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Cargo handling equipment productivity analysis of the Chittagong Port Authority [Bangladesh]

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CARGO HANDLING EQUIPMENT PRODUCTIVITY ANALYSIS OF THE CHITTAGONG PORT AUTHORITY

By

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A dissertation submitted to the World Maritime University in partial fulfilment of the requirements for the award of the degree of

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in

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DECLARATION

I certify that all the material in this dissertation that is not my own work has been identified, and that no material is included for which a degree has previously been conferred on me.

The contents of this dissertation reflect my own personal views, and are not necessarily endorsed by the University.

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ABSTRACT

Title of Dissertation: **Cargo handling equipment productivity analysis of the Chittagong Port Authority**

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The dissertation is a study of port cargo handling equipment and its productivity in order to find out the possible solutions to improve the efficiency of equipment and the port as well.

Ports are the key points of the global transport network. Presently, world sea borne trade constitutes more than 90% of world trade in volume. Hence, the importance of ports for handling cargo is unanimously recognized. In the present era of competition, a cost-effective and reliable cargo handling service at Chittagong port is important not only for the port but also for the economy of the country as a whole.

Containerization is an important revolution in the maritime field. With the rapid technological developments, many state-of-the-art techniques and innovations are contributing enormously to this phenomenon. Chittagong port is also influenced by this global and regional trend. The introduction of Information Technology (IT), dedicated container terminals, sophisticated cargo handling equipment, skilled manpower and a sound environment can ensure and enhance the performance of Chittagong Port Authority (CPA) in the future.

The present situation of the cargo handling equipment is not satisfactory for various reasons, from an improper inventory of the equipment to problems in maintenance and operation, insufficient facilities and other such influencing factors that are the main aspects of equipment productivity analysis.

The concluding chapters of the dissertation carefully examine the present drawbacks of port cargo handling equipment and try to find solutions and recommendations in this regard.

KEYWORDS: Cost-effective, Performance, Productivity, Cargo handling, Containerization, Information Technology, Innovation

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LIST OF ABBREVIATIONS

CCT	Chittagong Container Terminal
CEPZ	Chittagong Export Processing Zone
CFS	Container Freight Station
CPA	Chittagong Port Authority
DFI	Direct Foreign Investment
EMIS	Equipment Management Information System
EPZ	Export Processing Zone
FCL	Full Container Load
GCB	General Cargo Berth
GDP	Gross Domestic Product
GNP	Gross National Product
ICD	Inland Container Depot
IT	Information Technology
JNPT	Jawaharlal Neheru Port Trust
LCL	Less Container Load
MBWA	Management By Wandering Around
MIS	Management Information System
MPA	Mongla Port Authority
MTBF	Mean Time Between Failures
MTTR	Mean Time To Repair
OMIS	Operation Management Information System
PEST	Political, Economical, Social and Technical
PSA	Port of Singapore Authority
SWOT	Strengths, Weaknesses, Opportunities and Threats
TEU	Twenty Feet Equivalent Unit
UNCTAD	United Nations Conference on Trade and Development

CHAPTER 1

INTRODUCTION

1.1 An overview

Chittagong Port Authority (CPA) is a technical and economical entity and is used as an interface, a link, a gateway and a logistic platform for facilitating national and international trade. Cargo handling equipment of CPA occupies an important position in port operations and needs to be analyzed for its improvement.

CPA is the state-owned service organization. It is the biggest port in Bangladesh, situated on the right bank of Kornafully, at a distance of about 9 nautical miles from the shore line of Bay of Bengal, at Chittagong, in the south-eastern part of the country (Appendix 1).

Although the port is not located at a strategic position compared to the main East-West sea route, it has endless possibilities to grow in the future because of its own big market and regional traffic. The attractiveness of ports is no longer based on strategic location but on the provision of efficient and prompt services and on their being linked to efficient land and sea transport net works [United Nations Conference on Trade and Development (UNCTAD), Newsletter, November 1999].

Also political stability and strong commitment of the government is the key factor for its development. CPA handled about 14 million tonnes of cargo including container throughput of 366,000 TEUs in 1998-99. So, the port occupies a position amongst the top hundred container ports in the world. Trade through both general cargo and containers is growing steadily. But significant is, looking at the previous 10 years,

the continuously increasing growth rate of containers identical to the global trend of containerization. Table 1 illustrates percentage growth of container throughput at the port from 1990 to 1999.

Another port of the country, Mongla Port Authority (MPA) lies at the south-western part of the country about 150 nautical miles from CPA. A newly constructed river container terminal near the capital city of Dhaka is going into operation by the end of this year.

Chittagong port handles about 80 % of the country's import-export and its qualitative and quantitative impact through direct, indirect and induced effect on the national economy is quite high. Its hinterland for distribution of cargoes to and from the port covers major portions of the country (Appendix 2). The major import cargoes are food grain, cement, petroleum, sugar, salt, fertilizer, textile, machinery, iron materials, chemicals etc. and exports are jute/jute products, tea, frozen fish, garments, leather, fertilizer etc.

Table1 CPA cargo and container handling throughput (1990-1999)

Fiscal year starts	Total cargo handled in thousand tons			% growth	Total container handled in thousand TEUs			% growth
from 1st July	import	export	total		import	export	total	
1990-91	6280	920	7200	--	51	51	102	--
1991-92	6270	770	7040	--2.00	61	60	121	19.8
1992-93	6500	1120	7620	8.23	76	74	150	23.96
1993-94	6730	1170	7900	3.68	89	86	175	16.67
1994-95	8900	1350	10250	29.75	115	113	228	30.28
1995-96	8850	1450	10300	0.40	127	124	251	10.08
1996-97	9120	1440	10560	2.43	146	144	290	15.54
1997-98	9560	1530	11090	5.12	163	166	329	13.45
1998-99	12210	1700	**13910**	25.33	184	182	**366**	11.25
Average				**9.11%**				**17.63%**

Source: CPA

The port was not prepared to handle such an amount of growth as stated above. Port forecasting like shipping is sometimes unpredictable. In the1980s, for example, global container traffic was forecast to be 115 million TEUs in the year 2000 a figure which was passed several years ago. Similarly, in 1994, the CPA forecast traffic

275,000 TEUs in 2000, was already passed in 1996-97. This growth is the result of severe competition among ports and the economic developments of countries.

Like shipping companies, it now appears that port authorities and stevedoring companies are following the path of globalization and economies of scale by enlargement. The emergence of fourth generation ports is the new concept where large port or terminal operators are entering into partnership or alliance to operate the ports on a bigger scale with increased benefits and competition. Hutchinson Port Holdings and Port of Singapore Authority (PSA) corporations, for example, operate 17 and 7 ports respectively in different regions of the world.

Of course, such types of merging and competition are driven by two forces: dedicated container terminal and sophisticated cargo handling equipment. The major capital investments of a port are spent in these two fields in order to optimize port profitability. Developing ports, like CPA, have no alternative other than these two main aspects to improve efficiency. In this context, port cargo handling equipment performance should be analyzed carefully and action taken accordingly.

Bangladesh is one of the least developing countries of South Asia. More than 126 million people in a land of 144,000 sq. km. need rapid development of its economy for survival. This can only be possible by developing its maritime fields: ports, shipping and other related activities. In the present world, the leading maritime countries Japan, Netherlands, Singapore have developed their economies by improving ports, shipping and creating many value added activities in the related fields.

In this context, CPA as a premier port of Bangladesh could be a source of economic power by improving its performance in every aspect and creating a lot of value added activities to generate huge indirect employment. The port is a big organization headed by a chairman and consists of 15 departments responsible for different port functions. An organizational structure of the port has been placed in Appendix 3. Port cargo handling operation is the focal point of all port functions.

The traffic/operation department and mechanical branch are mainly responsible for cargo handling equipment operations.

Cargo handling equipment is the main component of cargo handling operations. It is estimated that 40% of a port's capital budget is spent on the procurement and maintenance of cargo handling equipment. So, it is most important for port management to put the required emphasis on maintaining a proper inventory and maintenance of the equipment.

The political and economic situation of the country and inter departmental co-operation influence a port's functions enormously. Another important influencing factor is the government interference in major investment in the port. As mentioned above, there is a rising cargo handling trend, which could be accelerated if there is no interference from the government to create facilities at the port in time.

This dissertation aims at describing and analyzing the cargo handling equipment productivity/performance of the Chittagong Port Authority based on identification of the problems/influences of maintenance and operation of the equipment and other related factors in order to find the useful solutions in this regard.

1.2 Identification of problems

No problems can be solved without their identification in the first place. This is also true in the case of port cargo handling equipment. However, the normal tendency of port and equipment management personnel is that they try to solve the symptoms rather than the problems without concentrating on the root causes. Equipment is a sensitive item in port operations. Maintenance of equipment and its operation involve a lot of factors at different stages which need to be solved in time in order to avoid any breakdowns which may affect the chain of operations. During identification, the following points require attention so that the problems can be handled and solved quickly:

1. What problems exist in relation to equipment maintenance?
2. What factors affect the maintenance and its performance?

3. How can equipment performance be improved?

1.3 The importance of the Analysis

In the maritime field, ships and ports are the two fields competing with each other fiercely to cope with the innovations and technological changes day by day. If a port fails to follow the changes in shipping, in time it will fall behind the competition. The changes in ports are mainly in connection with port cargo handling techniques and construction of dedicated terminals. This changing technology involves a huge amount of investment and needs proper maintenance and supervision.

Secondly, any improvement in this field demands careful observation. Particular factors and how much they influence the activities of operation and maintenance of equipment can be easily identified if the segments of activities are analyzed minutely. For example, if the performance of maintenance work in one month falls significantly compared to the previous month, there can be number of reasons behind this. They should be analyzed so that measures can be taken promptly.

Thirdly, the probability of occurrence of breakdown decreases if the faults are analyzed thoroughly and actions are taken on the basis of the findings.

Similarly, the behavior and skills of manpower, such as that concerns the operators and technicians, should be analyzed periodically for training needs assessment.

Finally, efficiency, which is the key word of operation and maintenance of equipment, can be improved by analyzing every piece of work. For this reason, comparison with similar ports or a standard is also essential.

1.4 Dissertation objectives

The objectives of this dissertation are as follows:

- To study and analyze the present inventory of cargo handling equipment

- To discuss the productivity and cost benefit of the equipment
- To analyze the problems/factors related with maintenance and operation
- To find out the training needs of the employees
- To compare the equipment performance and related activities with other ports
- To identify the management role in equipment productivity
- To identify awareness needs among the employees about importance of port cargo handling equipment
- To suggest possible solutions and recommend some measures to eliminate the problems of equipment in order to improve the port efficiency

1.5 Research methodology

In order to achieve the above objectives, the following methods were followed during the research period.

- Conducting research study at WMU library, Internet and other possible sources.
- Exchanging ideas and views with different personnel of CPA.
- Collecting data from the mechanical branch and other departments of CPA.
- Consultation with resource persons of World Maritime University (WMU) including both staff and students.
- Consultation with experts at some developed ports in Europe and Japan during field studies.
- E -mail correspondence with different personnel and organizations.

1.6 The scope of the analysis

For this analysis the present situation of cargo handling equipment and the related factors are studied. It is observed during research that different ports do not provide the detailed data of cargo handling equipment and productivity. However, efforts were made mainly to find out the CPA's present position with regards to other developed and growing ports in the region and Europe and how difficulties and limitations can be overcome successfully.

1.7 Organization of the dissertation

This dissertation is organized into six chapters in order to describe, identify, and analyze port cargo handling equipment and its productivity and to find out the possible solutions and recommendations to achieve the desired standard.

Chapter One is an introduction, which provides a general overview of the port in relation to basic study including the objectives, importance of study, research methodology, limitation of the analysis and its organization.

Chapter Two provides information about the present situation of port cargo handling equipment at CPA. It states the current equipment management, facilities, maintenance procedures, training system of the employees, equipment booking and operational procedures, present performance/ productivity.

Chapter Three identifies the main problems of equipment maintenance and operation, influencing factors of equipment productivity. These are in the areas of port and equipment management, management related with operation, stores and human resources development, management information system, inter-departmental coordination and co-operation and PEST (i.e. Political, Economic, Social and Technical) factors.

Chapter Four compares CPA with different ports. For this reason, local ports, regional ports and European ports are selected. Comparisons with local ports and other ports are done with a view to focus on the present position of CPA.

Chapter Five provides the possible solutions to the present and future needs of cargo handling equipment and explains the merits and constraints of each solution.

Finally, Chapter Six draws a conclusion with some recommendations. To conclude the analysis, all previous chapters are highlighted by key points. Recommendations are given to adopt suitable measures on short, medium and long-term bases to improve the present situation and achieve the desired targets and also to be a useful tool for further research and analysis in this field.

CHAPTER 2

CARGO HANDLING EQUIPMENT AND ITS MANAGEMENT AT CPA

2.1 Introduction

Like in any port, cargo handling equipment of the Chittagong Port Authority plays a vital role in operations. The main objective of the port is to ensure good and effective services to its customers at minimum cost. Good services are mostly offered by the equipment, facilities and the management. The total cargo handling area of CPA is divided into two main parts: General Cargo Berth (GCB) and Chittagong Container Terminal (CCT).

The cargo handling of CPA has been increasing day by day since 1977, when the first container handling operation was started with private equipment at the port. This was thanks to the contribution of private shipping lines such as Cobra Consortium, US Lines, Maersk Lines, APL, Sea Land, Container and Terminal services and others who used their own equipment to handle the containers when CPA had no container handling equipment of its own. With growing demand from the shipping companies and increased traffic in the country, CPA engaged M/S Mounsell consultant of Australia in 1980, to study different aspects of cargo handling including containerization in CPA. Based on the recommendations of the consultants, the Port Authority developed interim container handling facilities for containers in GCB area in 1984 and simultaneously built new multipurpose berths in 1986. But the berths could not be brought into full use for want of back-up facilities such as container handling equipment, workshop for running operation and maintenance of cargo handling equipment and container terminal. CPA had sufficient funds of its own at all times to invest in developing the facilities. In spite of

that, due to political unrest and lack of sufficient autonomy, it could not acquire and /or replace equipment in time.

However, at present CPA owns different types of equipment (general cargo and container handling) as seen in the list in Tables 2.2& 2.3. Due to the shortage of equipment, the port entered into a contract three years earlier with a private company to operate and maintain 4 more straddle carriers on lease. CPA has another cargo handling operation activity at ICD (Inland Container Depot) in Dhaka. ICD was established in 1987 by CPA and has been considered as a part of CPA, which serves as a cargo consolidation or de-consolidation centre transporting cargo to and from inland destinations.

CPA is going to procure, by 2001/2002, a number of cargo handling equipment including gantry crane, investing USD 60.4 m from its own budget. Work on a project has already started and will be implemented in two phases.

It is noticed that the equipment management is lacking in capability to use the available facilities efficiently due to various constraints. There are also bottlenecks in equipment operation and the maintenance system. Manpower related with the system requires more skills and knowledge to perform the work to the required standards. This chapter attempts to introduce the cargo handling equipment system, describe and explain the existing facilities, future procurement, maintenance and operation systems, equipment productivity including the training position of the port.

2.2 Cargo handling equipment system

Port management throughout the world are becoming more conscious about the need to provide modern equipped berths with the additional capital intensive cargo handling techniques involving low labour contents as a means of their general competitiveness and encouraging trade through their ports (Branch, 1986, p.86).

Different types of equipment is used for cargo handling in different countries depending upon the factors such as the nature of the cargo, handling costs,

resources available including land, labour and equipment, weather conditions, competitive situation compared with other ports, types of vessels, distribution arrangements, tidal conditions, inter-modal transport facilities etc.

Presently, containerization is booming in the shipping and port industry. Modern container handling equipment is the main discussion point over all other equipment and facilities. Although CPA has both conventional and modern types of container handling equipment such as forklifts and straddle carriers, it is old and inadequate. CPA is going to procure more sophisticated equipment including gantry cranes both for quays and yards.

Today, different types of cargo handling system are in use for container handling. Container handling system starts at the quayside where containers can be handled to and from the ships by the jib cranes, multipurpose cranes, gantry cranes and even mobile cranes. Quay transfer may be done by tractor-trailers, by straddle carriers or by heavy duty lift trucks. In the container yard, stacking and de-stuffing may be carried out by straddle carriers, yard gantry cranes or a variety of lift trucks/reach stackers. Receipt and delivery operations may also involve these equipment types as well as tractor-trailer systems.

So, the shore handling operation can mainly be grouped into four different container handling sub-systems:

1. **The Tractor-trailer system** in which containers are both handled and stored on ''over the road'' chasis or terminal trailers, and are moved around terminal by heavy duty tractor units.
2. **Heavy duty Forklift or Front end loader system,** in which heavy duty forklift trucks are used to perform quay transfer and yard operation, called direct system or in combination with other equipment called relay system.
3. **Straddle carrier system,** in which quay transfer, stacking and other duties are performed by straddle carrier, called direct system. Straddle carriers are used for in yard stacking while quay transfer and other movements are performed by tractor-trailer sets or other equipment, called relay system**.**

4. **Gantry Crane system,** in which the container is equipped with Rubber Tyred Gantry or Rail Mounted Gantry crane for stacking and unstacking with tractor-trailers for quay transfer and other movements.

The features of different types of container handling systems with advantages and disadvantages are shown in Table 2.1. The classification of container handling equipment categories and prices are shown in Appendix 3,4.

Table 2.1 Features of container handling equipment systems - summary

System Features	Tractor/chasis System	Straddle carrier Direct System	Straddle Carrier Relay System	Yard Gantry Crane System	Front-end Loader System
Land utilization	Very poor: 180 TEU/hector	Good: 385 TEU/hector	Good: 385 TEU/hector	Very good: 750 TEU/hector	Poor: 275 TEU/hector
Terminal development Costs	Very low: high quality surfacing not necessary	Medium: hard - wearing surface needed	Medium: hard - wearing surface needed	High: high load bearing surface (or rails) needed for crane wheels	High: heavy wear on terminal surface
Equipment costs	High: large number of chasis is required	Moderate: six straddle carriers per ship-shore crane	Moderate: four to five straddle carrier per ship-shore crane	High: expensive, specially rail mounted crane	Moderate: cost-effective for low throughputs
Equipment maintenance costs	Low: good avai-lability record; easily maintained	High: mainten-ance expensive and short opera-tional life	High: mainten-ance expensive and short oper-tional life	Low: very good maintenance record	Medium: familiar technology, good maintenance record & long life
Manning levels (for two-crane operation)	High: 28 men, but low skill requirement	Low: 22 men, but high skill requirement	High: 28 men, with medium-high skill requirement	High: 29 men, with medium-high skill requirement	Medium: 26 men, with medium skill requirement
Operating factors	Good accessibility low demage to containers,simple terminal organ.	High flexibility, good stacking features	High flexibility, moderate capital investment	Good land use, scope for automation. Fle-xibility restricted.	Versatile equipment easily deployed in all locations on terminal

Assumptions: 50:50 balance between impotrts and exports. Figures only indication of possible requirements

Source: Container terminal development, Improving port performance, UNCTAD, 1986.

The Cargo handling system at CPA consists of two types: Forklift system and straddle carrier direct system. In the Forklift system, forklifts fitted with top-lift spreaders, are used in the yards located in the GCB area while transfer of

containers between the quay side and yard are done by tractor-trailers. In the Straddle carrier system, a Straddle carrier is used in CCT for both yard operations as well as transfer between quayside and yards.

Straddle carriers are chosen as the handling system in CCT considering the versatility and flexibility of the equipment, the need for a high level of container selectivity and relative economy of the land use compared to forklifts.

CPA has been using forklifts effectively from the initial stage of container handling since1985. These are used in container yards of the GCB area which are small in size and irregular shapes. Their bearing capacity is insufficient for the current requirements. The consequence is that both the yards and equipment are damaged frequently. Empty containers are handled in both GCB and CCT areas by light duty forklifts with side shift spreader.

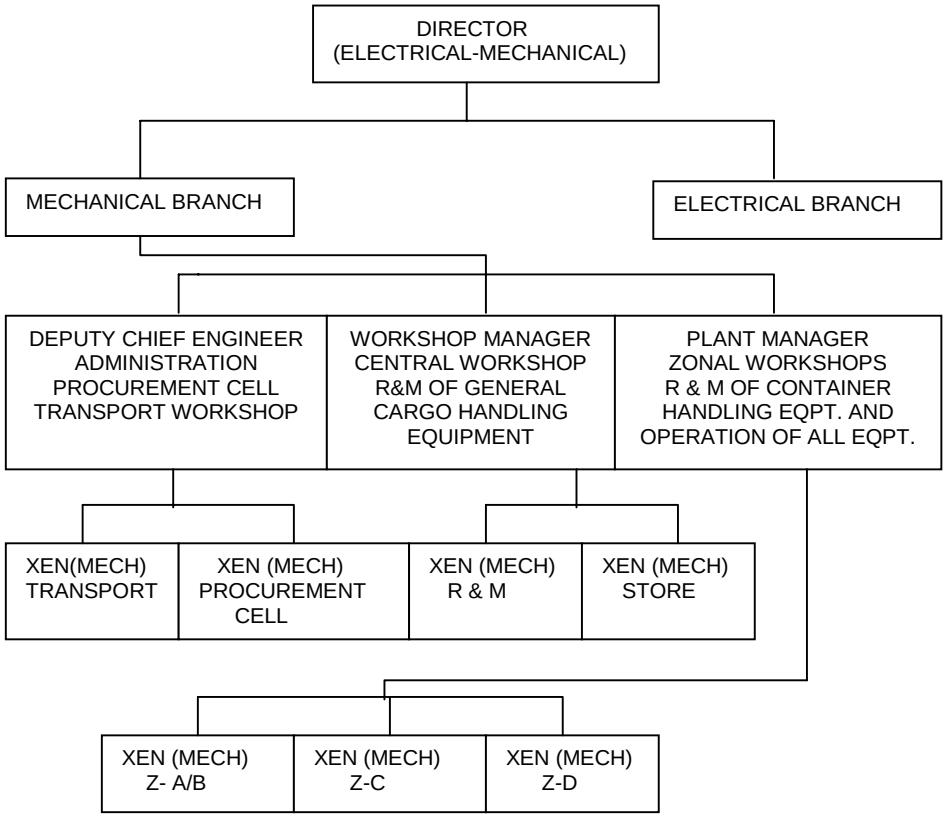
2.3 Organization

All cargo handling equipment of CPA is under the direct control of the Electrical/Mechanical department. It is headed by a director. This department has a big organizational structure, and is subdivided into two main branches: Mechanical and Electrical. Among the four deputy heads of the department, three are responsible for mechanical branch, especially for cargo handling equipment and the other is responsible for the electrical branch. Under the deputy heads, designated under different names, there are executive engineers in charge of different workshops and other functions. 500 employees comprising staff and officers work in different shifts.

There are four different workshops for the maintenance and operation of the equipment. The organization chart of mechanical branch has been shown together with some indication of major functions (Figure 2.1). Since the transport of CPA under mechanical branch is not included in cargo handling equipment, this will not come in to the discussion. The present organizational structure is working better than the previous one in which all functions of the mechanical branch could be

performed under one central workshop. Due to a decentralization of functions of the mechanical branch, the previous central workshop under a new structure split into one central workshop and three zonal workshops in different locations of the port protected area. This is the result of an increased volume of work in the mechanical branch due to the continuous growth in traffic.

Figure 2.1 Organization chart of mechanical branch



NOTE: XEN= EXECUTIVE ENGINEER, MECH= MECHANICAL, Z= ZONAL WORKSHOP
EQPT.= EQUIPMENT, R & M= REPAIR AND MAINTENANCE

Source: Mehanical branch, CPA

2.4 Equipment

2.4.1 Equipment Management

Management of equipment is accomplished by a group of people as shown in the organization chart. The main functions related to the equipment management are as follows:

- To set objectives and performance standards for the department.
- To plan and forecast the equipment necessary for efficient cargo handling operation in CPA.
- To take appropriate measures to maintain proper equipment inventory.
- To prepare cost-effective budget for management and maintenance of the equipment
- To organize and supervise the overall maintenance of the equipment to ensure equipment availability at all times.
- To arrange and implement continuous training and motivation schemes for the employees.
- To maintain discipline in order to achieve the smooth functioning of all activities.
- To measure and ensure quality in maintenance and all other related functions by controlling, reviewing and monitoring the activities and applying standard procedures and techniques with respect to set objectives and standards.

In addition, the management of mechanical branch has to perform other functions including maintaining a close relationship with port management and other departments. All functions as stated above are not accomplished by the equipment management properly due to different constraints and managers working under equipment management are not equally capable of supporting all functions.

2.4.2 Existing facilities

As said earlier, quality of cargo handling equipment is one of the key factors of port productivity. The equipment owned by the CPA at present is broadly divided into two categories: general (break bulk) cargo and container handling equipment. Facilities of different kinds have been created to maintain the equipment and to keep it in operation effectively. The establishment of three zonal workshops and one

central workshop are important among the facilities. The locations of the workshops have been shown in Figure 2.2.

- **Zonal and central workshops**

Three zonal workshops (A/B, C & D) have been established in port protected areas at almost equal distances from one another so that the equipment can go back and forth from the operations point to the workshops within the shortest possible time so as to give quick response during any operational failure/accident or maintenance problem. The central workshop is not placed at center point of the three workshops. Originally the idea was that all major repairs such as engine and transmission overhauling, fuel pump testing and repairs, etc. could be done in this workshop. Later on, however, considering that the two zonal workshops (C & D) are will be more useful so that they can be used directly for the maintenance and operation of container handling equipment, the central workshop is now only used for major repairs and the maintenance of general cargo handling equipment.

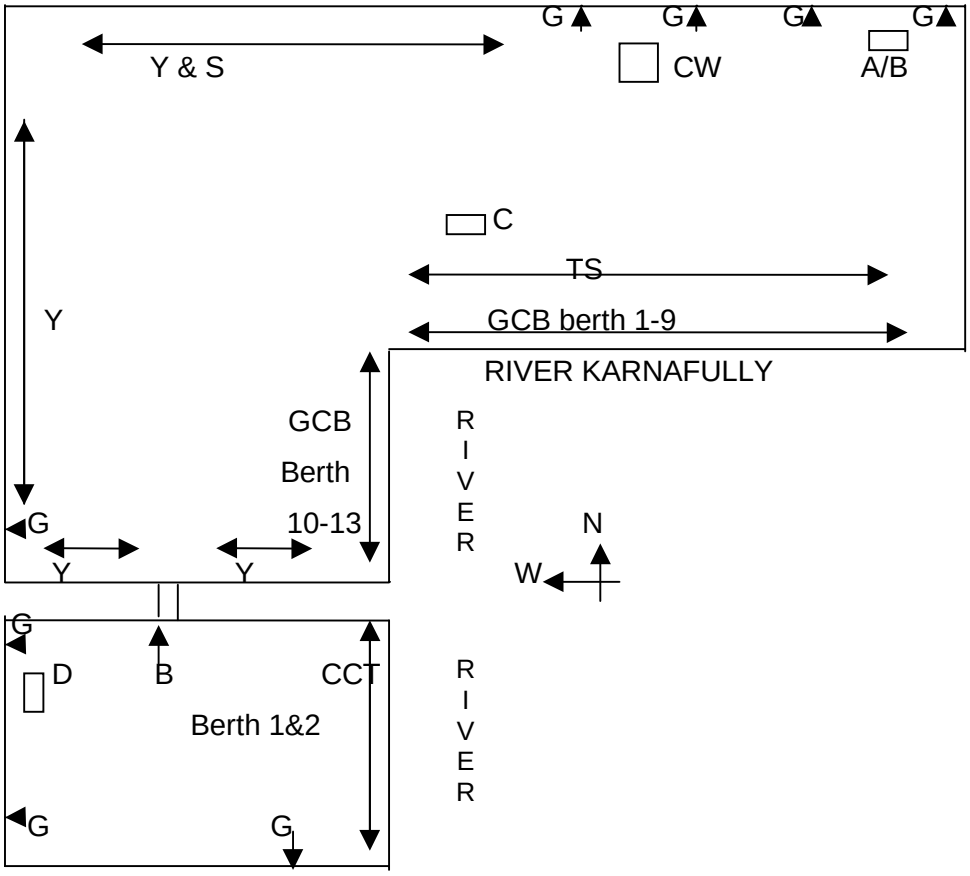
Zonal workshop A/B accounts for all general cargo handling equipment. Facilities available in this workshop include a dedicated area for preventive maintenance and running maintenance, open pavement space for preserving different types of equipment, fuel tank and pumps, distilled water making plant, equipment booking and other administrative offices**.**

Zonal workshops C and D account for all container handling equipment, and are used for parking, booking and maintenance of this equipment. Workshop-D was established as a container handling equipment workshop jointly with Chittagong Container Terminal. So, this workshop is better equipped, with repair and maintenance facilities, than workshop-C.

Facilities available at workshop D are overhead crane, servicing bay, diesel pumps, machine shop, equipment repairing areas, tyre repairing shop, battery charging room, electrical maintenance room, sub-store for spares, welding facilities, engine overhauling room and a covered shed for corrective maintenance. Moreover, workshop has an L-shaped two storied building. The top floor of this building houses

different offices, a training room and a prayer room and the ground floor is used for equipment booking room, operator and technician's rest room. Zonal workshop C has similar facilities as workshop D except the overhead crane, dedicated servicing bay, machine shop and sufficient space for repair and maintenance.

Figure 2.2 Rough sketch indicating location of cargo handling equipment workshops and other main facilities in CPA



Note: Zonal workshops: A/B, C & D, Central workshop : CW
Container yard: Y Shed : S Gate : G Bridge : B, Transit shed: TS
General Cargo Berth: GCB, Chittagong Container Terminal: CCT
Source: Author

The central workshop is provided with almost all facilities as described above for workshop C and D and has sufficient open space protected by steel fencing for placing and repairing different types of equipment at one time.

Figure 2.3 CPA zonal workshop-D shows straddle carriers and other equipment

Source: CPA

2.4.3 Types of equipment

There are different types and models of equipment for handling general/break-bulk cargoes and containers in CPA. There are some attachments, which are used in general, cargo handling to expedite and safe handling of various types of cargo such as jute bale, drums etc. The total equipment position of CPA under the mentioned workshops is shown in Tables 2.2 & 2.3.

Analysis of the Tables 2.2 & 2.3

It appears from the two tables that a large amount of equipment has been proposed for scrapping, but this has to wait for a long period for disposal. About 50% of 237 and 20% of 120 general cargo and container handling equipment respectively have

surpassed their economic lives. The economic life of equipment is that period during which it can be operated at minimum average annual total cost.

Table 2.2 State of CPA container handling equipment, December 1999

Type of equipment	Capacity (ton)	Equipment inventory	Nos. in working condition			Nos pro-posed for scrapping	Economic life yrs
			life under 5 yrs	life 5-10 yrs	life above 10 yrs		
Straddle carrier	35	8	4	4	--	--	12
Forklift truck	38-42	9	7	--	--	2	8
Forklift truck	32-35	2	--	2	--	--	8
Forklift truck	25-28	6	2	--	2	2	8
Forklift truck for empty handling	9-16	9	6	--	3	--	8
Tractor	50	50	12	27	5	6	10
Trailer	20'-40'	36	11	14	11	--	10
Total		**120**	**42**	**47**	**21**	**10**	
Percentage of inventory			**35**	**39**	**18**	**8**	

Source: Mechanical branch, CPA

Moreover, both categories as stated above, are creating problems in daily operation and maintenance work. However, the equipment having lost its economic life has not been declared for scrapping for two main reasons:

1) to meet the growing demand of traffic till new equipment is procured;
2) for the non-disposal of scraped equipment.

Table 2.2 shows that the main container handling equipment, straddle carrier has very low inventory compared to present requirement. Similarly, forklifts (32-35 ton & 25-28 ton) and tractors-trailers have low inventory and about 50% of them are still in use with high downtime. The origin of all container handling equipment is in Europe which have been procured from well-known manufacturers, Valmet-Sisu (Finland), Kalmar (Sweden) and Fantuzzi Reggiane (Italy).

Table 2.3 State of break bulk/general cargo handling equipment on December, 99

Type of equipment	Capacity (ton)	Equipment inventory	Nos. in working condition			Nos pro-posed for scrapping	Economic life yrs
			life under 5 yrs	life 5-10 yrs	life above 10 yrs		
Mobile crane	20-30	5	--	--	5	--	8
Mobile crane	6-10	23	8	2	7	6	8
Forklift truck	5	21	13	--	7	1	8
Forklift truck	3	66	16	7	23	20	8
Forklift truck (low mast)	2.5	16	--	16	--	--	8
Tractor	20-25	23	--	--	13	10	10
Trailer	6-25	52	--	--	39	13	10
Shore crane	2-3	31	--	--	25	6	15
Total		**237**	**37**	**25**	**119**	**56**	
Percentage of inventory			**16**	**10**	**50**	**24**	
Attachment for break bulk cargo handling							
JCBC attachment for jute carpet bale handling				7			
Bale handling attachment				9			
Fork extension				1			
Drum handling attachment				6			

Source: Mechanical branch, CPA

Table 2.3 shows that about 50% of the mobile cranes have passed their economic lives but still they are in use due to shortage of inventory. Forklifts (5-ton) have good inventory and these are also used for handling empty containers. Forklifts (3-ton) have considerable inventory but more than 30% of them crossed their useful lives and about 30% have been proposed for scrapping. So, the existing machines are not fulfilling the present requirements. Although low mast forklifts (2.5-ton) have been shown with general cargo handling equipment, these are used for container stuffing/destuffing purpose, and have insufficient inventory. More than 50% tractor-trailer units are aged and do not satisfy the operational needs. Most of the shore cranes have passed their useful lives but still they are giving better services. Among these equipment, 90% forklifts are of Japanese origin and all cranes have been procured from well-known manufacturers, Coles (U.K) and Locatelly (Italy).

2.4.4 Facilities at the Inland Container Depot (ICD)

The equipment facilities at ICD have been arranged by a private company since 1997 under lease contract. Prior to that time, CPA had been operating ICD container handling operation with its own equipment since its establishment in 1987. Presently, two big container handling forklifts (32 &36 ton) and 5 small forklifts (3 & 8 ton) are handling about 40,000 TEUs per year. It has area of 50,000-sq. m. for container storage. ICD is serving the needy port users of distant places and contributing as a part of the overall transport chain.

2.4.5 Other related facilities

There are some other facilities, which are directly or indirectly connected with equipment handling. The main facilities related to equipment are shown in Table 2.4. It is found from the table that CPA has different facilities for cargo and its handling.

Table 2.4 Related facilities for cargo handling in GCB and CCT area

For break-bulk handling		**For container handling**	
1.Numbers of general cargo berth	11	**1. Chittagong Container Terminal (CCT)**	
Total length (m)	2121	No. of berths	2
Maximum draught (m)	9.12	Total lengths (continuous in meter)	450
2.Cargo storage (protected area)in m2		Maximum draught (m)	9.12
Warehouses	18662	Vessel accommodation (ocean going)	2
Trasit shed	55877	Vessel accommodation (inland container)	1
Open dumps	90000	Container storage yard (m2)	150000
Car shed (2 nos.) in m2	5082	Warehouses (CFS) in m2	12700
3.Cargo storage outside protected area		Reefer points (415 volts)	210
Ware houses (15 nos.)(m2)	32500	Standby generator (750 kva each)	2
Open duumps (m2)	200000	**2. General Cargo Berth (GCB)area**	
4.Standby generator	4	No. of berths	2
(2*300kva, 2**663kva)		No. of container yards	14
		Storage area (m2)	110443
		Warehouses (CFS)(11 nos.) in m2	86168
		Reefer points (440 and 220 volts)	108
		ICD container yard (m)	123
		Container holding capacity(teus) at 1&2	**8947**
* Trailing suction hopper dredger	1	* Fire brigade	1 unit
Hopper capacity in cu.m.	2500	*Water reservoir in gallon	140000
* Tugs upto a maximum capacity 2250 bhp	6		

Note: GCB- General Cargo Berth, CCT- Chittagong Container Terminal, CFS- Container Freight Station .

Source: CPA overview,1999

Both the GCB and CCT areas are provided with berths, storage area and standby generator etc. Other facilities include: dredger for regular maintenance dredging in channel, tugs for pilotage, fire brigade and provision for water supply to ships. There are several special berths and storage facilities for dry and liquid bulk cargoes outside the CPA protected area operated by other companies.

2.4.6 New Equipment and facilities

Shortage of equipment is the burning question of the port today. If the equipment is not procured or replaced after a definite interval on the basis of traffic forecast, a catastrophic disaster might happen in port operations in the future. This kind of situation has been faced by the port several times and it influences the port itself and national economy greatly. However, it is expected that port is soon going to buy a number of containers handling equipment including gantry crane, by 2001/2002, and to construct a new container terminal with back up facilities by 2005/2007.

Work on two projects, named as "Procurement of container handling equipment including gantry crane'' and '' Construction of a container terminal at the New mooring area of Chittagong Port" has already started. An International tender for the first project has been invited and for the other project will be invited soon. The equipment to be procured and facilities to be created are shown in the Table 2.5.

From the table it is seen that CPA is going to procure new sophisticated equipment such as quay gantry crane and rail mounted gantry crane by 2001/2002 and rubber mounted gantry crane by 2005/2007. Moreover, reach stacker is also going to be added to the CPA equipment inventory. Obvious benefits of the reach stacker include its ability to reach out, its relatively low overall height and its ability to rotate and come in at an angle to the stock (PDI, March 2000). The new straddle carrier will be 4 high (1 over 3 units) instead of the existing 3 high (1 over 2 units). Inevitably, all this equipment will contribute greatly in handling the growing traffic and increase efficiency at the port.

Table 2.5 New facilities to be created by 2001/2002 and 2005/2007

***Construction of New Mooring container terminal by 2005/2007**			
Length of the berths (m)	1000		
Storage area (m2)	220000		
***Equipment will be procured by**	**2001/2002**		**2005/2007**
	phase -1	**phase-2**	
Ship to shore Gantry crane (40T)	4	nil	4
Rail mounted yard gantry crane (40T)	1	nil	nil
Rubber mounted yard gantry crane (40T)	nil	nil	6
Straddle carrier (4 high)	13	3	4
Reach stacker (5 high)	9	9	nil
Forklift trucks (12-16T)	nil	3	5
Low mast forklift truck (2.5T)	nil	5	nil
Terminal tractor (50T)	22	26	45(with trailer)
Trailer (20'/40')	27	17	

Source: Project proforma, CPA, 1999

2.5 Equipment maintenance

Maintenance of equipment is the most important aspect of equipment productivity. Equipment deteriorates and fails to attain its economical life because of poor maintenance. Due to technological growth of equipment handling systems, much sophisticated equipment has been procured by numerous ports to improve their productivity. This equipment needs proper maintenance and management. In a modern container terminal, the total equipment budget can amount to 45 % total terminal budget operations (Toubhans, 1999, p. 45). CPA has both conventional and modern equipment. As mentioned earlier, it has a big organizational structure for the maintenance and management of equipment.

2.5.1 Methods and procedures

There are three broad categories of maintenance: 1) Preventive maintenance, 2) Corrective maintenance, and 3) Designing-out maintenance.

Preventive maintenance is mainly based on routine inspection of equipment at scheduled time in order to avoid major breakdown of the equipment.

Corrective maintenance involves mainly breakdown repairs resulting from irregular component failures and damages due to accidents, which are caused by defective components and human errors.
Designing-out maintenance is mainly set out to remove the need for maintenance.

At the CPA both preventive and corrective maintenance are done at its own workshops. Designed-out maintenance is done rarely when there is a necessity to improve/design a system in order to upgrade or prevent it from failure. Another type of maintenance concerns attending very frequently to solve the running defects during operation. This is called running maintenance.

- **Preventive maintenance**

This maintenance for all types of equipment is done according to a monthly schedule prepared by the engineer in-charge at the end of every month. All equipment is grouped by type and model in order to list out maintenance tasks to prepare weekly, monthly, quarterly, half-yearly and yearly schedules according to the manufacturers recommendations. These schedules are printed in ready-made forms for instant use. Technicians assigned for doing maintenance work are instructed by the supervisor giving instructions in a repair book where name, type of maintenance (weekly or monthly, for example), and time of starting work are noted. The repair book is used as a document instead of a job card for giving instructions to the technicians and keeping records of all types of repairs. After finishing the work, the technician fills out the respective form and deposits it with the supervisor with the repair book, filling the columns of spare parts used, completion time and signature.

Importance is given to perform this type of maintenance according to the time schedule so that no equipment is left without maintenance. But, practically, due to various constraints such as shortage of employees, absenteeism etc. only 60-70% of the work is performed every month. The preventive maintenance schedule of a general type is shown below (Table 2.6). This table shows how different tasks are performed according to weekly, monthly, quarterly, half yearly and yearly schedules. Same procedure is followed for other types of equipment.

Table 2.6 Preventive maintenance schedule of forklift truck

TASKS	SCHEDULE A WEEKLY	SCHEDULE B MONTHLY	SCHEDULE C QUATERLY	SCHEDULE D HALF- YEARLY	SCHEDULE E YEARLY
Washing & Cleaning	P	P	P	P	P
Air filter element	C	C	R	R	R
Air compressor	--	--	CL	CL	CL
Lift chain and Chain wheel	A	A & L	A & L	A & L	A & L
Tyres and Rims	W	W	W	W	W & I

NOTE: P = PERFORM C = CHECK AND/ OR CLEAN R = CHANGE OR REPLACE A = CHECK AND ADJUST
CL = CHECK LEAKAGES L = CHECK A ND LUBRICATE W = CHECK WEAR AND DEMAGE
I = INTERCHANGE Source: Mechanical branch, CPA

- **Corrective maintenance**

This is done in the same way as preventive maintenance by writing necessary instructions in different column of the repair book. But in this case, no printed schedule is prepared. The repair book acts as a job card to the technicians. Generally, breakdowns such as failures of the steering system or brake system of equipment are reported by the operation supervisor to the maintenance supervisor in writing. According to this report, instruction for corrective maintenance is given to the technicians.

- **Running maintenance**

This maintenance is often performed during operation. Mobile workshops and small forklifts are used by the technicians to attend to the running problems of equipment in different locations. Problems include: tyre punctures, oil leakage, abnormal sound from engine or other systems, excessive emission of smoke etc. If the operator has a good technical knowledge and is experienced, he can report correctly to the workshop shift -in -charge to solve the problem quickly. Otherwise, delays occur for checking and taking corrective measures afterwards.

- **Working hours**

The daily working hours of the maintenance staff are 8 hours, called general shift from 7-30 to 16-30hrs excluding one-hour interval for lunch. Generally, maintenance work is done during the general shift, but some maintenance staff are booked in two shifts, 6.00 to 14.00 and 14.00 to 22.00 hrs to attend to emergencies and the running repairs of two shift operations. Since CPA does not have sufficient and good equipment to meet the traffic demand of everyday, some maintenance staff has to be booked daily including on weekly and government holidays on overtime to attend to the breakdown of equipment.

- **Spares and stores**

Spares and stores are the key points of maintenance. All spare parts issued are entered in the register as per requisition slip/form from the maintenance supervisor to store keeper. About 95% of spare parts are imported mainly from equipment suppliers in foreign countries and the remaining spares are procured locally from local suppliers. Demand for the foreign spares is placed in the beginning of the year. It takes a minimum of 6 months to 1 year or even more to procure the spares, which disturbs the maintenance work badly. Computerization of all spare parts is going on in different workshops but not in a planned manner.

2.5.2 Maintenance by local workshops

There are shortages of some special categories of skilled people and facilities in CPA workshops. Sometimes assistance such as machining works and special tools are needed from the out sources to perform engine and transmission overhauling, fuel pump repairs and other special jobs. Engine machining work is done on a yearly contract basis by the local workshops. Some spare parts are manufactured by some local reputed workshops in an emergency, though the longevity of these parts is not the same as the original ones.

2.6 Equipment booking and operation

2.6.1 Booking and operation system

The booking of Cargo handling equipment is done from respective zonal workshops. The traffic department of CPA is mainly responsible for the operation of equipment after booking. According to the requisition received from the traffic department, equipment is booked to specific locations. The daily booking position is sent to higher management and operation department (Appendix 5).

Before putting into operation, each equipment operator has to check the equipment, called pre-operational checks, as specified in the check list book. The main items of checklist book are physical condition of the equipment such as condition of tyres, battery, any oil leakage, functions of different levers and switches of panel board inside operator's cabin including brakes, steering, lifting systems and all oil and fuel levels in the tanks.

2.6.2 Working procedures and working time

Operators are under the direct control of mechanical branch but they have to obey the orders and instructions of traffic officers during operation. If there is any requirement for repairs and maintenance during the operational period, the equipment operator sends a message to the shift in-charge at the workshop by wireless set fitted on the equipment. The shift in-charge takes the necessary step for repairs either by sending a technician to the site or bringing back the equipment to the workshop. Two mobile workshops are available at two zonal workshops to attend running repairs at the sites.

Cargo operations are carried out in two shifts (day and night) but there are provisions for doing work after shifts, called evening through and morning through. Since the port is open for 24 hours, the operators have to do this work as overtime during emergency periods such as the sailing schedule of ships, exporting perishable goods or importing emergency spares or raw materials for industries. Every shift is for 8 hours excluding intervals for lunch/dinner.

2.7 Analysis of equipment performance and productivity

Equipment performance and productivity are closely related. According to Francou (1999), performance means the total optimization of all elements related to the equipment to get the desired productivity. Productivity of equipment is mainly based on performance of maintenance and operation. The yearly maintenance performance and utilization of general and container handling equipment for 1999 is summarized in the Tables 2.7 & 2.8. Another Table 2.9 shows the demand availability of container handling equipment. The tables are discussed in the following sections of maintenance and operation performance.

Table 2.7 Downtime, availability and utilization rate of each type of general cargo handling equipment in 1999.

Type of equipment	Capacity (ton)	Numbers	Down time		Availability		Utilization	
			hrs.	%	hrs.	%	hrs.	%
Mobile crane	20-30	5	31500	75	10500	25	8400	20
Mobile crane	6-10	17	52836	37	89964	63	57120	40
Forklift truck	5	20	33600	20	134400	80	80640	48
Forklift truck	3	46	200928	52	185472	48	123648	32
Forklift truck	2.5	16	30912	23	103488	77	64512	48
Tractor	20-25	13	61152	56	48048	44	38220	35
Trailer	6-25	39	117936	36	209664	64	127764	39
Shore crane	2-3	25	54600	26	155400	74	94500	45

Note: *Equipment, proposed for scrapping in table 2.3, are not included in this caculation.
*The possible machine hours are 8400 (350days/yr. * 24 hrs./day) per year.

Source: Mechanical branch, CPA

2.7.1 Maintenance performance

Maintenance performance of equipment is looked at using the following parameters:

Equipment Downtime: The total time in hours when each or type of equipment is not available for operation due to breakdown repairs, preventive maintenance, waiting for spares and other reasons. It is calculated for a given period by using the formula:

Downtime = (Downtime in hrs. /possible machine hrs.) * 100, where possible machine hours are the number of hours that berths in the port are scheduled to work in that period. In CPA, berths for general cargoes and containers are open for 24 hours and the maximum days available in a year are 350 excluding closed holidays, strikes and labour unrest. So, the possible machine hours per year are 8400.

Table 2.8 Downtime, availability and utilization rate of each type of container handling equipment in 1999.

Type of equipment	Capacity (ton)	Numbers	Downtime		Availability		Utilization	
			hrs.	%	hrs.	%	hrs.	%
Straddle carrier	35	8	17472	26	49728	74	34944	52
Forklift truck	38-42	7	10584	18	48216	82	29400	50
Forklift truck	32-35	2	9244	55	7556	45	5040	30
Forklift truck	25-28	4	12096	36	21504	64	15456	46
Forklift for empty handling	9-16	9	22680	30	52920	70	39312	52
Tractor	50	44	129360	35	240240	65	129360	35
Trailer	20'-40'	36	33264	11	269136	89	90720	30

Note: *Equipment, proposed for scrappping in Table 2.2 are not included in this calculation

*Possible hours are 8400 (350 days/yr. * 24 hrs./day) per year.

Source: Mechanical branch, CPA

Equipment Availability: This is a measure of the proportion of the time that each or type of equipment is accessible for berth operations. It can be calculated for a given period by using the formula:

Availability = (available machine hours / possible hours) * 100, where available machine hours are calculated by subtracting downtime from possible machine hours.

Demand Availability: This is a measure of the time that equipment is available when requisitioned by the traffic/operation department. It can be calculated for a given period using the formula:

Demand availability = (No. of machines supplied/ No. of machines demanded)*100

Equipment Utilization: This is a measure of proportion of the time that a machine is actually engaged in work. It has been calculated by using the formula:

Utilization = (Recorded machine hours/possible machine hours) * 100, where the recorded machine hours are the number of hours is actually worked by the machine in a given period.

Mean Time Between Failure (MTBF): This denotes reliability of the equipment and is expressed as duration of time the equipment is utilized before failure occurs.
MTBF = worked hours/frequency of failures.
Mean Time To Repair (MTTR): This measures the average duration of time the equipment is laid up for repair, which also denotes the maintainability of the equipment. MTTR = breakdown time/frequency of failures.

The last two parameters are not measured in CPA. The data collected from the mechanical branch are not sufficient enough to calculate the performance parameters with 100% accuracy. Because, every machine is not fitted with hour meters to record the actual working hours; some data collected from logbooks are based on assumptions. Some missing data are taken on average based on past records.

From the two tables (2.7 & 2.8) it is found that the availability of both categories of equipment is not satisfactory. Table 2.7 stipulates that mobile cranes of 20-30 ton capacity have very poor availability and excessive use of available equipment cause many breakdowns and create pressure on maintenance work. Similarly, 3 ton forklifts and tractors indicate excessive downtime and low availability. The position of shore crane is satisfactory. Though it is very old but it's electrically operated systems cause less breakdown. Its present availability is enough for shore handling operation.

Table 2.8 illustrates that availability of container handling equipment is in a better position than general cargo handling equipment, but still much below the standard (85-90% for straddle carriers, 90% for forklifts -Thomas & Roach,1993). Due to insufficient inventory, straddle carriers and forklifts (38 - 42T and 9 -16T) have been utilized more than other categories. The rate of utilization will be higher if it is

calculated with respect to actual available hours per year (available machine hours – non-working hours for lunch/dinner) rather than possible machine hours per year.

The two tables clearly show that both types of equipment have considerable downtime. The causes of downtime are mainly due to aged machines, lack of workshop performance, bad driving practices, shortage of spare parts, working environment, weather condition etc. On the other hand, poor utilization of some of the equipment categories of both types is due to excessive idle time. Idle time is the available hours that are lost due to administrative procedures, bad weather, spending more time by the operators and labours for lunch/dinner etc.

On the other hand, Table 2.9 shows that during 6 months period almost all categories of equipment have less supply against demand which indicates considerable shortage of operable equipment in CPA.

Table 2.9 Demand availability of container handling equipment, April-Sept./99

Equipment type	Capacity (ton)	Total demanded numbers	Total supplied numbers	% Availability against demand
Straddle carrier	35	2280	1506	66
Forklift truck	38-42	2244	1740	78
Forklift truck	32-35	744	144	19
Forklift truck	25-28	2232	1158	52
Forklift truck	9-16	1860	738	40
Tractor-trailer	50	13020	4626	36

Note: Generally demand has been placed based on existing inventory. It does not truly reflect the needs

Source: Mechanical branch, CPA

All machines for cargo handling have been procured under perfect competition from reputed manufacturers as said before. Satisfactory performances have been found from most of the machines and after sales services of the manufacturers were good. But because of many factors that will be discussed latter, timely maintenance of engines, transmissions, lifting systems, etc. according to manufacturer's recommendations, is not performed which increases downtime and reduces the performances of these systems substantially.

Utilization of labour force: Proper utilization of manpower is an important criterion for measuring performance of maintenance of equipment. It can be calculated by measuring annual utilized man-hours and annual man-hours available. But officially this is also not measured. In CPA many hours are lost due to internal and external factors such as unauthorized absence, bad weather, political and trade union strikes and huge amount of public and private holidays. However, a simple analysis of different types of leave and holidays (Table 2.10) for workshop employees shows that in a year more than 50% of the days are spent on leave, including government and weekly holidays. The excessive leave provision sometimes creates a terrible situation for maintenance and operation.

Table 2.10 List of holidays and leave in CPA

Name of annual leave and holidays	days
Casual leave	20
Earned leave	33
Medical leave	16
Optional holidays	3
Government holidays	27
Weekly holidays	104
Total	**203**

Source: CPA

The above parameters/indicators can be useful for measuring the maintenance performance/efficiency of CPA equipment.

2.7.2 Operational performance

The berth operations, ship operation, transfer operation, storage operation and receipt/delivery operation are directly connected with operational performance of the equipment. The total operational performances of CPA are summarized in the following (Table 2.11).

It is found from the table that overall performances are not good at all. High turn around time of vessels, high berth occupancy, low throughput for both general cargo and containers and low gang output with low equipment availability indicate poor

Table 2.11 Performance Indicators of CPA from 1995-96 to 1998-99

Operational Indicators	1995-96	1996-97	1997-98	1998-99
1.Turn around time of vessels	5.13	4.69	7.11	6.49
2. Throughput per ship day				
Containers (nos)	120.46	128.13	128.77	141.12
General cargo (tons)	566.73	600.15	560.07	671.70
3. Productivity per gang hour				
Containers (nos)	8.70	9.32	8.84	9.40
General cargo (tons)	16.31	18.87	16.80	19.03
4. Equipment availability (%)	38.06	50.04	49.97	52.72
5. Waiting time of ships (days)	1.80	0.74	1.85	2.87
6. Service time of ship (days)	3.65	3.16	3.38	3.90
7. Berth occupancy (%)	81.26	83.68	86.79	87.5*
8. Total number of ship call	1409	1482	1389	1425
9. Container ship call	334	455	385	475

Note: * estimated

Source: Port Overview, 1999 and traffic department, CPA

performance of the port. No considerable improvement is observed during the 4 years. The problems exist not only in the performances of equipment but also in other services, such as berth, storage, management and supervision of other infrastructures and superstructures and above all training and human resources development. However, the port is still making profit due to growing traffic, not because of best performances of management or by offering high quality services to the port users. The operational performance of the equipment can be discussed in relation to berth operations.

Ship operation - This is considered as the first activity of cargo handling in which loading and discharging operations between the vessel and quayside are done by the ship cranes as CPA has no quay cranes of its own. The performance of the ship cranes mainly depends on close supervision of four activities: cargo preparation, hook transfer, cargo release and hook return. Moreover, the ships call at the port

are conventional types and their cranes and derricks are not efficient to receive and delivery the cargoes/containers promptly. The gang performance at the port is not satisfactory because of poor control and unskilled labour in the gangs. The gangs are not properly trained for handling different types of cargo applicable to different size and pattern of ships. They are neither paid well or offered good incentives compared to developed ports. Their regular income is not more than US$ 3 per day and also there is no assurance of work everyday.

Quay transfer operation - This links shipboard activities with transit shed or warehouses or storage yards. Carefully equipping and planning of the transfer operation is often the most effective single method of measuring ship-handling productivity. Since, 1991 the port has been using straddle carriers and their performance is quite satisfactory. It has been found that because of equipment non-availability in transfer operation a serious congestion results, which slows down not only berth operations but also normal equipment performance. For example, if a tractor-trailer enters the gate for taking delivery of a container in peak period, it takes long time, even 7-8 hours due to long queue at the gate.

Storage operation – This operation provides a buffer between the ship operation and receiving/delivery operation. The efficiency of storage operation depends on the lay out of the yard/shed, equipment availability, documentation and supervision and coordination of the four operations. Excessive dwell time at the sheds and yards often creates congestion at the port and reduces the efficiency of equipment as well as total berth operations.

Receiving and delivery operation - This operation is also a link in the chain of the other three operations. Control of movements inside the port protected area is not strict and gate controls for the transport arrivals and departures are very poor due to unplanned security management. Moreover, custom formalities and port documentation system along with non-availability of equipment retards the whole operation considerably.

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2.7.3 Cost-benefit of equipment

To calculate the cost-benefit of equipment proper records of costs and benefits of each piece of machine is essential. In CPA, up to date records of costs of different types of equipment are not available. On the other hand, CPA tariff structure is such that tariff is not charged equipment-wise directly. According to tariff schedule, tariffs are charged on loading/unloading/stuffing/unstuffing/lift-on/lift-off etc. heads for handling different status of containers. The charges on container handling equipment are also included in these charges.

However, efforts are taken to calculate the annual/hourly operating costs of 3 main types of CPA container handling equipment for the year 1998 (Table 2.12). Annual operating costs is an important parameter to find the economic life of equipment Random-sampling method is applied for this calculation. To find out average annual operating cost, three machines are selected from each type and after aggregating the annual operating costs, average yearly operating costs of each type and each machine are calculated. All data related with this calculation is collected from the different records but 10% confused data is estimated.

Table 2.12 Hourly operating cost (in USD) of equipment

Type of equipment	Annual running costs		Annual maintenance costs			Annual operating costs	Annual operating hours	Hourly operating costs
	Fuel/power	Labour	Spares	Consumable	Labour			
Straddle carrier	20000	4000	27000	2000	3000	56000	4200	13
(35T)	36%	7%	Total = 32000 (57%)					
Forklift truck	16000	4000	20000	1400	3000	44400	3700	12
(38T)	36%	9%	Total = 24400 (55%)					
Terminal tractor	4000	3000	4500	1000	2500	15000	1800	8
(50T)	27%	20%	Total = 8000 (53%)					

Note: Percentage shown below costs is the percentage of annual operating costs, all costs are in US $
Source: Compilation of data from mechanical branch and author's experience

The table shows that the annual operating cost is the summation of annual running costs and annual maintenance costs. The average hourly operating cost is calculated dividing aggregate annual operating costs of 3 machines by total annual

operating hours. In this calculation, overhead cost is not included. The main feature of this calculation is that labour costs in CPA are very low in comparison with other costs. For example, the average salary and allowances per month of each operator/maintenance staff is 150 USD only.

Finally, it can be said that for total cost-benefit analysis of CPA equipment, the calculation of costs of other infra-structure facilities, berths, yards, roads and other inputs which have been used for the equipment, need to be taken into consideration as partial expenses. So, it is difficult to find out separately the cost and benefit of equipment.

However, after finding the yearly operating cost of the equipment, the economic life of the equipment may be calculated as discussed latter, which could be a good measure of performance for the management's guidance.

2.8 Training and human resources development

About 500 employees are involved in the management, maintenance and operation of cargo handling equipment under the mechanical branch. The staff directly involved with maintenance and operation of equipment, are offered training by the experts of equipment suppliers or CPA personnel trained for this purpose, after procurement of the new equipment. The training courses last for 2 or 3 weeks. A human resource development project was accomplished by CPA in 1989-90 to develop its people in various fields, which was conducted by Louis Berger International Inc., USA. At that time, the consultants offered training to different categories of maintenance staff, operators and management personnel, and developed some training instructors and gave some recommendations for the future training activities. The development of human resources relates to every aspect of the ports relating with its personnel: recruitment, integration, supervision, allocation of tasks, remuneration, assignments, transfer, promotion and training. There are bottlenecks in almost all of these subjects. Here, mainly, the training aspects of human resource development are discussed.

2.8.1 Present position of training

Consultants' recommendations are not implemented fully due to poor management commitment. The CPA training institute, is under the administrative department which makes training programmes in the beginning of the year for all departments of CPA. The training programme made for the staff of the mechanical branch is not good enough to serve the requirements of the maintenance and operational staff. The training performance of CPA training institutes indicating the number of courses per year for the staff of mechanical branch is shown below (Table 2.13).

It is evident from the table that the training offered is not in a uniform manner and also the numbers of participants are not satisfactory. Now and then, some special training conducted by foreigners for the staff and engineers may be available at CPA in the related fields of equipment maintenance and management.

Table 2.13Training courses for mechanical branch

YEAR	NO. OF COURSES	NO. OF PARTICIPANTS
1997 -1998	7	30
1998 -1999	2	10
1999 - 2000 (SIX MONTH)	4	20

Source: Training Institute, CPA

2.8.2 Shortcomings in the training system

The main problems identified for the training of employees are as follows:

- Lack of strong commitment of port management towards training.
- Lack of Training Need Assessment (TNA) of the employees.
- Unwillingness of the employees.
- Insufficient funds for executing training.
- No feedback and evaluation after training.

Analysis of the short comings

Management commitment is rarely found for providing training. In most cases investment in training is considered to be unproductive. A Training Needs Assessment of the employees is rarely done. In the absence of evaluation and feedback after training, no action for improvement can be executed. There is no remuneration system for successful trainees so that they can be encouraged to training. The unwillingness of the employees is due to despair when skilled and trained employees are not treated well during promotion or posting for jobs. The annual training budget of the training institute is only about US$ 25,000 i. e. .05% compared to the port expenditure of US$ 52 million in 1998-99.

Table 2.14 Revenue surplus of CPA (million US$)

Fiscal Year	1993-94	1994-95	1995-96	1996-97	1997-98	1998-99
Income TK (million)	2,056	2,604	3,159	3,243	3,452	3,741
USD (million)	51	65	76	74	74	77
Expenditure TK (million)	1,571	1,963	2,235	2,133	2,424	2,545
USD (million)	39	49	54	49	52	**52**
Net surplus TK (million)	485	641	924	1110	1028	1196
USD (million)	**12**	**16**	**22**	**25**	**22**	**25**
Exchange rate January, 1 US$ =Tk.	40.21	40.28	41.79	43.89	46.9	48.5

Source: Administrative report, CPA, 1997-98 and CPA overview, 1999.

As a result, the training institute is not capable of taking any initiative for providing good training to the employees, at home and abroad. The six years net surpluses of CPA are shown in Table 2.14.

2.9 Conclusion

The present position of CPA equipment, existing facilities, maintenance and operation system and performance has been discussed. It is observed that there are problems in the management, equipment inventory, port existing facilities,

manpower training and equipment maintenance and operation. It is paramount to analyze the details of the problems in order to find out solutions in these fields. So, the subsequent chapter tries to explain the internal and external problems/factors affecting performance of equipment.

CHAPTER 3

FACTORS INFLUENCING EQUIPMENT PRODUCTIVITY

3.1 Introduction

Cargo handling equipment is an integral part of port operation. Port performance / productivity can not reach its desired goal without equipment performance. This performance solely depends upon management, more specifically on management of equipment, maintenance and operation systems. The system is handicapped most frequently by internal and external forces. Internal forces are active within the system and inside the port, external forces influence the system from outside the port.

CPA has about 8000 permanent employees of its own placed in 15 departments, besides, the nearly 20 thousand people under different categories of port users including 10 thousand daily rated registered dock labours, are directly or indirectly involved with the port in various ways. The mechanical branch, responsible for maintenance of the equipment, has to maintain good relations among other departments in order to continue uninterrupted port operations. CPA lies in the heart of Chittagong, the second largest city of Bangladesh with 3.5 million people. Near the port lies the country's largest Export Processing Zone (EPZ). As a result, any disturbance in the city or surrounding industrial zone influences port operations. Also the PEST factors influence considerably. This chapter attempts to identify and analyze such factors including the inherent problems of equipment maintenance and the operations.

3.2 Port and Equipment Management

Port and equipment management are closely related to each other. Both play a vital role in port cargo handling equipment productivity. The main objective of the port in regards to cargo handling equipment is to give cost-effective services to the port users through performance of international standards. For this reason, port management has great responsibility to ensure the acquisition of equipment in time and to maintain it properly in order to cope with the operational demand.

Equipment inventory and traffic forecasting, the two main aspects of port operations are planned by the planning department of CPA with the assistance of equipment and operation management. Nowadays, a good amount of port investment is needed for the acquisition of modern cargo handling equipment to suit the growing technological developments in port and shipping. After acquisition, continuous and effective maintenance demands a huge investment and high quality management. If the equipment management responsible for the maintenance of equipment fails to maintain the equipment effectively, the following effects could occur:

- Low equipment availability
- Additional investment
- Additional maintenance and operating costs
- Low equipment productivity/ performance
- Lower competitiveness of the port
- Impact on country's economy

In fact, CPA has been suffering from problems on account of these factors for a long time. One can not guess from the outside that the port is facing problems because it has good financial reserves, growing traffic and a lot of activities compared to other organizations. But port performance indicators (Table 2.11**)** stipulate that no parameter is the sign of actual progress in the case of CPA. First of all, the internal problems that exist in equipment maintenance and operation which directly influence the equipment performance, need attention.

3.3 Factors directly affecting maintenance and operation

The main factors are grouped under the following headings:

- Poor equipment inventory and too much old equipment
- No standard system of maintenance
- Non-availability of spare parts
- Poor supervision and control of maintenance work
- Poor leadership
- Lack of control and supervision of operators
- Bad driving practices
- Lack of skilled manpower
- Poor incentives and motivation schemes
- Shortage of technicians and operators
- Poor working environment
- Employee participation

Analysis of the Factors

- **Poor equipment inventory and too much old equipment**

The state of cargo handling equipment (Tables 2.2 & 2.3) indicates the management's inability to maintain a proper equipment inventory. This is the job of port management to ensure an adequate equipment inventory for smooth cargo handling operations at all times. But in recent years, management has failed to do this due to various reasons and constraints such as the inability to obtain timely government approval, government interference, cumbersome bureaucratic procedures, failure to forecast the future traffic etc. As a result, port has been facing congestion frequently. How equipment shortage affect a port has been shown in Table 3.1 This table illustrates only 15 straddle carriers in a terminal produced chaos whereas 20 straddle carriers can serve the function smoothly with no congestion.

Table 3.1 Effect of equipment inventory

Number of straddle carriers	15	20	25	30
Lorries through the model	18018	23984	23981	23983
Mean cycle time in minutes	544.34	16.42	16.39	16.32
In - Gate queue length	1047	4	4	4

Source: S. Bonsell – Unpublished Ph. D Thesis, quoted from An analysis of change concerning ports and shipping, unpublished lecture handout, P. M. Alderton, 2000

Equipment inventory costs a great deal of investment but it is the key component of cargo handling. as well. According to UNCTAD, it is observed that average one-third of the port capital budget in developing countries is spent on cargo handling equipment alone (Thomas & Roach, 1990, p. 16).

The other consequences of insufficient inventory are frequent breakdowns and increased operating cost of old equipment, equipment unavailability, insufficient funding and space for maintaining too much old equipment, technicians' unwillingness to attend breakdown jobs frequently and so on. The tables 2.2 &2.3 also indicate that the equipment proposed for scrapping is not disposed of for a long time. Similarly, much of the equipment has passed its economic life, and continues to run with increased operating costs and risks. Table 3.2 shows that the lowest average annual total cost of the forklift occurs after 7 years of operations – the cost falls from year 1 to 7 and begins to rise. Beyond year 7, the actual annual operating cost exceeds the average annual total cost; and the most economic solution would be to replace the equipment at year 7.

Table 3.2 Economic life of a 3 tonne forklift truck

YEAR	CAPITAL COST →	ANNUAL OPERATING COST ►►	DISCOUNT FACTOR 10%	PRESENT VALUE ANNUAL TOTAL COST	ACCUMULATED PRESENT VALUE TOTAL COST	CAPITAL RECOVERY FACTOR	EQUIVALENT AV. ANNUAL TOTAL COST
1	45,000	11,000	1.000	56,000	56,000	1.000	56,000
2	-	12,000	0.909	10,908	66,908	0.524	35,060
3	-	13,000	0.826	10,738	77,646	0.366	28,418
4	-	15,000	0.751	11,265	88,911	0.287	25,517
5	-	17,000	0.683	11,611	100,522	0.240	24,125
6	-	19,000	0.621	11,799	112,321	0.209	23,475
7	-	22,000	0.565	12,430	124,751	0.187	**23,328**
8	-	25,000	0.513	12,825	137,576	0.170	23,388
9	-	29,000	0.467	13,543	151,119	0.158	23,877
10	-	33,000	0.424	13,992	165,111	0.148	24,436

Source: Lecture hand out, Gary Crook,2000 on equipment maintenance and management,

Note: → Including all attachments and years supply of spare parts

►► Based on 3000 hours of use per anum

- **No standard system of maintenance**

Good maintenance work needs a standard system to perform the maintenance jobs systemically. A standard system requires work orders, equipment service/maintenance schedule, reporting of equipment breakdowns, handling of equipment breakdowns and certification of the equipment. To perform these activities a proper maintenance plan on the short, medium and long-term basis is required. In CPA, the maintenance plan is not properly followed at all times. The main reasons are lack of strong management commitment, lack of proper guidance and training of the employees, insufficient tools and facilities. Without proper guidance and training, an employee does not understand the benefits of the system. Supervisors are not serious enough to implement the standard system. Proper hand tools and permanent repair facilities are not sufficient in all CPA workshops.

For example, if a technician is assigned an important technical job without special tools, he may directly refuse to do the job. Or he may somehow complete the work, just to satisfy the management, but the job will last for a short period and may cause danger to other parts or even an accident. All of the factors delay the maintenance work and affect maintenance quality. Major and strategic parts such as lifting chain, mast etc. need a periodical inspection in order to avoid major accidents. As shown

in Appendix 7**,** these major parts should be checked and inspected yearly not only to avoid accidents but also to save costs and time.

- **Non-availability of Spare parts**

The problems concerning spare parts have been identified as are delays in procurement process, drawbacks in storage, and issuing the spares. Most of the manufacturers of CPA cargo handling equipment are in Europe and Japan. There are local agents of equipment manufacturers in Bangladesh but they do not store the necessary spares in Bangladesh. The bureaucratic procurement process in the port itself consumes 50% of the total procurement time. On the other hand, it is not possible to procure all of the spares at a time because of insufficient storage facilities, and administrative constraints in the form of management approval. Sometimes, it has been noticed that critical equipment, like a straddle carrier or heavy forklift truck, becomes inoperable for over a month for want of a single spare parts. Even an emergency procurement order for some spare parts takes a minimum of 30 days to airfreight. This kind of emergency procurement is more costly and often discouraged by the finance department, even though it is profitable to CPA on account of revenue earnings and customer satisfaction.

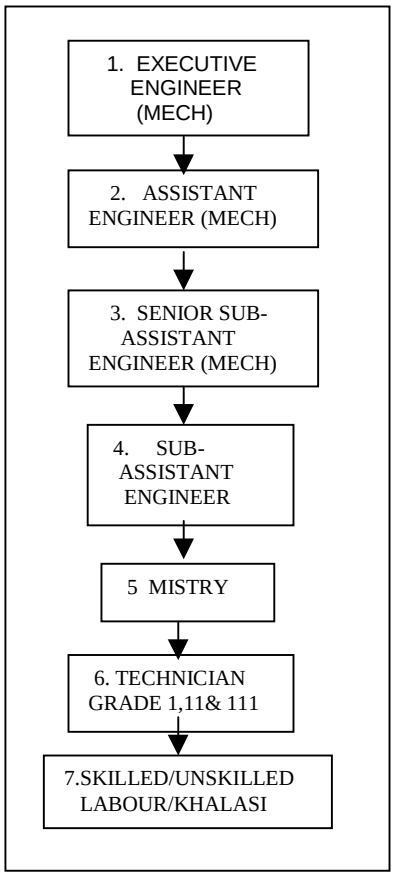
The internal store keeping system, issuing spare parts and personnel engaged in stores are not efficient enough to serve the technicians promptly. To maintain records of the inventory and prepare requisitions of spares over a wide range of equipment good and updated record keeping is necessary. Due to lack of computer skills, the spare parts inventory is not maintained properly by the store personnel. So, a long time is needed to find out the proper spares by investigating registers and the physical location.

Non-availability of spare parts due to delays in the procurement system adversely affects equipment maintenance and hampers cargo handling operations seriously from time to time.

- **Poor supervision and control of maintenance work**

This is the most important factor that retards the maintenance work and increases the chance of mistakes considerably. If supervisory staff do not monitor and control the activities and do not give guidance to the workers, sometimes major mistakes are committed leading to breakdowns and non-availability of equipment. In the workshop maintenance organizational structure (Figure 3.1) it is found that there are excessive supervisory levels (serial 3 to 5) between the engineers (serial 1&2) responsible for overall management and supervision and the technicians (serial 6) who actually do the work

Figure 3.1 Maintenance work organization in CPA workshops



Source: Author

.As a result, the technician has to follow the orders of his immediate supervisor, but this supervisor does not want to take all the responsibility of maintenance jobs because there are three more supervisors on top of him. This shared responsibility of supervision does not only result in poor maintenance but also leads to a lack of flexibility and control over technicians.

- **Poor leadership**

Poor management leadership influences maintenance activities. Many managers have little control over their staff; their commands are not honoured by the employees in most cases. This problem is enlarged when disciplinary actions are not handled properly because of deficiency in leadership qualities. Moreover, some managers have a tendency of low-task/low-relationship (delegating) leadership rather than low-task/high–relationship (participating) which increases the gap between managers and employees (Ircha, 2000). Management and supervisory personnel have fewer tendencies to inspect the assigned job of the employees i.e. keeping in touch by spending time with as many as possible; known as MBWA (Management By Wandering Around). The consequence is the increased communication gap which reduces performance substantially.

- **Lack of control and supervision of operators**

This is the job of traffic/operation department but often it is neglected by them. They blame that the operators do not carry out the orders of the traffic personnel. Sometimes, this happens when traffic personnel booked for supervision or organizing the work are in a lower grade and junior in service to the operator. The reporting against drivers is often delayed, even up to one month from the occurrence. The main blame against operators include not reporting at the working point in time, rough/bad cargo handling, misbehaving with the traffic personnel, illegal operations etc. In fact, there is a good communication system between engineers and operation managers over the telephone and mobile wireless sets, but these facilities are not utilized properly to solve such disciplinary problems immediately.

- **Bad driving practices**

This is a common phenomenon in equipment operation at the port. Most of the operators do not follow the proper driving practices because of lack of knowledge, training and a careless attitude. This practice includes handling overload containers, driving too fast, violent acceleration and breaking, running over obstructions, collision with other vehicles and structures and incorrect operating techniques. On behalf of the British Ports Association, Production Engineering Research Association (PERA) a report on ''condition monitoring and reliability of mobile plants in British ports'' identified 36 deadly sins, caused, mainly by operator abuse (PDI, Dec./85-Jan./86). Similarly, most of the breakdowns in CPA are due to operator abuse as mentioned above. Maintenance staff has to spend daily on average, 50% of their total time to repair equipment breakdowns due to this carelessness on the part of the operators. Equipment management is not strong enough to tackle the situation due to interference of the trade unions

.

- **Lack of skilled manpower**

It is observed that lack of training is affecting all corners of equipment maintenance and operation. . All technicians and operators need continuous training to maintain and improve equipment performance. Supervisory staff badly needs training for the application of new systems, supervision and control over staff activities. Management personnel also have deficiencies in managing the overall maintenance and operational activities. Training is the most influential factor to develop skill in every aspect of maintenance and operation in CPA. For example, in computer maintenance companies in the UK, each employee receives an average 7.5 weeks of training every year (Thomas & Roach, 1990, p. 152).

- **Poor incentives and motivation schemes**

In Bangladesh, the basic salaries of the employees are poor compared to neighbouring country India and other regional countries. In CPA, even the highly skilled employees are not paid a good salary nor given sufficient incentives.

There are no future prospects in jobs such as timely promotions or extra increments on salary. A skilled technician or operator only earns per month 125 to 150 USD

including all allowances. The existing incentive scheme provides two months of basic salary to all employees if the profit target is achieved. There is no incentive for excellent performance in maintenance or cargo/container handling. An unproductive employee gets the same benefit as an efficient one. So, the efficient and skilled employees are discouraged and find other opportunities to leave the present job or another part time job. Both activities reduce equipment performance.

Moreover, there is no provision for subsidized or free meals or snacks in the working place or canteen facilities. It is found that the staff leaving the office for lunch/dinner or snacks can not return in due time. Providing food facilities at the work place or some financial compensation in the form of cash money for meals, the persons or groups work with more speed than normal. Colombo port, for example, provides free lunch/dinner for all its employees (18000) which motivates the employees to a great extent to reduce the idle time and increase productivity (Karunadasa, 1997).

The motivation of people fluctuates in different countries. However, in CPA motivation is mostly influenced by the financial incentives as majority of the people do not fulfill their lowest level or most basic needs such as food, shelter, medicine etc. by the given salaries. The Maslow's need hierarchy theory focuses on these needs and postulates that people have five types of needs, activated in a specific order from the most basic, lowest level needs i.e. physiological needs to the highest level needs i.e. self-actualization needs (Francou, 2000b).

- **Shortage of technicians and operators**

Presently, the number of technicians and operators is not sufficient to maintain more than 300 hundred units of cargo handling equipment. The problem is mainly severe for the container handling equipment. It is difficult to maintain about 120 units of container handling equipment with 110 operators and 42 technicians. Most of the time, some running equipment is not deployed for operation for want of operators. After 8 hours duty, operators have to do overtime almost everyday. This causes an excessive load on operators and sometimes rate of absenteeism becomes very high.

The operator shortages could not be solved for a long time due to the cumbersome recruitment process. Similarly, for maintenance of an equipment at least one mechanic and one helper are needed. But, actually it is found that 25% of breakdowns and scheduled maintenance are not attended to due to the shortage of technicians. As a result, the volume of repair work increases and creates an excessive load on existing technicians. Manpower recruitment has been a burning problem in CPA for a long time.

- **Poor working environment**

There is inadequate covered space for performing maintenance jobs. Most of the workshop premises are slippery at all times due to hydraulic oil leakage from old equipment. Workers do not put on proper working dress and prefer to do the work in normal dress. First aid facilities are also lacking. A more serious threat to the environment concerns operational incidents during cargo handling resulting in the release of products. This may be due to the rupture of a connection hose or pipe line, the bursting of a valve or manifold. Sometimes, ship-unloading operations near the workshops pollute the working environment because of cargoes such as cement, food grains etc.

The other main cause of poor working environment is labour unrest. Five registered port labour unions, the biggest union of dock labours (which are separately managed by a dock labour board) and many other unions of the port users often agitate and hamper the sound environment of work.

There is a poor security system inside the port protected area which allows private transport, mainly private trucks, to create traffic jams almost everyday during the peak period between 11 to 18 hours. Most of the container yards in the GCB area are weak in strength which causes a frequent breakdown of equipment and reduces the speed of work. Very hot weather conditions and excessive rain sometimes make the environment unfriendly thus reducing work efficiency.

- **Employee participation**

Participation of employees to give complete suggestions about the current situation at the workshops is of great importance in the day-to-day performance of equipment. It has been found that when the problems are discussed with the employees and suggestions are invited, they feel happy and try to find the solution seriously. This is not only a moral obligation for management; it is also a motivational measure. As a result, the workers are committed to implement the decisions taken by the port conscientiously (Prokopendo, 1987, p.214).

3.4 Traffic forecasting

Traffic forecasting at the port is very significant in relation to forecasting the demand of services and cargo handling equipment, for example. Ports inevitably require a level of spare capacity to overcome traffic surges but perhaps more importantly, they need to plan future capacity sufficiently to cater for gradual traffic increase (PDI, May 2000). It is the preliminary step of the port system, especially in developing countries where decision making involves a complex process. To forecast demand for port services, there is a need to predict demand for imports and supply of exports of at least groups of commodities; these in turn, depend on domestic and foreign supply and demand. Furthermore, these demands should be based on local and regional basis. Demand forecasting is probably the task with the greatest uncertainty attached to it and therefore may require ranges (Jansson & Shneerson, 1982, p.151).

Influencing factors

There are many factors, which influence the traffic in different ways; some of them are as follows:

- World seaborne trade and world economy
- Local and regional trade and economy
- Technological developments in maritime field
- Past trends and future influential events
- Port control statistics

- Port financing in forecasting project.

The above factors influence the CPA traffic as well. In CPA, traffic forecasting up to 2010 was officially done during the preparation of the port master plan in 1995. After that regular review of the traffic has not been done. The present situation of total port traffic has been shown before (Table1). In the master plan, container traffic was estimated 228277 TEUs and 509170 TEUs in the years 1995-96 and 2005-2005 respectively.

Table 3.3 Projected container throughput in TEUs from previous study reports

Fiscal year	CPA master plan 1995, TEUs	Estimated growth	Port develo-ment project 1998, TEUs	Estimated Growth
1995-1996	228277	--	--	--
1996-1997	259051	13.5%	--	--
1997-1998	287252	10.9%	--	--
1998-1999	318063	10.7%	402000	--
1999-2000	351535	10.5%	458000	13.9%
2000-2001	378683	7.7%	514000	12.2%
2001-2002	407933	7.7%	577000	12.2%
2002-2003	439461	7.7%	640000	10.9%
2003-2004	472915	7.7%	700000	9.23%
2004-2005	509170	7.7%	765000	9.29%
Average growth		**9.3%**		**11.3%**

Source: CPA master plan, 1995 and port system development project, 1998

However, container throughput in 1998-99 was 3,65,762 TEUs indicating that the port will surpass the above forecasted container traffic before 2005. On the basis of growth of recent cargo throughput, the government and port reviewed the container traffic with the help of foreign consultants under the project '' Bangladesh port system development project: Master plan and trade facilitation study'' in 1998. In Table 3.3, the summaries of the two studies are shown.

Based on these two studies container traffic up to 2005 is again estimated by the author to have a 10% growth, and is shown below (Table 3.4). It is found that the traffic forecast is not constant. At different times, based on economic and political situation, in Bangladesh the traffic growth increases and decreases. Both imports to and export from the country over the years influence the port traffic enormously. The demand for container ports in the Indian sub-continent region is forecast to increase from 2.9 million TEUs in 1994 to 8.2 million TEUs in 2005 under an assumed optimistic economic environment (Shashikumar, 1998).

Table 3.4 Container throughput forecast upto 2005 based on previous growth and study reports

Fiscal year	CPA actual throughput in TEUs	Actual growth in TEUs	Projected year	Forecasting in TEUs by author upto 2005
1990-1991	101281	--	**1999-2000**	**402327**
1991-1992	121326	19.8%	2000-2001	**442559**
1992-1993	150487	23.4%	2001-2002	**486816**
1993-1994	174958	16.7%	2002-2003	**535498**
1994-1995	227172	30.9%	2003-2004	**589047**
1995-1996	250867	10.0%	**2004-2005**	**647952**
1996-1997	290330	15.7%	--	--
1997-1998	329163	13.4%	--	--
1998-1999	365752	11.1%	--	--
Average growth		**17.6%**		**10%**

Source: CPA overview, 1999 and author's estimate

In Table 3.5, it is seen that different components of key economic ratio of Bangladesh changed. Mainly Direct Foreign Investment (DFI) and domestic investment have increased considerably which gives an average annual GDP growth of 4.7 over the period 1988 to 1998. The recent devastating flood in1998 slowed down the GDP but a bumper growth in agriculture following the flood compensated to a great extent. Future annual GDP (1999-03) growth is estimated at 5.5 (Internet, World Bank page).

Simultaneously, a change in world economic growth and technical developments influence directly the World Sea born trade constantly over the years. Similarly, regional and local trade is influenced in the same way. How the World Sea born trade changed over 10 years and what will be the future forecast are shown in Appendix 8. The growth of trade is much higher than the world GDP. Appendix 9 shows that world exports during the period 1950 to 1997 have grown more than three times compared to the world GDP.

Table 3.5 Key economic ratios- Bangladesh

Average annual growth %	**1977-87**	**1988-98**	**1997**	**1998**	**1999-03**
GDP	5.0	4.7	5.4	5.0	5.5
Exports of goods and services	4.9	14.4	14.5	14.3	9.3
Import of goods and services	6.6	10.5	2.0	0.6	--
Gross domestic investment	4.4	6.0	10.0	11.2	--
GNP	5.2	4.8	5.5	5.9	--
Trade (US$ million)	1987	1997	1998		
Total exports (fob)	1074	4427	5172		
Total imports (cif)	2620	7120	7525		
Balance of payments (US$ million)					
Exports of goods and services	1301	5083	5879		
Import of goods and services	2876	7655	8049		
Resource balance	--1575	--2572	--2170		
Other important indicators (1998)					
Population	125.6				
Population growth	1.6				
GNP per capita	USD 350				
Illiteracy	61				

Source: Internet, World Bank page

3.5 Congestion in the port

There are several causes of congestion in the port. The ten major causes of congestion: management, labour, coordination, traffic operations, maintenance, clearance procedures and documentation, dynamic effects, function and location of the port as were summarized by BIMCO in 1976 through the UNCTAD working group are still valid (Alderton, 1995). These causes more or less exist in CPA which

result high berth occupancy and excessive dwell time of cargo, and are now seriously affecting the port as well as port equipment performance.

Port performance indicators (Table 2.11**)** indicate that port is facing high berth occupancy (more than 85%), in the recent years due to shortage of berths for container handling, equipment non availability, poor gang output and other poor port services. The direct impact of port congestion is excessive turnaround time, which produces ship owner higher costs in the calling port and the exporters-importers of the country fail to ship their cargoes in time according to the contract with foreign buyers and sellers. This results in a bad impact on the national economy.

Dwell time is the time that cargo spends in storage. The storage capacity of the shed and yard decreases with the increase of dwell time and vice versa. The present container holding capacity of CPA is about 9000 TEUs but occupancy under peak conditions is much higher. It means that the port now has over capacity that creates serious congestion for containers and other traffic. Infra-structural facilities with hinterlands of the country are not well established yet. About 80% of the containers terminate their journey at the port and cargo has to be loaded or off loaded to and from the containers and delivered/received in break-bulk form in the port area. This results in high dwell time and much re-handling of the containers in the port. Particularly empty containers, which constitute about 30% of the total boxes in storage in the port are a major problem for the port. The overall effects are as follows:

- Large yard space requirements for stuffing and destuffing of containers for cargo delivered/received from trucks within port protected area.
- Much re-handling of containers requiring more equipment service
- Frequent chaos and in-discipline in the container park area due to the movement of trucks, labour and smaller units cargo handling equipment.

The other main cause of high dwell time is the delay on account of custom documentation. Customs in the port require many formalities and much paper work to be completed for inspection of the different types of cargoes. Their time of working is limited i.e. does not conform to the port operations. Port operations go on

24 hours a day but customs work during one shift is from 9 to 17 hours. The dwell time of containers at the port as in July, 1998 is shown below (Table 3.6).

Table 3.6 Dwell time of containers in CPA

Container status	Average dwell time (days)
Import LCL containers	5
Import FCL containers	14
Import empty containers	15
Export LCL containers	4
Export FCL containers	4
Export empty containers	11

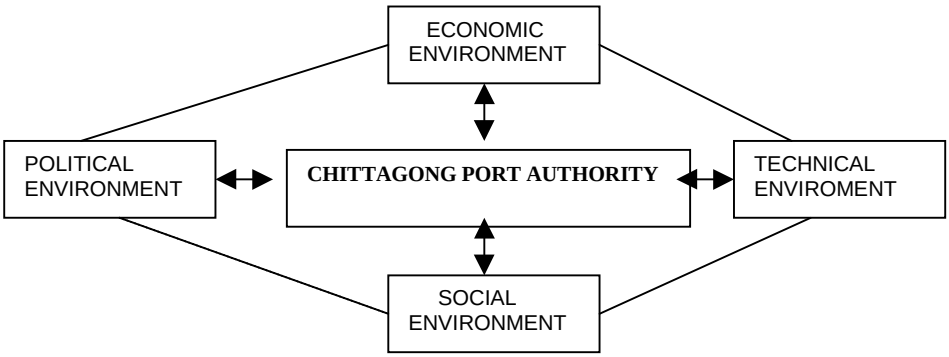
Source: CPA

3.6 PEST Analysis

Equipment management and maintenance decisions often depend on the PEST issues i.e. Political, Economic, Social and Technical factors. These forces or factors are acting on the port and its branches internally and externally. Many important decisions such as capital investment, staff recruitment, promotion, cargo handling equipment maintenance and operation are influenced by these forces. These forces are closely inter-linked to one another as shown in the figure 3.2. The capital investment project for the procurement of cargo handling equipment or procurement of foreign spares for equipment maintenance is influenced by these forces enormously. The political climate surrounding a port has a strong impact on the development strategy.

Political changes in the country bring changes in the port ministry, port administration and also on the social and economic condition of the country. Frankel argues that ports are world oriented and more affected by political factors, international trade and global economic condition than others (Ircha, 1999). Technological change in the field of Information Technology, for example, influences the port functions as well. On the other hand, any major changes in the port such as decrease in traffic causes direct, indirect and multiplier effect on the national economy

Figure 3.2 PEST Factors



Source: Lecture handout, David Mottram

All factors, including port internal deficiency in decision making process, cause abnormal delay in the case of project completion and purchasing of spares. All these affect equipment productivity in the form of increased budget due to currency fluctuation, inflation and interest rate.

Staff recruitment and selection is often delayed by political pressure on the port administration and frequent changes in government regulations. In addition, due to the port's internal bureaucratic process and organizational problems, this delay extends up to 6 months to 2 years. In consequence, dissatisfaction with jobs and the hopeless attitude of employees slows down equipment performance.

The PEST forces are inter-related. The political unrest in the country causes social unrest, slows down economic activities. Foreign investment and local investment in the country decrease which influences imports-exports of the country. The country's biggest industrial zone, Chittagong Export Processing Zone (CEPZ) is only 3 km from the port. This industrial zone consists of about 120 industries developed with investment from both foreign and local owners. There is a big impact from these industries on the port regarding the import of raw materials and the machinery and export of finished goods. As the port is located at the heart of Chittagong City, all

kinds of social, political and economic activities of the city influence the port in different ways.

3.7 Inter-departmental co-ordination and co-operation

CPA has 15 departments as shown in the organization chart (Appendix 3). Overall port performance depends on the close co-ordination and co-operation among the different departments. Trust along with co-ordination and co-operations are the key words in this respect. The functions of cargo handling equipment are mainly related with the traffic, accounts and finance and store departments. Other departments also influence directly or indirectly equipment functions.

- **Traffic/operation department**

The traffic department is mainly responsible for cargo handling operations in the port. The economic life of the equipment largely depends on the careful and efficient use of equipment during cargo handling operations. During operation, operators are instructed to perform duties under the supervision and control of the traffic staff/officers. But, in fact, the traffic department performs this job with less care and has blaming tendency towards the operators and equipment management. It is true that operator performance is not completely satisfactory, not only because of their faults but also because of lack of proper control and supervision of cargo handling operations. Therefore, equipment management has to maintain continuous coordination with traffic managers to solve problems quickly.

- **Accounts and Finance department**

The accounts and finance department is mainly responsible for formulating accounting and financial policies, preparation of budget etc. Any financial concurrence for maintenance work needs the approval of this department. Equipment maintenance requires continuous funds for maintaining the equipment. As mentioned before, procurement of both foreign and local spares consumes a great deal of time and money. Most of this time is spent at the accounts and finance department for financial concurrence. They often put up queries at the time of

concurrence, even for a trivial matter. For this reason, engineers have to engage in unnecessary paper work rather than thinking about the equipment and its performance. There is also a conflict of trust and this communication gap decreases the work efficiency.

- **Central Stores department**

The stores department is responsible for supplying all the goods and materials needed for various departments. It is not capable enough with the existing manpower and experience to provide different types of goods within a specific time. In this case a huge amount of time is lost in processing the file. Considering the importance of cargo handling equipment, a management decision has been taken to procure the foreign spares directly through the mechanical branch. In spite of this many other local procurements including fuel, lubricant and oil are done by the store department. When the stock is finished, the mechanical branch has to pursue and chase up every time for these stores.

- **Civil Engineering department**

The civil engineering department is mainly concerned with the construction and maintenance of container yards, container terminal and roads inside the port protected area and maintenance of permanent facilities such as workshop building, premises etc. In recent years, the condition of many yards has become so bad that equipment has faced continuous breakdown. Sometimes an awkward position has to be faced when there are repeated breakdowns due to tyre puncture and other parts failure. For this reason, continuous monitoring is needed to upkeep the roads and yards as far as possible to save the equipment from major breakdowns.

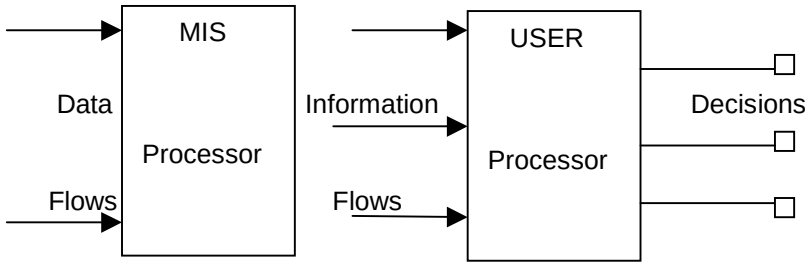
3.8 Port Management Information System (PMIS)

Today, is the age of Information Technology. An effective MIS using IT is crucial for CPA make quick decisions as well as give service to the port users. Port Management and other departments are using computers individually, which does

not serve the main objective of MIS. The main elements of MIS (Figure 3.3) are as follows:

- It is a system that consists of activities and data/records, available to all who need it when they need it, and in a convenient, easily managed and maintained form.
- It contains all the information, accurately recorded and updated, analyzed and presented in useable and easily comprehended form.
- It is a management tool in the decision making process.

Figure 3.3 Decision focus of MIS



Source: Management information systems, 1997, T. Lucey

The total activities of a port cargo handling operation could not be coordinated promptly without an effective information system, Equipment Management Information System (EMIS) and Operation Management Information System (OMIS), for example. A mechanic's hours of work on a particular repair need only be entered once in EMIS to be immediately available to the Personnel MIS (for calculating his wages and bonuses) and the Accounts MIS (for costing the job). Malta Freeport implemented a computer-based system within its engineering department, the Amos for Windows. This computerized system is enabling Malta Freeport to fully control and monitor any movement of stocks and effectively plan and schedule future work assignments, thereby achieving better time management (Annual review, 1998, Malta Freeport). The present drawbacks of equipment inventory and traffic forecasting are partly the consequence of an absence of PMIS/OMIS/EMIS. For example, to measure downtime of equipment needs % due to accidents, % of preventive maintenance, % of awaiting for spares, % of

breakdowns in use, total downtime hours and % downtime of total possible machine hours, which can not be effectively measured without EMIS.

3.9 Government interference

According to port ordinance 1976, the port has limited autonomy to perform all port functions smoothly. Moreover, this limited autonomy is hampered in different times due to government interference in the form of imposing new rules and orders. Various forms of government control are as follows:

*Investment control * The mechanism of investment control * Aid finance projects *Depreciation *Port charges *Foreign exchange *Procurement * Employment *

At present, the port is being affected by all of these control factors. For example, the two projects of CPA for the procurement of cargo handling equipment and related facilities took more than three years for government administrative and financial approval from different ministries and special committees. The consequence is that the estimated budget of these two projects will increase substantially due to inflation, currency fluctuation etc. The other form of influence from the government is political influence. The political party, which comes to power, uses the port for different purposes such as job recruitment, development works and demanding financial support etc.

3.10 Conclusion

Port competitiveness depends on quality of services. These services are continuously affected by various influential factors. In this chapter, efforts are made to highlight these factors that exist in different corners of the port relating to cargo handling equipment. There is now a crying need for the management of the port and equipment to take note of the real causes of poor equipment performance, to find solutions and recommendations which will be discussed in chapters five and six.

CHAPTER 4

COMPARISON WITH OTHER PORTS

4.1 Introduction

Today, port comparison is an important aspect in the competitive field of the port industry by which a port can evaluate its performance in order to improve its overall activities. It may turn out to be a very useful, even indispensable tool in medium and long term planning, making strategies, setting marketing objectives or management control and evaluating port organization (Ma, 2000). According to Ma (2000), there are seven objectives of port comparison: to sensitize people, to set objectives, to compete in the market, to improve management/efficiency, to evaluate performances, to undertake marketing and to make research. The needs to compare equipment performances also follow the same objectives. If port equipment, for example, a straddle carrier, has 85% availability in comparison with 70% of same type of equipment of another port, this indicates better performance.

Comparison is also crucial for competition between ports. Several factors affect competition: location that gives easy access to markets, to main sea-lanes or inland transport networks; quality, frequency and diversity of shipping service and inland transport connections. Above all, good productivity (i.e. vessel turnaround time) and adequate charges that highlight port competitiveness (Canamero, 2000).

The comparisons of ports with respect to equipment performance are not easy. This is mainly due to different types and models of equipment used by the different ports in different situations. There are a number of performance indicators that can be used for port comparisons: physical indicators, financial indicators, and operational

indicators. Comparison can only be successful if it is done 'like with like'. Above all, this chapter attempts to try compare local ports, some regional ports and European ports by SWOT analysis in order to find out the present position of CPA.

4.2 Local Ports

There are two national seaports in Bangladesh: Chittagong Port Authority (CPA) and Mongla Port Authority (MPA) which are state-owned and service organizations. CPA is located at a better position than MPA as compared on the basis of pilotage distance from sea, the Bay of Bengal. The working environment, working hours, labour costs, operating costs of equipment, tariff structure, labour and political unrest and government interference in different activities is identical in both ports. In spite of this, CPA performance is better than MPA. In the last 10 years, cargo throughput of MPA has been fluctuating around 3.5 million tons and 30,000 TEUs respectively (Port information, 1998-99) whereas throughput at CPA during the same time increased almost constantly to 14 million tonnes and 365,752 TEUs in 1999. There are some distinct reasons as to why CPA is showing better performance than MPA, which have been discussed later in the SWOT analysis.

4.3 Regional ports

As Chittagong Port Authority is located in South Asia, the comparison should be done with the ports of this region. For this work the nearest ports of neighboring country India: Calcutta, Mumbai, JNPT, and Chennai and Colombo port of Srilanka have been chosen. The location of these ports is shown in the map (Appendix 10). The other major port in this region, Karachi in Pakistan is far away from CPA. Competition for regional traffic is not a main factor with Karachi port but its growth in containerization is remarkable. All ports are growing as container ports and comparison will be mainly focused on container handling equipment and other related activities. Port comparisons by individual category are useful, dry dock facilities, for example. But sometimes it is necessary to combine different elements to compare the total costs. For example, if costs and transit time in two different

ports are opposite and vice versa, it is difficult to find out which port is more efficient. So, in this case performance can be measured on the basis of lowest cost result from the two costs, transit time and port costs.

From the data placed in Appendix 11**,** it is found that the main countries of South Asia, except Pakistan, have almost a steady GDP (World Bank report, 1999). The other economic indicators also show that overall trade is increasing in this region. This growing trend of the economy sensitizes the ports, increases port throughputs substantially. The following Table 4.1 compares the throughputs of the ports. Equipment performance influences directly the increased throughput of the port.

Table 4.1 Comparison of throughputs of regional ports (TEUs in 000's)

Ports	Fiscal years					Growth
	1994-95	1995-96	1996-97	1997-98	1998-99	
CPA, Bangladesh	**227**	**251**	**290**	**329**	**366**	**12.71%**
Calcutta, India	112	121	133	141	133	**4.33%**
Chennai, India	200	227	256	293	284	**9.44%**
Mumbai, India	487	518	583	601	509	**1.65%**
JNPT, India	244	339	423	504	669	**20.80%**
Karachi, Pakistan	513	550	555	505	527	**.52%**
Colombo, Srilanka	1029	1356	1688	1714	1704	**14.82%**

Note: TEUs in Calcutta port includes Haldia container terminal

Source: Compilation data from major ports of India profile, 1997-98, Internet and CPA overview, 1999.

From the table it is seen that there is a rising trend at all the ports. On average, growth rate in CPA is in the third position among regional ports. This is due to severe competition among Indian ports themselves and also with Colombo port. In fact, CPA faces no tough competition from any regional ports except Calcutta, as all regional ports are located at long distances from Chittagong port. Calcutta and CPA are located almost equal distances from the East-West main shipping route. At present, there is good land communication with Calcutta port. If Chittagong port fails to give better services to the customers, there is every possibility that the port users could use the Calcutta port. However, presently, the neighboring land-locked country Nepal is increasingly using Chittagong port **(**Table 4.2) and some eastern

provinces of India are also showing interest in using Chittagong port in order to save costs due to distance and competitive tariff rates at CPA.

Table 4.2 Nepal transit through CPA

Fiscal Year	Tons
1996-97	27083
1997-98	27093
1998-99	310696

Source: CPA overview, 1999.

Port equipment performance plays a key role in obtaining port throughputs. The Indian ports and Colombo port have many more advantages over CPA in many respects. Following Table 4.3 stipulates the differences between other ports and CPA. Later on it will be discussed by SWOT analysis.

Table 4.3 Comparison of data with different regional ports

	CPA	Calcutta	Chennai	Mumbai	JNPT	Colombo
Quay gantry cranes	--	1	4	2	6	17
Rubber tyred gantrys	--	3	8	3	15	39
Rail mounted empty stackers	--	--	--	--	2	4
Straddle carriers	8	--	--	--	--	--
Toplift trucks/reach stackers	22	10	7	4	3	--
Tractors	44	20	40	--	38	120
Trailers	36	33	40		136	160
Other parameters						
Equipment availability(average)	50%	49%	87%	89%	NA	NA
Container stacking capacity,teus	8947	5252	6672	7013	21960	37500
No. of container terminals	1	2	1	1	1	2
No. of berths	2+2*	7+1*	3*	5+1*	3*	6*+2
Quay length in meter	750	846	600	1044	680	1569
Maximum draft in meter	9.12	8.3	12	9.14	13.5	14
Throughput/ship/day(boxes)	128	193	281	227	566	1046
Berth occupancy	86.79%	NA	83.12%	70%	NA	NA
Turn round time in days	4.12	4.54	3.9	3.52	2.53	NA
Mendays lost due to strike/stoppage	#5500	2899	974	365	NA	NA
Number of employees	8000	12723	9699	**32125	1778	18000

Notes: *These are dedicated container berths Calcutta port includes Haldia container terminal

Mandays lost are estimated **Total employees include dock workers, NA = data not available

Source: Compiled data from major ports of India profile, Containerization International yearbook 2000, & CPA overview, 1999 and Internet (World ports)

All the useful data is not available equally for all ports. So, some collected data for container handling are shown in Table 4.3 for comparison. All the ports have quay and yard cranes except CPA. On the other hand, CPA is only using straddle carrier (direct system) and forklift (relay system) for container handling. The straddle carrier direct system is considered useful in CPA for its flexibility. However, mainly, in the absence of quay cranes ship output is very poor. Man-days lost due to labour and political unrest is at a maximum in CPA compared to other ports.

Colombo port is a regional hub port and has all modern facilities for all types of vessels and cargoes within the port. Its strategic location in the Indian Ocean has made it one of the main transshipment ports in Asia. As a regional shipping centre, Chittagong and other regional ports have regular feeder services with Colombo. The other Indian ports, Mumbai, Chennai/Madras, and JNPT have also good facilities to compete with Colombo but with a more advantageous location and better facilities than the Indian ports, Colombo is still in the leading position. Chittagong port, serving as a feeder port can only serve 1st generation feeder vessels and still is not equipped with proper infra-structural and super-structural facilities to serve the ship and cargo. The regional ports capacity by ranges to 2005, estimated by Ocean Shipping Consultants Ltd. are shown in the following Table 4.4.

Table 4.4 Future Container port capacity in Indian subcontinent (000's TEUs)

Ports	**1998**	**1999**	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**
India	2450	2550	3080	3260	4170	4370	4870	5370
Pakistan	1150	1330	1430	1430	1430	1780	1780	2030
Srilanka	1900	1900	1900	2200	2200	2200	2650	4650
Bangladesh	**450**	**450**	**450**	**450**	**450**	**450**	**450**	**450**
Total	5950	6230	6860	7340	8250	8800	9750	12500
Percentage								
India	41.18	40.93	44.90	44.41	50.55	49.66	49.95	42.96
Pakistan	19.33	21.35	20.85	19.48	17.33	20.33	18.26	16.24
Srilanka	31.93	30.50	27.70	29.97	26.67	25.00	27.18	37.20
Bangladesh	**7.56**	**7.22**	**6.56**	**6.13**	**5.45**	**5.11**	**4.62**	**3.60**
Total	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00

Source: Ocean shipping consultants, 1999

4.4 European ports

Ports in developed countries are usually developed according to their national development plan, either in the public or private sector. These countries give more importance to the development of the ports than others. The developed ports such as Hamburg, Bremen, Amsterdam, Rotterdam, Antwerp, Ghent, Zeebruge, Dunkirk and Le Havre in the Hamburg-Le Havre range in northwest Europe are developing constantly with state-of-the-art facilities. This is only due to severe competition among them in order to attract regional and global traffic. The throughputs of these ports indicate the competition (Table 4.5). Another port, Malta, a Freeport of a highly growing developing country like Malta is now properly equipped with modern facilities and services and is competing with other Mediterranean ports efficiently. Malta Freeport may be a good example of a developing port like CPA. Since in the midst of developed ports and a competitive region, by virtue of strong determination & using modern facilities it has produced an outstanding performance with 1,071,669 TEUs in 1998, starting from 94,500 TEUs in 1990.

Table 4.5 Throughput in the Hamburg - Le Havre range (million tons)

Ports	Years				
	1994	1995	1996	1997	1998
Hamburg	68.3	72.1	71.1	76.7	75.8
Bremen	30.9	31.2	31.5	34	34.4
Amsterdan	48.1	50.3	54.7	56.5	55.8
Rotterdam	293.9	293.4	292.1	310.1	314.8
Antwerp	109.5	108.1	106.5	111.9	119.8
Ghent	23.8	21.6	21	23	23.6
Zeebrugge	32.9	30.6	28.5	32.4	33.3
Dunkirk	37.1	39.4	34.9	36.5	39.2
Le Havre	54.5	53.8	56.2	59.7	66.4

Source: Annual report, Port of Rotterdam, 1998

The main strength of European ports are their strong base and firm commitment to develop information system, continuous updating training systems and the CRM (Customer Relationship Management) based marketing system. Felixstowe port, for example, has established a useful computerized information system connecting customs and port users with the in-house data base system. This includes almost

all port activities, real time graphical management (RTM) system for monitoring cargo operations, management control and planning (CHARTS) system for container and ro-ro terminals (Port of Felixstowe, Journal 2000).

Bangladesh urgently needs to develop its ports for rapid economic development of the country. It has large and cheap labour resources of its 126 million people, which can be a strong force in the development activities of the ports. In the operation of a port or terminal, the main difference between developed countries and developing countries are the labour costs. In Europe, labour is highly expensive. So, the European Ports are developing with increased automation using minimum labour resources. The following Tables 4.6 & 4.7 illustrate by comparison of container handling equipment performance and operating costs of important categories of equipment between CPA and the European ports..

Table 4.6 Comparison of equipment performance (Europe and CPA)

EUROPE			
Type of equipment	**Throughputs box/yr**	**Handling rate moves/hr**	**Average moves/ machine/yr**
Straddle carrier	12000-14000	12/15	30000-42000
Forklift with toplift	6000-8000	7/10	18000-24000
Tractor-trailer	8000	7	16000
CPA			
Straddle carrier (35T)	10000-12000	10	25000-35000
Forklift with toplift (25-42T)	5000-8000	8	15000-22000
Tractor-trailer (50T)	6000-8000	4	8000-12000

Source: UNCTAD secretariat and CPA

It has been shown in Table 4.6 that performance of CPA equipment is much below than European ports. Table 4.7 shows that the labour costs are a decisive factor in calculating the operating costs (running costs + maintenance costs) of equipment. The percentage shown in the table with running and maintenance cost is the percentage of annual operating costs. The basic differences in different costs are due to labour costs, which is much higher in European ports.

Table 4.7 Annual operating cost (USD) comparison with European ports

EUROPEAN PORTS								
Equipment type	**Purchase costs**	**Running costs**		**Maintenance costs**			**Operating costs**	**Operating costs % of purchase costs**
		Fuel/power	**labour**	**spares**	**consumable**	**labour**		
Straddle carrier	500000	30000	150000	35000	3000	22000	240000	**48%**
		10%	65%	Total=60000 (25%)				
Forklift truck	400000	20000	150000	24000	2000	14000	210000	**53%**
		10%	70%	Total=40000(19%)				
Terminal tractor	75000	20000	90000	8000	2000	10000	130000	**173%**
		15%	70%	Total=20000(15%)				
CPA (BANGLADESH)								
Straddle carrier (35T)	680000	20000	4000	27000	2000	3000	56000	**8%**
		36%	7%	Total=32000(57%)				
Forklift truck (38T)	370000	16000	4000	20000	1400	3000	44400	**12%**
		36%	9%	Total=24400(55%)				
Terminal tractor (50T)	90000	4000	3000	4500	1000	2500	15000	**17%**
		27%	20%	Total=8000(53%)				

Source: Data compilation from ''Port equipment management and maintenance'',UNCTAD, 1989, and CPA

Maintenance costs and fuel costs are also comparatively lower in Bangladesh. Overhead costs and capital recovery costs are excluded in the above calculation. Finally, it is observed that the operating costs in percentage of purchasing costs of each machine in CPA are much less than those in European ports.

4.5 SWOT analysis

SWOT is the acronym, derived from the first letter of Strengths, Weaknesses, Opportunities and Threats. Strengths and Weaknesses are discovered internally i.e. under internal environment and Opportunities and Threats are surveyed externally i.e. under external environment. To develop an organization SWOT can be a useful tool. To think about and plan for the future of the organization, there must be an analysis of the internal and external environment. Areas in which organization holds superiority or lacks superiority over its competitors should be found out.

The strongest message from SWOT analysis is that, whatever course of action is decided, decision making should contain each of the following elements: building on Strengths, minimizing Weaknesses, seizing Opportunities and counteracting Threats (Internet, 2000,SWOT analysis).

4.5.1 Local Port (MPA)

Strengths

- Present CPA growth rate will encourage the employees to achieve a better performance in the future.
- It has better facilities in cargo handling such as several decentralized workshops with machinery and other facilities as described in chapter 2, and an independent training institute for the training of employees.
- It has considerable financial reserves to support the port development activities in need. For example, CPA presently is implementing two projects for the procurement of cargo handling equipment and construction of a new container terminal from its own resources amounting to US$ 200 million.
- It is located at a better position i.e. shorter distance from the common sea route.
- CPA has better hinterland links by road, rail and waterways, Capital City Dhaka and other distant places.
- CPA provides better basic and welfare facilities such as education, health and sports to its employees and their families.
- Information and communication system are more developed at CPA.

Weaknesses

- The large numbers of the port community often create hindrances in the work raising different issues.
- Labour problems are more severe in CPA.

Opportunities

- A new container river terminal is expected to be commissioned by the end of 2000 near the Capital City Dhaka. This terminal will be equipped with modern equipment and is expected to handle 116,000 containers annually (Bhuyan, 1998). CPA container movement through waterways will considerably increase.

- The country's biggest industrial area, Chittagong Export Processing Zone (CEPZ) is very near to the port.
- Many potential port users have permanent offices close to the port.

Threats

- The government has given permission to establish a container terminal to a foreign company, Stevedores Services of America at about 10 km distance from the port, which may create a negative influence on port performance in the future.
- Government is thinking to develop Mongla for strategic reasons including natural disasters (National development plan, 1995).
- CPA is situated at the heart of the city compared to MPA, which is far away from the city. So, any disturbance and unrest at the city influences port operations.

4.5.2 Regional Ports

Strengths

- CPA as the country's main port, handles more than 80% of exported and imported cargo, which is expected to continue in the future.
- It has recently adopted two big projects: to procure modern container handling equipment and to construct a dedicated container terminal of 1000 m quay length. Both projects are valued at US$ 200 million.
- CPA has a shorter pilotage distance compared to Calcutta.
- Labour costs are comparatively low in CPA.

Weaknesses

- Labour and political unrest destroys many working days compared to other regional ports.
- Equipment availability is poor compared to many regional ports.
- Frequent breakdown of the equipment and non-availability of spare parts causes severe pressure on maintenance performance and increases operating costs.

- Non-availability of shore-to-ship crane decreases the gang output and ship output as most of the feeder vessels calling at the port have old derricks and cranes.
- IT-based MIS and EDI system has yet to be developed.
- In CPA, training scope and facilities are not sufficient compared to Colombo, Chennai, Mumbai and Calcutta. There is a shortage of skilled maintenance and operational personnel.
- Absence of employee motivation scheme such as free or subsidized meals at the working point, compared to Colombo and other ports, increases the equipment idle time and drop in equipment performance.
- There are no motivational incentives on the basis of the daily and monthly performance of operators and dock labourers in CPA compared to many regional ports.

Opportunities

- As the country's present GDP growth (5%, 1998) is expected to continue in the near future due to increased foreign investment and subsequent development activities, there will be a positive impact on port performance.
- Surrounding the port there are many industries including CEPZ, which are constantly contributing to the port by generating a large share of the export-import trade. Another Export Processing Zone by a foreign investor in the close vicinity of the port is going into operation soon, which will further contribute to the port performance.

Threats

- The neighboring port Calcutta has some special facilities compared to CPA such as own modern dry dock, the most modern vessel traffic system, and good communication and information system.
- In the absence of quay cranes and other sufficient good cargo handling equipment, ship owners may reduce their port calls to the port or they may impose surcharges when there is congestion in the port.
- As compared to Calcutta port, which commands a vast hinterland that comprises almost half of Indian states (eastern and north-eastern region) and the two

neighboring countries - Nepal and Bhutan, CPA does not have such a cargo back-up.

- Stevedores Services of America (SSA) during 1999 experienced a significance global expansion with the addition of facilities in Bangladesh. A joint venture between FRS service companies and Orient Maritime Ltd. was formed to plan, develop and operate container terminal operations in Dhaka and Chittagong (Cargo Systems, September 1999). This could share the port traffic substantially.
- Political unrest in the country and government interference severely affects port performance compared to other regional ports.

4.6 Conclusion

Meaningful port comparison is difficult for want of similar data or statistics in different ports. However, using the SWOT Analysis, decision making may be easier and prompt by listing and ranking strengths and weaknesses and seeking how well they match the opportunities and threats. The better they match, the better are the chances of continuous success. The area of poor fit will identify development needs for the organization (Ward, 1999). Comparison contributes not only to identifying problems but also creates the opportunity to cooperate with ports of the same country and other countries. A country does not work in a closed environment and is open to the outside or even totally oriented towards the outside. Every country nowadays needs other countries for its development (Francou, 1999).

The CPA compared to other regional and European ports, is facing serious bottlenecks in maintaining a proper equipment inventory and operational performance to cope with the increased traffic and better services demanded by the port users. Other problems evolved from the analysis include lack of proper training scheme, good communication system and incentive measures.

CHAPTER 5

SOLUTIONS

5.1 Introduction

In the previous chapters, the present situation of the port explaining the problems that exist in equipment maintenance and operation, the influence of external and internal factors and the comparison with other ports through the SWOT Analysis.have been presented. Now in this chapter the following solutions are proposed to overcome the present problems in Chittagong port in order to improve performance in the future.

- Maintaining a proper equipment inventory
- Improving equipment maintenance and operational performance
- Giving more autonomy to the port

5.2 First Solution: Maintaining a proper equipment inventory

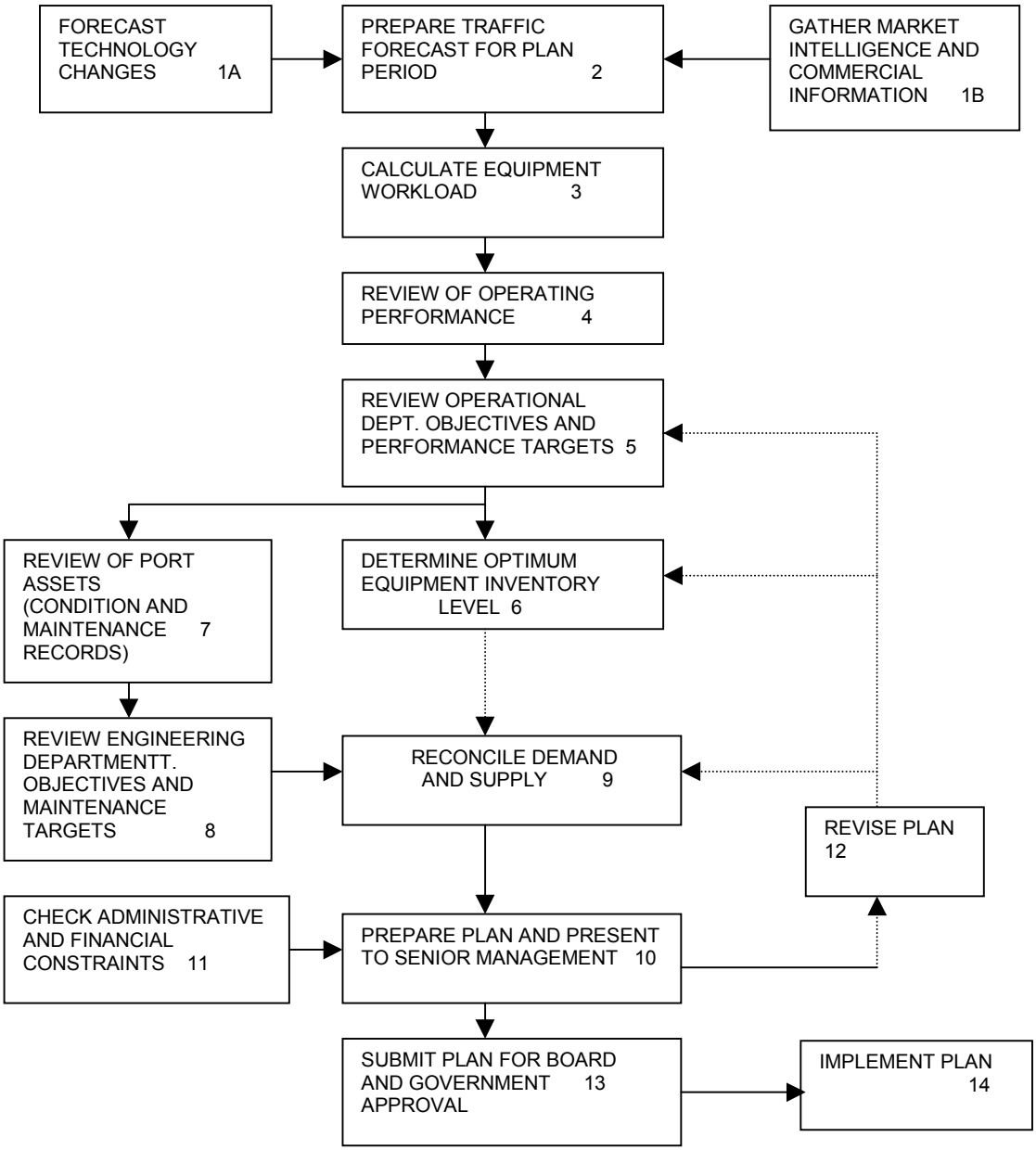
To maintain a proper inventory complete reshuffling in the equipment inventory system is essential. The equipment is not only the biggest single structure, but in practice it determines the operational procedure and performance of the terminal (Constantinides, 1990, p.5). To maintain proper inventory needs a proper equipment plan which is duly implemented.

The equipment plan and its implementation

The port management should establish procedures for preparing an equipment plan that ensures an appropriate inventory exists at all times to meet operational and

other requirements. A careful observation and study regarding investment decisions, planning procedures and the amount of huge data/information is necessary before preparation of an equipment plan. To obtain the approval of a competent authority, a well-prepared equipment plan is needed. Figure 5.1 shows a detailed equipment plan.

Figure 5.1 The equipment planning process



Source: Port Equipment Management and Maintenance, UNCTAD, 1989

The following guidelines should be followed during the preparation of the plan:

- Preparation of traffic forecasts
- Calculation of the equipment workload
- Setting performance targets
- Preparation of traffic forecasts
- Calculation of the equipment workload
- Setting performance targets
- Determining the optimum equipment inventory level
- Reviewing the port assets
- Setting engineering objectives and targets
- Reconciling demand and supply
- Financial and administrative constraints

The first step of planning as shown in Figure 5.1 is forecasting. A detailed forecasting procedure is shown in Appendix 12. After forecasting a series of studies should be done before implementation. Another main aspect of the plan is to determine the optimum inventory required. For this purpose, the total economic lifetime of each category of equipment should be calculated (as shown in Table 3.2).

Based on the present CPA record of economic life time of existing equipment (Tables 2.2& 2.3), the number of equipment to be scrapped and the number of equipment to be procured has been calculated (Tables 5.2 & 5.3) considering the existing inventory, present performance of equipment and other facilities, equipment and demand availability, future forecast and estimated future performance. The total number of container handling equipment to be required is calculated based on the present estimated total moves and annual moves per equipment with 25% downtime up to the year 2005 (Table 5.1). The total number of general cargo handling equipment to be required are calculated based on the percentage of cargo handled by each type which has been stated in the notes of Table 5.3. From Table 5.2 it is found that complete new equipment, ship to shore gantry cranes, rail mounted gantry crane, reach stackers with sophisticated technology are to be added to the CPA inventory by 2001 as mentioned before in Table 2.5.

Table 5.1 Moves calculation for required container handling equipment

Year	Import in TEUs				Export in TEUs				G. T.
	FCL	LCL	empty	total	FCL	LCL	empty	total	TEUs
1999-2000	160931	22128	18105	**201164**	24140	114663	62361	**201164**	402328
2000-2001	177024	24341	19915	**221280**	26554	126130	68597	**221280**	442560
2001-2002	194726	26774	21907	**243408**	29209	138743	75456	**243408**	486816
2002-2003	214199	29452	24097	**267749**	32130	152617	83002	**267749**	535498
2003-2004	235619	32398	26507	**294524**	35343	167878	91302	**294524**	589048
2004-2005	**259181**	**35637**	**29258**	**323976**	**38877**	**184666**	**100433**	**323976**	**647952**
Year	**Import in boxes**				**Export in boxes**				**G. T.**
	FCL	**LCL**	**Empty**	**Total**	**FCL**	**LCL**	**Empty**	**Total**	**boxes**
1999-2000	118332	16271	13313	**147915**	17750	84311	45854	**147915**	295829
2000-2001	130165	17898	14643	**162706**	19525	92743	50439	**162706**	325412
2001-2002	143181	19687	16108	**178976**	21477	102017	55482	**178976**	357953
2002-2003	157499	21656	17718	**196874**	23625	112218	61031	**196874**	393749
2003-2004	173249	23822	19490	**216562**	25988	123440	67134	**216562**	433124
2004-2005	190574	26204	21513	**238218**	28586	135784	73848	**238218**	476435

Total number of moves by container handling equipment in 1999-2000

SC=straddle carrier FLT=forklift truck RS=reach staker TR= tractor TT=tractor-trailer

RMG= rail mounted gantry crane FCL=Full container load LCL=Less container load MT= Empty container

Container in boxes	Average moves per cont.			Moves of each status	Total yearly moves		
	SC / FLT	RS / FLT	TR / TT		SC/FLT	RS / FLT	TR / TT
Import FCL	3.75	2	2	118332	443745	236664	236664
Import LCL	2.5	2	2	16271	40678	32542	32542
Import MT	--	1	1	13313	--	13313	13313
Export FCL	2.5		1	17750	44375	--	17750
Export LCL	4.5	4	3	84311	379400	337244	252933
Export MT	--	4	1	45854	--	183416	45854
Total moves of each category					908197	803179	599056

Number of equipment needed based on yearly moves

Type of equipment	Capacity	Total moves per year	Annual moves per equipment	Number of equipment required	Number with 25% downtime
Straddle carrier	35T	681148	32000	21	28
75% of total moves					
Forklift truck	25-42T	227049	21000	11	15
25% of total moves					
Reach stacker	25T	481907	30000	16	21
60% of total moves					
Forklift truck	12T	321272	30000	11	15
40% of total moves					
Tractor	25-50T	599056	8000	75	100
Trailer	(20'/40')	599056		75	#88
Quay gantry crane	40 T	--	70000	4	#4
Rail mounted gantry crane	40T	--	120000	1	#1

Note: #15% downtime for trailer, quay crane and RMG have been considered in future.

*Total moves are calculated based on present position and considering peak period.

* Total percentage of moves of SC and FLT will be 75:25 in the future.

*Total percentage of moves of RS and FLT for empty handling will be 60:40.

Table 5.2 Container handling equipment requirement up to year 2005

Equipment to be required by 2005							
Type	**capacity Ton**	**present inventory**	**2001**	**2002**	**2003**	**2004**	**2005**
Straddle carrier	35	8	28	28	35	35	40
Forklift truck	25-42	13	15	15	17	17	20
Reach staker	25		21	21	25	25	28
Forklift truck	12-16	9	14	14	17	17	20
Tractor	50	44	100	100	115	115	125
Trailer	20'-40'	36	88	88	100	100	115
Quay gantry crane	40	--	4	4	4	4	4
Rail mounted gantry crane	40	--	1	1	1	1	1
Equipment to be scrapped by 2005							
Straddle carrier	35	8	--	--	--	4	--
Forklift truck	25-42	13	2	--	2	--	--
Forklift truck	12-16	9	3	--	--	--	--
Tractor	50	44	5	--	10	--	10
Trailer	20'-40'	36	5	--	6	--	--
Equipment to be procured by 2005							
Straddle carrier	35	8	20	--	7	4	5
Forklift truck	25-42	13	4	--	4	--	3
Reach staker	25	--	21	--	4	--	3
Forklift truck	12-16	9	9	--	3	--	6
Tractor	50	44	61	--	25	--	10
Trailer	20'-40'	36	57	--	18	--	15
Quay gantry crane	40	--	4	--	--	--	--
Rail mounted gantry crane	40	--	1	--	--	--	--

Notes: * Present inventory has been shown by subtracting scrap proposed equipment in Table 2.2

* Based on total yearly moves, required equipment of each type has been calculated with 25% downtime.

* During moves calculation peaking factor has been considered for peak period.

* Mainly, equipment to be procured in the years 2001, 2003 and 2005 considering different factors.

* Quay crane, Rail mounted gantry crane and reach stacker will be newly added to CPA equipment inventory.

* Total moves of reach stacker, quay crane and RTG are estimated with existing circumstances.

*Since no berth will be constructed upto 2005, 4 quay cranes will be used for handling containers in CCT terminal.

* Rail mounted gantry crane will be used for ICD (Inland container depot.) container handling.

Table 5.3 General cargo handling equipment requirement upto year 2005

Equipment to be required upto 2005							
Type	**capacity Ton**	***Present Inventory**	**2001**	**2002**	**2003**	**2004**	**2005**
Mobile crane	20-30	5	8	8	8	10	10
Mobile crane	6-10	17	22	22	22	24	24
Mobile crane	50	--	2	2	2	2	2
Forklift truck	5	20	16	16	16	18	18
Forklift truck	3	46	38	38	38	42	42
Low mast forklift	2.5	16	25	28	30	30	35
Tractor	20-50	13	28	28	28	30	30
Trailer	6-50	39	46	46	46	50	50
Note: *= Present equipment inventory by subtracting proposed for scrapping equipment in table 2.3							
Type	**Proposed equipment for scrapping from 2001 to 2005**						
Mobile crane	20-30	5	5	--	--	--	--
Mobile crane	6-10	17	7	--	--	--	--
Mobile crane	50	--	0	--	--	--	--
Forklift truck	5	20	7	--	--	--	--
Forklift truck	3	46	23	--	7	--	--
Low mast forklift	2.5	16	8	--	8	--	--
Tractor	20-50	13	8	--	5	--	--
Trailer	6-50	39	20		19		
Equipment to be procured upto 2005							
Mobile crane	20-30	5	8	--	--	--	--
Mobile crane	6-10	17	12	--	--	--	--
Mobile crane	50	--	2	--	--	--	--
Forklift truck	5	20	3	--	--	--	--
Forklift truck	3	46	15	--	7	--	--
Low mast forklift	2.5	16	17	3	2	--	--
Tractor	20-50	13	23	--	5	--	--
Trailer	6-50	39	27	--	19	--	--

Note: * Number of general cargo handling equipment is calculated considering that out of the total cargo 62 % is handled by the equipment

* Formula: Number of equipment to be required = Cargo to be handled by equipment / No. of working days (350)* no. of shift(2)*capacity of equipment

*Out of ship delivery cargo and discharge cargo, 94% and 1.25 % are handled by crane respectively.

*Out of ship discharge cargo and delivery cargo, 98.75% and 6% are handled by forklifts respectively.

*Heavy tractor-trailer is calculated based on per shift booking to each vessel

*Light tractor-trailer is caculated based on per shift booking in each of general cargo sheds.

*Low-mast forklift truck is estimated based on number of container stuffed and destuffed by each forklift per shift.

*30% down time for all equipment and 15% for trailer has been estimated to find out the total no of each type of equipment.

*Proposed scrapped equipment will be disposed off mainly in the years 2001 and 2003

*New equipment will have to be procured by 2001 and 2003. It is estimated that due to slow growth, no equipment needs to be purchased between 2003 and 2005.

* Shore crane will not be required upto 2005 as its present availability is serving the purpose

* Mobile crane of 50 ton capacity will be added to inventory for handling heavy consignments and other port functions.

5.2.1 Advantages

- Increased port revenue by handling more traffic and more ships calling at the port which contribute to the national economy through generating more value added activities.
- Reduced operating costs of equipment by avoiding frequent breakdown, which ultimately decreases cargo handling cost.
- Reduced overall costs by saving time. This means turnaround time decreases and the potential ship owners will be encouraged more to use the port and ultimately, the freight rates will go down. Import costs will decrease and exporters will be able to compete in the international markets for exports, garments for example.
- Creation of direct and indirect jobs due to increased port productivity will also contribute to the national economy as an economic multiplier and solve unemployment problem as well.

5.2.2 Constraints

- Uncertainty and risk of capital tied-up in investment and increase in interest rate is a common aspect of any capital investment. If careful and efficient management control over all related activities can not be ensured, there will be little possibility to get the desired benefits.
- Scope of misuse of new equipment may happen if management supervision and control are not ensured.
- Cost of inventory maintenance may be a great burden and challenge to the management.

5.3 Second Solution: Improving performance of maintenance and operation

Increasing efficiency of a sea port is an important key to growth of more than 90% world trade and hence without improvement ports will be a fundamental obstacle to

growth (Rissik, 2000). Therefore, CPA needs to improve its equipment performance as it plays a key role in port operations. Following are the some main aspects for improvement:

(1) Ensuring the proper role of equipment and operation management
(2) Establishing comprehensive training and incentive scheme
(3) Establishing an IT-based information system
(4) Creating infra-structural facilities

(1) Ensuring the proper role of Equipment and Operation Management

Equipment and operation management must be well dedicated to improve the overall performance of equipment. The following three main objectives as mentioned in UNCTAD publication (Thomas & Roach, 1990, p.211) should be followed by the equipment management as a guidance to achieve the required performance:

- To provide efficient maintenance work by ensuring 85% availability of port cargo handling equipment.
- To upgrade the knowledge and specialized skill of workshop personnel through training and maintenance skills and the acquisition of modern cargo handling equipment time to time.
- To ensure cost-effectiveness in the maintenance of equipment.

Based on these objectives, equipment management should perform the following functions:

- A standard quality system should be established which ensures proper supervision, quality control and inspection, good working environment, job satisfaction, employee participation, good working practice and maintaining proper records in every workshop.
- Downtime of equipment could be reduced by introducing opportunity maintenance during non -working period. Moreover, instead of present one shift (general shift) two shifts at day and night may be considered in the future.
- A spare parts inventory should be maintained in order to perform effective and quick maintenance at all times. In this regard, care should be taken to

determine the minimum stock of strategic and non-strategic parts and to maintain up to date records of issued items.

- An equipment Management Information System (EMIS) should be established to monitor all information regarding maintenance and cost control and also record all maintenance and repair costs for each piece of equipment.

Operation management should perform the following functions:

- To ensure an effective planning and control of berth operations which is the key to improved cargo handling performance.
- To ensure specialized and integrated training of the dock labourers and other berth employees so that flexibility to transfer men or gang for one activity to another in response to operating conditions could be possible.
- To ensure frequent visits to the quays, sheds, yards and ships at berth by keeping a close lookout for problems and thinking up improved methods.
- To maintain close coordination with equipment management to solve the problems of equipment and operators quickly.

(2) Establishing comprehensive training and an incentive scheme

Training scheme

Training plays a vital role in any service organization like CPA. For example, the Port of Singapore's training programme has boosted productivity by 14% over ten years aiming at training as a source of productivity, reduction of operational costs, enhancement of the status of port workers and a source for future managers and skilled employees (Loon, 1993). Management commitment to personnel development is of paramount importance for the CPA.

In the light of the present situation as stated in chapter two, port management should adopt a comprehensive training scheme that includes the following aspects:

- Training needs assessment of the employees
- Development of course and course materials
- Training must be motivation oriented
- Training must be evaluated
- Adequate funds should be ensured.

- **Training Needs Assessment (TNA)**

This is an essential criterion before implementation of a training course. The CPA training institute with the assistance of equipment management should make a complete study to prepare the present and future needs of training of all categories of the mechanical branch including management personnel. Moreover, a job description of all employees should be prepared urgently so that every employee can clearly understand and perform his duties and responsibilities.

- **Development of courses and course materials**

Training courses and materials should be prepared on the basis of TNA and the growing development in the field of cargo handling techniques and equipment. The three courses, job related training, refresher and remedial training and common training courses should be developed covering technical aspects such as all types of maintenance and operational details and general aspects such as motivation, job satisfaction, disciplinary matters, working environment, safety and security etc. for all employees.

- **Training must be motivation oriented**

Motivation is a management technique by which management tries to increase productivity by using motivators such as pay, status, recognition etc. depending on situations. The promise of training is a source of good motivation, if the achievement of training can ensure better job prospects, recognition and promotion.

- **Training must be evaluated**

Evaluation must be done before and after training to determine * whether it is accomplishing its objectives * to identify the strengths and weaknesses of the course * to determine the cost-benefit ratio of the program * to get feedback from trainees and trainers.

- **Adequate funds should be assured**

Allocation of adequate fund is pre-condition for adopting and implementing a comprehensive continuous training scheme. The importance of training should be realized from the present global competition where every port is growing mainly based on the continuous training of the employees.

Incentive scheme

According to the present performance and study of the problems that exist in relation to cargo handling equipment, it is obvious that a comprehensive incentive scheme is urgently needed to motivate the employees. A scheme has been proposed for this purpose which includes the following:

- Free meal packet should be provided to all port employees during working period. Moreover, subsidized canteen facilities should be established in all workshops and other important places in the port.
- Incentives should be introduced for operators and dockworkers based on daily and monthly performance of cargo handling.
- Incentives in the form of promotion, recognition, increment in salary should be introduced based on maintenance and operational performance, accountability, obedience to official discipline and other important criteria as written in yearly evaluation sheet, maintained by CPA.
- Welfare facilities such as free education and scholarships for the children of employees should be introduced.

(3) Establishing an IT- based information system

The regional and European ports as described earlier are improving their system of work successfully by introducing IT-based information systems for internal and external communication. Every equipment planning, maintenance and operational activity depends, for its effectiveness and efficiency, on the availability of relevant, accurate and comprehensive information. Port and equipment management should establish a computerized MIS system for communicating and collecting quick information from their own and various departments. Later on, this system should be extended to establish more advanced information system for giving services to

the port users, customs and others. The proposed MIS system will ensure the following benefits:

- Equipment management will be able to achieve good maintenance and equipment planning, control of work, control of spares and consumables, measurement of operational performances of equipment, training and internal communications.
- This will ultimately reduce time, save money and make management react promptly in the decision making process.

Care must be taken by the equipment management to maintain the system with the help of reliable personnel and to ensure regular input of maintenance data. Otherwise, the system will ultimately collapse.

(4) Creation of infra-structural facilities

Equipment performance is directly or indirectly influenced by port infra-structural facilities as described in chapter 3. Among these facilities, berth and storage are important. On the other hand, customs documentation is another important factor which influences enormously on these facilities. Customs administration needs to be managed and organized effectively if they are to make positive contribution to their national prosperity and competitiveness as well as security of their respective people (Lozbenko, 1999). However, at this moment the port is not ready to construct these facilities, interim arrangements are stated below to solve these up to the year 2005.

Effective and planned use of existing container and general cargo berths

- At present, the yearly total of 1425 vessels, including 475 container vessels call at the port. But there are only two dedicated container berths in the CPA which are able to accommodate only two ocean-going vessels of each 180 meter length and one inland container vessel. So, two general cargo berths out of 13 have been dedicated for containers.
- The berths as stated above are not enough for handling present and projected throughputs as shown in the Table.5.4. The present capacity of berths at CCT and GCB are calculated using the formula:

Capacity at CCT= 2 (no. of cranes per berth)* 15 (TEUs/hr.)* 350 (days)* 16 (hrs/day)* 0.50 (max. occupancy)* 2 (no. of berths) = 168000 TEUs. Similarly, capacity at GCB is 123200 TEUs using the existing throughput 11 TEUs /hr. So, the total throughputs, 291200 TEUs are less than the actual throughputs of 365,762 TEUs.

- The above calculation shows that there is a severe congestion in container berths. Therefore, efforts are made to use 2 more general cargo berths, to install quay gantry cranes at CCT, and to improve the overall cargo handling performance in order to meet the requirement of container berths up to the year 2005.
- Based on the present and projected container and general cargo throughputs, capacity and number of berths are calculated for general cargoes and containers (Table 5.4).
- Actually, there should be no congestion in general cargo berths if the berths are effectively used. But practically, congestion also happens due to other related activities, proper monitoring and recording of arrival of vessels, for example.
- For general cargo handling, the total capacity of the 11 general cargo berths calculated is 1872640 tons, which is sufficient to handle the existing 1573947 tonnes and projected traffic.
- Due to future plans to use two general cargo berths for containers, the capacity of the rest of the general cargo berths should be increased by increasing gang output and other performances. Finally, it is seen that the number of general cargo berths is reduced to 9, which will be capable of handling the projected traffic.
- Using the berths as proposed would effectively reduce congestion at the berths and will help to reduce service time considerably and thus reduce overall congestion at the port. Ultimately, total turnaround time will fall substantially and port performance will increase.

Table 5.4 Berth requirement for containers and general cargo

(1) Berth requirements for container handling

Formula: Capacity= no.of crane per berth*throughput/hr*days/yr*hrs/day*maxm.occupancy* no. of berths

Year	Berth at GCB	Berth at CCT	Capacity			Projected throughput in TEUs	Growth	Remarks
			GCB in TEUs	CCT in TEUs	Total in TEUs			
1998-1999	2	2	123200	168000	291200	365762 (actual)		congestion
1999-2000	2	2	123200	168000	291200	402327	10%	congestion
2000-2001	3	2	262080	224000	486080	442559	10%	no congestion
2001-2002	3	2	262080	246400	508480	486816	10%	no congestion
2002-2003	3	2	294840	277200	572040	535498	10%	no congestion
2003-2004	3	2	294840	277200	572040	589047	10%	no congestion
2004-2005	4	2	432432	277200	709632	647952	10%	no congestion

(2) Berth requirements for general cargo handling

Formula:

Capacity=no. of gang/ship*gang output/hr*days/year*hrs/day*maxm. occupancy*no. of berths

Year	Number of berth	Actual cargo handled (ton)	Capacity of berths (ton)	Projected throughput (ton)	Growth	Remarks
1998-1999	11	1573947	1872640			no congestion
1999-2000	11		1872640	1621165	3%	no congestion
2000-2001	10		1724800	1669800	3%	no congestion
2001-2002	10		1724800	1719894	3%	no congestion
2002-2003	10		194040	1771491	3%	no congestion
2003-2004	10		194041	1824636	3%	no congestion
2004-2005	9		1905120	1879375	3%	no congestion

Number of berths	Maximum occupancy ratio
1	30%
2	50%
3	60%
4	66%
6-10	70%
11-13	80%

Notes for (1) and (2)

* Berth cpacity caculation based on TEUs/boxes for containers and ton for general cargoes
* The number of days in a year are 350 excluding closed holidays and unavoidable non-working days for strikes, labour unrest .
*The actual working hour per day is considered 16 excluding tidal loss for vessels/berthing/sailing,tea break,shift change
* Maximum occupancy is calculated based on figure given above
* New gantry crany will be installed in CCT by 2001/2002.
*Present throughput /crane/hour is 11 boxes/15 TEUs in CCT and 8 boxes/11 TEUs in GCB for containers.
*These throughputs should be increased to 20,22 and 24 TEUs in CCT and 11 to 13 TEUs in GCB.
* Present gang output of general cargo is 19 ton/hr, it should be increased to 22 ton/hr and 24ton/hr gradually.
* Due to improvement of operational and maintenance performance, introduction of training and incentive scheme and improving equipment inventory, capacity both in GCB and CCT will be increased.
* From 2001 to 2005, two general cargo berths will be used dedicatedly for container handling.
* Ultimately, 9 general cargo berths will be used for general cargo handling with increased gang productivity.
*Working hours for both general cargo and containers should have to be increased from 16 to 18 hours in 2003 to 2005.

Storage requirements for containers and general cargo

Based on existing storage facilities for containers and general cargo, a computer simulation has been done to find out the required storage capacity for the present and future traffic.

- The existing total storage area for general cargo inside and outside protected are nearly 400000 sq.m. To accommodate within existing storage capacity, the present dwell time of 20 days has been decreased to 12 days.
- Present storage areas for containers in CCT and GCB is 260443 sq.m. and container-holding capacity at both the areas is about 9000 TEUs (Table 2.4). It is found from the calculation (Table 5.5**)** based on existing dwell time for FCL, LCL and empty containers, 4, 4,11and 14,5,15 respectively for exports and imports (Table 3.5) and different factors, the total storage required are 337795 sq.m. This indicates that there is a significant shortage of container storage area
- This situation has been overcome by decreasing dwell time for all status of containers and increasing the stacking height of export and import empty containers. Then, required storage areas,197,881sq.m. have been found, which will serve the present and future requirement. If more storage area is needed, the existing CFS area may be used in case of emergency that might require extra movements.
- For CFS, the existing storage areas in GCB and CCT are 86168 and 12700 sq.m. respectively, which are sufficient enough to satisfy the present and future requirements.
- With the estimated growth rate of 10% and 3% for containers and general cargo respectively up to 2005, the requirement of the storage area will be fulfilled with the introduction of some steps.
- To reduce the dwelling time, mainly, the delays should be reduced in customs on the one hand and the port tariff policy should be reviewed on the other hand.
- Adopting a realistic free storage period and punitive tariffs for overdue cargo/containers should be considered during tariff revisions.
- Port administrative and custom procedures could be simplified using useful computer programmes efficiently and establishing a good communication system with customs.

Table 5.5 Storage area requirement for projected general cargo and containers

Year	Import in TEUs				Export in TEUs				G. T.
	FCL	LCL	Empty	Total	FCL	LCL	Empty	Total	in TEUs
1999-2000	160931	22128	18105	**201164**	24140	114663	62361	**201164**	402328
2000-2001	177024	24341	19915	**221280**	26554	126130	68597	**221280**	442560
2001-2002	194726	26774	21907	**243408**	29209	138743	75456	**243408**	486816
2002-2003	214199	29452	24097	**267749**	32130	152617	83002	**267749**	535498
2003-2004	235619	32398	26507	**294524**	35343	167878	91302	**294524**	589048
2004-2005	**259181**	**35637**	**29258**	**323976**	**38877**	**184666**	**100433**	**323976**	**647952**

(1)General cragoes

Storage area(S)in sq.m.=Throughput*stowage factor*dwelling time/365, peaking factor(pf)=1.4
operating reserve factor(of)=1.25, separation factor(sf)=1.2

Year	2000	2001	2002	2003	2004	2005
Throughput in ton	1621165	1669800	1719894	1771491	1824636	1879375
Stowage factor	3	3	3	3	3	3
Dwelling time in days	20	12	12	12	12	12
Storage area in sq.m.	266493	164693	169633	174722.4	179964	185363
S with peaking factor	373090	230570	237487	244611	251950	259508
S with operating factor	466363	288212	296858	305764	314937	324385
S with separation factor	559635	345854	356230	366917	377925	**389262**

(2)Containers ***Container Yard** peaking factor=1.3 separation factor=1.25

DCSR=Daily Container Slot Requirement TGS= Twenty feet Ground Slots Average area per TGS=45 sq.m.

Container status	Annual throughput (TEUs)	Average daily th. (TEUs)	Av.daily th. with pf (TEUs)	Dwell time (Days)	DCSR (TEUs)	DCSR with sf (TEUs)	Stacking height meter	TGS in (TEU)	Stacking area sq.m.
Exp. FCL	24140	66	86	4	344	430	3	143	6448
Exp.LCL	114663	314	408	4	1634	2042	3	681	30629
Exp.emp.	62361	171	222	11	2443	3054	3	1018	45810
Imp. FCL	160931	441	573	14	8025	10031	2	5015	225689
Imp.LCL	22128	61	79	5	394	493	2	246	11083
Imp.emp.	18105	50	64	15	967	1209	3	403	18136
Total	402328	1102	1433		13806	17258		7507	**337795**

Container status	Annual throughput (TEUs)	Average daily th. (TEUs)	Av.daily th. with pf (TEUs)	Dwell time (Days)	DCSR (TEUs)	DCSR with sf (TEUs)	Stacking height in meter	TGS in (TEUs)	Stacking area sq.m.
Exp. FCL	24140	66	86	3	258	322	3	107	4836
Exp.LCL	114663	314	408	3	1225	1531	3	510	22972
Exp.emp.	62361	171	222	10	2221	2776	5	555	24987
Imp. FCL	160931	441	573	8	4585	5732	2	2866	128965
Imp.LCL	22128	61	79	4	315	394	2	197	8866
Imp.emp.	18105	50	64	10	645	806	5	161	7254
Total	402328	1102	1433		9250	11562		4397	**197881**

***CFS**

Container status	Annual throughput (TEUs)	Average daily th. (TEUs)	AV. daily th. with pf (TEUs)	Dwell time (Days)	DCSR (TEUs)	DCSR with sf (TEUs)	stacking height in meter	TGS in (TEUs)	Stacking area sq.m.
Exp. LCL	114663	314	408	4	1634	2042	3	681	30629
Imp. LCL	22128	61	79	5	394	493	3	164	7389
Total	136791	375	487		2028	2535		845	**38018**

5.3.1 Advantages

- Improved equipment and operation performance will ensure overall port productivity by ensuring equipment availability, reducing overall turnaround time and thereby reducing ship waiting time costs, ship cost at berth, cargo handling costs, and reduce overall inland transport costs.
- The economic life of the equipment will be increased; major investment costs will be saved.
- Introduction of IT- based MIS will ensure maximum efficiency, effectiveness and responsiveness in the management system.
- Reduced port congestion will prevent imposing surcharges by the ship owners.
- Employees will be encouraged to contribute more for the organization as they are motivated by the improved systems.

5.3.2 Constraints

- If equipment operating costs are not controlled effectively, the costs will increase and impact on port operating surplus and thus create pressure to increase tariffs to compensate, which may be an economic blow for the port users.
- If the equipment misses its routine services, any minor problems may turn into major defects, causing breakdowns and excessive repairs.
- Care should be taken that poor maintenance of roads, quays and backup areas can severely reduce the life of the cargo handling equipment.
- Substandard operating performance and high demand for maintenance would cause increased cargo handling costs.

5.4 Third Solution: Giving more autonomy to the port

Chittagong port is a state-owned service organization that governs 80% of the country's export-import trade. Considering its importance, more autonomy should be given to the port to run it in a more unrestricted manner and free to adopt its own policy for any improvement in port cargo handling operations in the future. In recent years, there has been a clear trend everywhere to increase autonomy in the port sector due to increased competition. In view of this, it is obvious that CPA needs

more autonomy to keep its existing position and to increase more market share by competing with national ports and regional ports. However, different forms of government controls have been acting on the port. Considering this, the following steps should be taken to ensure more autonomy to the port.

- The port should be given greater autonomy and freedom to manage their own affairs, by relaxation of government controls on all aspects of equipment management, while still retaining some government control to protect the national interest.
- Government policy to appoint top management from other public sectors should be changed by appointing experienced personnel from the port and shipping sector who will better serve the port.
- The government should encourage and initiate measures for financing port capital investment through the international lending institutions and bilateral funding from foreign governments with a flexible regulatory role.
- Since the port itself earns foreign currency directly, it should have full autonomy to use this fund quickly in response to its development.
- The port should have full autonomy to review and determine its own tariffs without government intervention to achieve marketing and financial objectives.
- To select and recruit manpower for a new project, 'procurement of new equipment project' for example, the port should be given full autonomy to select and recruit the right manpower within the shortest time.
- Finally, the Port Ordinance Act, 1976 should be reviewed and government policy should be re-defined so that port can take steps to improve equipment performance.

5.4.1 Advantages

- Increased efficiency of the port by quick response to the requirements
- Greater contribution to the national economy will be by promoting the exports-imports of the country.
- Increased trade growth and foreign exchange earnings will contribute to the country's GDP and import capability.

5.4.2 Constraints

- Risk of misuse of port fund if it is not properly utilized.
- Strong management commitment is essential otherwise performance could ultimately slow down.

5.5 Conclusion

The given solutions could be useful if the port and equipment management as well as all the employees involved in equipment maintenance and operation are aware that the existing situation must be changed in order to achieve required equipment performance. Moreover, the present global trend of containerization will never be fully realized if an adequate stock of the right type of equipment is not provided. Furthermore, it should be borne in mind that the country's import will be more expensive and export will be uncompetitive if port cargo handling productivity is low and the resultant effects are a high unit cost and increased ship time at the port.

CHAPTER 6

CONCLUSION AND RECOMMENDATIONS

6.1 Conclusion

The main objective of this dissertation is to analyze the cargo handling equipment productivity of the port of Chittagong by identifying and analyzing the factors influencing its productivity.

The present position of the port is that its traffic is growing. But on the other hand, port services are not being developed and well maintained to keep pace with that growing trend. The growing trend towards containerization is remarkable. On the basis of this trend, future forecasting has been done.

The serious problems that the port is facing now are lack of facilities and services to cope with the growing traffic. The cargo handling equipment performance depends on the adequacy and reliability of machines, their maintenance, operational performance of the employees and other internal and external influencing factors.

The influencing factors identified are port internal labour unrest, political and economic condition of the country, regional and international trends of trade, interdepartmental coordination and co-operation, port storage and berth capacity, traffic forecasting, government interference and cumbersome documentation procedures.

The existing situation of equipment is not satisfactory at all. The equipment, which is aged and proposed for scrapping, is a burden on the equipment management as

they increase downtime and decrease the maintenance performance. On the other hand, employees are not motivated to dedicate themselves in order to improve the present situation. The main reasons behind this are insufficient salary, incentives and lack of effective training.

The factors stated above influence negatively the equipment performance. All these factors not only have drawbacks of their own, but they are also closely inter-linked to each other. For example, delay in custom procedures and documentation results in high level of dwell time. This dwell time creates congestion in the port yards calling for much shifting/re-handling of containers within the port. The outcome is an increased requirement of container handling equipment and container parking areas.

According to the trends and forecasts of container traffic (Table 3.3), CPA needs modern container handling equipment and quick related development in the field of human resources and other infra-structural facilities.

By using a SWOT Analysis, the weaknesses and threats of the port are identified compared with local, regional and developed ports. Solutions have been suggested mainly in three fields: maintaining a proper equipment inventory, improving performance of equipment maintenance and operation and giving more autonomy to the port.

Finally, it is evident that there is a great deal of interdependence between all port activities linked with cargo handling. Equipment is an important element of these activities. So, in order to achieve the best performance from the equipment, the spirit of common consciousness/joint effort should be developed which could lead the port to its desired goal.

6.2 Recommendations

As solutions have been proposed and described in the previous chapter. So, some specific measures for short, medium and long-term periods are recommended

based on these solutions. The duration for three terms will be one, two and five years respectively. In order to maintain close coordination short and medium terms should be applied together. Finally, a comment is presented for this work.

(1) Acquisition of new cargo handling equipment

Short and mid-term Measures

- Port management should take the immediate steps to dispose of the aged equipment (Tables 5.2 & 5.3).
- New cargo handling equipment should be procured in 2001. In this regard, the necessary government approval should be taken up immediately.
- Immediate action should be taken to select and recruit the required manpower
- The port should implement this investment from its own funds.

Long -term Measures

- To ensure the availability of the equipment up to 2005, another procurement action should be taken in 2003.
- Port management should initiate actions now in order to achieve government approval and arrange funding by government secured loans from multilateral lending institutions (World Bank, Asian Development Bank, etc.).

(2) Improving port equipment and operational performance

Short and medium-term Measures

- Port and equipment management should take actions in restructuring of maintenance work organization, improving the working environment, executing the maintenance plan and establishing standard procedures. Management should introduce two shifts maintenance system instead of existing one general shift in order to reduce the downtime of the equipment.
- Operation management should introduce an effective plan to harmonize and control and supervise all berth operations.
- Port management should urgently adopt a policy to introduce a computerized MIS system connecting all departments, with due importance given to the introduction of EMIS and OMIS in equipment and operation management

- A comprehensive needs based training scheme should be adopted for imparting training to all categories including supervisory and management personnel.
- The port should introduce an interim incentive scheme for the operators and dock workers based on daily/monthly cargo handling performance. In this regard, a fund should be arranged from the port's own resources.

Long-term Measures

- Port Management should prepare a plan and submit it to the government to increase the salary of port employees considering the present inflation rate (7%).
- A comprehensive permanent incentive scheme should be introduced covering financial benefits, free meals, welfare facilities, promotions, and job recognition to employees based on monthly and yearly performance of overall activities.
- The port should bear the expenses of all additional costs from its own fund.

(3) Reducing congestion at the port

Short-Medium term Measures

- Port management should increase the actual berth working time from 16 to 18 hours to handle growing traffic.
- Management supervision and control in all corners of the cargo handling operation must be ensured.
- Customs documentation and port internal administrative procedures should be simplified by introducing computer systems.
- The port security system should be redesigned in order to reduce traffic congestion at the gate and inside the port
- The port tariff policy should urgently review in order to reduce dwell time of cargo/containers.

Long -term Measures

- The port should take necessary steps to construct new terminal and berths for the future traffic.
- The government should come into dialogue with political parties to keep the port free from any political unrest, strikes and pass regulations in this context

considering the strategic and economic importance of ports to the nation and its economy.

-

(4) Giving more autonomy to the port

Short-Medium term Measures

- The government should give complete autonomy to CPA for replace and procure cargo handling equipment and to introduce an interim training and incentive scheme from its own funds in order to improve the present cargo handling operation in the port. For this purpose, the port should be allowed to retain sufficient foreign currencies.
- The government should influence the custom authority directly to solve the problems of delays due to customs documentation.
- The government should give full autonomy to the port to select and send its employees to participate in port related training courses abroad.

Long -term Measures

- The government should think about a commercialization and deregulation policy where port management is given autonomy and is accountable for its decisions and performance.

Final Comment

Cargo handling equipment and its productivity may be compared with human beings. Human beings after coming into existence need proper care, education/training and other fundamental needs for their continuous developments. Similarly, equipment after acquisition needs proper maintenance and operation fulfilling its requirements such as spare parts, skilled and motivated manpower, good environment etc. in order to achieve the best performance. So, the four main aspects, equipment inventory, standard system, training and incentives/motivation are highlighted in analyzing the equipment productivity.

However, there is a vast scope for detailed studies and analysis of different categories of cargo handling equipment and other related activities. This is an author's little step to indicate the direction for further study and research in this field.

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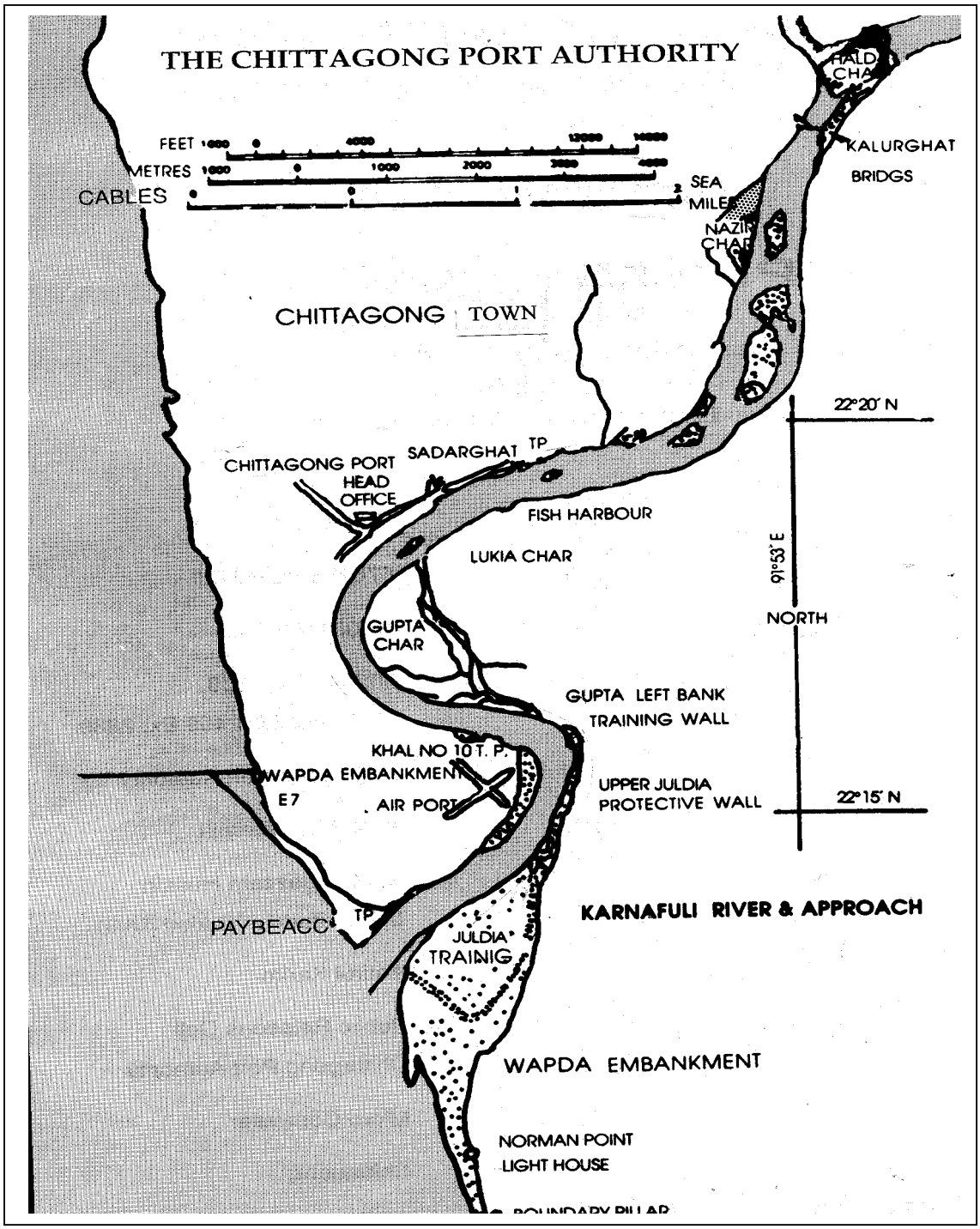
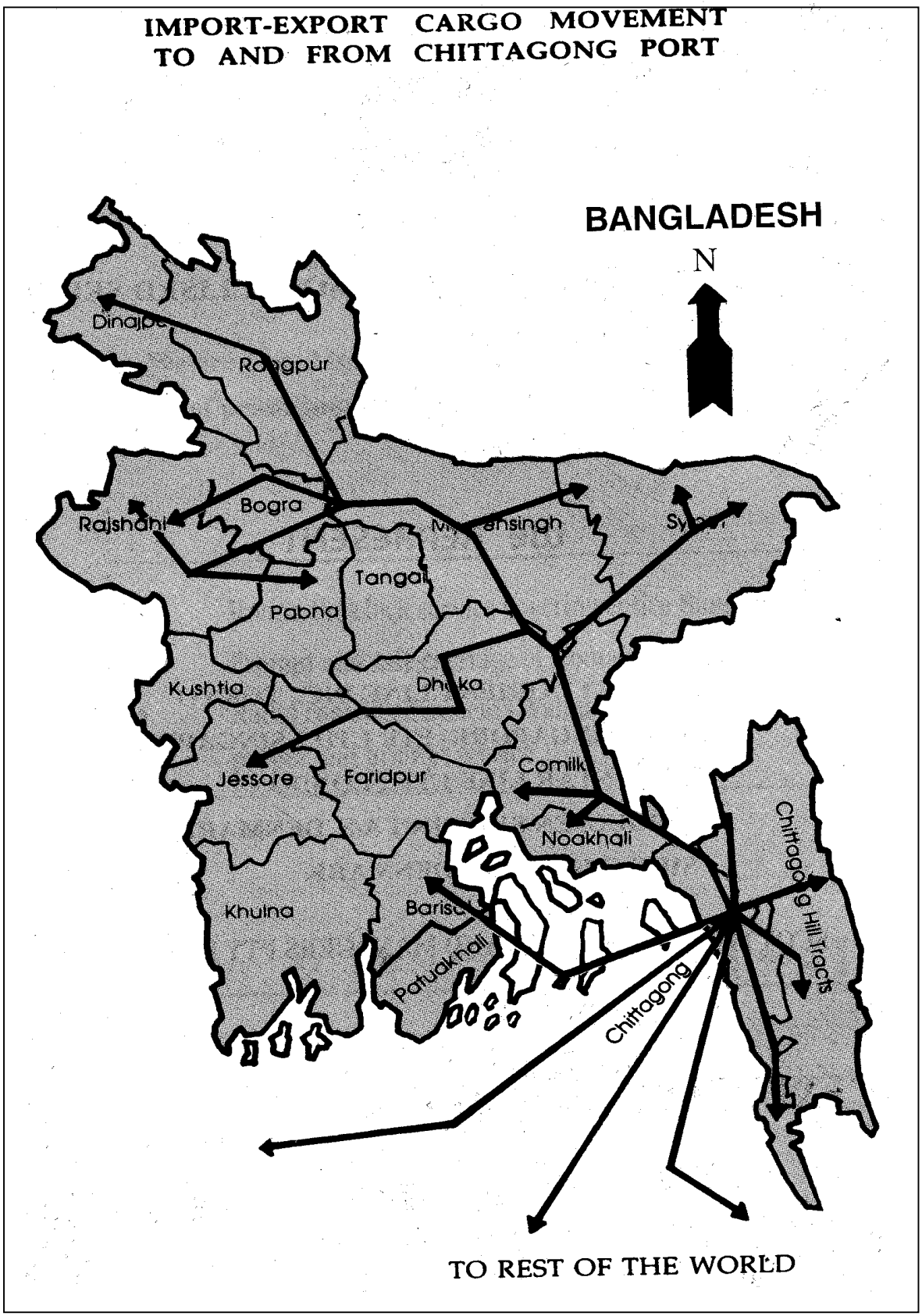
APPENDICES
Appendix 1

Map showing location of CPA



Source: Year book, 1996-98, CPA

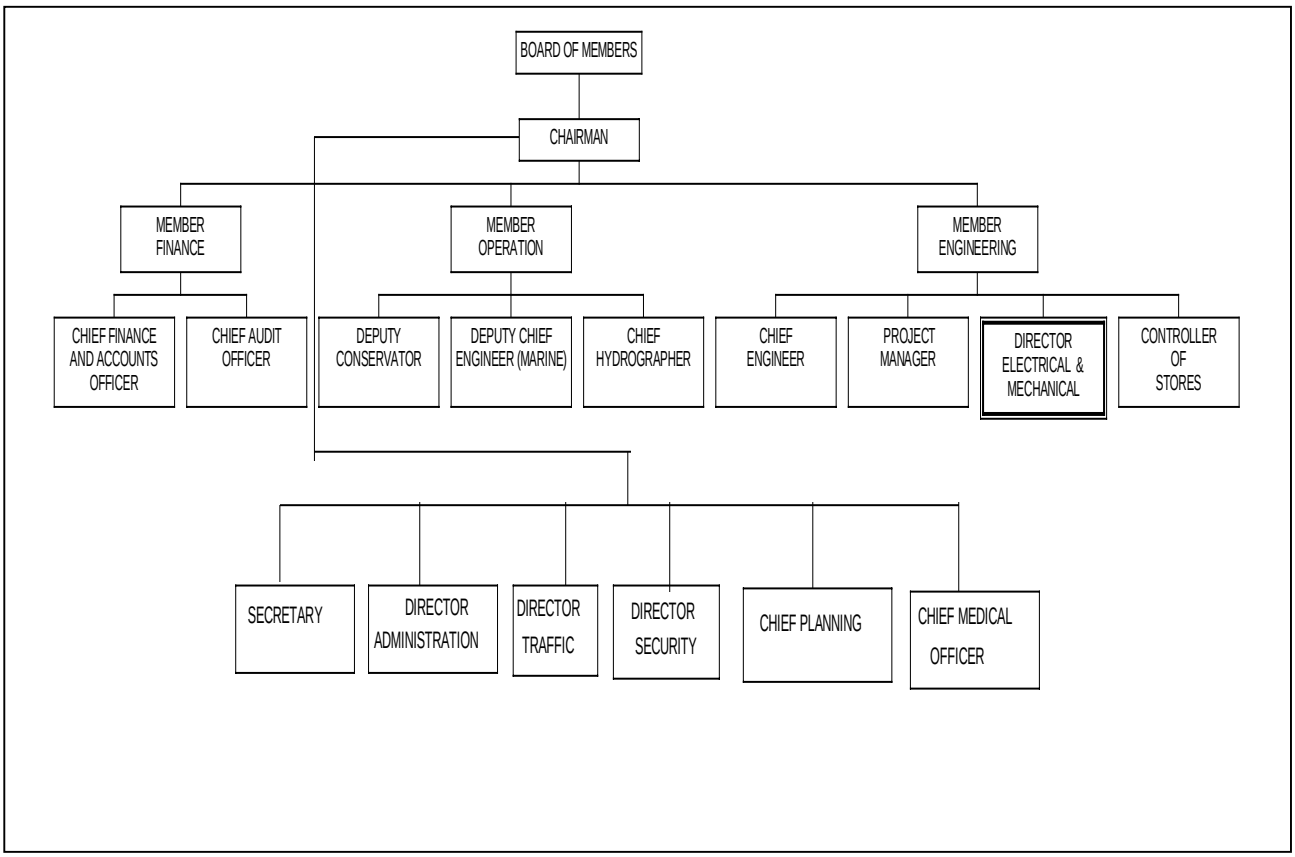
Appendix 2



Source: Year book, 1996-98, CPA

Appendix 3

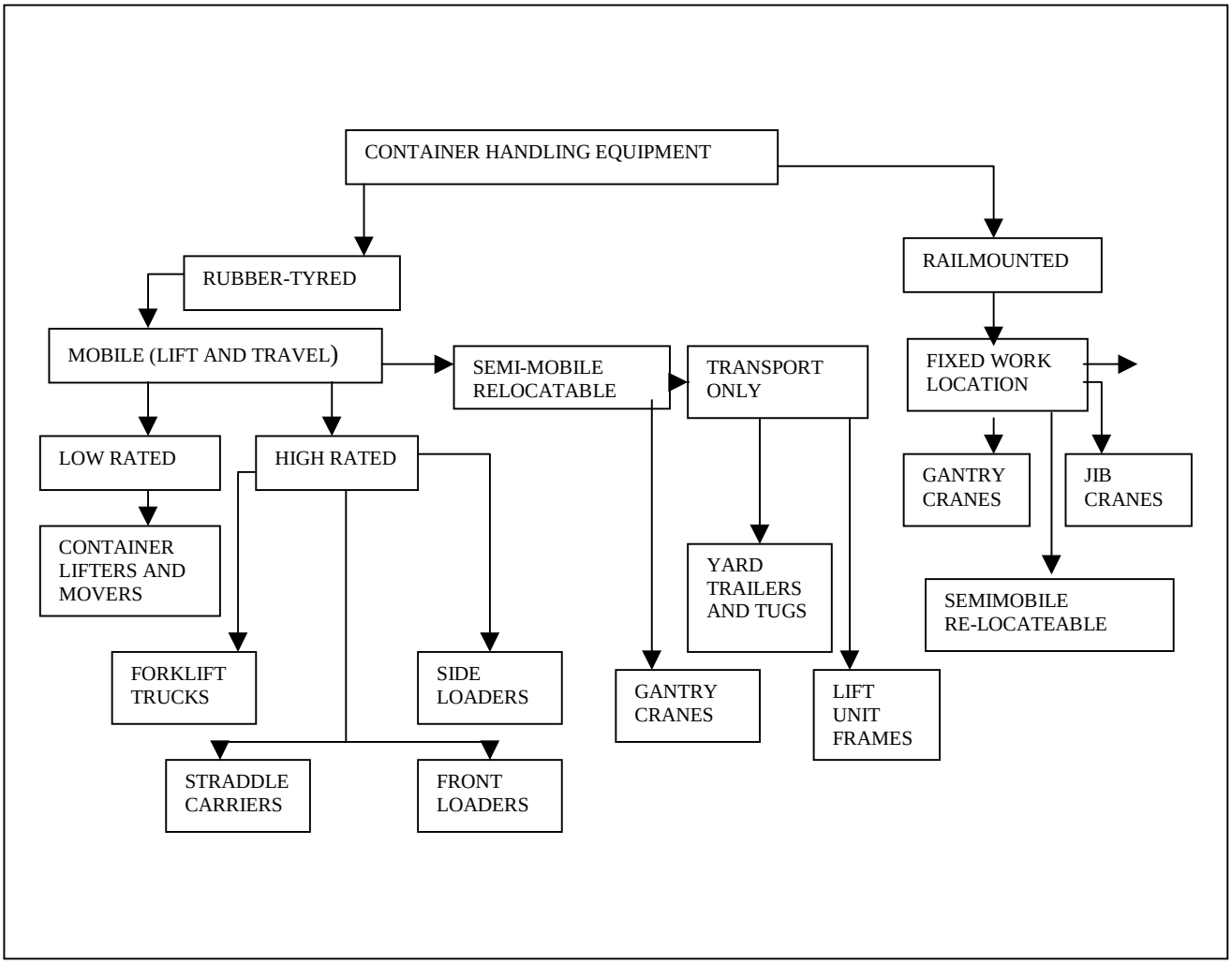
Organization chart of CPA



Source: CPA

Appendix 4

Container handling equipment categories



Source: Elements of port operations and Management, 1997, Alan E. Branch.

Appendix 5

Prices of different types of container handling equipment

QUAY CRANES	outreach	maximum	handling	erection	transport	cost
	meter	lift (ton)	rate	cost	cost	(US$ 000)
	25	40	18-24 box/hr	10%	3%	5000
	40	40	30-36 box/hr	10%	3%	6000
	45	50	60 box/hr	10%	3%	7000
MOBILE CRANES	outreach(m)	maximum	hoisting	erection	transport	cost
		lift (ton)	height	cost ($)	cost	(US$ 000)
	25-40	45-63	30	110000	3%	3000-4000
RUBBER TYRED	span (m)	maximum	lift height	erection	transport	cost
GANTRY CRANE		lift (ton)		cost	cost	(US$ 000)
	20-24	40	1 over 3	10%	3%	1500
	20-24	40	1 over 4	10%	3%	1700
	23-27	40	1 over 5	10%	3%	2500
	24	40	1 over 6	10%	3%	2000
RAIL MOUNTED	span (m)	maximum	lift height	erection	transport	cost
GANTRY CRANE		lift (ton)		cost	cost	(US$ 000)
	30-50	40	1 over 4	10%	3%	2000
	30=50	40	1 over5	10%	3%	3000
		maximum	lift height	erection	transport	cost
		lift (ton)		cost ($)	cost ($)	(US$ 000)
STRADDLE CARRIER		40	1 over 2	34000	23000	740
		40	1 0ver 3	34000	23000	840
		40	1 over 4	34000	23000	890
FRONT END LOADERS		9	1 over 4	--	10%	200
		9	1 over 5	--	10%	220
		16	1 over 3	--	10%	150
		25	1 over 2	--	10%	200
		36-40	1 over 4	--	10%	310
		44-48	1 over 5	--	10%	340
REACH STACKERS		40	1 over 4	--	10%	350
		50	1 over 5	--	10%	370
FORKLIFT TRUCKS		2.5	--	--	10%	25
		3.0-5.0	--	--	10%	50
		7.0-15.0	--	--	10%	100
TERMINAL TRACTORS					transport	cost
					cost	(US$000)
					10%	90-130
TERMINAL TRAILORS (40')			axle type	load	transport	cost
				capacity	cost	(US$000)
			single	40	10%	15
			double	50	10%	18
			double	65	10%	20

Source: Compiled by the UNCTAD secretariat based on 1996 manufacturers prices

Appendix 6

Daily equipment position of CPA

DATE:
SHIFT:

CHITTAGONG PORT AUTHORITY
CONTAINER EQUIPMENT UNIT
DAILY POSITION OF EQUIPMENT

SL. NO.	TYPE OF EQUIPMENT	TOTAL NOS.	IN ORDER	OUT OF ORDER	DEMAND	BOOKED	AVAIL ABILITY%	REMARKS
1								
2								
3								
4								

SUMMARY

COPY FORWARDED FOR INFORMATION:
1.MEMBER (E&D)/CPA
2. DIRECTOR (E&M)/CPA
3.DIRECTOR TRAFFIC/CPA
4.
5.

SD.
EXECUTIVE ENGINEER (MECH)

Source: Mechanical branch, CPA

Appendix 7

Annual inspection and testing of forklift

ASSET NO.: _____ DATE OF LAST INSPECTION/TESTING : _____

	ITEMS	RESULTS
(A)	**VISUAL INSPECTION**	
(1)	**Lift Chain**	
1	Straightness	☐
2	Elongation	☐
3	End attachment	☐
4	Chain tension	☐
(11)	**Forks**	
1	Crack	☐
2	Heal wear	☐
3	Deflection	☐
(B)	**OPERATIONAL TEST**	
1	Hoisting and lowering	☐
2	**Tilting and side-shifting**	☐
3	Attachment (e.g. Paper roll clamp, Turn-a-fork, push-pull attachment)	☐
4	Brake test	☐
5	Hand brake	☐
6	Steering	☐
(C)	**LOAD TEST**	
1	Loaded with 10% above its rated load	☐
2	Lifting drift	☐
3	Fork	☐

(/) -- Acceptable, (x) -- Not acceptable, (NA) -- Not Applicable

Inspected and tested by : ----------
Name : ----------
Signature : ----------
Date : ----------

Certified By : ----------
Name : ----------
Signature : ----------
Date : ----------

Source: PSA Training Institute, 1991.

Appendix 8
Growth of world sea borne trade, past and future

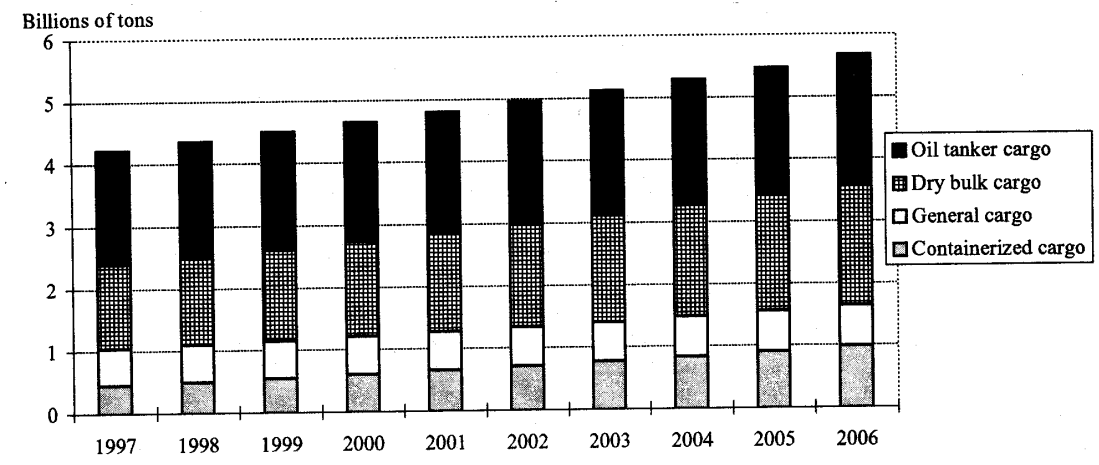
(A) Development of World sea borne trade in million tonne 1990-98

Year	Crude oil	Oil products	Iron ore	Coal	Grain	Other cargo*	Total trade	% Change over prev. year
1990	1190	336	347	342	192	1570	3977	3.0
1991	1247	326	358	369	200	1610	4110	3.3
1992	1313	335	334	371	208	1660	4221	2.7
1993	1356	358	354	367	194	1710	4339	2.8
1994	1403	368	383	383	184	1785	4506	3.8
1995	1415	381	402	423	196	1870	4687	4.0
1996	1466	404	391	435	193	1970	4859	3.7
1997	1534	410	430	460	203	2070	5107	9.0
1998*	1550	395	420	465	190	2050	5070	4.3
Av. growth rate 1990/98	3.4	2.0	2.4	3.9	--0.1	3.4	**3.1**	

Note: * estimates for 1998 and 'other cargo' estimates are based on world trade growth as indicated official sources and fleet data

Source: Containerization Yearbook,1998

(B) Forecast of world sea borne trade, 1997-2006

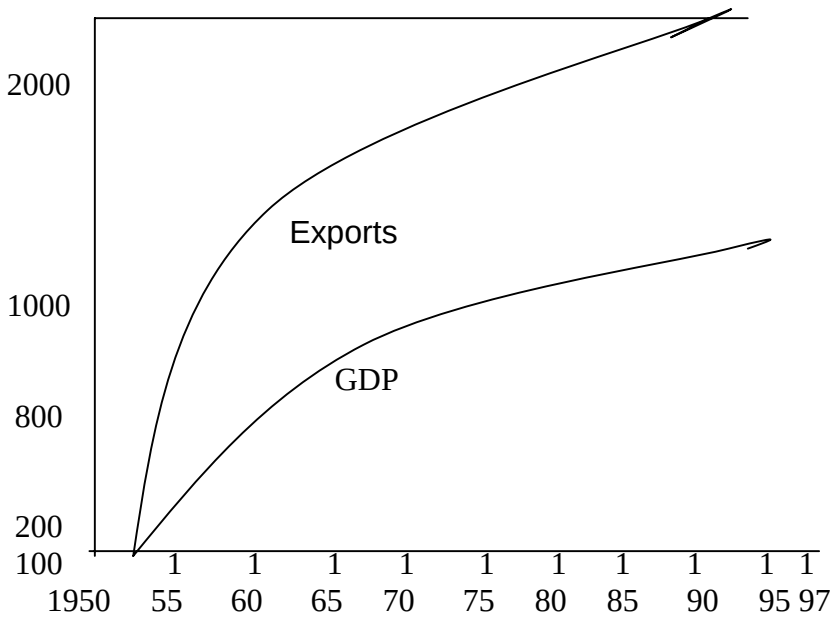


Source: DRI/Mc Graw—Hill, World sea borne trade service, quoted from UNCTAD Review of Maritime Transport.(1997.p.13).

Appendix 9

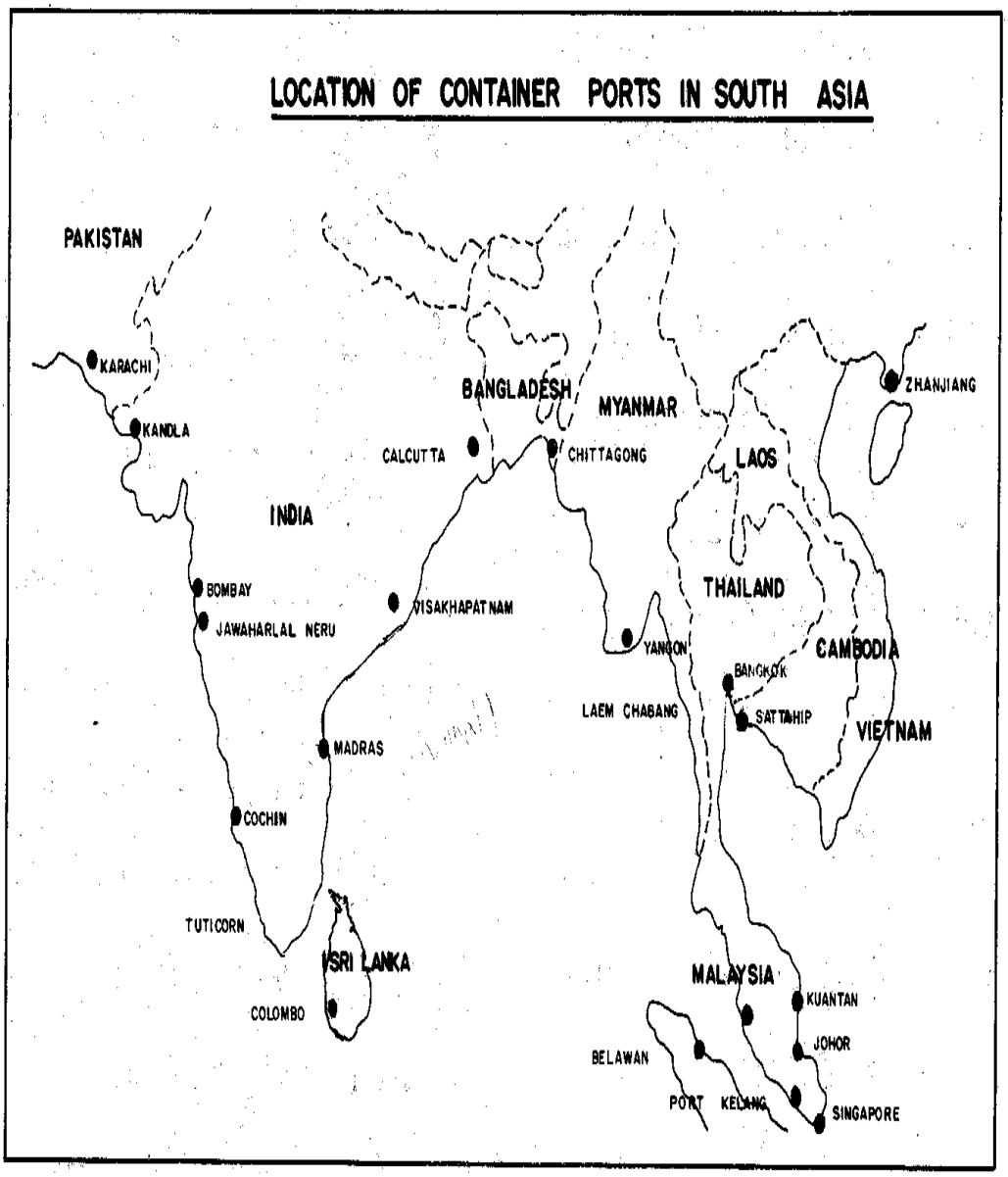
Growth of trade is higher than GDP

(1950-1997) (Index: 1950= 100 log scale)



Source: Principles of economics, R.G. Lipsey & K. A. Crystal, 1999.

Appendix 10



Source: National ports and shipping policy of Srilanka, 1997.

Appendix 11

Key economic ratios (South Asia)

	1977-87				1988-98				1997			
Average annual growth	India	Pakistan	Srilanka	Bangla-desh	India	Pakistan	Srilanka	Bangla-desh	India	Pakistan	Srilanka	Bangla-desh
GDP	5	6.8	5.0	5.0	5.5	4.2	5.2	4.7	4.6	1.2	6.4	5.4
Exports of goods and services	4.2	10.6	5.2	4.9	11.9	5.7	8.8	14.4	6.2	--6.5	11.6	14.5
Imports of goods and services	7.3	3.0	8.5	6.6	9.9	4.1	8.2	10.5	11.7	--3.8	10.5	2.0
GNP	4.9	6.1	5.2	5.2	5.6	4.5	5.0	4.8	4.7	0.9	6.8	5.5
Gross domestic investment	4.8	7.2	7.8	4.4	5.6	3.7	5.4	6.0	13.1	--3.6	4.5	10.0

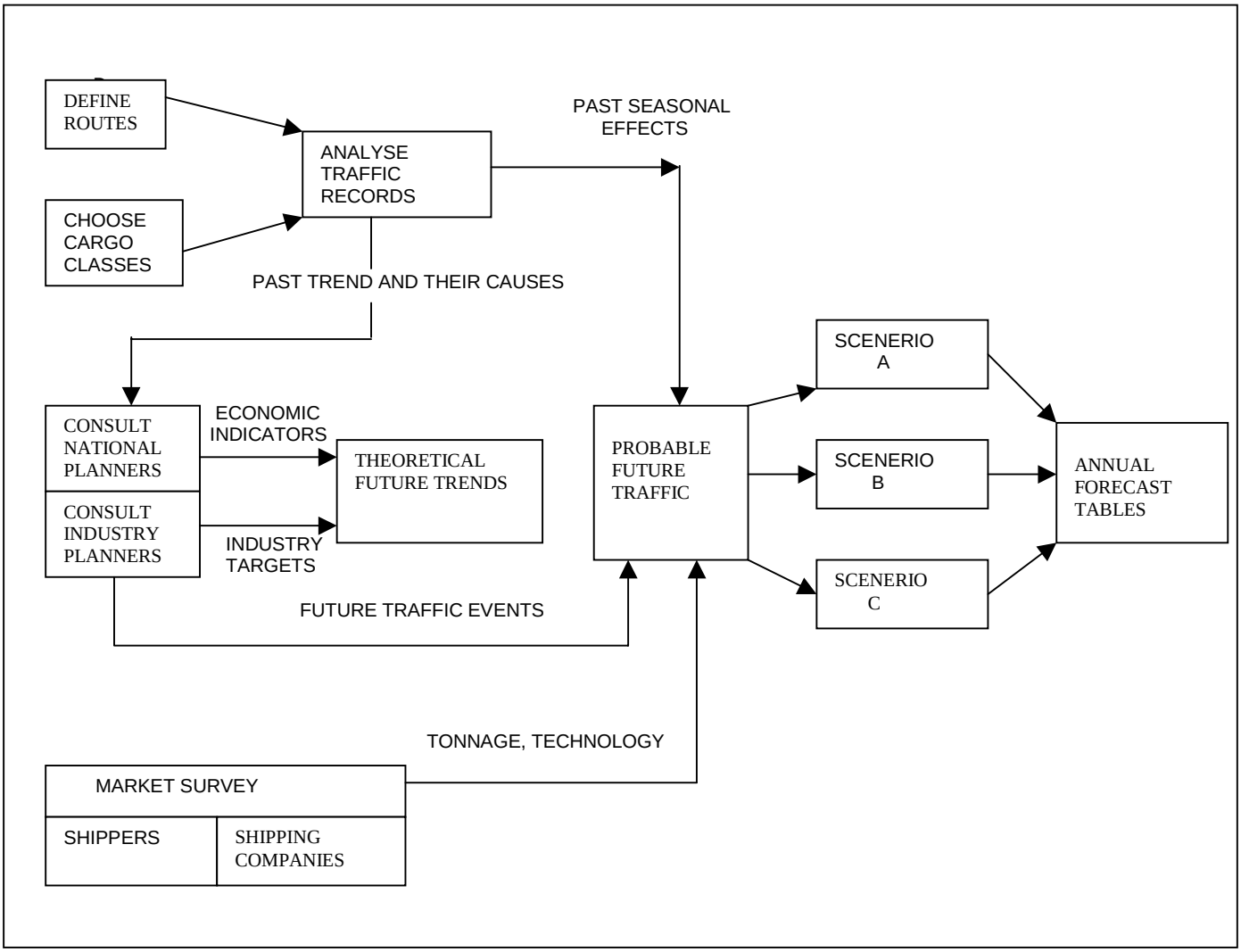
Trade	1997				1998			
(US$ million)	India	Pakistan	Srilanka	Bangla-desh	India	Pakistan	Srilanka	Bangla-desh
Total exports (fob)	35013	8096	4648	4427	34298	8437	4742	5172
Total imports (cif)	41484	12219	5662	7120	47544	11215	5913	7525

Balance of payments (US$ million)	1997				1998			
Exports of goods and services	45109	9781	5523	5083	47484	10001	5655	5819
Imports of goods and services	59297	14418	6580	7655	58565	12841	6661	8049
Resource balance	--14188	--4637	--1057	--2572	--11081	--2840	--1006	--2170

Source: World Bank page, South Asia, Internet

Appendix 12

Forecasting procedure



Source: Port development, A handbook for planners in developing countries, UNCTAD, 1985.