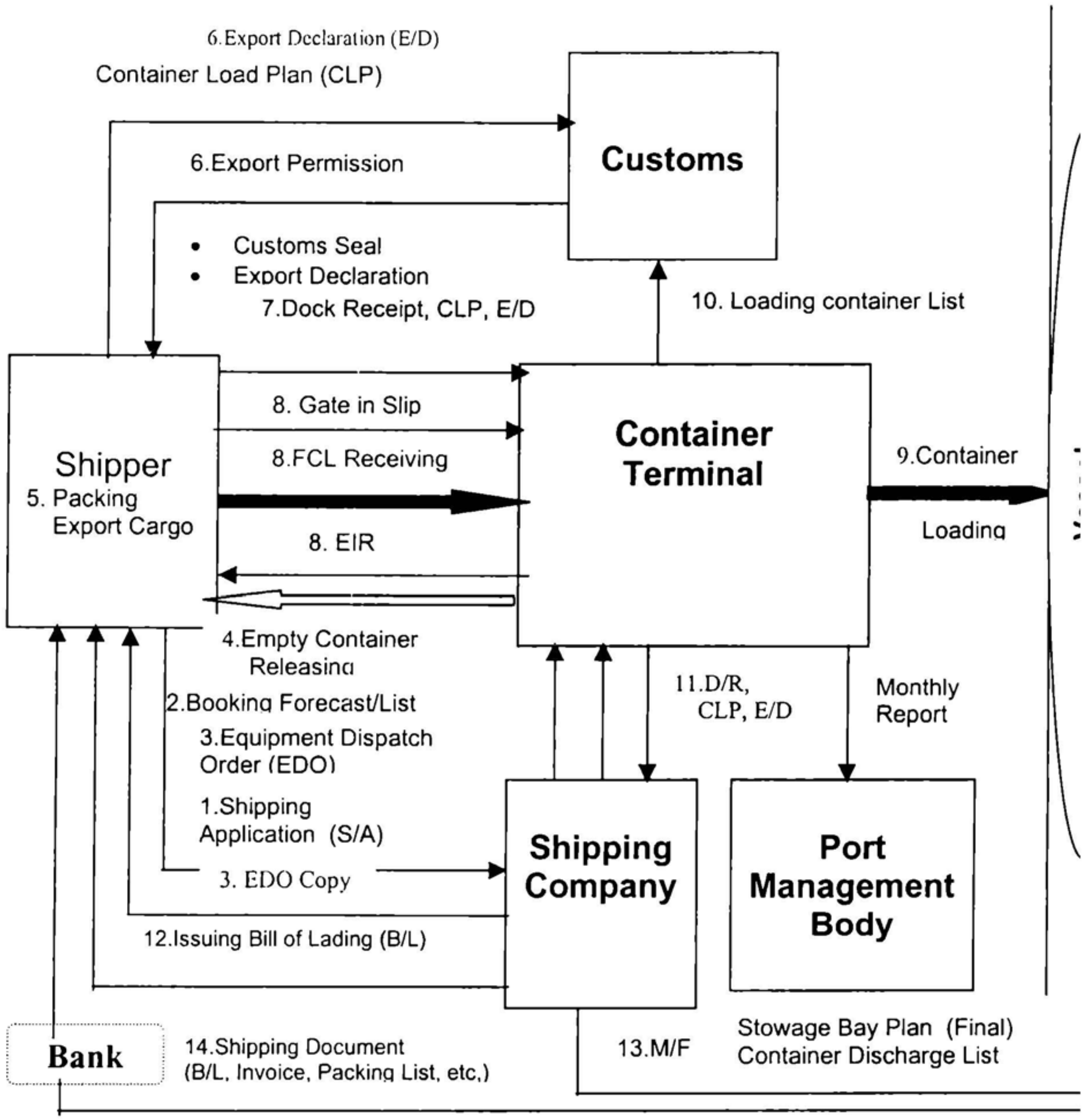


Figure 8.8 Export Container Operations (Document Flow Diagram)

8.4.2 Import Container Operations

Import container movement from the consignee to the ship at the berth is shown in Figure 8.9. The departments involved in the movement of import containers are also shown in the figure. Figure 8.9 also depicts the flow of documentation related to import containers. The figure is self-explanatory and hence the details are not explained.

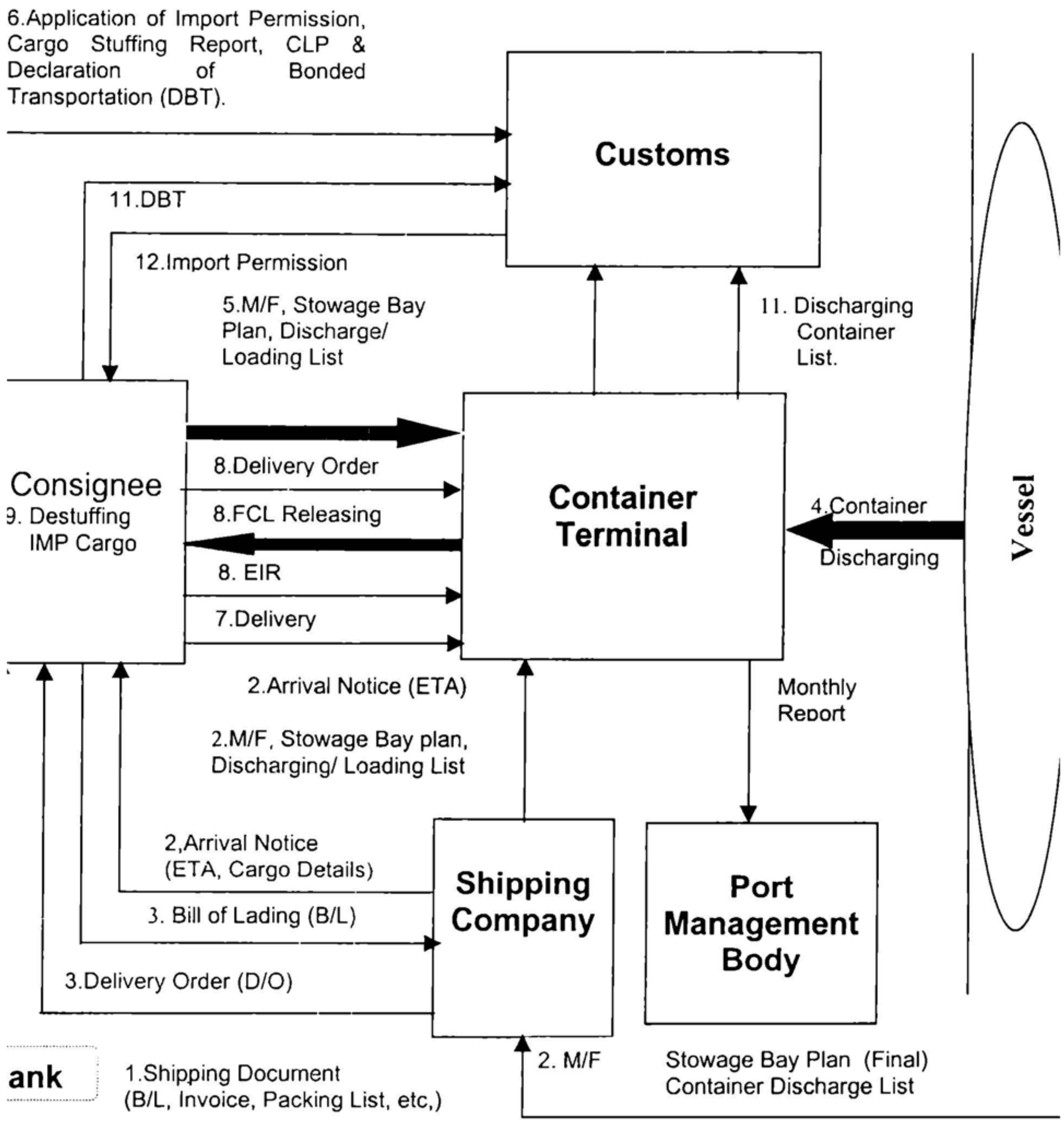


Figure 8.9 Import Container Operations (Document Flow Diagram)

8.5 Operational Problems of RGCT

Port operations have become highly mechanized and simpler with containerization. Competition has intensified between ports and customer expectations are steadily growing. Under these conditions inefficiency has no place. With globalization the volume of container cargo handled is also increasing. There is opportunity for Cochin Port to make best use of its container terminal to give good service to its customers and increase its earnings.

This part of the study has used data on operational performance from logbooks, reports and also directly collected by use of work-study methods. The reasons for some of the problems were also analyzed. Some actions that can be taken to overcome these problems are also suggested. This work to locate the operational problems at the Cochin Port, was carried out with the following dual objectives in mind: a) to locate the process and other avoidable delays in container terminal operations area and remove them to reduce the berthing time requirement for ships and b) to locate the process bottlenecks so as to attempt de-bottlenecking to increase the capacity of the Container Terminal (CT) in the short term. In order to do this, the causes of delay at CT are examined next.

8.5.1 High pre-berthing detention time

High Pre-berthing detention time is an indicator of poor service in a port. The reasons for these could be berth related, navigation related, or an option of the ships agent. In order to find these delay figures and locate the cause for these delays a cause wise analysis of the delay for the period from 1996 to 2000 was carried out. The summary of the findings is presented in Table 8.11. From the data in the table we see that the pre-berthing delay of containerships that called at the Container Terminal was found to be coming down from 13 hours in 1996 to about 7 hours in 2000, which is a positive sign. It is also worth noting that during this period the number of ships that called on the CT has also increased from 279 to 348 and this decrease in pre-berthing time is in spite of that. However more reduction in this is necessary since the ships that call on Cochin port are mostly small feeder ships connecting to Colombo. What is noted from the data is that the delay due to non-availability of berth has decreased to nearly half of that in 1996. The delay because of tidal conditions has also become zero. However what is to be noted as a cause of worry is that delay recorded by the port as due to Ship Agents option is increasing. This has to be looked into to find its hidden causes. Only when this is also reduced further reduction of Pre-berthing time will be possible.

Table 8.11 Showing cause-wise analysis of Pre-berthing delay

Sl No	Reason for Pre-berthing delay	1996	1997	1998	1999	2000
1	Non-availability of Berth in Hours	1074	1344	174	72	592
2	Tidal/Weather constraints in Hours	213	14	708	511	0
3	Ship's/ Agents option in Hours	2145	1478	5057	4089	2001
4	Others	320	0	247	145	0
	Total Pre-berthing Time in Hours	3752	2836	6186	4817	2593
	No. Of Ships called at Terminal	279	314	377	359	348
	Pre-berthing time per ship	**13.45**	**9.03**	**16.41**	**13.41**	**7.45**

8.5.2 Poor performance of container handling equipment

There are two key equipment named Quay Gantry Cranes (QC1 & QC2) of 40 ton capacity each that are used for lifting or loading containers from/to ships. The following back-up equipments are used for container handling. (1) Rubber Tyred Gantry cranes (RTG or TCs- 5 numbers of 35.5-ton capacity, out of which one is on lease basis, (2) Reach Stackers-2 numbers with 40 ton capacity, (3) Reach stackers for empty containers- 2 numbers, (4) Heavy duty top lift truck- 4 numbers, with 25 to 30 tons, (5) Light duty top lift truck-2 numbers, 5 ton capacity, (6) Heavy duty Tractors, 22 numbers. (7) Trailer Chassis (20ft)- 9 numbers, (8) Trailer Chassis (40ft)-26 numbers, (9) Fork lift Trucks (3 ton)-25 numbers, and (10) Heavy Duty Tractors- 22 numbers.

8.5.2.1 Quay Gantry Cranes

Two Quay Gantry Cranes were commissioned at the container terminal in 1995 for lifting/ loading of containers from/to ships. Its capacity is 40 ton and the design time is 2 minutes per movement of containers from/to ship to/from the

Trailer Chassis, i.e. 30 moves per hour. But the performance of these two equipments is very poor when compared with its design output. This is mainly due to the frequent breakdown of equipment and power failure/ low voltage of the power supply.

The actual moves of QCs per hour were computed from the working details collected from the logbook of year 2000. The average moves per hour for year 2000 was obtained as 10.45. The average moves per hour per QC is only 10.45 which is very low and its performance index is only 0.35.

The availability and utilization of the QCs were also studied for five years from 1996 onwards. Table 8.12 shows the equipment availability and utilization in percentage. The average availability is 89.02 percent and the utilization is only 37.51 percent. Hence the down time (1- Availability) equals 10.98 percent which is very high when compared with values of modern developed ports. For a modern developed port, the standard value of availability of QCs is 95 to 98 percent, utilization is 30 to 45 percent, and the down time is only 2 to 5 percent.

Table 8.12 Availability and Utilization of Quay Gantry Cranes

YEAR	Total Hours	Available Hr	Worked Hr	% Availability	% Utilization
1996	17452	15904	5281	91.13	33.205
1997	17520	14897	5498	85.029	36.907
1998	17520	16406	6032	93.642	36.767
1999	17568	15486	6159	88.149	39.771
2000	17520	15273	6246	87.175	40.896

8.5.2.2 Back-up Equipment

Next, the availability, utilization, and the down time of the back-up equipment of the container terminal were also studied. The results of the calculation gave the availability and utilization of all back-up equipment for 5 years from 1996 to 2000. The average availability, utilization, and downtime in percentage of all equipment were calculated. It is seen that the average availability, utilization, and downtime of the Transfer Cranes are 66.86 percent, 30.85 percent, and 33.14 percent respectively. The average availability, utilization, and downtime of Top Lift Trucks are 65.62, 38.09, and 34.38 percent respectively. Similarly, the availability, utilization, and the downtime of Tractor Heads are 82.60, 31.90, and 17.40 percent and that of Reach Stackers are 84.37, 27.89, and 15.63 percent respectively. The downtime of all back-up equipment is very high, due to frequent breakdown of all these equipment. The availability of all these equipment can be improved by providing proper maintenance in time.

8.5.3 Improper Container Yard Planning

A container yard (CY) is the place where containers are received, delivered and stored, and may include a marshalling yard, an empty container storage area, a chassis area and an apron. The size of a container yard may vary depending on the capacity of the containerships calling or the frequency of their calls. The standard size of CYs in Japan is 75,000 m^2 for a 250 meter long quay and 1,05,000 ^{m2} for a 300 meter long quay.

In Cochin port, the length of quay is 414.10 meters, whereas the container stacking area is only 64,220 m^2. This area is very less compared with the standards of Japan's port. The total number of slots in the CPY is only 936 for stacking the containers. Since the number of slots is less, the average stacking height is 3.5 high (the average stacking height is only 2 to 2.5 in modern container ports). When the stacking height increases, the cycle time for the movement of containers will increase and thus it badly affects the overall performance of the container terminal, resulting high turn-around-time of the ships calling at the port. This is the most important performance indicator widely accepted by the port stakeholders.

The containers are stacked in the yard according to the predetermined stowage plan. Lines drawn at right angles to the size of the containers demarcate the marshalling yard. The containers to be loaded onboard ships are lined up in these slots according to the stowage plan prepared for loading by destination or weights or by ships. The yard plan aims at delivering and receiving import and export containers according to a pre-determined schedule based on ship's schedule and stowage plan, and storing them efficiently in the limited space of the CY, so as to facilitate the next step of delivery to the consignee or loading to the ship smoothly. The yard planners, in close touch with the gate clerk, must ensure smooth receipt and delivery of the containers, which are stored and delivered according to the yard plan.

In Rajiv Gandhi Container Terminal (RGCT), stacking of containers is generally done in port wise, weight wise, and vessel wise. In modern container terminals, the yard planning is done using computer facilities and has integration with gate operations, Container Freight Station (CFS) operations, and control room operations. In RGCT, these operations are done manually and hence there is no direct access with other operations in the terminal. During the month of January, February, and March, the volume of container movement is very high, resulting congestion in the yard and hence the containers cannot be properly stacked according to the stowage plan. Another limitation is the flexibility provided to the shippers to bring the export containers even after the berthing of ships at the Quay. This is not permitted in modern terminals. Due to lack of equipment, containers are to wait long time to get it stacked in the yard.

8.5.3.1 Reefer Container Yard Problems

There are 111 plug points available in the reefer containers for controlling the temperature inside the containers. Skilled technicians are not available to maintain the plug points in time. Separate equipment is not allocated for handling of these containers. Hence high delay is affected for unloading and lifting the containers. The surface of the reefer yard is uneven and hence it will badly affect the life of the containers and its sophisticated instruments and equipment.

8.5.3.2 Delay in gate operations of the container yard

The Equipment Interchange Receipt (EIR) is collected from the gate office of the container terminal by the Customs House Agents (CHA) or C/F Agents. In fully automated container terminals (e.g. Port of Singapore), it will take only 1 or 2 minutes to collect the EIR, whereas in RGCT it will take 15 t0 30 minutes. This is mainly due to the frequent failure of the computer system in the gate office. The frequent failure of the system is mainly due to the lack of knowledge of the operators and the poor implementation of the computer system. Before computerizing the gate operations, the clerks are assigned duty based on a daily shift schedule. The same system is continued even after the computerization of the operations. So this system must be immediately stopped and personnel with computer operating ability must be appointed permanently in this office for avoiding the delay.

8.5.4 Low productivity of gangs at Container Freight Station (CFS)

Container Freight Station is meant for stuffing and de-stuffing of containers handled at the container terminal. These operations are performed by gang of workers under the control of Assistant Traffic Manager, CFS. The gang of workers consists of 14 mazdoors, and 1 leader and mechanical aid is provided by forklift. The productivity of the gang is fixed as 6 TEUs per shift for both stuffing and de-stuffing operations.

The labour productivity fixed at the CFS is not done scientifically. It was also seen that the work content of stuffing operation is not same as that of the de-stuffing operations. Hence, time study was conducted to determine the exact gang-time requirements.

The time study showed that standard time for stuffing a 20-foot container was 66 minutes, whereas that for de-stuffing the same was only 33 minutes. The above shows that the standard time taken for de-stuffing of one TEU is nearly half that taken for stuffing operation. Hence the de-stuffing two TEUs are equivalent to stuffing one TUE of container. So the standard productivity of a gang is to be fixed as 7 TEUs per gang for stuffing operations and 14 TEUs per gang for de-stuffing operations.

8.5.5. Lack of co-ordination between Mechanical, Traffic, and Finance Departments

The management of the container terminal has to be revamped to bring it under a single chain of command. Currently the Traffic Department, the Mechanical Department, and the Finance and Accounts Department are functioning as watertight compartments without proper communication and interaction with each other. A barrier exists between these departments. The flow processes of the terminal are fragmented and a holistic approach to management/ problem solving is lacking. Such a system only breeds inefficiency and the tendency to pass the buck. This system makes the customers/ port users dissatisfied. Hence, to achieve integration of the flow processes, it is imperative that a container terminal manager with a unified command be appointed. He should have control over the three entire departments. The Manager should preferably be a senior engineer with MBA background.

8.5.6. Issues Related on Procedures and Documentations

An analysis of the procedure reveals that 94 percent of the port users believe that the procedure of container handling to be as cumbersome as or more cumbersome than those of the neighboring ports. Out of them, 47 percent seem to believe that the procedure is more cumbersome. The major procedure difficulties are listed in the following paragraph.

8.5.6.1. Multiple permissions

Each time the customer needs equipment for the same container, separate applications have to be filled. This involves wastage of time and considerable paper work.

8.5.6.2. Multiple window clearance

For filing of import application (IA) or export application (EA), the customer has to submit it in different offices located at different places in the port. In modern ports, single window clearance system is introduced for time saving and avoiding the difficulties of customers.

8.5.6.3.Multiple handling charges point

The payment for each handling operation is done at different offices. It must be avoided and all the handling charges could be collected to a single point while issuing the landing permission.

8.5.6.4. Lack of computers and printing devices

Due to poor office automation and insufficient number of computer facilities and printing machines at various offices, the clearances are getting delayed resulting wastage of time.

8.5.6.5. Lack of co-ordination between different offices

Due to lack of co-ordination between Electronic data center (EDC) and Confederation of Customs House Agent's (CCHA) office, the processing of IA/EA are getting delayed. The co-ordination between port officials and the Customs officials are also very poor and hence, the terminal operations are getting delayed.

8.5.7 Problems in Computerization

The computerization activities in Cochin port started in 1988. The results of the study of history of computerization at RGCT and the current status are presented here. The beginning was made by installing a mini-computer system and a few personal computers in the computer center in the central accounts department (CAD) in 1989. The port also installed a separate computer set-up at the container terminal building in 1994, for assisting container operations. During the eight-year period between 1989 and 1997, the port could only implement PC-based Payroll System, Wharf Cash Office Billing System and a Materials

Management System. Thus a majority of the port operations were carried out manually. In 1997, port entrusted a consultant to make a detailed study for the installation of MIS. They submitted a detailed report and the Board of Trustees approved the estimate amounting to Rs. 27.2 million, for the procurement of Computer Hardware, System Software, Application Software, and Data Communication Network and for providing other infrastructure. M/s Pentafour Software and Export Ltd., Chennai were entrusted with the work of development of software for the Financial Accounting System, Payroll and Personnel Information System. They were also entrusted with additional work of porting the existing application related to Container Operation to the new computer environment. M/s TCS Ltd., Bangalore was entrusted with the development of Software of the Cargo Information and Billing System, and the Vessel Information and Billing System. The new system was commissioned in 1999. Following Application software sub-systems were implemented in the MIS project of Cochin Port.

- Financial Accounting System including Cash Office Operations
- Payroll and Personnel Information System.
- Cargo Information and Billing System
- Vessel Information and Billing System
- Container Tracking and Control System

The port installed a computerized Container Tracking and Control System during 1992-94, under the overall supervision of their consultants, M/s Engineers India Ltd. The application software, which was provided by M/s TCS, included the following modules:

- Ship Planning
- Yard Planning
- Container Inventory and Tracking and
- Invoicing.

M/s TCS provided support till 1995. However, the port could only carry out parallel runs and entire operations continued to be done manually. Suspending the two modules of Yard Planning and Ship Planning this was put to use. The original application developed by M/s. TCS was ported on client/Server architecture and shifted to the new Computer Hardware installed at the container terminal. After this the Yard Planning and Ship Planning modules have been restored.

Several steps have been taken to fully computerize the container terminal from 1995 onwards. Even today, the Yard Planning and Ship Planning Modules are not being utilized. At present, computers used only for container inventory and tracking, and invoicing modules. A large amount of money has been spent for computerization of RGCT. The benefits from the money spent could not be fully realized due to a variety of reasons such as:

1. The organization does not have the expertise to state its own Information system requirement and to Plan and implement it even if the development is outsourced.
2. Lack of Managers with knowledge and skill in the area of Computer and IT and undue dependence on consultants.
3. Inadequate importance is given to the Computer department. In the Modern container terminal, the Computer/IT department is the most essential service department in the port. e.g. Port of Singapore, Hong Kong
4. Lack of training to the employees in the computer department
5. Lack of expertise to maintain the Computer and network systems
6. Opposition from Trade unions
7. Lack of motivation to the employees in the Computer Dept.
8. Improper implementation and usage of computerization in the past

A model of fully computerized software system was discussed earlier in section 8.3.1. This discusses the present state of application and utilization of computers in Container terminal. The size of the gap to be bridged has been made clear.

8.5.8 Problems in EDI Implementation

EDI has not been implemented fully at Cochin Port. A study of the EDI system and a survey of customers was used to find problems in EDI implementation at Cochin Port. This section is devoted to discussion of the findings.

Since EDI has only been partially implemented, port users and others are facing many problems now. The important problems are given below:

1. Import and export applications cannot be submitted at the port office through EDI facilities. Hence the port users have to go to port office for submitting the same. Due to this expected labour savings of port users have not been achieved.
2. Container loading report for export containers takes a longer time to reach through EDI because of delay in EDI updating. The message should be available at least within 6 hours after the vessel sails off. But it is not available to the respondents within this time period.
3. The bill and invoice stays in the system only for around a month. Due to this, it cannot be referred back after one month.
4. Errors in the invoice take longer to be corrected.
5. Delay in getting CVIA number after the vessel registration application is submitted.
6. There is no provision in the present EDI system to know whether the messages send by the customer has reached the port or not. Message conformation information, which is a very important feature of EDI, is missing.
7. Due to a third party EDI vendor, the users may feel insecure regarding confidentiality of important business data sent though EDI.

8. The users have to pay around Rs. 25,000/- per year for the EDI provided by the EDI vendor. However, the messages they are sending through EDI are less in volume and frequency. So many customers feel that the use of EDI is a costly affair.
9. The users have expressed the need to get gate pass, stack report and Export/Import applications through EDI system.

The major reasons that have adversely affected in EDI implementations according to the customers are as follows.

- Lack of qualified professionals in Port and on customer side for exploiting the full advantages of EDI implementation.
- Partial implementation of EDI
- Problems on the vendor side
- Lack of proper information flow between port, customs and port users
- Frequent breakdown of systems due to hardware breakdown as well as that of EDI site not functioning properly.
- Many data entry errors in the port.

A proper EDI system if fully implemented can be very useful for the users of Cochin Port. The billing system already implemented has helped the customer to a very large extent and goes to show that computerization if done properly can result in performance improvement and increased customer satisfaction.

8.6 Study of some aspects of Container terminal using Simulation model

Container Terminal operation is a very complex and dynamic in nature. Multiple operations such as: pilotage, loading and unloading of containers from ship, stacking of containers in the import yard, delivery of containers from import yard to customers, receipt of containers from the customers to the export yard, loading of containers from the export yard to the ship, gate operations, and stuffing and de-stuffing of containers in CFS, allocation of handling equipment and its maintenance, and preparation of load plan and planning of yard work etc are going on simultaneously. Any interruption on these operations will affect the overall performance of the terminal, which will cause delay in leaving the ship from the terminal after completing the unloading and loading of containers from/to the ship. The performance of a container terminal is measured by turnaround time of ship, which is an internationally accepted performance indicator.

8.6.1 Problem Statement

Container yard operation is a critical operation in any Container Terminal. Allocation of optimum number of equipment, sufficient stacking area, yard plan and stacking/unstacking of containers in the yard are the deciding factors for the efficient operation of a container yard. The Rajiv Gandhi Container Terminal was designed to handle 1,00,000 TEUs per annum, but now its capacity is over utilized by more than 150% (In 2001, RGCT has handled 1,51,829 TEUs). Due to this, high congestion effected in the terminal and delayed ship works. During periods of high congestion, export containers could not be stacked according to their predetermined plans, resulting in delayed loading of export containers in the ship. In Cochin Port, the container stacking area is only 64,220 sq.metres which is very less when compared with international standards. (Benchmark data of Japan has given in section 8.5.3). Due to this low stacking area, the average stack height seems to be 3.5 whereas the average stacking high is only 2 to 2.5 in case of modern container terminals. When the stack height increases, the unproductive movements of the transfer crane will increase and thereby interrupting the smooth operation of ship work. Hence the effect of increase in area of the yard and stacking high of export container yard are two important parameters to be studied.

From chapter five, it can be recalled that the port users opined that one of the critical reasons for the poor performance of equipment in RGCT is due to insufficient number of handling equipment (See section 5.7.4.1). Another cause stated is due to the poor planning of container yard operations (See section 5.7.4.3). Literature shows extensive use of simulation models in logistic systems specially container terminal related systems. This section is devoted to the study of effect of increase in area of the container stacking yard and stacking high of export container yard on ship turnaround time using simulation model. The following sets of experiments were conducted using the model.

1. Effect of increasing the container yard area

- The existing export yard area increased by two fold
- The existing import yard area increased by two fold
- The existing export and import yard area increased by two fold

2. Effect of increasing the stacking high of containers (Congestions)

- Containers stacked in export yard at 1 high (ground level)
- Containers stacked in export yard at 2 high equally likely
- Containers stacked in export yard at 3 high equally likely
- Containers stacked in export yard at 4 high equally likely

8.6.2 Methodology and model

The problem mentioned above is a real life problem, which is characterized by the process of probabilistic activity time elements of multiple activities taking place simultaneously. Such real life problems are modeled by discrete event computer simulation. The methodology used here involved the development of a basic simulation model to represent the container ships, waiting at outer sea, berthing, import/export container operations inside the terminal, un-berthing of ship after completing the ship and sail off from the port. The import container operations modeled involve unloading of containers from ship by quay gantry cranes, movement of trucks carrying the containers to the import yard, placing of containers from truck to the import yard by using transfer cranes, truck movement from import yard to the Quay Crane point for receiving

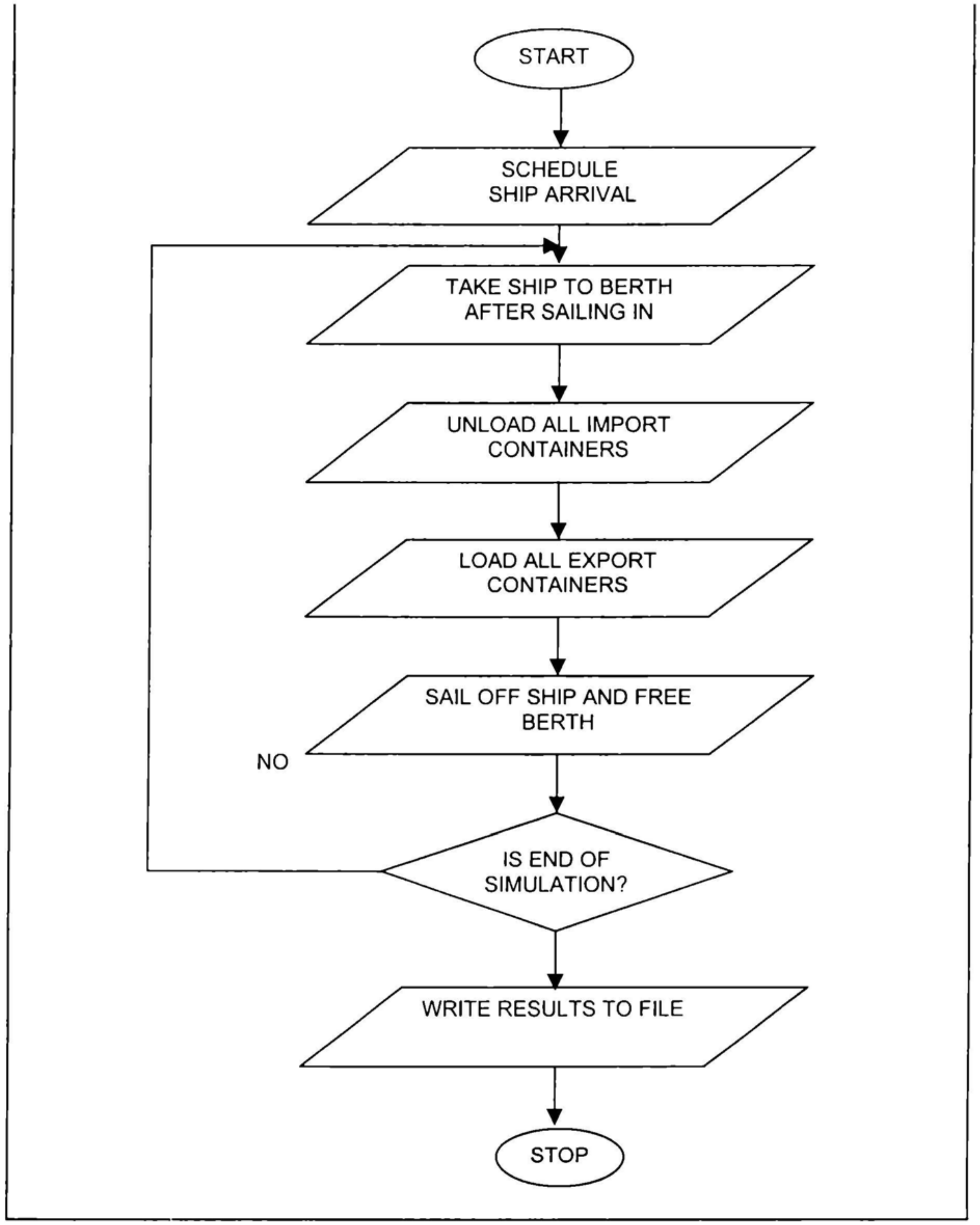


Figure 8.10 Flow Chart of the Simulation Model of CT Operations

the next container unloaded from the ship. Similarly the export container operations covered include the stacking of export container from the shippers in the export container yard by transfer cranes or stackers, picking of export containers from export yard and placing to the truck by using transfer crane, movement of trucks to the QC point for loading the containers in ship, picking and placing of containers from truck to the ship by means of QC, and movement of trucks from QC point to the export yard for taking the next container from the export yard. The occurrence of day and night is also incorporated in the model. The model uses inter-arrival time of ships at the outer sea, ratio of number of export to import containers in a ship, total containers in a ship and time elements taken for the above-mentioned operations (primary data collected using stop watch). The turnaround time of each ship was calculated by taking the total time from the time at which the ship arrives at the outer sea (NOR), to the time at which the ship reaches at the outer sea after completing the ship work at the container terminal. The output from the model is the minimum, mean and the maximum turnaround time of ship call at the container terminal for one month.

The effects of different options mentioned above on the turn around time were studied using the simulation model. In the model, it was assumed that the loading and unloading operations are taking place continuously without any interruption; equipment required is available as and when required. This assumption ignores breakdown and stoppage of equipment. This is not a serious issue here, since the same is the case in all models used here to compare the impact of the options studied. It was also assumed that the loading of export containers starts only after completing the unloading of import containers from the ship. In practice at times this is not true. However, all import containers will have to be unloaded and all export containers loaded. The sequence of operation could vary, this has minimum impact on total operation time, which is the parameter studied here. The flow chart showing the logic used in the simulation-based model is given in Figure 8.10.

The simulation model was developed using SIGMA. The model so developed was converted into PASCAL and the other input-output modules were added for use and faster execution. The event graph of the container operations at the terminal is shown in Figure 8.11. The event descriptions are given in Table 8.13.

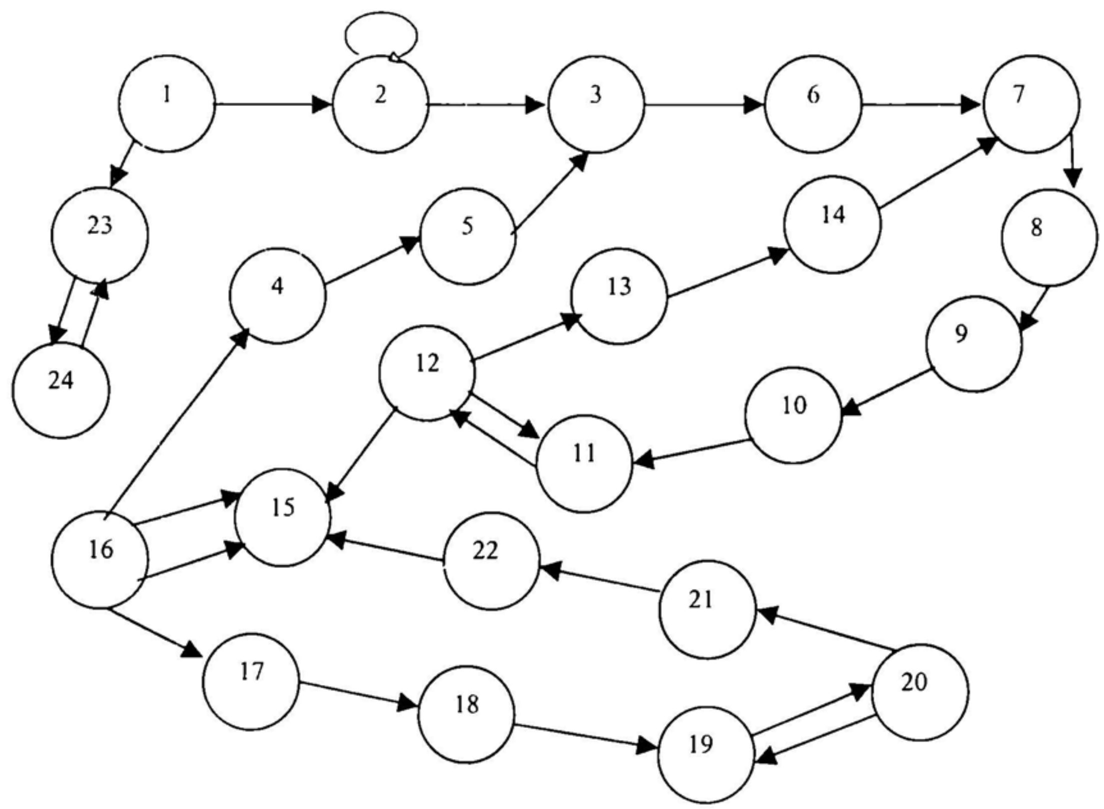


Figure 8.11 Event Diagram of Simulation Model

Table 8.13 Description of Events in event-graph of the Simulation Model

Node No.	Node Name	Description
1	RUN	START OF SIMULATION AND VARIABLE INITIALISE
2	SHIPAR	MODELS SHIP ARRIVAL AT OUTTER SEA
3	STSAILIN	SHIP STATRS SAILING IN TO THE CHANNEL
4	LVBERTH	SHIP LEAVES BERTH
5	SAILOFF	SHIP LEAVES THE OUTER OF COCHIN PORT
6	RH BERTH	SHIP REACHES AND IS BERTHED
7	QSTUNLD	QC STARTS UNLOADING A CONTAINER FROM SHIP
8	QEDUNLD	QC ENDS UNLOADING THE CONTAINER FROM SHIP
9	QEFTRK	LOADED TRUCK MOVES BACK TO IMPORT YARD
10	RIMPYRD	TRUCK LOADED WITH A CONTAINER REACHES IMPORT YARD
11	STULITC	START UNLOADING CONTAINER WITH IMPORT YARD TC
12	EDULITC	END OF UNLOADING CONTAINER WITH IMPORT YARD TC
13	FETRUCK	EMPTY TRUCK MOVES FORWARD TO CONTAINER BERTH
14	QBETRK	EMPTY TRUCK AT CONTAINER BERTH QUEUE
15	QSTLOAD	QC STARTS LOADING A CONTAINER FROM TRAILER TO SHIP
16	QEDLOAD	QC ENDS LOADING THE CONTAINER TO SHIP
17	BETRUCK	EMPTY TRUCK MOVES BACK TO EXPORT YARD
18	REXPYRD	EMPTY TRUCK REACHES QUEUE AT EXPORT YARD
19	STLDETC	START LOADING CONTAINER WITH EXPORT YARD TC
20	EDLDETC	END LOADING CONTAINER WITH EXPORT YARD TC
21	FFTRUCK	LOADED TRUCK MOVES FORWARD TO CONTAINER BERTH
22	BFTRUCK	LOADED TRUCK AT CONTAINER BERTH QUEUE
23	DAY	DAY STARTS
24	EDDAY	END OF DAY

operation time distributions used in the model were based on actual field time data for the operations collected from RGCT. Basic conditions such as time distribution of unloading of import containers from ship to place on truck, time distribution of movement of trailers to the import yard, the time distribution of placing of containers at the import yard, and the time distribution of movement of trailers from import yard to the QC point are examples of time data used. Similar time distributions for export containers operations were also given to the model. The distribution of stacking of containers were taken as same for import yard and export yard as 50 percent of the containers are stacked/picked in/from 4 high, 30 percent of the containers at 3 high, 15 percent of the containers at 2 high and the remaining 5 percent of the containers are at 1 high. This is based on work sampling observations in the CT.

The simulation model was validated using white box method of validation. Comparing the average ship turnaround obtained from the model with that collected from RGCT records did further validation. The result obtained from simulation was that the average turn around time is 1.5 days and the actual turnaround time is 1.9 days. This deviation is mainly due to the delay in operations and the frequent interruption in the continuous operation of the terminal, which is about 28% of total working time. The model therefore correctly represents the CT studied.

8.6.3 Experiments using Simulation Model

Using the base conditions mentioned above, the simulation model was run and the turnaround time was obtained. Three different experiments were conducted to study the effect of increasing the area of the container yards on ship turnaround time. Thereafter, four experiments were conducted to study the effect of stack height of export containers stacked at the export yard, on ship turnaround time. The first experiment was to study the effect of keeping the area of the import yard as it is in the base condition; the area of the export yard was doubled. Since the area of export yard doubled, the time distribution of transfer crane at the export yard also doubled and the distribution of containers from the yard at 4 high, 3 high, 2 high and 1 high was taken as equally likely. (25% of containers are picked from 4 high, 25% picked from 3 high, 25% picked from 2 high and the remaining 25% from 1 high). The second experiment was to study the effect of the area of import yard being doubled, keeping the export yard area as that of base condition. Since the area of import yard doubled, the time distribution of transfer cranes at the import yard also doubled and the distribution of placing the containers has changed as 75%, 15%, 8% and the remaining 2% in 4 high, 3 high, 2 high and 1high respectively. Third experiment was to study the effect of area of both export and import yard doubled.

The next four experiments were conducted to look into the effect of stacking high when the export containers are stacked at 4 high, 3 high, 2 high and 1 high. Here it is assumed that the export containers at export yard are distributed equally likely in each high. For example, the distribution of containers stacked at 3 high are distributed equally likely means that 33.33% of containers are to be picked from 1 high, next 33.33% from 2 high and the last 33.33% from 3 high. The time distribution taken was as that of the base condition.

8.6.4 Results and Discussions of the Simulation Model

The results from the experiments to find effect of increasing the yard area are shown in the Table 8.14. As the area of export yard doubled, the average turnaround time increased by 5.40 percent. When the area of import yard doubled, the average turnaround time increased by 5.42 percent. But when the areas of both export and import yards doubled; the average turnaround time increased by 16.47 percent. The percentage change in turnaround time is also shown in brackets in the table.

The turnaround time has increased when the area of export yard area has doubled. The time has again slightly increased when the area of import yard has doubled. There is a significant increase in average turnaround time when the areas of both export and import container yards has increased. This increase in turnaround time is due to the increased horizontal movement of the transfer cranes in the yard and the increased time for the movement of the trailers from/to the QC point. Therefore, if areas of export yard and import yard are increased the turnaround time can only be maintained at current levels by providing more handling equipment in the yard or by increasing the operational efficiency of the existing cranes in the yard.

Table 8.14 Effect of turnaround time due to the increase of the areas of stacking yards

PARTICULARS	TURNAROUND TIME FOR DIFFERENT OPTIONS IN MINUTES			
	1 Base Condition	2 Export Yard Area Doubled	3 Import Yard Area Doubled	4 Both Yard Area Doubled
MINIMUM	1141	1367 (19.8)	1367 (19.8)	1183 (3.68)
MEAN	2157.31	2273.8 1(5.40)	2274.25 (5.42)	2512.71 (16.47)
MAXIMUM	3641	3417 (-6.15)	3417 (-6.15)	3627 (-0.47)

Congestion in the terminal is a serious problem. When the congestion increases in the terminal, stacking high will increase due to the limited number of ground slots. As a result the number of non-productive movements will increase and there by increase the turnaround time. This situation in case of export containers will be more serious than the import containers in the import yard. Hence the effect of turnaround time of export containers due to congestions in the export yard has studied using the simulation model.

Table 8.15 Effect of turnaround time due to the congestions in the export stacking yards

PARTICULARS	TURNAROUND TIME FOR DIFFERENT OPTIONS IN MINUTES				
	1) Base Condition	2) Effect of 1 High	3) Effect of 2 High	4) Effect of 3 high	5) Effect of 4 high
MINIMUM	1141	1440 (26.20)	1418 (24.28)	1172 (2.72)	1646 (44.25)
MEAN	2157.31	2346.65 (8.77)	2352.65 (9.05)	2474.65 (14.70)	2377.59 (10.21)
MAXIMUM	3641	2858 (-21.50)	3182 (-12.60)	3247 (-10.82)	2831 (-22.25)

The results from the experiments to find effect of stack height on ship turnaround time are shown in Table 8.15. The percentage increase of turnaround time with respect to the base condition is also shown in brackets.

When all the containers are stacked at 1 high, the average turnaround time has increased about 8.77 percent when compared with base condition. When the containers are stacked at1 high and 2 high, the turnaround time has increased further. Similarly when the containers stacked at 1 high, 2 high and 3 high, the turnaround time has again increased. But slight decrease in turnaround time has shown when the containers are stacked at 1 high, 2 high, 3 high and 4 high equally likely as compared with the previous case. The increase in turnaround time is mainly due to the non-productive movement of transfer cranes due to congestions in the export yard. From this analysis, it is very clear that the stacking area is not sufficient and hence congestion increases and also the turnaround time increases subsequently.

It is known that doubling of yard area will decrease performance, however quantifying the extent of performance degradation was possible using simulation model. Similarly with the help of the simulation model it was possible to quantitatively predict the degradation in performance with congestion in the container terminal.

8.7 Conclusion

This chapter focuses on the study of operational problems of Rajiv Gandhi Container Terminal and the study of the effect of turnaround time of container ships, when the existing areas of the container stacking yard has increased and the impact of congestions in the yard on turnaround time using a simulation model.

The chapter begins with reviewing the history and development of containerization in the world followed by the development of containerization in India and in Cochin Port. The marine containers were first used during the Second World War. During 1970s the capacity of container ships slowly come up and it reached at the level of more than 10,000 TEUs at the beginning of the 21^{st} century. During 1964 the volume of container traffic was absolutely nil and it has increased to 225.30 million TEUs in 2000. During this time the technology of handling equipment changed, more powerful equipment were developed, geared vessels were replaced by quay gantry crane, which can be operated from the quay.

The Indian seaports entered the containerized era by receiving the first containership in Cochin port in 1973. Container traffic increased from 0.13 million TEUs in 1980 to 2.89 Million TEUs in 2001-02. At present, six Indian ports namely Calcutta/Haldia, Chennai, Cochin, Jawaharlal Nehru Port (JNPT), Mumbai, and Tuticorin have been increasingly handling the containers. Many operations in Container Terminals were privatized as a result of new economic policy started in 1992. Joint operations with foreign collaborations also started in container terminals of JNPT, Chennai, and Tuticorin. In 1995, Rajiv Gandhi Container Terminal has inaugurated and two berths Q_8 and Q_9 were used exclusively for container handling. Many development schemes were incorporated in the eighth and ninth five-year plans. A Container Freight Station started functioning in the terminal from 1998 onwards. The facilities available in the container terminal were also discussed.

A computer system for container terminal management was described in detail. The sub system of the Container Terminal Management Systems such as: Terminal-planning system, Terminal Operation system and Terminal Management systems were discussed. This computer system was successfully implemented in Japan. An EDI implementation process in port was then discussed. Its advantages, areas of application and necessity of implementation in ports were highlighted.

Next the Container Terminal operations were discussed in detail. The terminal operations are broadly classified into two, namely export container operations and Import container operations. The information and documentation flow diagrams for both export and import operations were prepared. This study was necessary to understand the operation problems of a container terminal. In the next section, a detailed study of the operation problems of RGCT was done using the operational data collected from the port. Many operational problems were identified. This brought to light the problems such as, High pre-berthing detention time, Poor performance of container handling equipment, Improper Container Yard Planning, Delay in gate operations of the container yard, Lack of co-ordination between Mechanical, Traffic, and Finance Departments and Issues Related on Procedures and Documentation.

Problems in computerization and EDI implementations were studied separately. Several steps have been taken to fully computerize the container terminal from 1995 onwards. Even today, they are not able to utilize the Yard Planning and Ship Planning Modules. At present, they are utilizing computers only for container inventory and tracking, and invoicing modules. A large amount of money has been spent for computerization of RGCT. The benefits from the money spent could not be fully realized due to a variety of reasons such as, lack of priority, plan, expertise and training.

Finally a discrete event simulation model of the container terminal operations was successfully developed and used to study the effect of increasing the existing areas of the container stacking and the effect of congestions on the turnaround time of the container ships calling at the terminal. It was found that both doubling of yard areas and increasing stack increased the ship turnaround time. The model helped to quantify the degradation in performance with changes in container yard. This model can be used to measure and quantify benefits of implementing changes in the container terminal at project evaluation stage itself so that cost effective solutions are selected for implementation in practice.

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CHAPTER 9

SUMMARY AND CONCLUSIONS

9.1 Introduction

The chain reactions of growth in World Trade, consequent on growth in sea borne trade, increase in shipping demand, and need for development of ports was noticed in India also. This demand for port development further intensified after 1991 due to the new economic policy of globalization and liberalization implemented by India. The volume of traffic through Indian ports increased from 23.11 MMT in 1955 to 152.67 MMT in 1990 and to 382.71 MMT in 2001-02. The number of major ports increased from 5 at the time of independence to 12 in 2001. The performance of Indian ports is still poor when compared with other ports in the same region, such as Port of Colombo and Port of Singapore. Indian ports are facing problems related to facility upgradation, high manning scales and planning and operations. In this thesis, the planning and operation problems of Indian Major Ports were studied. The study has specifically gone into details of the Planning and Operations problems of Cochin Port.

The review of literature showed that the poor operational performance in ports could be due to either non-availability of adequate facilities or improper use of the same if available or both. Lack of adequate facility could be due to lack of funds, poor planning or poor plan implementation, or a combination of the above factors. Common problems related to policy and planning were identified, common operations problems were also found out. Since planning and operations problems differ very much from firm to firm, it was felt necessary to study this from a firm level. Operations can be improved only by solving problems at firm level, it was therefore deemed necessary to study the same and solve it for one port in detail. The problem at hand was therefore to find common planning and operation problems of Indian Major ports. After this, study of the planning and operation problems of a major port in detail at firm level was presented. For this study, one of the oldest major ports in India - Cochin Port - was selected. Solutions for some problems identified were also discussed.

A comparative study of all major ports in India, was conducted using data collected from reports published by the Government of India, Administrative reports of all major ports and annual reports of Indian Port Association was presented. The five-year plan proposals from first five-year plan to the ninth five-year plan and economic review reports were analyzed to locate planning problems and recommended strategies for improvement.

Operation processes of Cochin port were studied using flow process charts and some problems were identified. A survey was conducted using a questionnaire to understand the perceptions and views of the port users of Cochin port, regarding the operations of the port. Parato Analysis was done on the results tabulated from the questionnaire survey to understand the severity of the problems. The income and expenditure schedules of Cochin port were collected for a period of 12 years from 1989 to 2000. This data was used to study the present financial position of Cochin port. The reasons for the sorry financial state of the port were identified using the analysis of the data. The effect of indirect expenditure was also studied. A micro level study was conducted at the Cochin Oil Terminal and Container Terminal, which were identified as the important areas of operations of Cochin Port that needs improvements. Simulation models were developed and experiments were done to identify the bottlenecks and to evaluate de-bottlenecking alternatives in Cochin Oil Terminal and in Rajiv Gandhi Container Terminal. Sensitivity analysis was conducted in Cochin Oil Terminal to find out the suitable operation parameters. Work-study was conducted to fix the manning scale for stuffing and de-stuffing operations.

9.2 Summary of the Report

The first chapter provided the introduction to the thesis and described the present trends in world trade, simultaneous demands in shipping services and the growth of sea borne trade. The changes in seaports and the present scenario of port development were also discussed. This discussion was useful in understanding the need for further development of Indian ports especially after 1991 due to the new economic policy of globalization and liberalization implemented by India. The specific problem studied in this thesis, the objectives and methodology of the study were clearly explained under the heading 'Work in this thesis'.

An extensive literature survey was done to understand the port related studies conducted during the 20th century. Literature survey was done for seaport related studies by classifying the studies into six categories namely 1) Geography, locations of ports and hinterland and transportation studies, 2) Operation planning, operation management, and operational improvement studies other than container terminals, 3) Container port related Studies, 4) Crude Oil Terminal related Studies and 5) Studies based on Indian Major ports and 6) Studies based on Cochin Port. From the literature, it was seen that the latest studies had already shifted towards container port concentration for improving the performance of Container Terminal.

From the review of literature, it was clear that operational problems in the port sector have come because of the rapid increase in demand and increased service level requirements of specialized modern ships. Inability to change processes and operations with times also resulted in inability of ports to cope with the problems. It was noticed only a very few research have been reported using the operation management tools like modeling, simulation and work-study methods to improve the operational performance of Indian ports, even though a many studies have been reported world wide. Hence this study was an attempt to fill this gap in the planning and operation studies of Indian major ports.

A comparative study of 11 major ports in India by considering all important port related variables were done. This comparison between all major ports were done by making use of various variables related to port operations such as operational performance indicators, financial performance indicators, physical facilities available, and manpower available and its utilization. Weighted score method was used to compare the performance of each port. This comparative study of all major ports was carried out to understand the present status and trend in the growth and development of ports in India.

The operational performance indicators considered in this study were average turn around time of ships, average pre-berthing time, average idle time of ships in ports, average output per ship-berth day, capacity utilization of ports, average berth occupancy and volume of cargo handled. Port of New Mangalore was found to be operating with maximum operational performance followed by port of Visakhapatanam. JNPT and Mormugao are coming in the third and fourth position respectively. The operational performance of port of Tuticorin is worst when compared with other ports in India.

Major financial performance indicators such as operating income, operating surplus, operating ratio, net surplus and ratio net capital employed to net surplus were taken to compare the major ports in India. From the analysis, it was seen that the port of Calcutta and Haldia had maximum values for financial performance indicators. The port of JNPT and Chennai were in second and third positions respectively.

Facilities available in ports were classified into four groups, which are a) berthing facilities, b) storage facilities, c) cargo handling facilities and d) capacity available to handle major commodities of each port. Channel depth, channel width, and number of berths available in ports were considered to compare the berthing facilities. Area of transit shed, area of warehouses and open area available in each port was used to compare the storage facilities. Number of wharf cranes, number of mobile cranes and all other back-up equipment were taken to compare cargo-handling facilities of all ports. Capacity available to handle major commodities such as container cargo, POL, fertilizers and iron ore were considered to compare availability of capacity of each port. While comparing all facilities available in each port together, it was seen that the port of Mumbai has maximum facilities provided followed by Calcutta/Haldia and then JNPT.

Comparison based on the manpower available in all ports as on 31st December 2001 showed that the port of JNPT has minimum manpower, followed by New Mangalore and then Tuticorin. This study showed that the staff strength of all old ports was very high when compared with new ports. All ports have taken steps to reduce the staff strength due to new policy of Goverment of India.

A class wise analysis of staff strength was also done. From the analysis, it was seen that the staffing pattern has to be changed drastically for the efficient and effective utilization of the available manpower in ports. Based on the comparative study of net capital employed in each port, it was found that the port of Kandla has employed maximum capital, followed by Calcutta and Haldia and then the JNPT. The manpower utilization was measured using two parameters namely operating income per man and tons per man. The comparative study showed that the port of JNPT has good manpower utilization followed by New Mangalore and then port of Kandla Port of Mumbai showed a very poor manpower utilization when compared with other major ports in India.

Finally, all the above variables were integrated in to a composite score for all major ports to know the present status of each port. The analysis showed that the port JNPT is the best port in India among the eleven major ports. The port of New Mangalore is the second best and port of Visakhapatanam is the third best port in India. Similarly, the important Container Ports were also compared with the variables related to the container operations. Among the important six Container Ports, it showed that the JNPT is the best Container Port in India. Next best Container Port is Chennai and then Mumbai. Port of Calcutta/Haldia is in the last position as far the container terminals are concerned.

Then the problems related to making and implementing in five-year plans in port sector in India after independence was discussed. The process of planning and development of ports in the country was studied. The process of fund allocation through five-year plans to the port sector was also discussed to understand the formalities involved in this process. The eighth and ninth five-year plans that have proposed many development programmes exclusively for port sector in the context of liberalization of Indian economy were also reviewed in more detail. Various programs such as corporatization of ports, joint venture and private sector participation in port sector, new developments in science and technology, and manpower planning were discussed. The review showed very slow progress in implementing these schemes in Indian ports. It was noted that joint venture participation in Indian ports has progressed to some extent in four major ports in India during the ninth five-year plan period.

Problems related to planning and plan implementation have been discussed. The analysis also showed some operational problems faced by Indian major ports. The important suggestions for improvement cover, corporate structuring for ports, better finance for projects, establishment of project department, rationalization of manpower both direct and indirect, improved training, and harnessing of IT. The above study discussed in the fourth chapter has been clearly brought out that the Indian major ports are lagging behind international benchmarks, as far as planning and operational performance is were concerned. Actions for improvement have to be taken on war footing to make good the damage already done.

Next the study was focused on Cochin Port. The description covered the present organization structure, layout and its natural advantages. Then flow process charts were given to help understand the operations of the port. The port operation was classified in to three groups as 1) Container Terminal operations, 2) Oil Terminal operation and 3) other Terminal operations. The operations in each classification were divided in to sub process and its flow process diagrams were presented. Various delays were identified from the flow process chart. The important delays thus noted were: 1) delay in bringing the ships in to the berth, 2) delay in registration of loaded containers for export, 3) delay in stacking of loaded containers at parking yard due to want of unloading equipment, 4) delay in getting the gate pass, 5) delay in off-load the containers in the rail track, 6) delay in off-load the reefer containers from truck, 7) waiting for loading of export containers to ships, 8) delay in execution of ship work after berthing, 9) delay in starting the unloading of containers from ships,10)delay in removal of cargo at wharf, 11) delay in getting the containers from CFS for loading to the ships, 12) cargo waiting for loading in vehicle, 13) delay in un-berthing the ships after completing the ship work, and 14) waiting of ship at Fair Way.

Information flows were also shown in appropriate charts. From the flow process that we noticed that the physical movements and operations related to cargo for both import and export were related to processing of documents and paper work. Therefore the delays in paper work also have adverse impact in cargo handling performance.

A survey using questionnaire was conducted among the port users of Cochin port to study the problems that they faced with the operations of the port. The questionnaires focused on problems classified in to five groups viz. Equipment related problems, procedure/documentation related problems, Container terminal operation problems, Ernakulam/Mattanchery wharves operation problems, and other general issues and comparison with other major ports in India. Parato analysis was done to prioritize the problems coming under each category. A summary analysis of problems from survey was done and the problems were categorized in to six, which are: 1) facility design and installation problems, 2) Maintenance problems, 3) Operation and skill related problems, 4) Manpower related problems, 5) procedure and documentation related problems and 6) Other problems. Different problems in each category were identified and actions to be taken for improvement were suggested. Based on the analysis of the questionnaire, and suggestions of the port users, some recommendations were proposed for implementation. A few important recommendations were: single window clearance system, market focused strategy, unified custom formalities and procedures, better labour and equipment productivity, building of a transshipment container terminal at Vallarpadom, Joint/Private sector participation, and harnessing the advantages of automation using computers.

Using process charts, problems were identified from material flow point of view. Using user survey, the problems from documentation process and service point of views were also collected. There was agreement to be seen between results of the two methods for problem identification.

An analysis of annual income and expenditure schedule was done to identify the most critical areas of operations among the three areas operations identified in chapter five. This study using the annual financial statement of the port for a period of twelve years clearly showed the eroding strength of the organization. The observation was that over the years total expenditure has increased, and from the year 1999 has overtaken the total income, pushing it into red. This has happened because of the following reasons: (a) the surplus generated from operations (money left over from direct income after meeting the direct expenditure) has steadily decreased over the years, (b) the indirect expenditure head has also increased dramatically during this period. This double crisis has resulted in poor financial position of the port.

The other important observations made in this chapter were the high dependence on POL operations by the port, high cost of operations and maintenance, and high staff strength of the port. The main causes of high indirect expenditure have been identified as interest payment and pension payment. The suggestions made to tackle this are: (1) renegotiate old high interest loans in light of lower interest regime prevailing now, (2) create a pension fund to manage pension payment, and (3) re-examine the other non-statutory benefits provided to pensioners.

This study has revealed the scope for more work in the area of excess staff strength problem. The port operations also needed to be studied separately in order to find ways of improving service levels, efficiency, and to reduce the direct expenses involved. This study also showed that the POL operation is the most critical area of operation, which has high dependence on income generated in the port. Another area of importance in operation is the Container Terminal, which has further scope of growth because only less than 45 percent of the cargo is moving in containerized form in India today. The third area of operation- other wharves operation- is very expensive and it has limited further growth in future because the trend has changed towards containerization of cargo. Hence it was felt that there was need of a micro level study of POL Operations and Container Terminal Operations, which was therefore undertaken.

Break- even analysis was done to compare the financial position of port in 1996-97 and 2001-02. The analysis revealed that the financial position of the port in 1996-97 was very comfortable and the financial position in 2001-02 was very poor. The analysis also revealed the reasons for the poor financial position of the port today. The main reasons are the uncontrollable increase of the fixed expenses during the last five years and high rate of increase of variable expenses during the same period. The comparison of the findings of break-even analysis with the previous analysis showed that the reasons for the poor financial position of the port today are shown by both analyses is one and the same.

Then the focus has given to the critical operational parameters of Cochin Oil Terminal and Rajiv Gandhi Container Terminal. The bottlenecks in the operation of COT were identified and effects of key parameters on its performance were studied. Pre berthing delay was found to occur due to the following reasons: (a) berth occupied by another vessel, (b) full night navigation restriction, (c) want of pilots, tugs, mooring boats and its crew and (d) delay in getting of survey report. A key parameter, discharge time, was found to be high due to the poor performance of the discharge pumps in the tanker, and low allowable pressure of the old crude pipe line from COT to KRL. The time after finishing of discharge to sail off was also seen high in the case of some tankers. COT is clearly a bottleneck and de-bottlenecking can be done by either increasing average discharge rate from tankers or by bringing fewer tankers with larger parcel size.

A discrete event based simulation model of the Oil tanker berth operations was successfully developed and used for finding the size and number of tankers to use to bring in the crude for a refinery. The least cost alternative for the refinery was found out and recommended. Besides cost per ton, there were other factors such as volume of paper work and other work generated, requirement of time for maintenance, etc that have to be considered when determining the tanker size to use. Considering all the above, it was suggested that a system of bringing a few 55 thousand DWT tankers with majority of 35 thousand DWT tankers would be a solution suitable both for the port and the refinery.

Chapter eight dealt with the study of operations problems of Rajiv Gandhi Container Terminal and the study of the impact of turnaround time of container ships when the existing yard area was doubled and the effect of congestion in the yard. A brief history and development of containerization in worldwide followed by the growth of containerization in India has been described in the initial part of the chapter. The containerization era had started in 1973, when the first container ship called at the port of Cochin. Operations of RGCT were discussed in detail. Operations related to export containers and import containers were described separately. The information flow has also been described by means of flow diagrams.

A detailed analysis using the data conducted to identify the operations problems of RGCT was presented. From this analysis, it was found that the turnaround time of ships arriving at RGCT is very high when compared with other international container ports of Singapore, Korea and Colombo, which are also located in the same maritime region. The study also found that the container stacking yard operation is a bottleneck. Container yard planning was not possible at times due to overcrowding. The reasons for the partial implementation of the computerization and EDI were mentioned. A good computerized system, which was successfully implemented in Japan, was described as a model for use in RGCT for improving the performance of the Terminal.

A discrete event simulation model was developed to study the effect turnaround time when the areas of Export yard, Import yard and area of both yards was doubled. Using the same simulation model, the effect of congestion in the export yard was also studied. The result obtained from the model showed that the turnaround time of container ships increased when the areas of stacking yards doubled. It also showed that when the stacking high resulted from the congestion in the export yard the turnaround time for ships has also increased. This study was also able to quantify the changes in performance when changes are introduced in the Container Terminal.

9.3 Limitations of the study

There are a few limitations in this study. The main limitations are listed below.

- The simulation models are specific to Cochin port and therefore the results obtained from simulation studies are applicable only for Cochin Port. The same can however be extended in other ports in India by changing the logic and input variables wherever necessary.

- The shipside operations of the Container Terminal could only be simulated in this study due to time limitation. The results obtained from the simulation model of container terminal could have been better, if were able to simulate the whole operations including gate operations, yard operations and CFS operations of the container terminal.
- Work- study was conducted to fix the manning scale for stuffing and de-stuffing operations at CFS. Work-study could not be extended for other operations in the port, which is necessary for fixing the new manning scales.
- This study mainly concentrated on the planning and operational problems of two operational departments viz. Mechanical and Traffic departments of Cochin port. The planning and operation problems of the third operational department (Marine Department) could not be studied.

9.4 Conclusion

This research has made a comparative study of operational performance of Indian major ports. Problem areas in operations have also been identified. Problems in the five-year planning process that resulted in the present imbalance between facility availability and demand and inadequacy of facility have been identified and some remedial measures have been suggested. The critical areas of operation at Cochin Port were identified and studied in detail. Simulation models were developed and used to find the optimum operating parameters for COT and Container terminal of Cochin Port. The results regarding planning problems in Indian ports and common operation problems of Indian ports and their comparative study are have a wide usage and utility. The results from the study of Cochin Port have narrower use.

In this thesis, it has been demonstrated that logistics problems have many dimensions, from successful forecasting of future requirements to proper planning, plan implementation for facility and system creation. There is also problems of logistic system operation planning, operation and control and short-term debottlenecking to be taken care of. A wide variety of methods tools have been used in this thesis to identify problems in each area. It has been shown that the methodology followed in this thesis could be used effectively to study logistic problems in detail. This research has also shown the benefits of covering logistic research from strategic planning level to operations trying to understand and integrate the linkages involved. The fact that logistic system study has to be multidisciplinary and tools and techniques from different disciplines find there use here, was felt.

9.5 Scope for future Research

At the end of the above study, it was felt that there is need for a lot of scope for further studies in the area of Operation Management of Ports. This is because there are many approaches that could be adopted for research in this area and also there are many problems to be researched. The reality that the same problem in logistic studied at a different time yields a different challenge also increases scope of research in this area. The scope for further studies in line with the work presented in this thesis is given below.

There is scope to study the manning and management issues in Indian Ports. Study of financial statements of Cochin port has revealed the scope for more work in the area of excess staff strength problem. Project management and project implementation in ports is also an area worth studying. The port operations also need to be studied separately in order to find ways of improving service levels, efficiency, and to reduce the direct expenses involved. The simulation models developed here could be modified and used for more related studies. Studies to benchmark Indian port operations with international ports also have scope. The simulation models developed and used here are having average complications more realistic models with animation and other advanced features can be developed and used.

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PUBLICATIONS OUT OF WORK IN THIS THESIS

SI. NO	TITLE	AUTHORS	JOURNAL/SEMINARS	REMARKS
1	Operational Problems of a Modern Container Terminal	R.Sasikumar & Dr. M. Bhasi	Indian Ports	Published. Vol.XXXIV, No.4, April 2003, pp 5-10.
2	A port Users Survey of Cochin Port Operations	R.Sasikumar & Dr.M.Bhasi	Shiptechnic	Published. Vol.XIX, 2003, pp 103-109.
3	Study of Operations of an Indian Port Using its Annual Financial Statements	R.Sasikumar & Dr.M.Bhasi	Economic and Political weekly	Communicated.
4	Port Facility Development-Understanding and Overcoming Problems	R.Sasikumar & Dr.M.Bhasi	Indian Journal of Transport Management	Communicated
5	Understanding Port Operation Problems Using Customer Survey	R.Sasikumar & Dr.M.Bhasi	Survey	Communicated
6	Study of the effect of Critical Parameters on Performance of a Crude Oil Terminal	R.Sasikumar & Dr.M.Bhasi	Industrial Engineering	Communicated
7	Crude Tanker Selection for Efficient Use of Oil Terminal Using Simulation	R.Sasikumar, Kemthose P Paul & Dr.M.Bhasi	Vith Conference of the Association of Asian-Pacific Operational Research Societies (APORS) on " Operations Research: Emerging Paradigms for Information Technology " on December 08-11, 2003.	Paper Accepted for Presentation
8	Operational Problems of a Modern Container Terminal	R.Sasikumar & Dr.M.Bhasi	Proceedings of the VI thAnnual Conference of The Society of Operations Management, Dec 20-22, 2002, at IIM Kozhikode.	Presented in the Seminar
9	Port Facility Development-Understanding and Overcoming Problems	R.Sasikumar & Dr.M.Bhasi	Proceedings of the Regional Seminar on RAMSAR sites of Kerala, 21 February 2003, at CWRDM, Kozhikode	Presented in the seminar.
0	Study of Effect of Critical Parameters on Performance of a Crude Oil Terminal	R.Sasikumar & Dr.M.Bhasi	Proceedings of the National Conference on Infrastructure Management: Emerging Issues, 16-18 May 2003 at Manipal Institute of Management, Manipal.	Presented in the seminar.

Annexure-A

Plan Outlays and Utilization of Major Ports in India

Table.A1 Percentage utilization of outlays of Bombay port

Plan Period	Plan outlay Rs. in Crores	Actual Expenditure Rs in Crores	Percentage Utilization
First five year plan (1951-55)	22.88	10.92	47.73
Second five year plan (1956-60)	25.18	5.22	20.73
Third five year plan (1961-65)	25.53	12.94	50.69
Annual plan (1966-67)	9.85	4.39	44.57
Annual plan (1967-68)	10.28	5.60	54.47
Annual plan (1968-69)	9.48	9.01	95.04
Fourth five year plan (1969-74)	22.70	16.96	74.71
Fifth five year plan (1974-78)	29.88	16.32	54.62
Annual plan (1979-80)	8.37	1.18	14.09
Sixth five year plan (1980-84)	129.41	72.45	55.98
Seventh five year plan (1985-89)	198.62	59.54	29.98
Annual plan (1990-91)	19.08	12.47	65.36
Annual plan (1991.92)	25.85	22.30	86.27
Eight five year plan (1992-97)	215	158.13	73.55
Annual plan (1997-98)	94.86	106.75	112.53
Annual plan (1998-99)	70.50	21.16	30.01
Annual plan (1999-00)	50.00	50.51	101.02
Annual plan (2000-01)	101.70		-

Sources:(1) Animesh Ray, Maritime India-Ports and Shipping, Pearl Publishers, Calcutta.
(2) Basic Port Statistics of India 1999-'00, Transport Research wing, Govt. of India.

Table.A2 Percentage utilization of outlays of Nhava-Sheva (JNPT) Port

Plan Period	Plan outlay Rs. in Crores	Actual Expenditure Rs in Crores	Percentage Utilization
Sixth five year plan (1982-84)	125	16	13
Seventh five plan (1985-90)	870	806	93
Annual plan (1990-91)	45	33	73
Eight five year plan (1992-97)	413	252.69	61.18
Annual plan (1997-98)	156.24	75.61	48.39
Annual plan (1998-99)	110.90	55.46	50.00
Annual plan (1999-00)	223.10	211.21	94.67
Annual plan (2000-01)	217.99	-	-

Sources:(1) Animesh Ray, Maritime India-Ports and Shipping, Pearl Publishers, Calcutta.
(2) Basic Port Statistics of India 1999-'00, Transport Research wing, Govt. of India

Table.A3 Percentage utilization of outlays of Calcutta Port

Plan Period	Plan outlay Rs. in crores	Actual Expenditure Rs in Crores	Percentage Utilization
First five year plan (1951-56)	12.07	3.49	28.91
Second five year plan (1956-61)	31.03	15.73	50.69
Third five year plan (1961-66)	34.51	26.67	77.28
Annual plan (1966-67)	12.91	8.25	63.9
Annual plan (1967-68)	13.66	10.41	76.21
Annual plan (1968-69)	13.24	10.80	81.57
Fourth five year plan (1969-74)	53.86	83	154.10
Fifth five year plan (1974-78)	52.27	106.04	202.87
Annual plan (1978-79)	18.44	6.79	36.82
Annual plan (1979-80)	10.30	22.72	220.58
Sixth five year plan (1980-85)	178.75	44.71	25.01
Seventh five year plan (1985-90)	126.44	39.66	31.37
Annual plan (1991-92)	108.90	69.84	64.13
Eight five year plan (1992-97)	421.00	175.71	41.74
Annual plan (1997-98)	45.22	28.11	62.16
Annual plan (1998-99)	30.10	61.36	203.85
Annual plan (1999-00)	30.00	82.28	274.27
Annual plan (2000-01)	279.14	--	--

Sources:(1) Animesh Ray, Maritime India-Ports and Shipping, Pearl Publishers, Calcutta.
(2) Basic Port Statistics of India 1999-'00, Transport Research wing, Govt. of India.

Table.A4 Percentage utilization of outlays of Mormugao Port

Plan Period	Plan outlay Rs. in Crores	Actual Expenditure Rs in Crores	Percent Utilization
Third five year plan (1961-66)	12.02	1.75	14.56
Annual plan (1966-67)	0.37	.04	10.81
Annual plan (1967-68)	0.71	0.37	52.11
Annual plan (1968-69)	2.00	0.54	27
Fourth five year plan (1969-74)	32.00	21.19	66.22
Fifth five year plan (1974-78)	69.34	51.27	73.94
Annual plan (1978-79)	10.26	4.66	45.42
Annual plan (1979-80)	7.75	2.28	29.42
Sixth five year plan (1980-85)	25.30	25.13	99.34
Seventh five year plan (1985-90)	--	16.04	--
Annual plan (1990-910	--	4.88	--
Annual plan (1991-92)	--	2.75	--
Eight five year plan (1992-97)	123.00	84.86	68.99
Annual plan (1997-98)	15.42	7.78	50.45
Annual plan (1998-99)	15.00	31.00	206.67
Annual plan (1999-00)	30.00	25.50	85.00
Annual plan (2000-01)	50.21	--	--

Sources:(1) Animesh Ray, Maritime India-Ports and Shipping, Pearl Publishers, Calcutta.
(2) Basic Port Statistics of India 1999-'00, Transport Research wing, Govt. of India

Table.A5 Plan outlays and actual expenditure of Visakhapatanam Port

Plan Period	Plan outlay Rs. in Crores	Actual Expenditure Rs in Croses	Percent Utilization
First five year plan (1991-55)	--	1.36	--
Second five year plan (1956-60)	--	4.31	--
5.36Third five year plan (1961-65)	--	9,07	--
Annual plan (1966-69)	--	6.54	--
Fourth five year plan (1969-73)	--	62.63	--
Fifth five year plan (1974-77)	--	55.88	--
Annual plan (1978-80)	--	7.4	--
Sixth five year plan (1980-84)	--	71.39	--
Seventh five year plan (1985-89)	--	56.81	--
Annual plan (1990-91)	--	18.06	--
Annual plan (1991-92)	--	20.63	--
Eight five year plan (1992-97)	250	197.41	78.96
Annual plan (1997-98)	70.50	55.29	78.43
Annual plan (1998-99)	50.00	51.30	102.6
Annual plan (1999-00)	51.80	91.25	176.16
Annual plan (2000-01)	138.4	--	--

Sources:(1) Animesh Ray, Maritime India-Ports and Shipping, Pearl Publishers, Calcutta.
(2) Basic Port Statistics of India 1999-'00, Transport Research wing, Govt. of India.

Table.A6 Percentage utilization of outlays of Chennai Port

Plan Period	Plan outlay Rs. in Crores	Actual Expenditure Rs in Crores	Percent Utilization
Eight five year plan (1992-97)	570.00	222.88	39.10
Ninth five year plan (1997-02)	1500 (approved)	-	--
Annual plan (1997-98)	228.38	123.10	53.90
Annual plan (1998-99)	170.00	225.86	132.86
Annual plan (1999-00)	379.00	302.10	79.71
Annual plan (2000-01)	228.50	--	--

Sources: Basic Port Statistics of India 1999-'00, Transport Research wing, Govt. of India

Table.A7 Percentage utilization of outlays of Cochin Port

Plan Period	Plan outlay Rs. in crores	Actual Expenditure Rs in Crores	Percentage Utilization
First five year plan(1951-56)	--	0.59	--
Second five year plan(1956-61)	--	3.00	--
Third five year plan(1961-66)	--	1.88	--
Annual plan (1966-67)	--	1.09	--
Annual plan (1967-68)	--	0.88	--
Annual plan (1968-69)	--	1.32	--
Fourth five year plan(1969-74)	--	7.47	--
Fifth five year plan (1974-78)	--	7.38	--
Annual plan (1978-79)	--	0.62	--
Annual plan (1979-80)	--	3.00	--
Sixth five year plan (1980-85)	--	56.05	--
Seventh five year plan(1985-90)	--	49.83	--
Annual plan (1990-91)	--	26.78	--
Annual plan (1991-92)	--	32.43	--
Eight five year plan(1992-97)	117.00	89.59	76.57
Annual plan (1997-98)	16.21	10.04	61.94
Annual plan (1998-99)	10.00	19.93	199.30
Annual plan (1999-00)	20.00	22.76	113.80
Annual plan (2000-01)	26.00	--	--

Sources:(1) Animesh Ray, Maritime India-Ports and Shipping, Pearl Publishers, Calcutta.
(2) Basic Port Statistics of India 1999-'00, Transport Research wing, Govt. of India.

Table.A8 Percentage utilization of outlays of Tuticorin Port

Plan Period	Plan outlay Rs. in Crores	Actual Expenditure Rs in Crores	Percent Utilization
Third five year plan (1963-66)	21.76	5.07	23.30
Annual plan (1966-69)	Previous provision	4.63	--
Fourth five year plan (1969-74)	-Do-	18.61	--
Fifth five year plan (1974-78)	Do	26.94	--
Annual plan (1978-80)	3.75	6.71	178.93
Sixth five year plan (1980-85)	25.57	24.85	97.18
Seventh five year plan (1985-90)	Previous+2.50	12.75	--
Annual plan (1990-91)	Continued	2.17	--
Annual plan (1991-92)	10.00	6.53	65.3
Eight five year plan (1992-97)	85.00	76.54	90.05
Annual plan (1997-98)	34.18	16.07	47.02
Annual plan (1998-99)	55.00	48.38	87.96
Annual plan (1999-00)	170.00	194.38	114.34
Annual plan (2000-01)	367.18	-	-

Sources:(1) Animesh Ray, Maritime India-Ports and Shipping, Pearl Publishers, Calcutta.
(2) Basic Port Statistics of India 1999-'00, Transport Research wing, Govt. of India

Table.A9 Percentage utilization of outlays of Kandla Port

Plan Period	Plan outlay Rs. in Crores	Actual Expenditure Rs in Crores	Percent Utilization
Eight five year plan (1992-97)	226.00	99.95	44.23
Ninth five year plan (1997-02)	580.00 (approved)	--	--
Annual plan (1997-98)	85.08	50.90	59.83
Annual plan (1998-99)	65.50	50.19	76.63
Annual plan (1999-00)	71.80	63.38	88.27
Annual plan (2000-01)	109.93	--	--

Sources: Basic Port Statistics of India 1999-'00, Transport Research wing, Govt. of India

Table.A10 Percentage utilization of outlays of Paradip Port

Plan Period	Plan outlay Rs. in Crores	Actual Expenditure Rs in Crores	Percent Utilization
Eight five year plan (1992-97)	486.00	233.95	48.14
Ninth five year plan (1997-02)	1200.00	--	--
Annual plan (1997-98)	224.84	117.82	52.40
Annual plan (1998-99)	120.00	199.73	166.44
Annual plan (1999-00)	344.00	235.96	68.59
Annual plan (2000-01)	275.52	--	--

Sources: Basic Port Statistics of India 1999-'00, Transport Research wing, Govt. of India

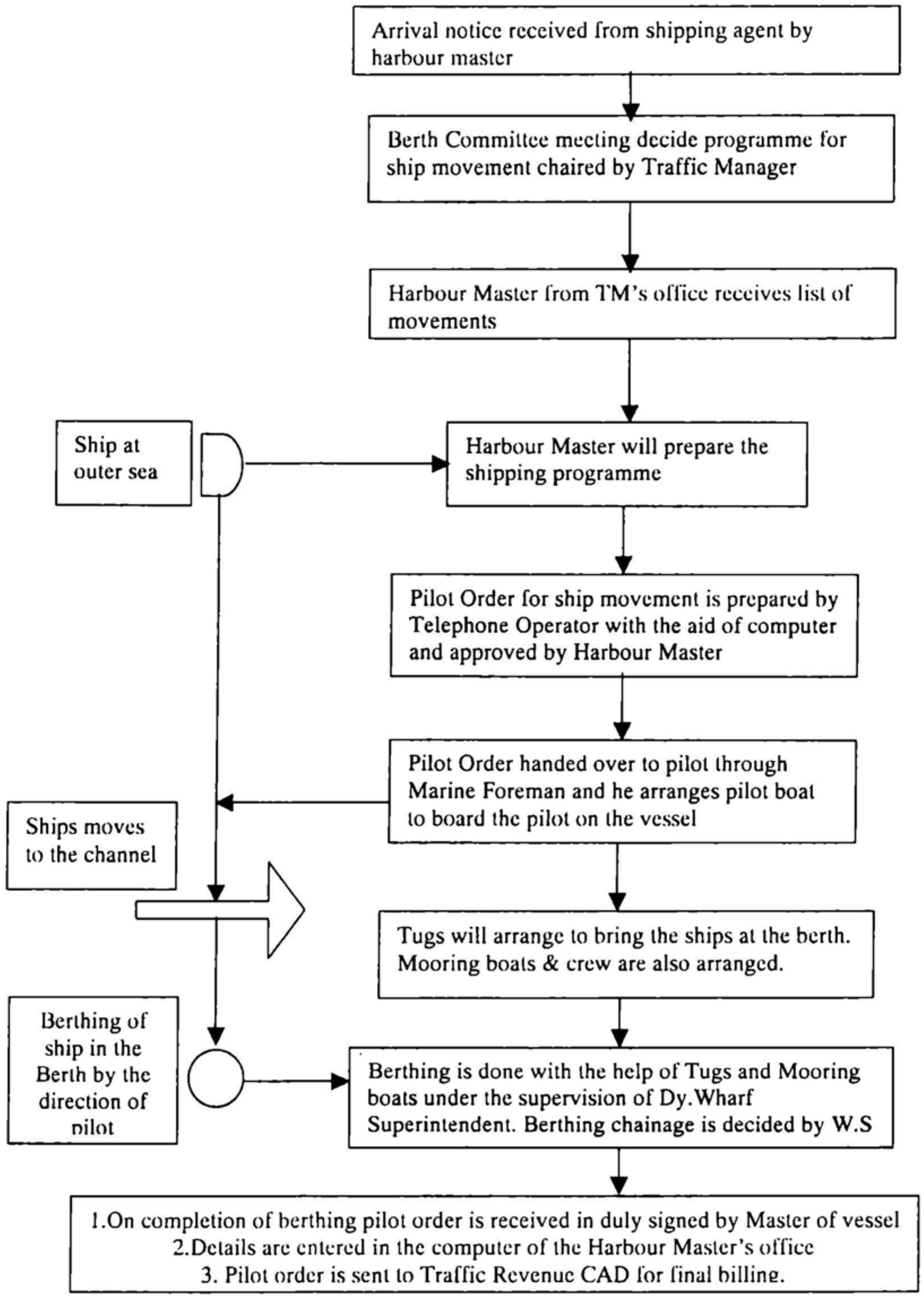
Table.A11 Percentage utilization of outlays of New Mangalore Port

Plan Period	Plan outlay Rs. in Crores	Actual Expenditure Rs in Crores	Percent Utilization
Eight five year plan (1992-97)	98.00	218.90	223.37
Ninth five year plan (1997-02)	640.00	--	--
Annual plan (1997-98)	31.44	20.58	65.46
Annual plan (1998-99)	30.00	14.31	47.70
Annual plan (1999-00)	44.00	44.35	100.80
Annual plan (2000-01)	90.00	--	--

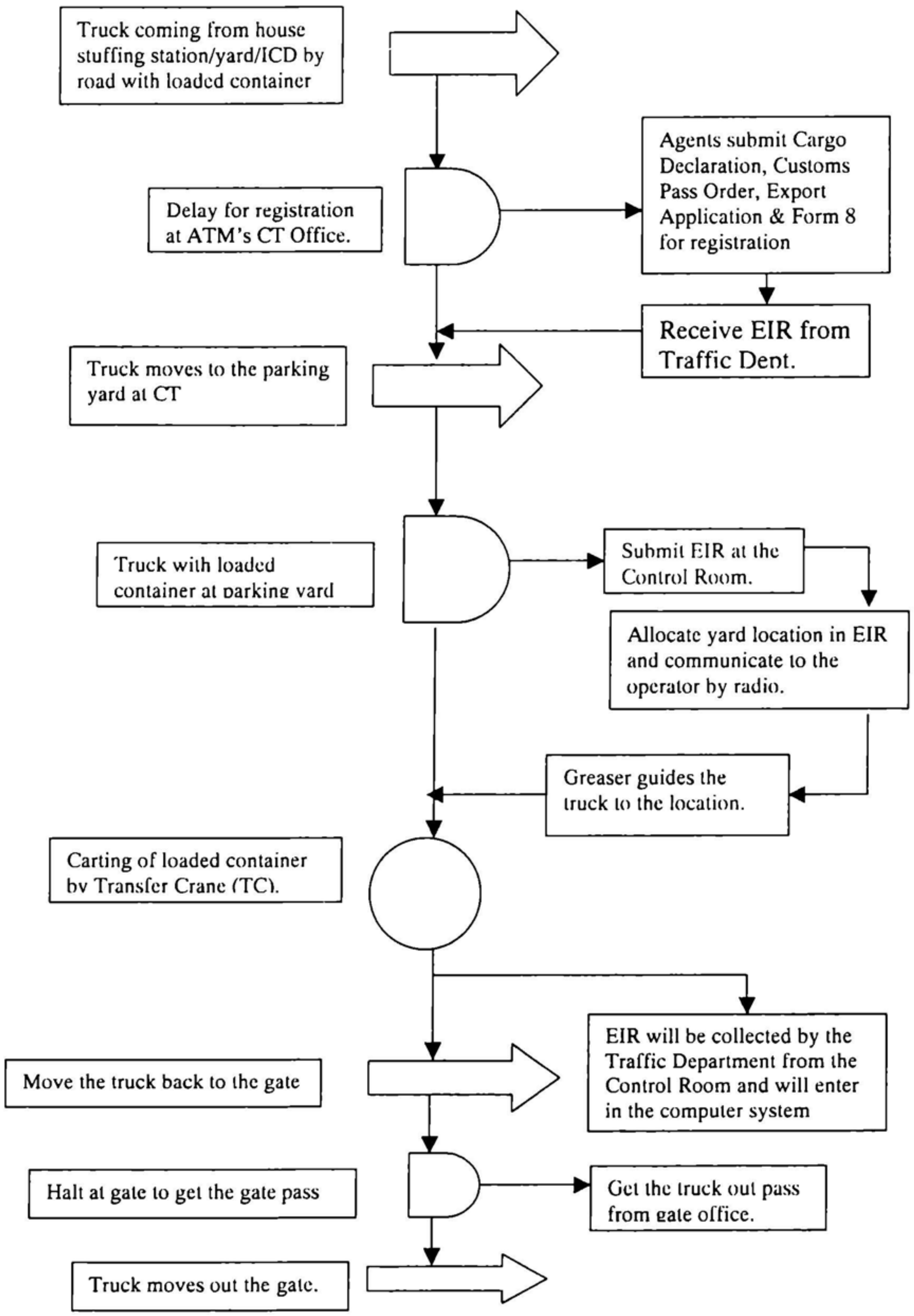
Sources: Basic Port Statistics of India 1999-'00, Transport Research wing, Govt. of India

ANNEXURE-B

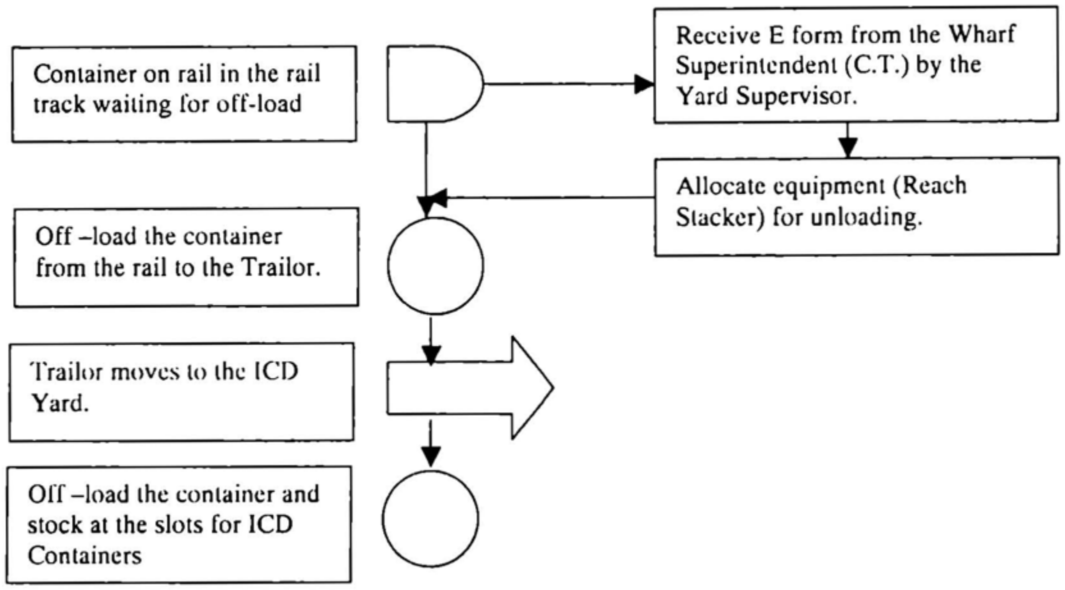
1. BERTHING OF SHIPS



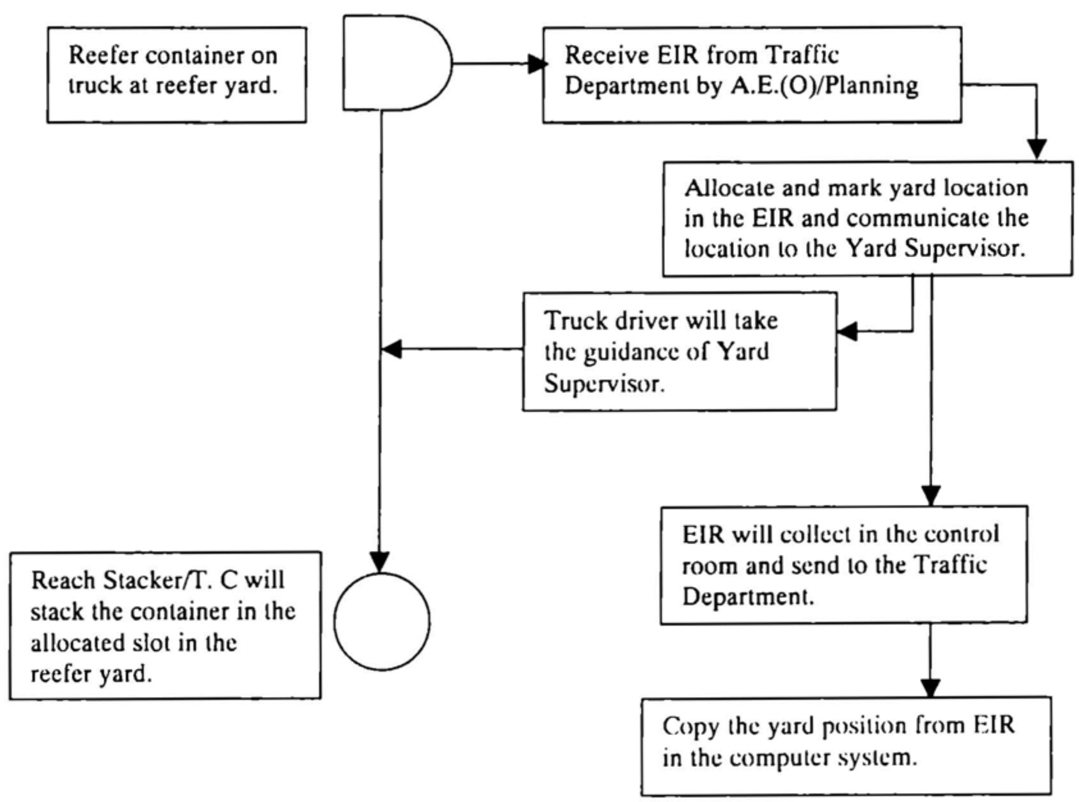
2. RECEIVING LOADED CONTAINERS FOR EXPORT



3. CONTAINERS ARRIVING BY RAIL FOR EXPORT

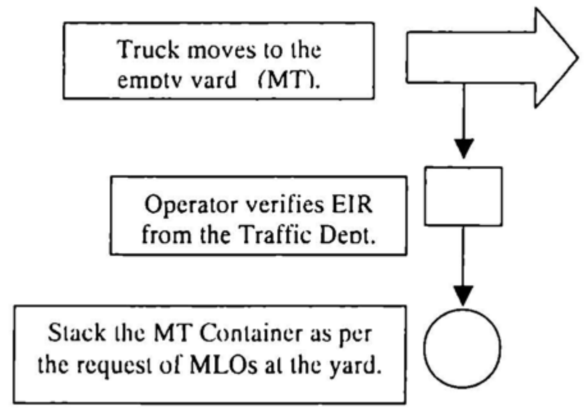


4. REEFER CONTAINERS FOR EXPORT

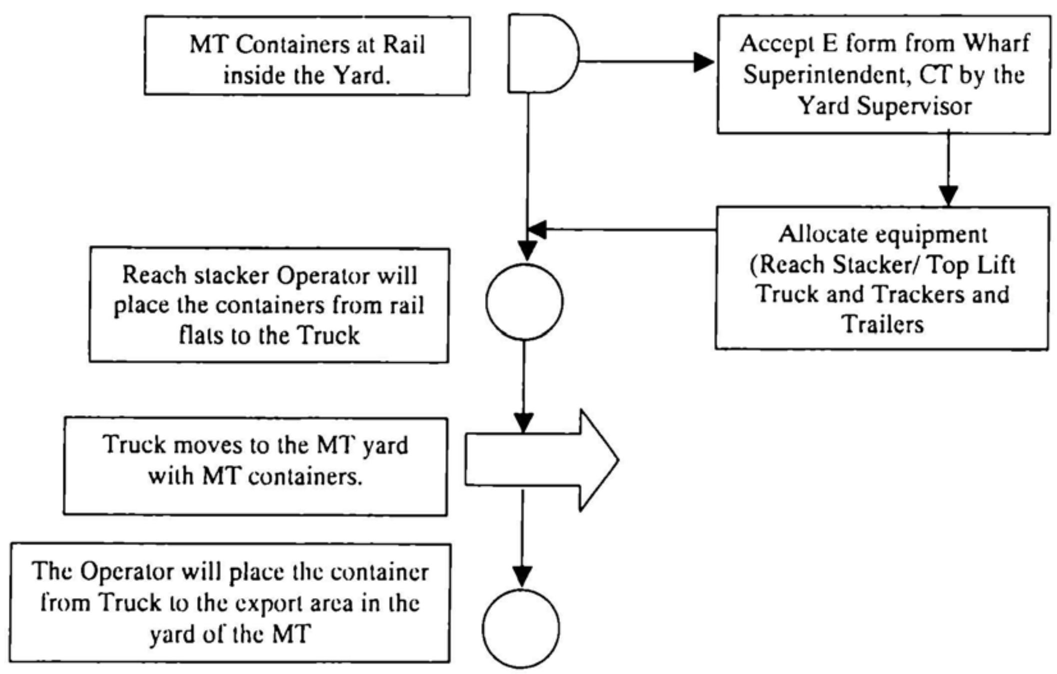


5. RECEIVING EMPTY CONTAINERS FOR EXPORT.

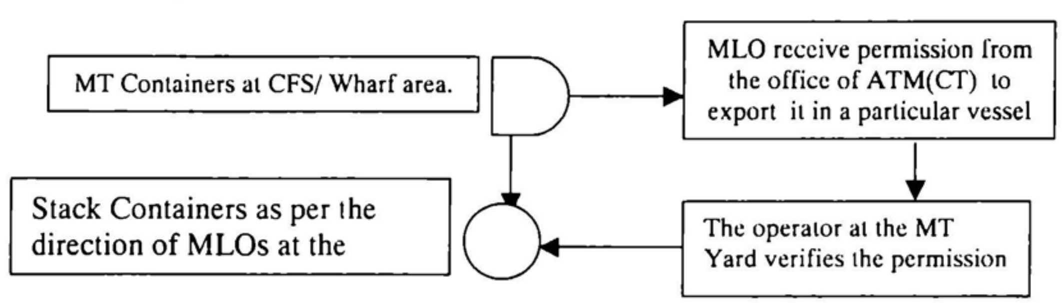
(A) Containers from outside CT gate



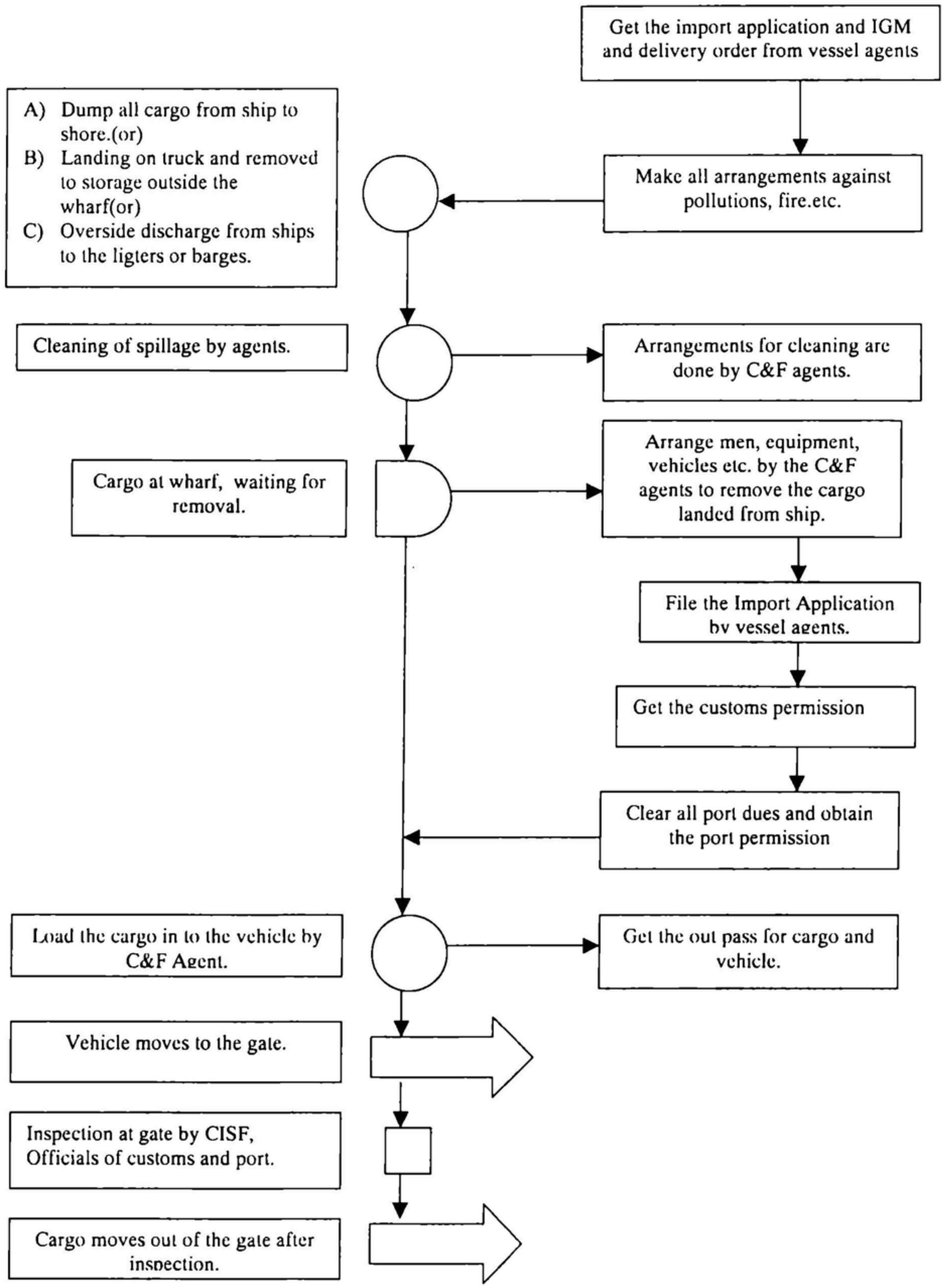
B) MT Containers from ICD by Rail.



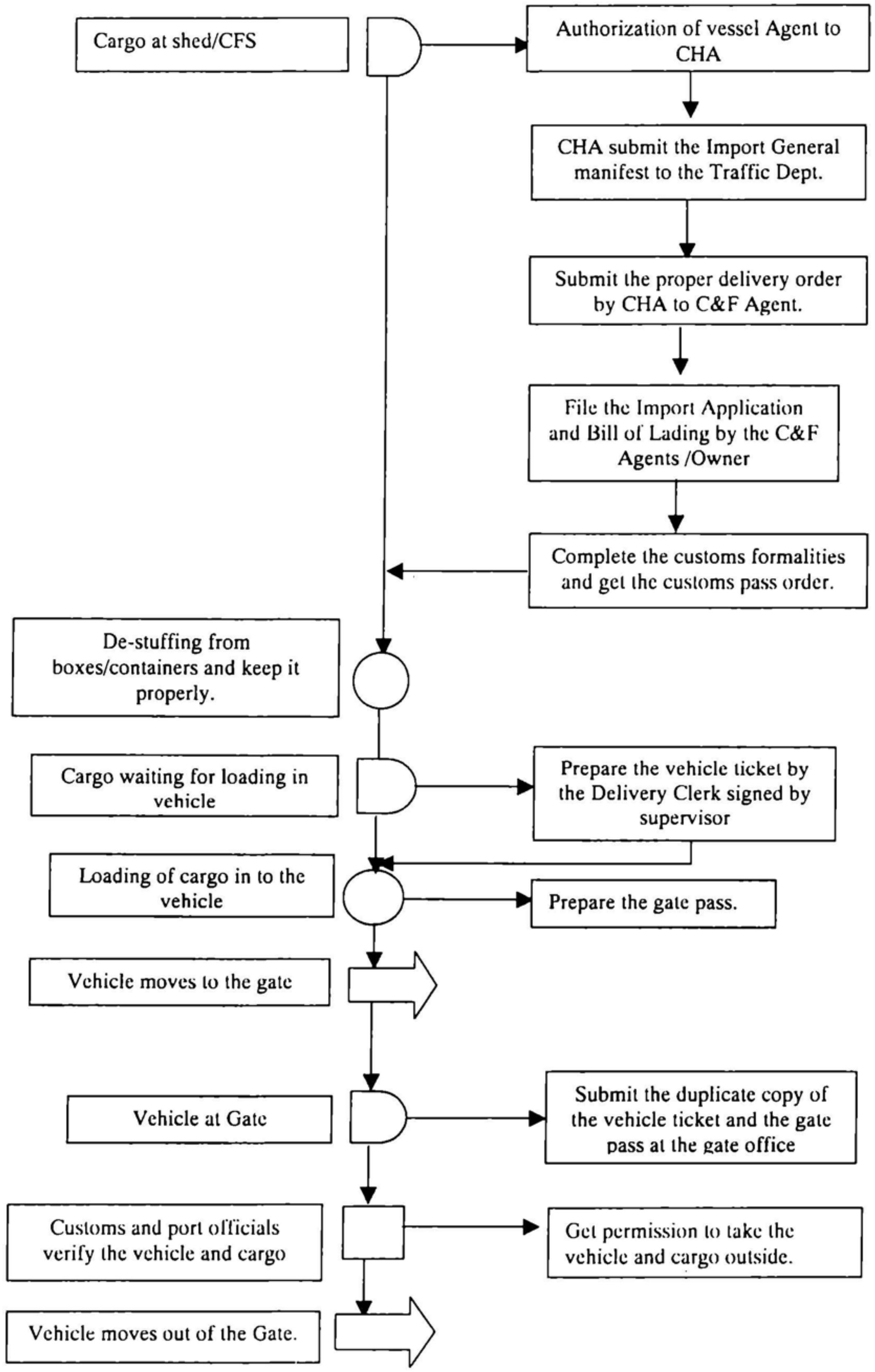
C) MT Containers De-stuffed at CFS / Wharf Area.



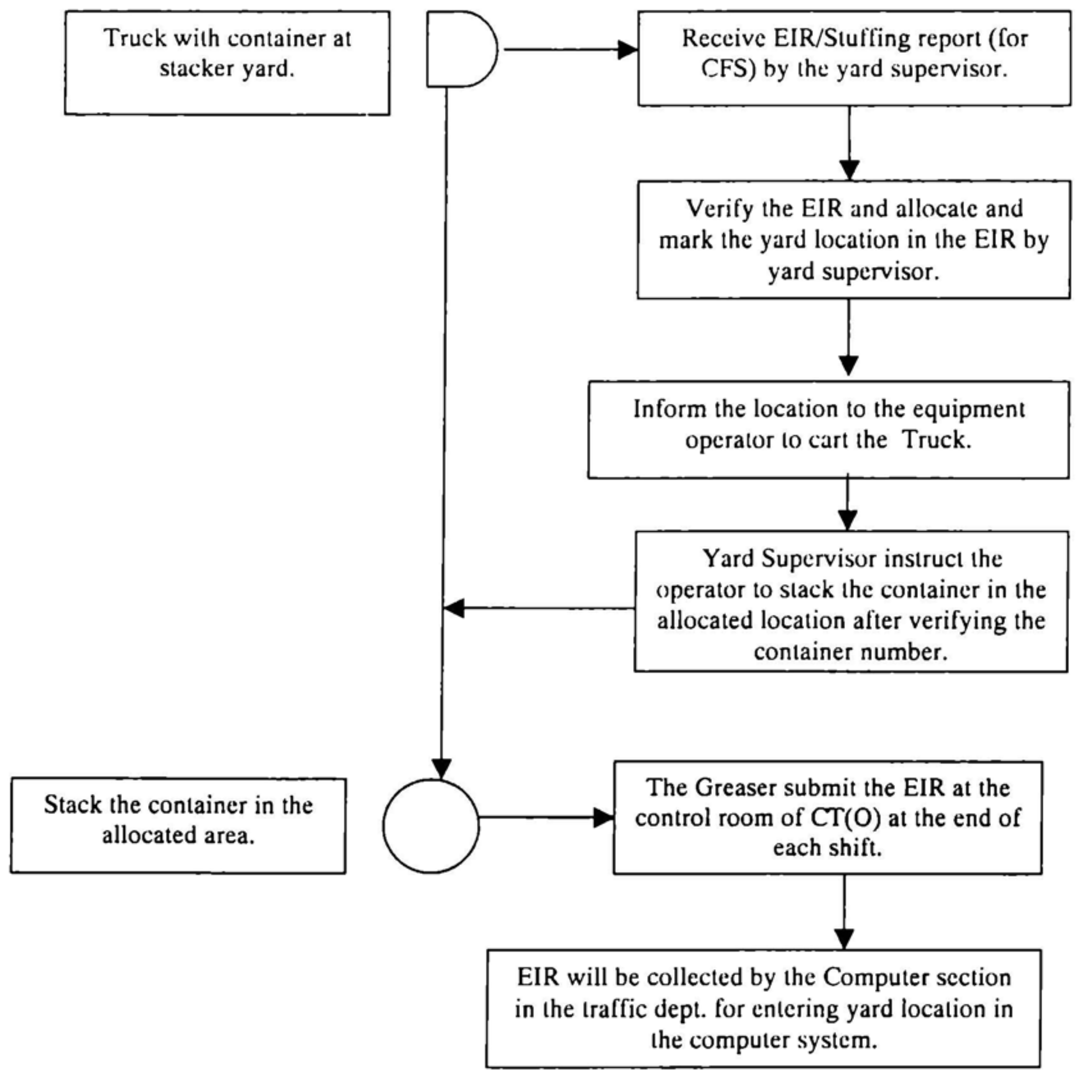
6. HANDLING OF BULK CARGO AT WHARVES



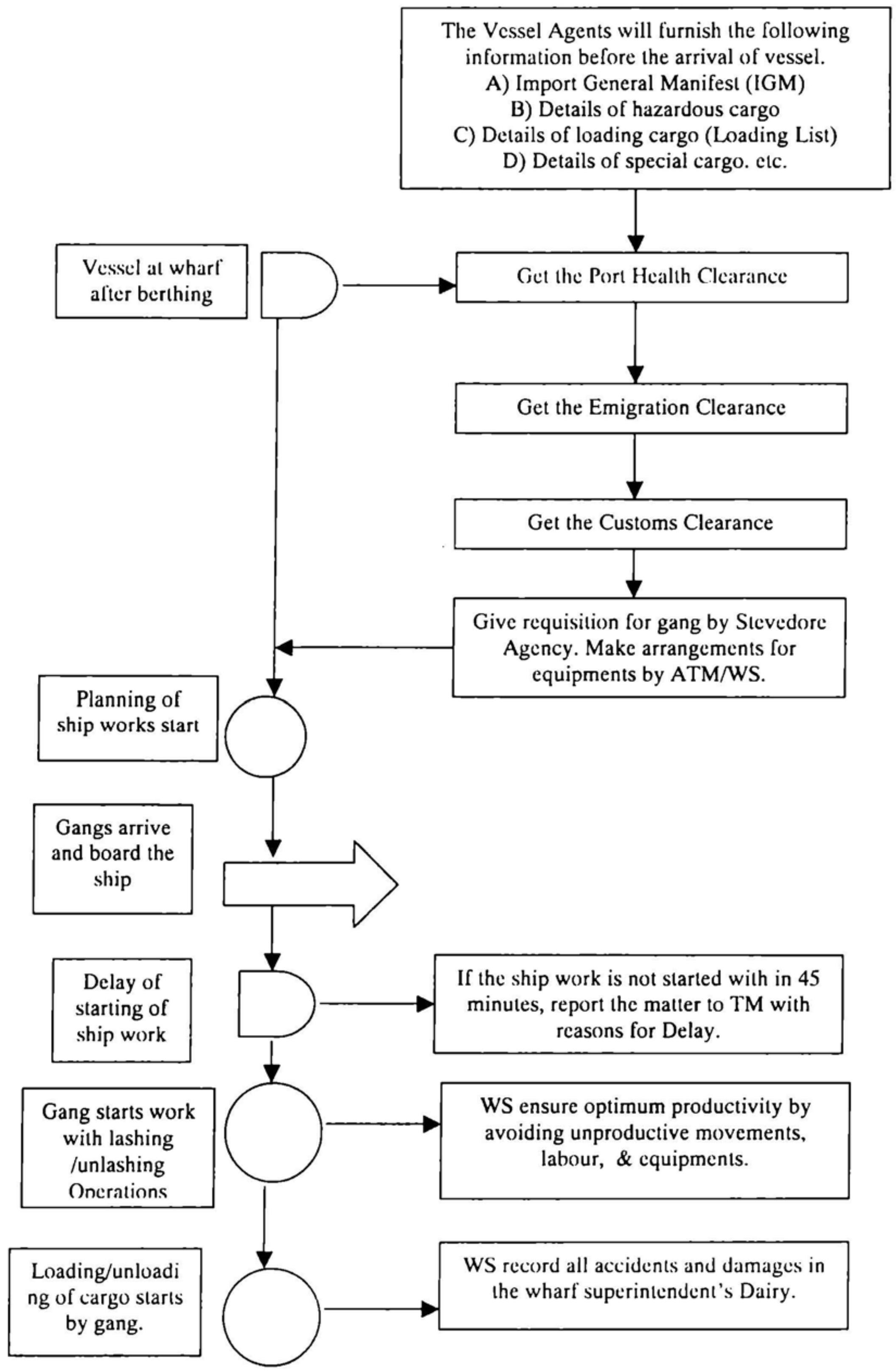
7. HANDLING OF IMPORT CARGO DE-STUFFED FROM CONTAINERS



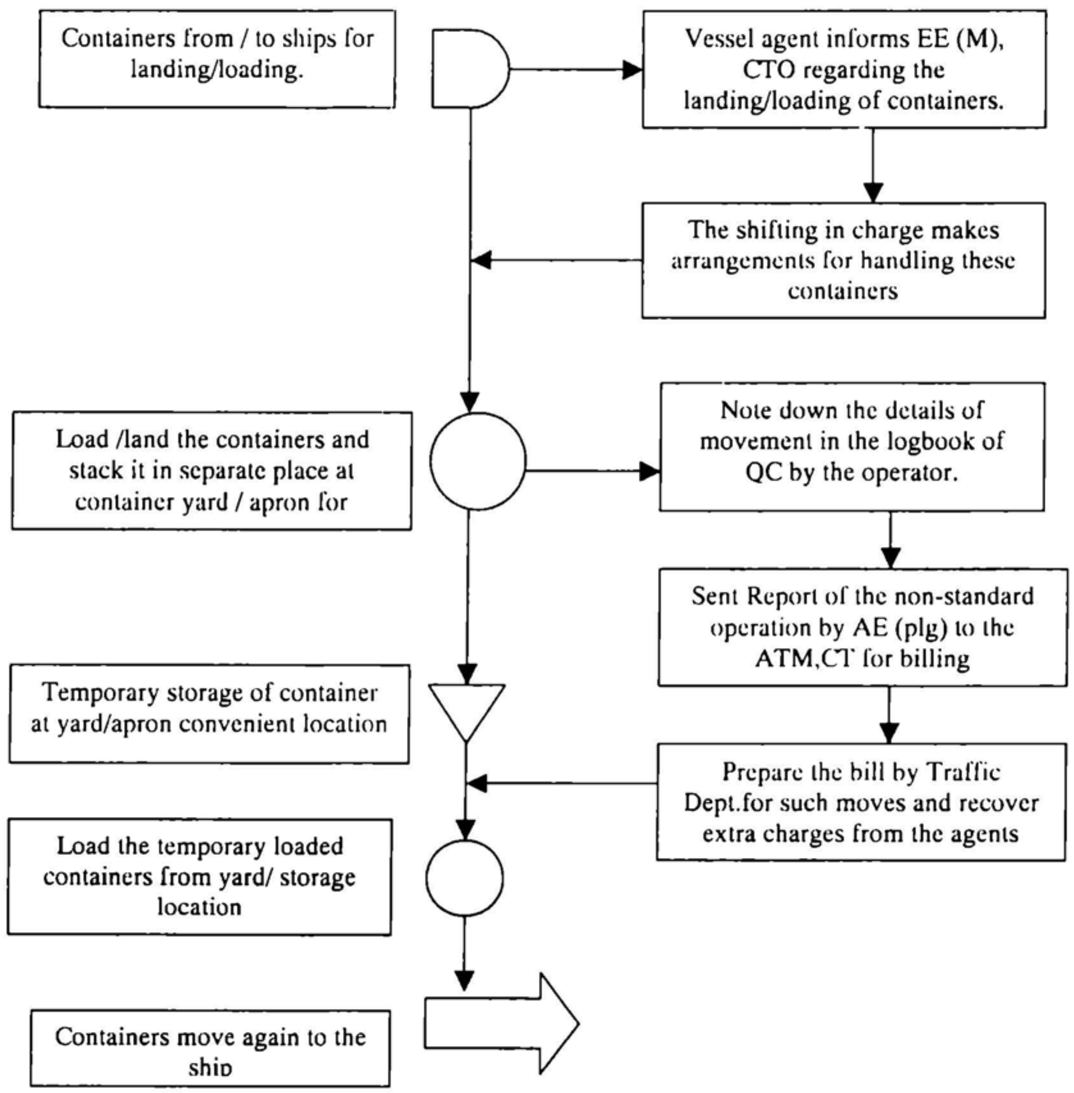
8. PLANNING AND STACKING OF EXPORT CONTAINERS AT YARD



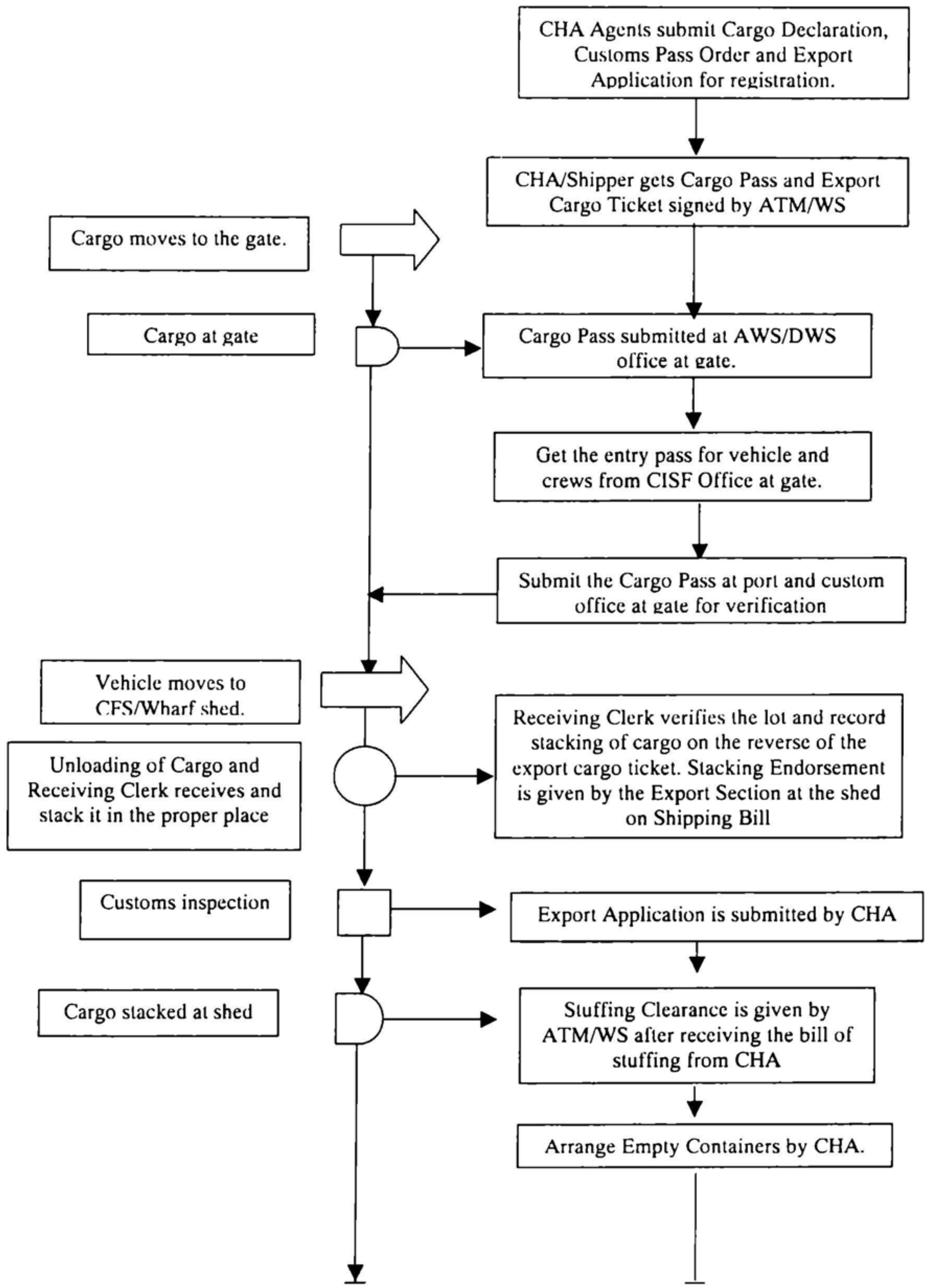
9. PLANNING AND EXECUTION OF SHIP WORK

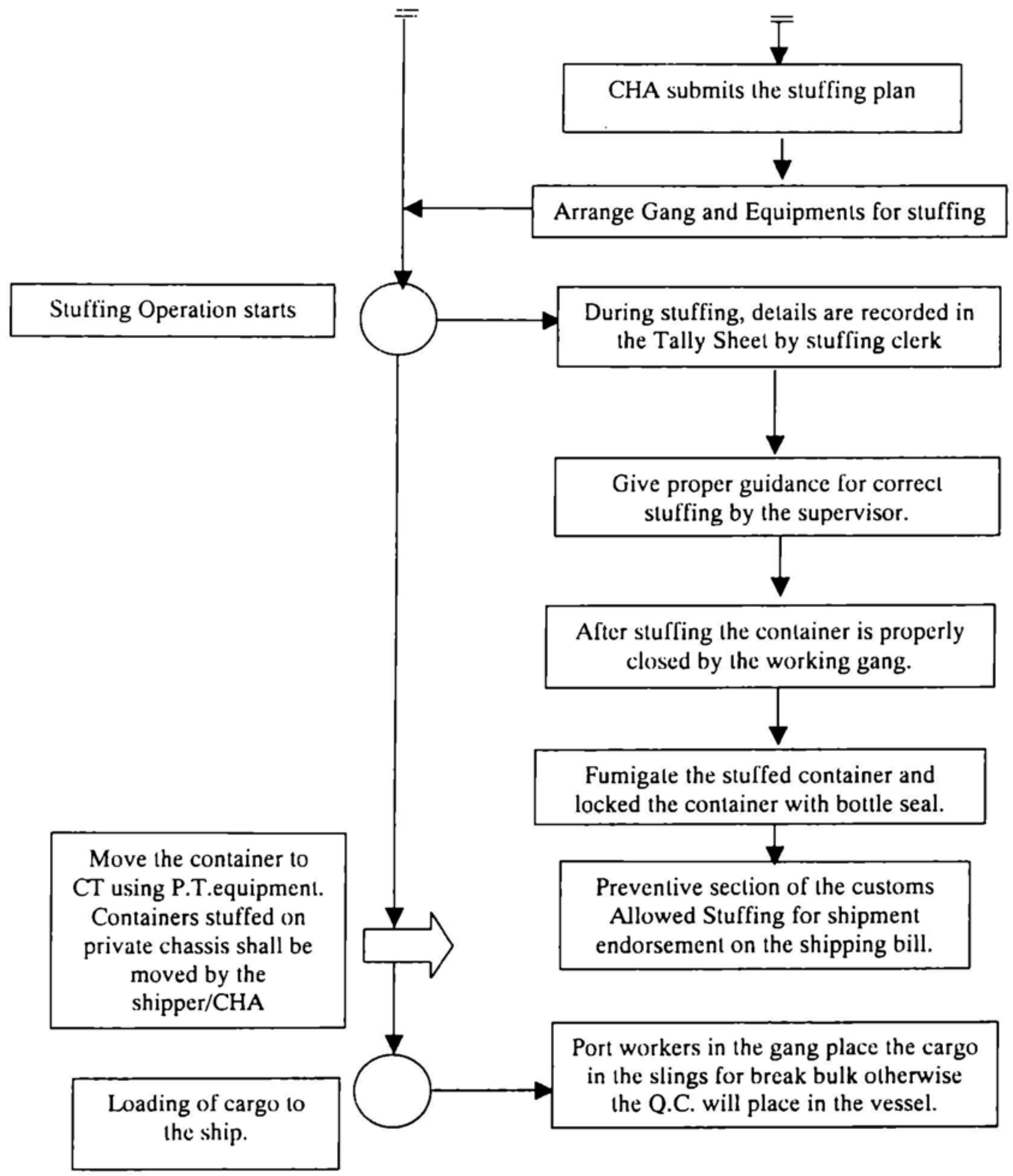


10.TEMPORARY LANDING/LOADING OF CONTAINERS FROM/TO SHIPS

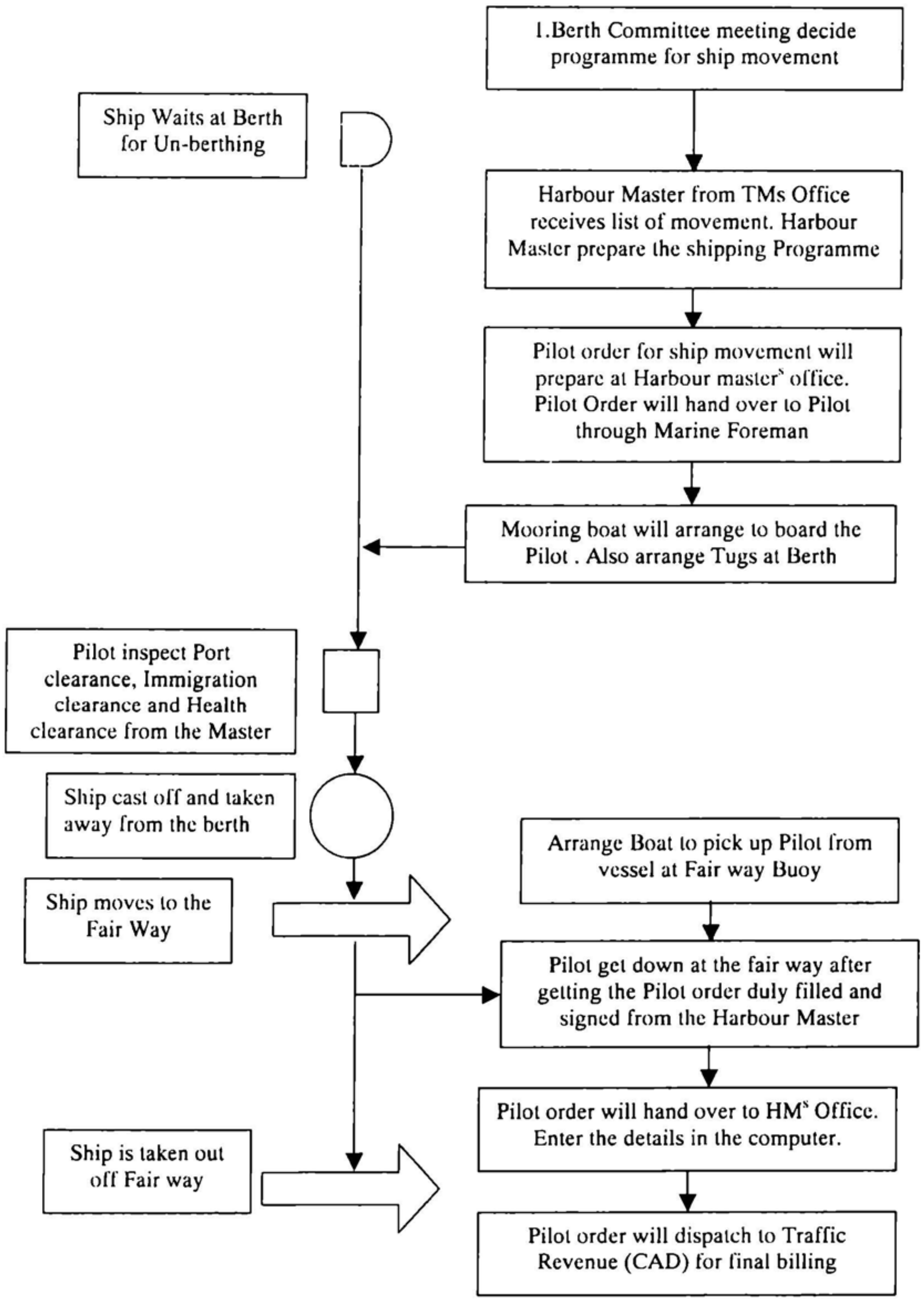


11. HANDLING OF EXPORT CARGO/CARGO FOR STUFFING




CHA submits the stuffing plan
Arrange Gang and Equipments for stuffing
Stuffing Operation starts
During stuffing, details are recorded in the Tally Sheet by stuffing clerk
Give proper guidance for correct stuffing by the supervisor.
After stuffing the container is properly closed by the working gang.
Fumigate the stuffed container and locked the container with bottle seal.
Move the container to CT using P.T.equipment. Containers stuffed on private chassis shall be moved by the shipper/CHA
Preventive section of the customs Allowed Stuffing for shipment endorsement on the shipping bill.
Loading of cargo to the ship.
Port workers in the gang place the cargo in the slings for break bulk otherwise the Q.C. will place in the vessel.

12. UN-BERTHING OF SHIPS



ANNEXURE-C

QUESTIONNAIRE

This **QUESTIONNAIRE** relates to the operations of Cochin Port. This is an attempt to identify areas of operation problems of Cochin Port Trust. As being a port user, you have perceptions about the performance of port. As a researcher, I am trying to share your experiences regarding the operations of Cochin Port. The findings of this survey will form the basis of a thorough analysis of the various problems that afflict the performance of Port and will suggest strategies for overcoming them. This will increase the overall performance and utilization of Cochin Port Trust.

This Questionnaire contains two parts viz. Part-A and Part-B. Part-A is exclusively prepared for C&F Agents/ Customs House Agents (CHA). The objective of Part-A is to identify the problems facing with the procedure and documentation formalities of Port Operations and Customs. Part-B is meant for identifying the problems facing with Shipping Agents/ Steamer Agents, MLO, Stevedores, Shippers, etc. in operations of Cochin port. Many questions of this Questionnaire are meant for ranking the reasons. In such cases, you may please assign a weight from 0 to 100 among the factors subject to a total weight is equal to 100. An example is cited below.

Q). Rank the following reasons for the higher rate of road accidents in Kerala?

a) Road Conditions [35]

b) Careless Driving [20]

c) Want of proper Traffic Signals [10]

d) Over speed [25]

e) Vehicle conditions [10]

f) Lack of proper rules and regulations [0]

You have given the choice to add more relevant points wherever necessary on the backside of the questionnaire. Therefore, please answer the Questionnaire carefully and contribute the effort to bring the Cochin Port Trust, a premier transshipment port of South Asia. Your responses will be kept confidential.

1. Name of your Company/Agency

2. Address of the Company

3. Business you are engaged in at Cochin port :
   (Please put tick mark against your choice)
   : Shipping Agent
   : Customs House Agents/C&F Agent
   : Main Line Operators
   : Shippers (Exporters/Importers)
   : Stevedores
   : Any other, please specify.

4. How long have you had business with Cochin Port?
   a) < 2 years b) 2 to 5 years c) 5 to 10 years d) > 10 years

5. Do you operate in port other than Cochin? Please specify.

PART- A

PROCEDURE AND DOCUMENTATION FORMALITIES OF COCHIN PORT

1. Which system is more convenient for you to file the shipping bill? Please tick against your choice.

   a) Manual system   b) Computerized system.

2. (a) What is the average time taken for completing the formalities of shipping bill using Manual system?

   i) <1hr   ii) 1 to 2 hrs   iii) 2 to 3 hrs   iv) 3 to 4 hrs   v) 4 to 5 hrs   vi) > 5 hrs

   (b) What is the average time taken for completing the formalities of shipping bill using Computerized system?

   i) <1hr   ii) 1 to 2 hrs   iii) 2 to 3 hrs   iv) 3 to 4 hrs   v) 4 to 5 hrs   vi) > 5 hrs

   © If computerized system takes more time, is it because of

   i) your unfamiliarity   ii) poor implementation of computerization   iii) other reasons, specify.

3. What are the difficulties you are facing with the procedure of filing shipping bill using EDI system? Rank them.

   a) You do not have training ☐
   b) No work target to the office staff ☐
   c) No follow up from the officers ☐
   d) No strict time schedule to the staff ☐
   e) Lack of control of higher officers over the office staff ☐
   f) Other reasons, specify. ☐

4. Rank the problems you have experienced in filing of Export/Import Applications at port

   a) Bureaucratic approach in the office ☐
   b) Too much procedure ☐
   c) No strict time schedule for the employees at EDC ☐
   d) Lack of co-ordination of the operations of EDC and CCHA ☐
   e) Delay in collecting port charges at the counters ☐
   f) Inefficiency of the employees in the section ☐
   g) Persons not found in seat/counters mostly ☐

5. What are the difficulties you are facing with Customs and Documentation procedure Rank them.

a) Officers are seated at different offices ☐

b) Too many steps in documentation procedures ☐

c) Lack of computers and printing devices ☐

d) Duplication and repetitions in procedures ☐

e) Lack of delegation of powers ☐

f). Lack of co-ordination between port officials and customs officials ☐

g). Repetition in inspection processes. ☐

6. What are your suggestions for simplifying the procedures/ formalities? Rank them.

a). Form modification ☐

b). Transparency of operations ☐

c). Duplication Avoidance ☐

d). Better inter/intra department communication and co-ordination ☐

e). Better control on time schedule of employees ☐

f). Fix the daily target of output to officers and employees ☐

h) Proper training to the concerned employees ☐

7. Do you think that the business through Cochin Port is very expensive when compared with other Indian Ports? Yes/No

If your answer is 'Yes', rank the charges that cause high expenses.

a) Port Charges ☐

b) Bribes at various level ☐

c) Ghost Money/ Speed money ☐

d) Rain Money ☐

e) Charges outside Port ☐

f) Any other Charges ☐

8. How will you evaluate the procedure and documentation of Cochin Port with other ports in India?

a). Simpler than Others

b). As cumbersome

c). More cumbersome

d). Much more cumbersome

e). Same as others

9. Do you think any stage of the customs procedure could be dispensed with? yes/No

If 'Yes', please list out the dispensable steps.

10. Make a comparison of customs formalities of Cochin Ports with other major ports.

i) Simpler

ii) As cumbersome

iii) More cumbersome

iv) Most cumbersome

If your answer is iii) or iv), please specify the reasons and give your suggestions for improving the existing formalities.

PART-B

I. CONTAINER TERMINAL OPERATIONS AT COCHIN PORT

1. Rank the following ports with its performance of container terminal operations of Cochin port. (Give 15 points to the performance of CT of Cochin Port)

   a) Chennai ☐
   b) Tuticorin ☐
   c) JNPT(Govt. Terminal) ☐
   d) JNPT(NSICT operated by P&O) ☐
   e) Mangalore ☐

2. Please give your ratings of Container Terminal of Cochin port on the following performance factors in comparison with other major Container Terminals in India.
   (Please give a rating from 0 to 10; 0-lowest, 10-highest. If you are not familiar with the other Container Terminals, give your ratings against what you feel is your requirement)

   a). Labour Service ☐
   b). Delays in Ship Operations ☐
   c). Service from Equipments ☐
   d). Storage facilities of Containers ☐
   e) Stuffing/ Destuffing facilities ☐
   f) Port procedures/ Documentations ☐
   g) Port charges/Rates ☐

3. Mention some important factors, which according to you, affect the performance of the Container Terminal Operations of Cochin Port according to their importance.

   1.
   2.
   3.
   4.
   5.

4. Rate the reasons for the low performance of Container Terminal at Cochin Port.

   a). Management Lapses ☐
   b). Personnel/ Labour related ☐
   c). Technical Problems of Equipments ☐
   d). External Factors ☐
   e). Poor Planning of Container Yard ☐
   f). Trade Union Attitude ☐

5. Are you satisfied with the turn-around time of ships coming at the container terminal of Cochin Port? Yes/No.

a). If you are not satisfied, what should be the ideal turnaround time in your expectation?

b). Rank the reasons for the high turn around time

i) Pilotage Operations Related ☐

ii) Equipment Related ☐

iii) Poor Planning of loading/ unloading of Containers ☐

iv) Labour/Operators related ☐

v) Customs Related ☐

vi) GPM related ☐

vii) Ship related ☐

6. What are the critical factors responsible for the low performance of equipments in the Container Terminal. Rank them.

a). Operators related ☐

b). Insufficient equipments ☐

c). Outdated equipments ☐

d). Improper maintenance schedule ☐

e). Lack of Training to the operators ☐

f). Planning failure of export/import containers ☐

7. Are you satisfied with the GPM operations at Container Terminal. Yes/No.

a). If the answer is 'No', specify the reasons

1.

2.

3.

4.

b). How many times have you experienced delay in operations due to shortage of GPM in the last one year?(Please tick against your choice)

i) Up to 10% ii) 10-25% iii) 25-50% iv) 50-75% of the occasions

c). How many occasions have you experienced delay due to unethical trade practices of GPM in the last one year (Please tick against your choice)

i) < 2 times ii) 2 to 5 times iii) 5 to 10 times iv) >10 times

8. Do you think that the "cut off time" provided for export container is advisable? Yes/No.

a) If your answer is 'Yes', how much containers do you exported using these facilities

i) < 5 % ii) 5 to 10 % iii) 10 to 20 % iv) > 20%

b). If your answer is 'No', specify the reasons.

1.

2.

3.

4.

9. Rank the problems you are facing with the handling of Reefer Containers inside the Yard

a). Frequent power failure ☐

b). Low Voltage ☐

c). Insufficient plug point ☐

d). Poor maintenance ☐

e). Poor supervision from port side ☐

f). lack of experts ☐

g). Insufficient equipments for handling ☐

10. Do you have any inconvenience due to the terminal operations controlled by three Departments Viz, Mechanical, Traffic and Finance Department Yes/No

If your answer is 'Yes', state your experiences.

11. What are the average Speed Money/ Ghost Money/ Hidden Money you are required to incure per Container. (if you do not have the information readily, please obtain the figures from your Stevedores)

Particulars	20'Containers	40'Containers
1.Stuffing/ Destuffing		
2.Loading/ Unloading		
3.Port Clearance/ Documentation		
4.Customs Clearance/Documentation		
5.Outside Port		

12. Rank the reasons for the delay in getting EIR at Container Terminal gate

a) Poor implementation of compute ☐

b) Frequent changes of operators at gate ☐

c) Any other reasons, Please specify. ☐

13. Rank the difficulties you are facing with the port's CFS operations in stuffing/ destuffing of Containers.

a). Uncertainty in shipment ☐

b). Gang Availability ☐

c). Quality of Stuffing/ Destuffing ☐

d). Security of Cargo ☐

e). Cost ☐

f). Availability of Equipments ☐

g). Space availability in CFS ☐

h). Procedural/ Documentation Problems ☐

14. Compare the rates of Port's CFS with the rates of other agencies.

Descriptions	Stuffing Charges		Destuffing Charges	
	20'	40'	20'	40'
i). Port's CFS				
ii). House Stuffing				
iii). Private CFS				

15. Rank the suggestions for improving the performance of port's CFS operations

a). Introduce one more shift ☐

b). Appoint labours permanently instead of Gang booking ☐

c). Increase the space availability ☐

d). Privatise the operations ☐

e). Provide equipments and crews exclusively for CFS operations ☐

II. CARGO OPERATIONS AT ERNAKULAM & MATTANCHERY WHARF

1. What is the average turn-around time of ships arriving at Erm/Mty Wharf?

   a). 2 days b) 3 days c) 4 days d) 5 or more days

2. Rank the reasons for the high turn-around time.

   a). Pilotage Problem ☐

   b). Poor performance of the GPM gangs ☐

   c). Poor Performance of the Handling Equipments ☐

   d). Insufficient Storage facilities ☐

   e). Ship related problems ☐

   f). Customs related ☐

3. Are you satisfied with the performances of Electrical Cranes? Yes/No.

   If your answer is no, rank the problems of Handling Equipments?

   a). Outdated Equipments ☐

   b). Maintenance Problem/ Frequent failure ☐

   c). Insufficient Equipments ☐

   d). Operator related problems ☐

4. Are you satisfied with the existing storages facilities available in Erm/Mty wharf? Yes/No.

   If you are not satisfied, list the additional facilities required for.

   1.

   2.

   3.

   4.

5. Are you satisfied with the procedure of handling personal effects in the wharf? Yes/No.

   If you are not satisfied,

   a) List the drawbacks of the existing procedure.

   b) What are the changes in procedure you would like to bring in?

5. What is the average 'speed money/hidden cost/ ghost money' you are required to spend per ton of bulk cargo/vessel for the following operations.

a). Loading/Unloading operation ☐

b). Stuffing/Destuffing operation ☐

c). Port clearances/Documentation ☐

d). Customs clearances/Documentation. ☐

e). Handling of Bulk Vessel ☐

III. GENERAL QUESTIONS

. Compare the charges of Cochin Ports with other major ports in South India?

Types of Charges	Very high	High	Equal	Lower than Others	Very low
a). Stevedoring charges					
b). Hiring Charges of Equipments					
c). Pilot Charges					
d). Speed /Hidden/Ghost money					
e). Ground Rent					
f). Charges outside port					

If you feel that the charges are very high or high, what in your opinion are the major factors responsible?

Have you diverted cargo from Cochin Port to other nearby ports in the last three years? If so what are the reasons?

1.

2.

3.

4.

3 .Are you satisfied with the Gate Operations at Cochin Port Yes/No.

If you are not satisfied,

a) State the drawbacks of the existing systems.

b) Give suggestions for improving the Gate Operations.

ł. What are the problems you are facing with pilotage operations of Cochin port? Rank them.

a). Availability of Pilots ☐

b). Availability of Tugs, Mooring boats and its crews ☐

c). Restrictions in night Pilotage ☐

d). Tides problems ☐

e). Draft ☐

f). Weather Monsoon ☐

a) What are the steps the port authorities have taken for promoting the business through cochin Ports?

)).Are they providing any incentives for promoting your business through Cochin port?
Yes/No

.Do you have any experience of strike of port employees, which cause the stoppage of port operations during the last three years?
Yes/No.

If so, how many days does it affect the port operations?

'.Do you think, when the ports are registered under Companies Act will improve from its present status?
Yes/No

If so, what are the changes in improvements you are expected from the present status?

8. Can Cochin port function effectively as a transshipment center in Indian Sub-continent?
Yes/No

If so, list the merits and demerits.

9. Do you think Mother Vessel can call at Cochin Port using the existing facilities?
Yes/No.

If your answer is 'No', what are the conditions, in your view, necessary for successful operations of Mother Vessel at Cochin Port?

10. What will be the overall savings per container or per ton in handling of cargo, if Mother Vessel will call at Cochin Port?

11. Do you think Cochin Port can compete effectively with Colombo Port as a transshipment port with:

i) The existing handling equipments	Yes/No.
ii) The existing stacking facilities	Yes/No.
iii) The existing stuffing and destuffing arrangements.	Yes/No
vi) The existing draft conditions	Yes/No
v) The existing labour productivity.	Yes/No.

Comment if any.

2. Do you think that the whole problems you are facing with the existing port operations/facilities will end with the introduction of Vallarpadom container transshipment terminals?
Yes/No.

ANNEXURE - D

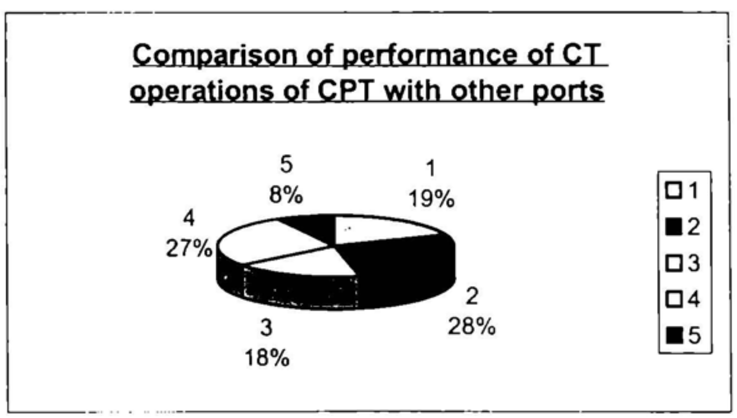
ANALYSIS OF THE RESPONSES OF PORT USERS BASED ON QUESTIONNAIRE

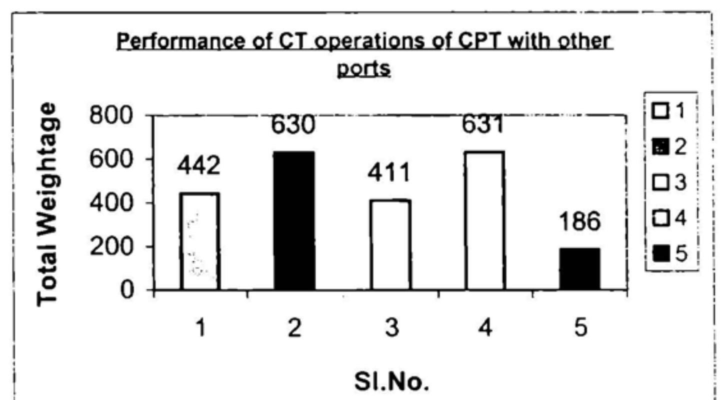
PART-B

I.CONTAINER TERMINAL OPERATIONS OF COCHIN PORT

QUESTION NO.1/ Comparison of the performance of container terminal operations of other ports with Cochin port

PARTICULARS	RESPONSES																							TOTAL	MIN.	MAX.	MEAN
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23				
1)Chennai	20	25	15	30	20	20	15	20	20	30	25	15	10	27	20	15	20	10	10	15	25	25	10	442	10	30	19.22
2)Tuticorin	20	40	20	30	30	30	27	30	27	20	25	27	35	20	22	27	25	15	50	30	50	10	20	630	10	50	27.39
3)JNPT(Govt.Terminal)	25	10	27	10	15	20	20	18	15	10	15	20	10	15	18	20	18	30	10	20	10	30	25	411	10	30	17.87
4)JNPT(NSICT)	25	20	30	10	27	30	30	30	30	40	15	30	35	30	25	30	22	40	20	27	10	30	45	631	10	45	27.43
5)Mangalore	10	5	8	20	8	0	8	2	8	0	20	8	10	8	15	8	15	5	10	8	5	5	0	186	0	20	8.067





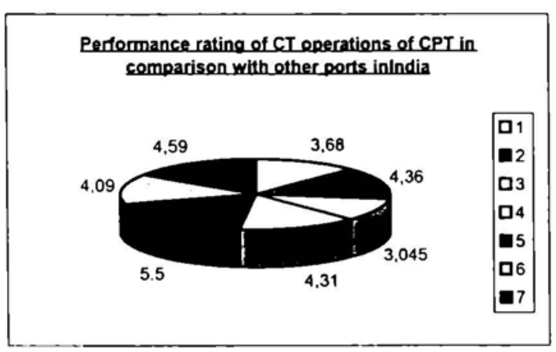
ANALYSIS OF THE RESPONSES OF PORT USERS BASED ON QUESTIONNAIRE

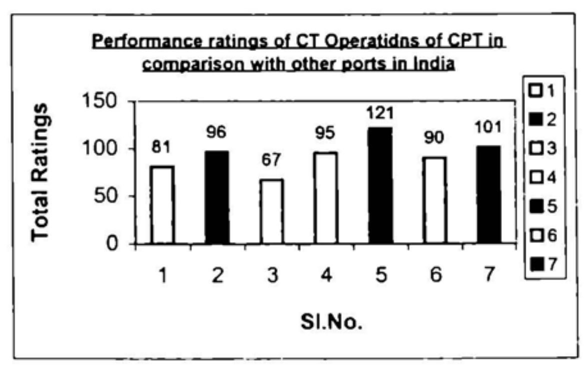
PART-B

CONTAINER TERMINAL OPERATIONS OF COCHIN PORT

QUESTION NO.2/Rating of CT Operations of Cochin Port with performance factors of other major CT in India.

PARTICULARS	RESPONSES																						TOTAL	MIN.	MAX.	MEAN
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22				
1)Labour Service	5	1	6	5	4	5	1	2	0	4	0	2	10	3	5	4	2	3	6	5	2	6	81	0	10	3.682
2)Delays in ship operations	3	1	3	7	4	2	7	2	4	7	5	2	4	4	4	5	3	8	3	6	5	7	96	1	8	4.364
3)Service from Equipments	2	1	6	3	2	4	0	1	3	5	2	1	3	3	5	2	2	4	5	8	2	3	67	0	8	3.045
4)Storage facilities of containers	8	4	6	7	5	8	1	4	0	5	2	4	1	3	5	4	2	3	7	2	7	7	95	0	8	4.318
5)Stuffing/Destuffing Facilities	6	5	6	6	5	8	1	5	7	4	10	4	10	4	7	5	3	3	6	3	7	6	121	1	10	5.5
6)Port procedure.documentation	3	3	6	5	2	5	0	5	5	6	5	4	1	5	5	5	2	6	5	3	4	5	90	0	6	4.091
7)Port charges/Rates	8	2	5	5	7	2	0	2	0	6	8	3	1	4	7	4	4	8	6	8	6	5	101	0	8	4.591





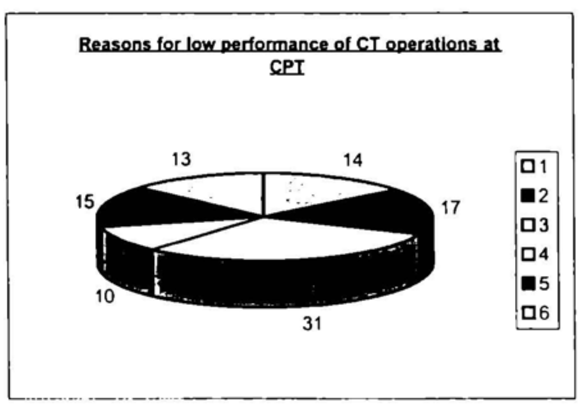
ANALYSIS OF THE RESPONSES OF PORT USERS BASED ON QUESTIONNAIRE

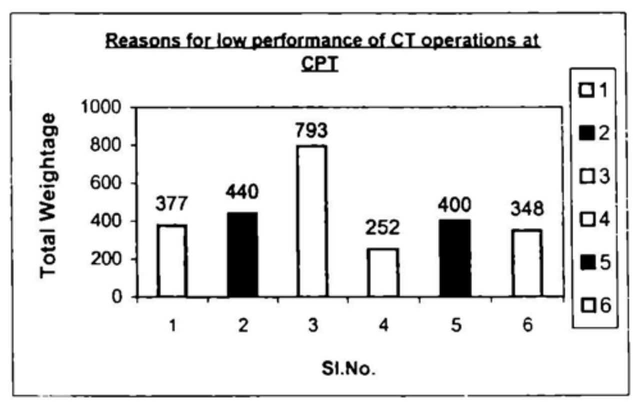
PART-B

CONTAINER TERMINAL OPERATIONS OF COCHIN PORT

QUESTION NO.4/Rank the reasons for the low performance of container terminal operations at cochin port

PARTICULARS	RESPONSES																										TOTAL	MIN.	MAX.	MEAN
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26				
1)Management Lapses	10	10	0	0	30	10	20	40	30	30	10	5	12	20	5	10	10	15	20	15	20	20	5	10	10	10	377	0	40	14.5
2)Personnel/Labour related	20	15	30	30	15	15	15	5	10	20	15	10	15	20	10	15	10	20	25	20	15	20	25	25	10	10	440	5	30	16.92
3)Technical problems of equipments	40	30	40	40	25	25	25	40	20	20	30	25	18	15	50	30	50	25	20	30	30	30	25	20	50	40	793	15	50	30.5
4)External factors	0	10	10	10	0	20	10	5	10	5	5	30	12	25	5	15	0	5	10	5	5	10	10	15	5	15	252	0	30	9.692
5)Poor planning of container yard	20	15	0	0	20	15	30	5	0	15	15	20	25	5	25	15	30	15	15	25	15	20	20	15	0	20	400	0	30	15.38
6)Trade Union attitude	10	20	20	20	10	15	5	5	30	10	25	15	18	15	5	15	0	20	10	5	15	0	15	15	25	5	348	0	30	13.38



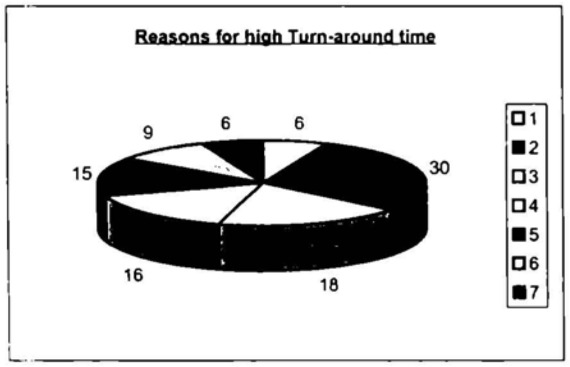


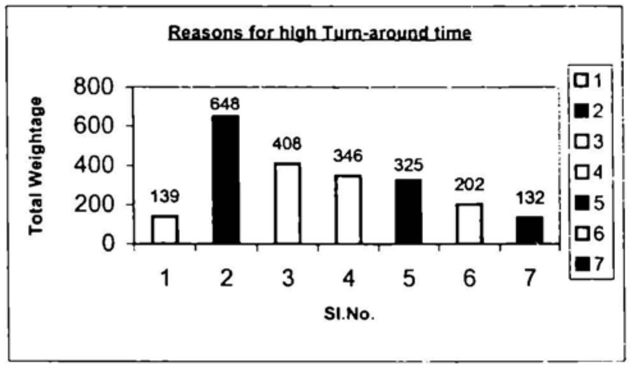
ANALYSIS OF THE RESPONSES OF PORT USERS BASED ON QUESTIONNAIRE

PART-B
CONTAINER TERMINAL OPERATIONS OF COCHIN PORT

QUESTION NO.5(b)/Rank the reasons for high turn-around time

PARTICULARS	RESPONSES																						TOTAL	MIN.	MAX.	MEAN
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22				
1)Pilotage operations releated	5	5	10	10	10	5	5	0	7	10	5	10	5	10	2	0	20	15	5	0	0	0	139	0	20	6.318
2)Equipments related	25	25	30	25	25	60	25	50	18	25	25	15	25	25	30	50	20	20	30	30	30	40	648	15	60	29.45
3)Poor planning of containers	30	25	0	0	20	10	15	20	10	18	18	12	20	20	45	10	15	25	20	30	25	20	408	0	45	18.55
4)Labour/Opeartor related	10	20	20	25	18	5	20	30	28	15	15	18	10	10	8	0	20	14	10	20	20	10	346	0	30	15.73
5)Customs related	0	5	30	25	7	10	7	0	15	20	20	15	18	25	3	0	15	15	30	20	25	20	325	0	30	14.77
6)GPM related	20	10	10	15	15	5	18	0	20	5	10	12	15	5	7	10	7	8	5	0	0	5	202	0	20	9.182
7)Ship related	10	10	0	0	5	5	10	0	2	7	7	18	7	5	5	30	3	3	0	0	0	5	132	0	30	6





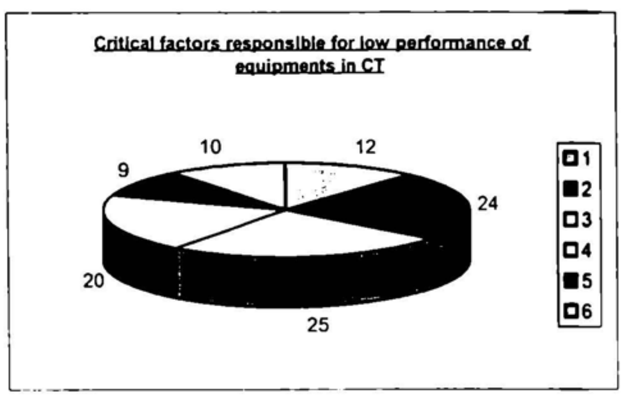
ANALYSIS OF THE RESPONSES OF PORT USERS BASED ON QUESTIONNAIRE

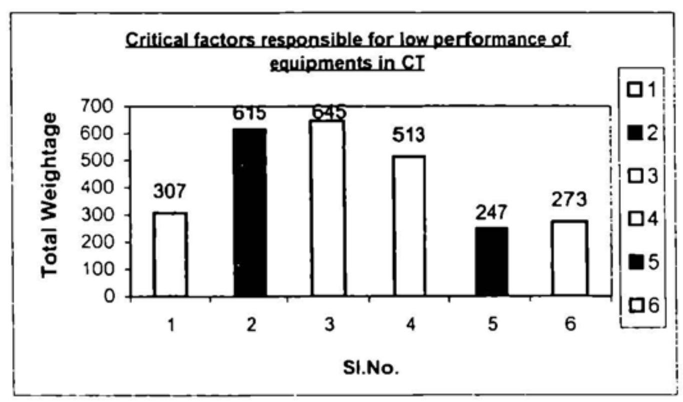
PART-B

CONTAINER TERMINAL OPERATIONS OF COCHIN PORT

QUESTION NO.6/Rank the critical factors responsible for the low performance of equipments in CT

PARTICULARS	RESPONSES																										TOTAL	MIN.	MAX.	MEAN
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26				
1)Operators related	5	20	0	10	10	10	10	5	10	20	15	20	10	15	20	5	10	0	12	0	20	30	5	15	25	5	307	0	30	11.81
2)Insufficient equipments	28	30	30	20	15	40	30	10	23	30	30	20	18	8	28	30	25	10	25	20	30	40	5	15	25	30	615	5	40	23.65
3)Outdated equipments	23	10	50	30	20	40	20	40	28	10	0	20	15	30	14	25	25	50	25	40	20	0	50	10	30	20	645	0	50	24.81
4)Improper maintenance plan	14	10	20	20	25	5	30	30	14	30	40	15	22	20	23	25	15	30	20	20	10	30	15	15	0	15	513	0	40	19.73
5)Lack of training to the operators	10	30	0	10	15	5	10	5	20	5	15	5	10	0	10	0	5	0	12	10	10	0	10	20	20	10	247	0	30	9.5
6)Planning failure of containers	20	0	0	10	15	0	0	10	5	5	0	20	25	27	5	15	20	10	6	10	10	0	15	25	0	20	273	0	27	10.5





ANALYSIS OF THE RESPONSES OF PORT USERS BASED ON QUESTIONNAIRE

PART-B

ERNAKULAM/MATTANCHERY WHARF OPERATIONS

QUESTION NO.2/Reasons for high turn-around time of ships arriving at E/M Wharves

PARTICULARS	RESPONSES																				TOTAL	MIN. VALUE	MAX. VALUE	MEAN VALUE
	1	2	3	4	5	6	7	**8**	**9**	10	11	12	13	14	15	16	17	18	19	20				
1)Pilotage problems	10	5	10	10	0	0	5	**5**	**0**	0	5	20	5	0	20	5	0	10	20	0	130	0	20	6.5
2)Poor performance of GPM gang	10	5	20	15	30	25	14	**35**	**0**	10	10	20	15	0	23	2	30	40	20	40	364	0	40	18.2
3)Poor performance of Equipments	0	35	30	15	40	25	28	**20**	**50**	70	28	20	65	20	25	50	30	10	20	30	611	0	70	30.55
4)Insufficient storage facilities	40	30	20	10	20	25	20	**18**	**20**	0	23	10	0	30	15	3	20	10	20	0	334	0	40	16.7
5)Ship related problems	20	15	0	25	10	10	23	**2**	**10**	0	14	15	10	50	7	0	10	15	0	15	251	0	50	12.55
6)Customs related	20	10	20	25	0	15	10	**20**	**20**	20	20	15	5	0	10	40	10	15	20	15	310	0	40	15.5