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Constraints of Navigation on Inland Waterways in Bangladesh - Dredging is an Option

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ABSTRACT

Bangladesh lies within the deltaic plain of the Ganges-Brahmaputra-Meghna (GBM) and many tributaries and distributaries are flowing through the low-gradient alluvial land from north to south (ISPAN, 1995). The GBM basin ranks third in the world river system in terms of sediment transport and water discharge (Schumm and Winkley, 1994). The rivers are of varying nature and have different hydraulic characteristics. There are 1007 rivers embrace Bangladesh as spider net. There are about 24,000 km of waterways as a relatively cost -effective means of transport. Out of which Class-I: 683 km, Class -II :1000 km, Class -III; 1885 km and Class-IV: 2400 km. These rivers discharge about 0.2 million m^3/s of water during the flood and 2.4 billion tons of silts are flown annually through the rivers which is 18.5% of the total silts 12.50 billion of the world. Due to the movement of silts about 18.5% of the total silts of the world causing deposition of huge quantity of the same on the river bed. As a result, waterways loss navigability causing hind plying of water transport. Then it becomes utmost necessary to resuscitate navigability by dredging river bed. Bangladesh Inland Water Transport Authority (BIWTA) is mandated to maintain and develop waterways. BIWTA alone cannot able to perform the expected dredging to maintain and develop the waterways for navigability owing to various reasons like paucity of budget allocation. This research is conducted with the objectives to identify the present situation of the navigable waterways network in Bangladesh and to determine the constraints/problems of navigable waterways and its mitigation using dredging an option. To achieve the objectives, methodology adopted are visiting of dredging sites. Study Hydrographic survey charts, dredging alignment etc. Conduct Questionnaire survey with concerned officials of BIWTA, stakeholders and Association of launch and cargo vessel owners. Data on dredging performance collected from BIWTA, Bangladesh Water Development Board and private entrepreneurs. Collected data presented and analyzed and found that BIWTA is mandated authority to maintain and develop the waterways all over Bangladesh. BIWTA has only 40 cutter suction dredgers with capacity of each dredger ranges from 250 to 1400 m^3/h whereas BWDB and private entrepreneurs have 171 (=155+16) CSD. From 2011-2012 to 2021-2022 BIWTA carried out 64.51 million m^3 sediments. Average annual dredging capacity of BIWTA stands 5.86 million m^3 sediments. On the other hand, total annual dredging capacity of Bangladesh is 84.65 million m^3 whereas yearly requirement of dredging is 165.51 million m^3. Hence every year dredging shortfall stands 80.86 million m^3. To cope up this shortfall Bangladesh needs more 76 dredgers above 211. Total annual average budget allocation for both revenue and ADP are 3544.18 million BDT for dredging against requirement 4435.56 million BDT respectively. Due to the budget paucity BIWTA cannot procure required dredgers with ancillary equipment. Thus, dredging of channel hampered, as a result, waterways are being lost its navigability and died day by day. There are only 211 dredgers in Bangladesh owned by both the government and private sector whereas total dredger requirement for Bangladesh is about 500, and for Delta 2100, Bangladesh will have to procure an additional 2,000 dredgers over the next 20 years. To resuscitate the navigability of the rivers, preparation of extensive dredging program and implementation are necessary. Maintenance and Development of navigability across the river network of Bangladesh require extensive dredging action plan. To implement this dredging action plan required budget allocation for procurement of dredgers with ancillary equipment and dredging technology for economic dredging are necessary. To conduct this, government should look into the allocation of appropriate budget and implementation. Otherwise, waterways will lose its navigability and in course of time the dieing of rivers will increase causing decrease of plying water transport and in transit and inter-country traffic.

Key Words: Waterways, navigability, sediment/silt, modal share, dredging, dredger, budget, draught, IWT, resuscitate, maintenance and development, ADP, Revenue, constraints

Preface

Bangladesh is embraced by considerable lengths of waterways as a relatively cost-effective means of transport. Waterways are and will remain a very important feature of rural life, providing vital links not only to urban centers but also between different rural areas. By providing these links the waterways help to sustain life in the rural areas and so lessen the drawn of the cities. There are 1007 rivers including mighty rivers, the Meghna, the Jamuna and the Padma Rivers. The total length of waterways 24,000 km including 5968 km classified waterways all over Bangladesh. Many people use this waterway as their travelling mode due to its cheapest cost. Every year this waterway carries huge silt and deposit on the river bed resulting loss of navigability. Bangladesh Inland Water Transport Authority as a mandated authority dredges river bed to regain the navigability of the waterways and hence provides facility for fare plying of water transport. This research "Constraints of navigation on Inland Waterways in Bangladesh -Dredging is an option." is conducted to identify the problems of navigability and its mitigation. The pre-requisite theory course for phd degree like Mathematical model, River Engineering, Dredging, Statistics and Mathematics completed from the Bangladesh University of Engineering and Technology (BUET). This research was being conducted for 2 years before for the fulfillment of phd degree. I would like to pay homage to the Selinus University of Science and Technology, 200-97100 Ragusa-Italy which privileged to provide facility for this research. I am very much pleased and grateful and to pay homage to the dissertation supervisor Dr. Salvatore Fava – Uniselinus. His unparallel suggestion and time spent for the review of the dissertation for which it was possible to complete the research successfully. Primary and secondary data related to water ways have been collected from BIWTA, Bangladesh Water Development Board (BWDB) and Department of Shipping (DOS). Interviews were taken from the higher officials of BIWTA, BWDB and DoS under Ministry of Shipping. Stakeholders were interviewed. Representatives of Cargoes and Launch Owners Association were also interviewed to get information regarding the pattern of water transport and plying. I therefore, acknowledged all those with gratitude who have helped by providing data and interview. Information used here has been mentioned under references and inside writeup also where it is thought to be mentioned. Any mistake found is unintentional. If any citation is not written here is unintentional may be forgiven.

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Abbreviations

LAD = Least Available Depth

LLWL = Lowest Low Water Level

BIWTA = Bangladesh Inland Water Transport Authority

BIWTC = Bangladesh Inland Water Transport Corporation

BWDB = Bangladesh Water Development Board

BDT = Bangladesh Taka

DOS = Department of Shipping

NRCC = National River Conservation Commission

NSAPR =National Strategy for Accelerated Poverty Reduction

GBM = Ganges-Brahmaputra-Meghna

IWT = Inland Water Transport

GDP = Gross Domestic Product

PROB = People's Republic of Bangladesh

ERZ = Economic Resource Zone

ESCAP = United Nations Economic and Social Commission for Asia and Pacific

ECNEC = Executive Committee for National Economic Council

UNDP = United Nations Development Program

AWB = An air waybill (AWB limited) is a courier service

RSN and IGN = River Steam Navigation and Indian general Navigation

PRS =Pakistan River Steam Navigation

EPIWTA = East Pakistan Inland Water Transport Authority

TSHD= Trailing Suction Hopper Dredger

CSD = Cutter Suction Dredger

ISPAN = Irrigation Support Project for Asia and Near East

Chapter 1

Introduction

1.1 Background

Bangladesh is a riverine country located in South Asia with a coastline of 580 km (360 miles) on the northern littoral of the Bay of Bengal. The delta plain of the Ganges (Padma), Brahmaputra (Jamuna), and the Meghna Rivers and their tributaries occupy 79 percent of the country. These rivers spread all over the country as a spider net. Bangladesh being a country with many rivers, Inland Water Transport (IWT) is a major mode for the transport of goods and people. A total of 57 international rivers flow through Bangladesh. Bangladesh geography and culture is influenced by the riverine delta system. IWT has three functions with distinct modes of operations and stakeholders. i) National, ii) Local, iii) Ferries.

(i) **National:** This indicates trunk road for carrying freight and passenger along main corridors between inland ports and major economic centers both within country and international. Trips are medium to long distances with high volume movements. Freight and passenger movement by using modern big vessels as long as 100 m to 300 m having large capacity of freights 50 to 5000 tons where 100 to 5000 passengers can travel.

(ii) **Local:** Local comprises of feeder, distribution and traffic. Trips are mostly on short distances with low volume movements to from smaller communities. Local trips use traditional country boats offering a capacity of up to 200 passengers and 200 tons

(iii) **Ferries:** Ferries are road connector with the small or big channels like rivers in absence of bridges. Since they are part of the road transport system rather than IWT system. On the other hand, considering operational system it is an integrated part of IWT. Because channel is maintained and developed by dredging.

The transport system of Bangladesh has change substantially over the last forty-seven years. There are about 24,000 km of waterways in Bangladesh of varying nature and have different hydraulic characteristics. Depending on the characteristics of rivers, they are of following types:

i) The braided types

ii) The tributaries

iii) The distributaries

iv) The tidal rivers.

Present condition of the waterways network: as the chartered duty, BIWTA performs the hydrographic survey to know the waterways condition in Bangladesh. Presently BIWTA performs hydrographic surveys only in the routes and areas which require priority attention. Waterway navigation in Bangladesh just in last decade dredging works across the country have an additional 2300 kilometers of navigational waterways to Bangladesh's rivers system.

There are many patterns of water transport, they are:

1) Mechanical boat
2) Country boat
3) Launch
4) Cargo
5) Oil tanker
6) Berger
7) Steamer
8) Ferry

For the improvement of waterways in terms of passenger travel through waterways can be as follows:

1) Increase service
2) Increase fashion and beauty including entertainment
3) Increase passenger service quality
4) Reduce fuel prices
5) Removal of waterways

Restriction due to illegal encroachment, pollution threats. Bangladesh has a long and proud transport and seamanship, lack of regular maintaining and development of waterways; rivers lose navigability and in course of time causes decline of navigable rivers. Inland water transport (IWT) is a major mode for the transport of goods as well as people. IWT is important for the poor as well as for the competitiveness and growth of the economy since it is the cheapest **transport compared to road and rail**. Bangladesh lies within the deltaic plain of the Ganges-Brahmaputra-Meghna (GBM) and many tributaries and distributaries are flowing through the low-gradient alluvial land from north to south (ISPAN, 1995) **[3].** The GBM basin ranks third in the world river system in terms of sediment transport and water discharge (Schumm and

Winkley, 1994). These complex water network has spread in such a pattern that a huge portion of the country, especially the southern tip and the offshore areas, are hardly accessible by land transportation. As the land is crisscrossed with the waterway, almost all infrastructures in the country have always been river dependent. The IWT system is well-connected with rest of the transport system. IWT plays a vital role in the transportation sector of Bangladesh. A previous study reveals that around 102 million passengers covering 110 billion passenger-kilometers and 30 million metric tons of freight covering 18.6 billion ton-kilometers are transported by inland waterways (Ministry of Shipping, 2009). A substantial portion (12.3%) of the rural population only has a reasonable access to the transportation system through IWT, which is half of all rural households (25.1%) who have access to river transport (PROB, May 2007). Thus, IWT plays a pivotal role to government's effort towards growth and reduction of poverty under National Strategy for Accelerated Poverty Reduction (NSAPR)- (Ministry of Shipping, 2009) [5] . Climate change impacts the various spheres of the business activities of the inland water transportation sector. Bangladesh possesses a unique geomorphologic setting with an intensive network of around 700 rivers, covering a length of 24,000 kilometers, which is almost 7% of the surface of the country (Huq, N.A. & Dewan, A.M., 2003) [2]. Bangladesh has about 9,000 square kilometers of territorial waters with a 720-kilometer-long coast line and 20,000 square kilometers of economic resource zone (ERZ) in the sea **[4].**

According to Bangladesh Water Development Board (BWDB) about 230 rivers currently flow in Bangladesh during summer and winter, although the number stated are ambiguous in some sources. As stated by a publication called "Bangladesher Nad Nadi" by BWDB, 310 rivers flow in the summer although they republished another study in 6 volumes where they stated 405 rivers. The number differs widely due to lack of research on the counts and the fact that these rivers changes flow in time and season. Historical sources state about 700 to 800 rivers but most of them have dried out or are extinct due to lack of attention and pollution. The numbers also differ because the same rivers may change names in different regions and through history. About 17 rivers are on the verge of extinction and the 54 rivers flow directly from India and 3 from Myanmar. A total of 57 international rivers flow through Bangladesh. The international number of rivers can be 58 as Brahmaputra is called "Nod" while the general term for river is "Nodi". The gender division of rivers is interesting from history and mainly depending on the source of the river but not the size or flow briskness. Sangu and Halda are the only two internal rivers originated and end within Bangladesh. Brahmaputra is the longest river and the Padma

is the swiftest. The Jamuna is the widest river. According to Banglapedia 700 rivers flow in Bangladesh, but the information is old and obsolete. These rivers including tributaries flow through the country constituting a waterway of total length around 24,140 kilometers (15,000 miles). But the number differs ambiguously due to the lack of updated information. Most of the country's land is formed through silt brought by the rivers. Bangladesh geography and culture is influenced by the riverine delta system. Very recently 26 August 2023, National River Conservation Commission published a draft report (NRCC) where they mentioned 907 rivers in Bangladesh. After that on October 2023, they published final report, mentioned total number of rivers in Bangladesh are 1007. According to NRCC Ichamati and the Padma are the largest and third largest river in Bangladesh respectively. Bangladesh lies in the biggest river delta of the world - the Ganges Delta system. Bangladesh is embraced by considerable lengths of waterways as a relatively cost-effective means of transport. The inland waterway in this country plays not only a pivotal role within the overall transport sector especially in the field of passenger and cargo transportation but also share a large contribution towards the Gross Domestic Product (GDP). The waterways are and will remain a very important feature of rural life, providing vital links not only to urban centers but also between different rural areas. By providing these links the waterways help to sustain life in the rural areas and so lessen the drawn of the cities. Figure 1-1 Map of waterway: shows the waterways route operated by Bangladesh Inland Water Transport Corporation (BIWTC).

Table 1-1: Major rivers (Source: Wikipedia)

Name of River	District Covered by a River in Miles	Total length in Miles
Surma-Meghna	Sylhet, Cumilla. and Barishal	359 miles (78 km)
Karatoya-Atrai-Gurgumari-Hursagar	Dinajpur, Rajshahi & Pabna	382 miles (615 km)
Donai-Charalkata-Jamuneswari-Karatoya	Rangpur . Bogura & Pabna	227 miles (365 km)
Padma (Ganges)	Rajshahi ,Pabna ,Dhaka & Faridpur	222 miles (357 km)
Garai-Madhumati-Baleswar	Kushtia , Faridpur and Jashore Narail, Khulna and Barishal	233 miles (375 km)
Old Brahmaputra	Mymensingh	150 miles (240 km)

Brahmaputra-Jamu	Rangpur . Pabna	94 miles (151 km)
Kobadak	Jessore, Khulna	113 miles (182 km)
Banshi	Mymensingh, Dhaka (25)	115 miles (185 km)
Ghagat	Rangpur	148 miles (238 km)
Dhanu-Boulai-Ghor	Sylhet , Mymensingh	136 miles (219 km)
Nabaganga	Kushtia and Jashore	144 miles (232 km)
Kushiyara	Sylhet	143 miles (230 km)
Bhogai-Kangsa	Mymensingh	141 miles (227 km)
Jamuna	Dinajpur. Bogura and Tangail	56 miles (90 km)
Dakatia	Cumilla and Noakhali	69 miles (111 km)
Little Feni	Noakhali and Cumilla	50 miles (80 km)
Bhadra	Jashore and Khulna	119 miles (192 km)
Betna-Kholpotua	Jashore and Khulna	80 miles (130 km)
Sangu	Chattogram and Chattogram Hill Tracts	113 miles (182 km)
Chitra	Kushtia and Jashore	97 miles (156 km)
Banar	Faridpur and Barishal	101 miles (163 km)
Kumar (Faridpur Di)	Faridpur	81 miles (130 km)
Punarbhaba	Dinajpur and Rajshahi	100 miles (160 km)
Arial Khan	Faridpur and Barishal	102 miles (164 km)
Dhaleswari	Mymensingh	105 miles (169 km)
Bhairab	Jashore and Khulna	136 miles (219 km)
Mathabhanga	Rajshahi, Kushtia	81 miles (130 km)
Rupsa-Pasur	Khulna	41 miles (66 km)
Karnafuli	Chattogram Hill Tracts.	100 miles (160 km)
Teesta	Rangpur	71 miles (114 km)

The waterway is one of the important modes of transport in a riverine country like Bangladesh, it is the gift of nature and the cheapest mode of transport. Besides, there are still many areas in the country where no alternative mode of transport is available other than waterways. The length of rivers of Bangladesh is about 24,000 km. These rivers discharge about 5.00 million cusecs of water during the flood and 2.4 billion tons of silts are flown annually through the rivers which is 18.5% of the total silts 12.50 billion of the world. But it is not possible to dredge

out the huge amounts of silts from the river bed due to various constraints like inadequate budget allocation and dredging equipment. As a result, the rivers are being gradually died and navigable waterways reduce. As per Bangladesh Transport sector study, 1994 (Vol. 1, page 2.2) the length of navigable waterways was 8,400 km during the monsoon season and 5,200 km during the dry season in 1984 which is, at present, declined to 6,000 km and 3,800 km respectively, the reasons for gradual deterioration of rivers are as follows:

i) **Stream flow reduction**

Increased obstruction of surface water and ground water in low flow season resulted in reduced stream flows, tributaries and connectors are most affected in this respect;

ii) Reduction in cross boundary flow

Withdrawal of cross boundary flows (from India) which is beyond Bangladesh control affecting the reduction of a downstream connector i.e. inland waterways flows;

iii) Silting up of off-takes

Silting up of the off-takes has created 'Chars' and sedimentation has indeed reduced the navigability of waterways;

iv) Reduction of tidal volume

Reduction of tidal volume due to the flood control and drainage projects, the rivers of Bangladesh has triggered off a siltation process reducing the rivers cross section which starts with the rise of the river bottom.

As a result, it is hampering the smooth plying of Inland Water Transport (IWT) vessels as well as irrigation facilities and fisheries production. Besides, it is creating obstruction to the drainage capacity of floodwater, which has adverse impact over the whole economy of the country. In this respect it is very much essential to improve the waterways for socio-economic development of the country. It is possible to continue waterways transport, flood control, fisheries production and above all, natural environmental balance cheaply by means of development and maintenance of waterways.

1.2 Role of IWT

The importance of water transport in the perspective of the economy of Bangladesh needs no elaboration. With the development of motorized road and rail transport over the last two decades, the traditional functions of inland water transport are now shared by the other modes

of surface transport. However, the movement of bulk and heavy cargoes has to a large extent, remain with inland water transport sector while much of passenger traffic has been diverted to road and rail. The Padma multipurpose bridge has been inaugurated on last 25 June in the year 2022 and opened for people use on 26 June 2023. Though the bridge has roadway connected to the southern part of Bangladesh but waterways connection reduces at about 30%.

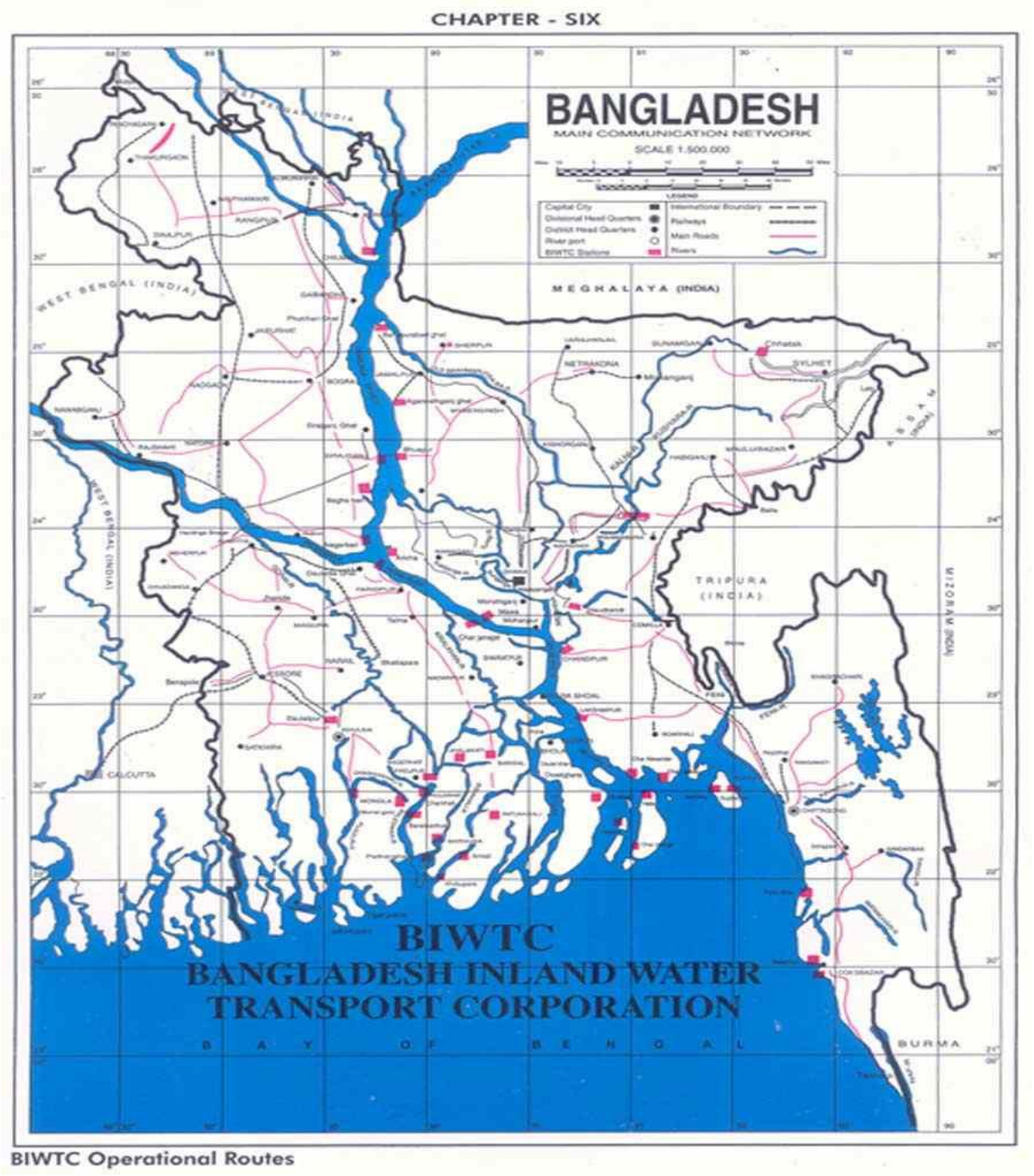


Figure 1-1: Map of waterway: shows the waterways route operated by Bangladesh Inland Water Transport Corporation. ***(Source: BIWTC)***

1.3 Modal Shares

1.3.1 Share of IWT in total transport demand

As per Bangladesh transport sector study, June 1994 conducted by planning commission, 13% passenger and 32% cargo of the country were transported by inland waterways in 1992-93. Other than this study, as per Agriculture census (1998), 8,87,168 country boats have been played a vital role in carrying both cargo and passengers. As per Improved Mechanization of Country Boats published by NOAMI in 1991, the country boats cater 15-million-ton cargo annually. An enormous river, canals, creeks (beells) etc. spread over the country as a spider net and these are accessibly. More than fifty percent of the economic activities in the country are located within a distance of 10 km from the nearest navigable waterways in all seasons. The topographic, soil and climatic condition in Bangladesh are such that cost of building and maintenance of roads & railways are very high compared to inland waterways, besides, cultivable land is needed for the improvement of roads and railways while for inland waterways it is not necessary. IWT vessels carry more cargo & passengers in the cheapest cost than that of bus, truck, wagon, railways etc. As per inter modal transport study carried out in 1985 that for carrying cargo over a range of 100 km, the cost of per ton km is BDT. 0.90, 2.20 & 2.00 in waterways, roads & railways respectively. According to UNDP/ESCAP publication of 1987-91, it is found that ton-km /liter of fuel consumption in IWT sector is 217 whereas, 85 in railways and only 25 in roads (diesel truck). Moreover, environment is less polluted by waterways [17],[19].

Although the transport demand for passenger and freight increased over the years, the share of all the modes did not increase in the same proportion. It is evident that the predominance of road sector has continued but the rail and water transports have decreased. The share of IWT in the passenger transport market has decreased from 16 percent to 15 percent in the year 1996 and 8 percent in 2005.

In comparison, rail lost more of its market share from 30 % in 1975 to 6 % in 1996 and 4 % in 2005. The road share has dramatically increased from 54 % in 1975 to 88% in 2005, reflecting the heavy investments in the sector. Comparing again rail and IWT, IWT continuously lost traffic in absolute values during the period analyzed, whereas since 1996 rail has been able to reverse the negative trend observed during 1975 and 1996. Table 1-2 illustrates modal share of traffic both passengers and cargo in Bangladesh.

Table 1-2: Modal Share of Passengers and Cargo Traffic:1974/75 – 2005

Year	Passenger Traffic (Billion Pass km)							Cargo Traffic (Billion Ton km)						
	Total	Road		Rail		IWT		Total	Road		Rail		IWT	
		Road	%	Rail	%	IWT	%		Road	%	Rail	%	IWT	%
1974/75	17.0	9.2	54	5.1	30	2.7	16	2.6	0.9	35	0.7	28	1.0	37
1996/97	66.0	52	79	3.9	6	10.1	15	10.7	6.9	63	0.8	7	3	30
1996/97 2005 Annual growth	7.1%	6.6%		0.7%		-1.3%		6.9%	8.6%		0.8%		0.1%	
2005/06	111.5	98.4	88	4.2	4	8.9	8	8	19.6	80	0.8	4	3.0	16

Source: Bangladesh integrated transport System Study. Final Report, Planning Commission, 1998

1.3.2 Share of IWT in the passengers and cargoes transport

The share of IWT in the cargo market has decreased from 37 % in 1975 to 30 % in 1996 and 16 % in 2005. Like for the passenger market, rail lost more of its market share than IWT, from 28 % in 1975 to 7% in 1996 and 4% in 2005. The road share has again dramatically increased from 35% in 1975 to 80% in 2005. Comparing rail and IWT, IWT traffic in absolute values has stabilized since 1996 while since 1996 rail has continued to increase moderately since 1975. Figure 1-2, 1-3 and Figure 1-4 illustrate the modal share with respect to passenger traffic, cargo traffic and volume percent respectively. Figure1-2 a bar chart on modal share regarding different modes of transport shows that from 1974-1975 IWT carries lowest passengers whereas in the year 1996-1997 it increases from 2.7 billion to 10.1 billion. But declined in the year 2005-2006.[19]

1.3.3 Relative advantages of IWT

Inland water transport has many advantages over other transport modes, due to its large capacity, low cost, least pollution, high energy efficiency, high safety, leased land consumption and lower investment requirements. The trend of modal share since 1974/75 indicates that the predominance of road transport in carrying passenger and freight still persists and although both the rail and water transport are gradually losing share of both passenger and freight traffic. The faster expansion of the country's road network as well as the increase in the road vehicles have led to such an overwhelmingly major share of the road transport of the country.

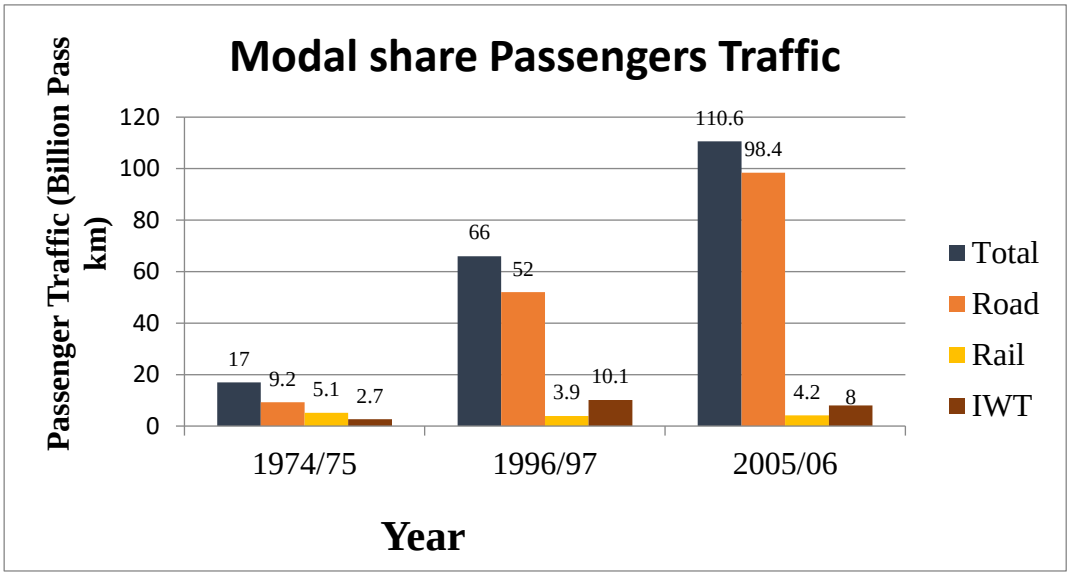


Figure 1-2 Bar chart represents modal share Passengers Traffic (billion pass km)

Cost

Inland water transport is the cheapest mode of transport. It has been analyzed in "inter modal Transport Study" carried out in 1985 that for carrying cargo over a range of 100 km. the cost of per ton km is Tk. 0.90, Tk2.20 &Tk. 2.00 in waterways, roads & railways respectively. In "People's Republic of Bangladesh Revival of Inland Water transport- Options and strategy" a report No.38009-BD, 29 May 2007 mentioned that IWT tariffs for cargo are below Tk.1.00 per ton -km whereas for road they around Tk. 4.5, Rail tariffs range between Tk.2.5 and 4.0. Even after adding to IWT and rail traffics the cost of handling at the port/railway station and terminal transport between the port/railway station and the origin/final destination, IWT still remains the cheapest mode of transport. For example, between Dhaka and Chattogram, the tariff to transport a 20-foot container is around Tk.600 per ton by IWT, compared to Tk.1200 for rail and Tk. 6000 for road. as economy, cost-based prices are always considered as key factors, and then transport cost, as one of significant portion of overall product cost, should be weighed with more importance in the process of selecting transport mode.

Energy

From the fuel consumption point of view, it is found that inland water transport consumes the least quantum of energy, the statistical analysis reflected in the publication of UNDP/ESCAP (1987-91), shows that ton-km per liter of fuel consumption in IWT sector is 217, whereas, 85 in railways and only 25 in roads (diesel truck).

Environment

Inland water transport is always accepted as the most environmentally sound mode of transport. The use of IWT instead of road transport estimated to save about 58.5 million liters of diesel and 155,000 tons of CO_2 per year because of lower diesel consumption (ref. report No.38009-BD-mentioned above).

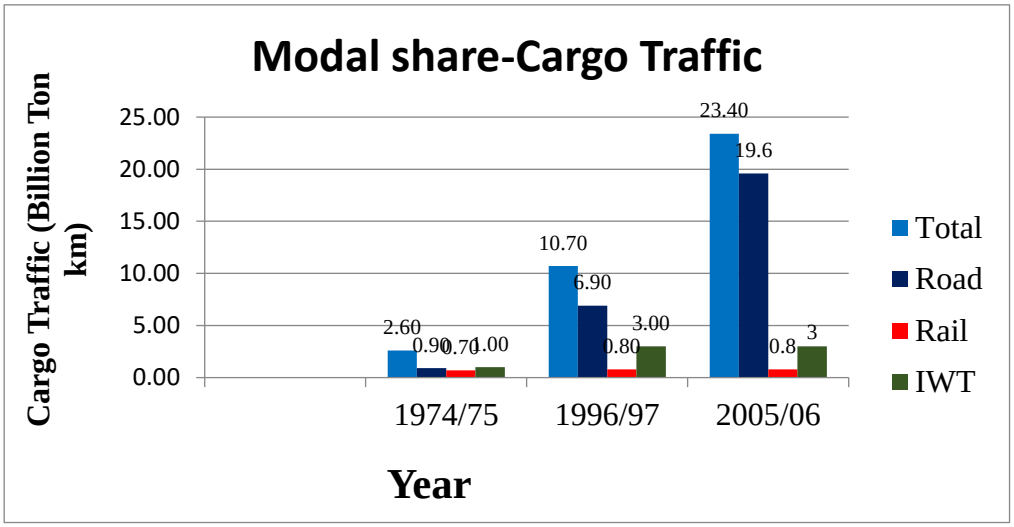


Figure 1-3 Bar chart represents modal share - Cargo Traffic (billion-ton km)

Land

Inland waterways mainly utilize natural rivers canals and lakes. The training works of the rivers remain within the natural boundaries of the rivers. A recent statistical analysis shows that about 2 to 2.7 hectare of land are required to build one kilometer of railway and 5 hectares. are required to build one kilometer of highway but nearly no land is required for development and maintenance of inland waterway.

1.4 Institutions for IWT

The Ministry of shipping (MOS) as part of the Government and the private ship operators with their associates are two organs dealing with the IWT sector. Three agencies, namely Bangladesh Inland Water Transport Authority (BIWTA), Bangladesh Inland Water Transport Corporation (BIWTC) and Department of Shipping (DOS) are the extended arms of MOS through which it executes the Government policy. Plying water transports, both for passengers and cargoes are the function of BIWTC whereas DOS functions as regulating body for inland water transports.

1.5 Maintenance of navigational routes

The length of BIWTA network has been declined to 6000 km, maintained by Bangladesh inland Water Transport Authority (BIWTA), the rest 20000 used for irrigation, fisheries, drainage and flood control are maintained by Bangladesh Water Development Board (BWDB) during monsoon and 3800 km during dry season from 8400 km and 5200 km respectively as per the Bangladesh Integrated Transport sector study, 1998. Besides it is creating obstruction to the drainage capacity of flood water, which has adverse impact over the whole economy of the

Figure 1-4: Dredger D-136 - CSD of BIWTA is in action in the Meghna River

country. In this respect it is very much essential to improve the waterways for socio economic development of the country. There is a huge requirement of dredging to remove silt from the rest of the rivers (20000 km) as maintained by BWDB for irrigation, fisheries, drainage and flood control purpose. [8],[9]

As chartered functions, BIWIA undertakes maintenance and development dredging works for improved navigation in the waterways. In order to carry out the chartered functions, BIWTA has to undertake annual maintenance dredging in order to keep the trunk and secondary navigation routes navigable and the inland ports operational. Figure 1-4 : Shows dredger D-136 is in dredging activity on the Meghna river. At present, a sum of 5.86 million m^3 of dredging per year is carried out by BIWTA on an average at Aricha, Daulatdia, kazirhat, Mawa – Charjanajat basin and approach channel of ferry routes. Hence dredging demand per year is (5.9+2) =7.90 million m^3. On the other hand, as per the report of the committee constituted by the Ministry of Water Resources in 1999, dredging **demand** of 62.27 million m^3 for the seven-

year period i.e. for 2007 has been estimated for maintaining the navigability of the waterways. Based on this estimate the annual **dredging demand** is about 8.9 million m^3. But those reports were prepared on the basis of the assessment made at least eight years ago. Therefore, if the extent of siltation occurred so far is taken into consideration the current **annual maintenance dredging demand** would averagely become 10 million m^3. Development dredging is the dredging conducted to excavate or dredge from a river almost dead in order to make the river alive with navigability of definite draught. On a requirement of 130 million m^3 maintenance dredging in last 13 years (10 million m^3 per year). Only 47 million m^3 dredging has been carried out. Therefore, a number of rivers already silted up almost fully due to unavailability of **maintenance dredging** every year and need re-excavation to make those fully navigable with required draught for designated water craft. As a result, there is a need of huge quantity of **development dredging** beside the maintenance dredging in order to make the waterways navigable as maintained by BIWTA throughout the country. ” (***Source: CBECL GROUP- Prospects of Dredging in Bangladesh: published Dec.9,2019***

***https://www.google.com/search?client=firefox-b-d&q=yearly+BIWTA+dredging+capacity+in+Bangladesh+2023*).**

There is a huge requirement of dredging to remove silt from the rest of the rivers (20,000 km) as maintained by BWDB for irrigation, fisheries, drainage and flood control purpose. Delta plan 2100 has great impact on navigability of waterways in Bangladesh. For the implementation of Delta plan 2100, Bangladesh will need an additional 2,000 dredgers over the next 20 years (***source: web side-BWDB*)**. However, there are only 211 dredgers in Bangladesh, and these include those owned by both the government and private sector contractors. BIWTA has a fleet of 40 dredgers (cutter suction dredgers of size vary from 150 mm to 650 mm) collected just after the liberation 1971 to 2022. BIWTA is mandated institution to develop and maintain waterways but lack of dredge machine and adequate budget, it cannot keep the waterways navigable. As a result, waterways are losing navigability and in course of time navigable waterways will reduce extensively.

1.6 Objectives

The objectives of the research are mentioned below:

1) to study the present situation of the navigable waterways network in Bangladesh and
2) to identify the problems in navigable waterways and its mitigation – dredging is an option.

1.6.1 Specific objectives

The surface of Bangladesh is formed by alluvial soil. As a result, river is silted up during flood due to the transportation of soil. Thus, the sedimentation in the river bed increases day by day causing loss of draught in the navigational waterways which hampers the smooth plying of water transport. The specific objective of this research is to identify the causes of sedimentation in the river bed and to find the way to minimize sedimentation for fare navigational waterways.

1.7 Organization of the Dissertation

This research work is organized with six chapters are demonstrated below:

(1) Chapter- 1: Introduction,

This chapter describes the waterway systems in Bangladesh. Waterway networks. Present condition of rivers including major rivers' list. Location of waterways and the route of water transport, etc.

(2) Chapter-2: Literature review

Chapter 2 describes the detail demonstration of rivers and waterways in Bangladesh. Methods of survey for dredging river bed to maintain draught of navigation. Demonstration of maintaining and development of waterways for fare movement of water transport.

(3) Chapter-3: Methodology

This chapter illustrates the way and methods of collection and presentation of data. Dredging methods and its application for construction of fare navigation.

(4) Chapter 4: Data collection & presentation and Data analysis

This chapter describes data presentation, its analysis to find out the problems of waterways and its mitigation. Describe the dredging works.

(5 Chapter 5: Results and Discussions

This chapter illustrates results come out from the data analysis and then discuss the results.

(6) Chapter -6 Conclusions and Recommendations.

This chapter accumulates conclusions and recommendations resulting from chapter 4 and chapter 5.

Chapter 2

Literature Review

2.1 Introduction

Bangladesh is always vulnerable to flooding. Most areas remain under water for two to five months in a year and many roads and railways remain inundate during flood season. As a result, costs of development and maintenance of roads and railways are high. On the other hand, inland water transport has always been a natural and relatively cheaper means of transport. In certain areas, it is the only mode of transport. Including the country's unclassified routes, the total length of its waterway is about 13,000 km. Among these, 8433 km is navigable by larger vessels where in the rainy season 5,968 km is classified for navigation while in the dry season, classified 3,865 km out of about 4,800 km is navigable. Depending on season and navigability, Bangladesh Inland Water Transport Authority (BIWTA) classified navigable waterway routes into four class. They are, Class-I: identify as four trunk routes (depth 3.65m-3.96m, length about 683 km), (i) Chattogram-Chowkighata (ii) Chandpur-Shambbupura Narayangonj/ Dhaka;Shambhupura-Demra; (iii) Shambhupura-Bhairab Bazar/Ashugonj; and (iv) Chowkighata-Barisal-Mongla-Khulna-Maheswarpasha; Class-II: Eight link routes (depth 1.83m - 3.65m, length about 1,000 km)- (i) Mohanpur-Daikhawa; (ii) Bhairab Bazar-Chhatak; (iii) Chalna-Raimongal; (iv) Hijla-Saistabad; (v) Satnal-Daudkandi; (vi) Chattogramg-Cox's Bazar; (vii) Diara-Barisal via Nandir Bazar; and (viii) Chandpur-Ichuli; Class-III: Twelve secondary routes (depth 0.91m-1.82m, length about 1,905 km)- Dilalpur-Fenchuganj-Zakiganj; Chattogram or regional highways, but only a few routes connecting Dhaka with rest of the country. The extensive network of natural waterways provided alternative mode of inland water transport (IWT) which served the entire country along with a railway network of around 2,900 km that linked 17 out of the then 19 districts. Figure 2-1 illustrates the waterways network of Bangladesh showing inland river port, sea port, launch ghat, ferry ghat, etc.[1],[5]

2.2 Inland Waterways Network

2.2.1 Pattern of Waterways of Bangladesh

There are about 24,000 km of waterways in Bangladesh of varying nature and have differing hydraulic characteristics. Depending on the characteristics of rivers, they are of following types:

The braided rivers: The very large rivers of Bangladesh like the Ganges, the Jamuna, the Padma and the lower Meghna fall in this category, in the monsoon seasons or the high-water periods their discharges cover the entire river bed, often overtopping the banks and flooding adjacent areas. In the winter seasons or the low water periods, the reduced discharges cause the river to bifurcate in to a number of branches that meander within the high-water banks. **Figure 2-2** -satellite images of the Padma and the Meghna rivers-expresses meandering and braided characteristics.

- **The tributaries**

The branch rivers, those collect the discharges from the local catchment and feed the main rivers. Generally, these fall in the meandering river category. The Atrai and the Barak are the examples of these type of rivers.

- **The distributaries**

These are the rivers branching out from larger rivers e.g., the Lakhya the Arial Khan and the Meghna rivers. Their water levels depend upon the discharges received from the mother river. Generally, their confluences at the offtakes are problematic for navigation due to silt deposition and formation of shoals caused transitional changes in cross section.

- **The tidal rivers**

These rivers are located mostly in the southern part of the country and are dominantly tidal in character. Generally, the waterways of Bangladesh display a high water and a low water flow period. The low water period usually takes place from November to April every year. The lowest water levels usually occurring in the months of February, March. During this time not only water levels fall but also shoals appear in the channel's restriction smooth navigation.

2.3 Classification of Inland waterways

Bangladesh is a flat deltaic plain of about 1, 47,570 sq km (56,526 sq. miles). Most of the lands excepting the hilly regions of the Chattogram Hill tracts have been formed by the sediment deposits carried down through millions of years by the mighty river systems of the sub-continent. Through these rivers, the Padma (Ganges), the Brahmaputra, the Jamuna, the Meghan, the Teesta and there innumerable tributaries flow about 1400 billion cubic meter (or

1150 million acre- feet) of water annually, the length of the padma (Ganges) (Godagari to Mohonpur), the Jamuna (Daikhawa to Gualunda) and the Meghna (Dilalpur to Ramgati) inside Bangladesh are 355.00 km, 280.00 km and 270.00 km respectively. BIWTA provides pilotage

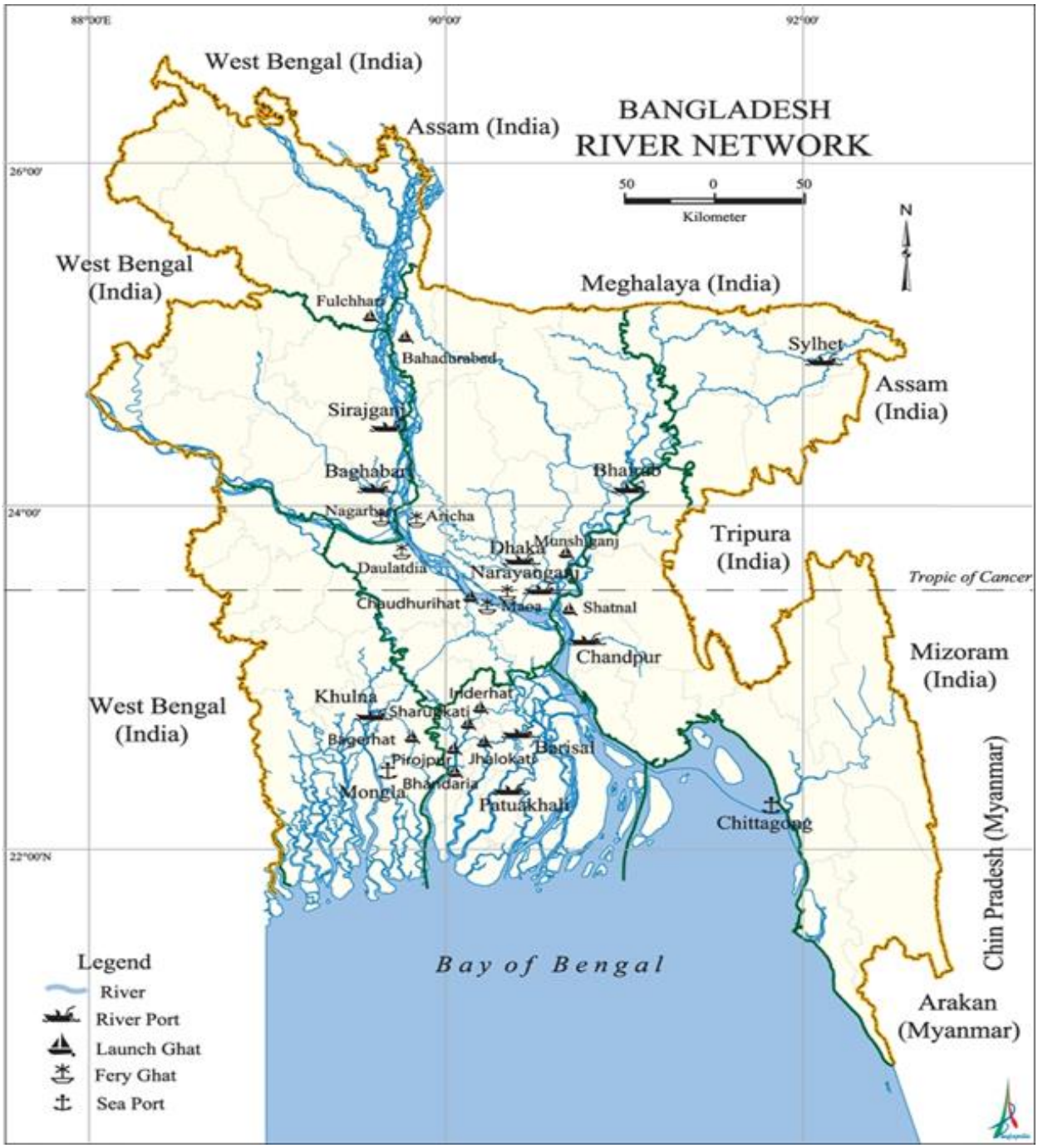


Figure 2.1: Bangladesh River Network shows river port, launch ghat, sea port etc.
(Source:BIWTA)

facilities to about 7,000 inland water vessels and 270.00 km waterways respectively. They regulate the movement of about 2000 passenger launches and maintains 22 inland ports along

with about 800 launch ghats including terminals. Approximate 6000 km navigable river route is further classified into following 4 categories by BIWTA depending on the drought (least Available Depth-LAD) and clearance. Draught ranging from 3.96 m to1.50 m which is shown in **Table-2-1.** Classified waterways are shown in the **Figure 2-3.**

Figure 2-2: Satellite images- braided and meandering characteristic of rivers. (source-CEGIS)

BIWTC facilitates passenger and cargo movement in the inland waterways and also offshore islands in the public sector vis-à-vis private sectors. It is operating 35 ferries in different routes.

Table 2-1
Classification of waterways with length (Source: BIWTA)

Route Classification	LAD	Vertical clearance	Horizontal clearance	Route Length (%)	Remarks
Class-1	3.65-3.96m (12-13ft)	18.30 m	76.22 m	683km (11)	Least Available depth (LAD) of 3.6 m Maintained round the year with necessary navigational aids for day & night navigation.
Class-2	2.1-2.4m (7—8ft)	12.20 m	76.22 m	1000km (17)	Maintained all the year round.
Class-3	1.5-1.8m (5-6ft)	7.62 m	30.48 m	1885km (32)	Being seasonal in nature, it is not feasible to maintain higher LAD throughout the year
Class-4	1.5 (5ft)	5.00 m	20.00 m	2400 km (40)	These are seasonal routes where maintenance of LAD of 1.5m or more in dry season not feasible
Total				**5968 km (100)**	

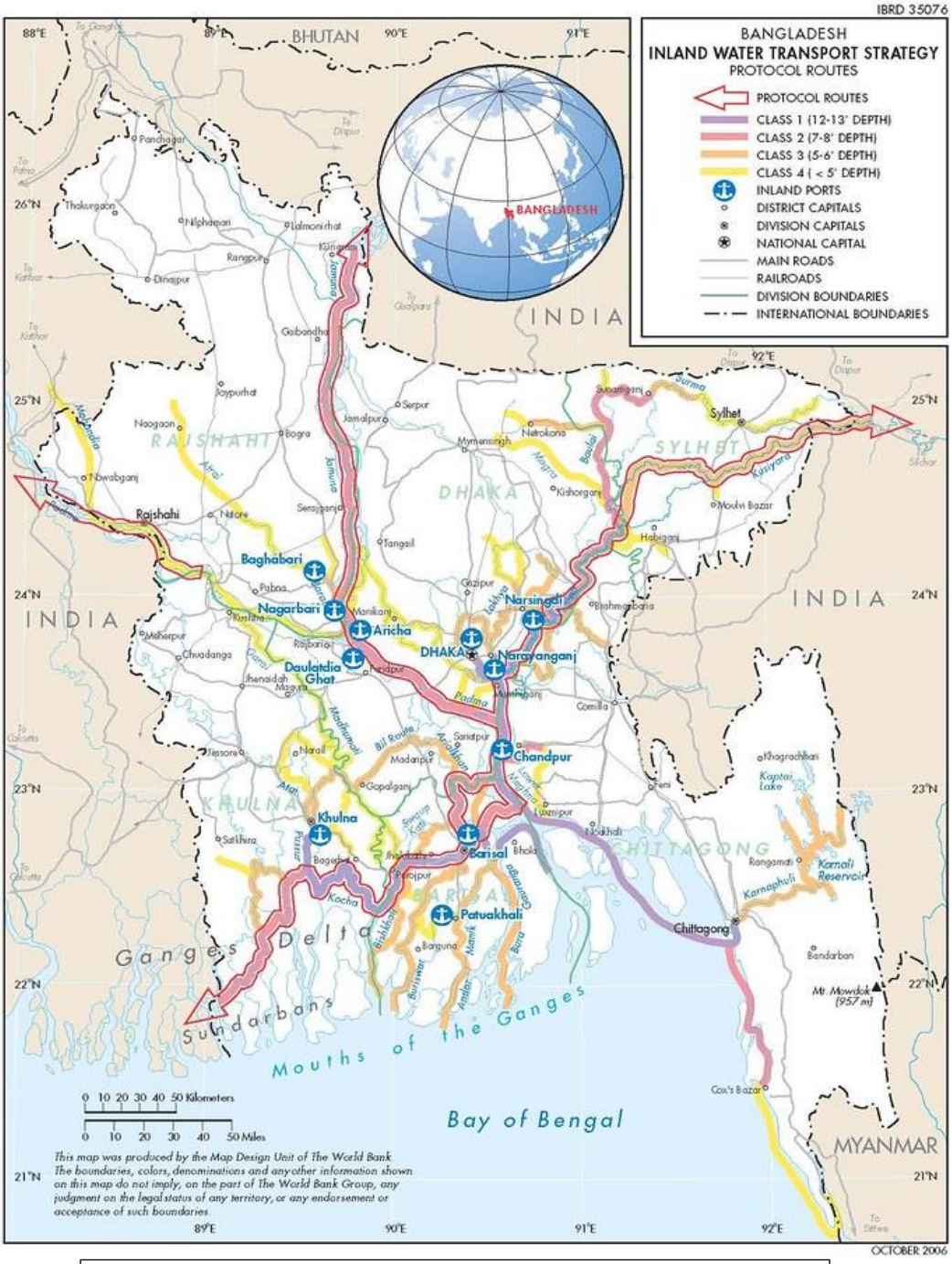


Figure 2-3 : Bangladesh map showing classification of rivers.

On the other hand, ocean shipping performs 80% of the export-import trade. AWB study reveals that IWT has been the least expensive mode of transport than that of rail and road. As such, considering the facts of land-man ratio and scarcity of land for further expansion of road networks in the country, IWT sub-sector has given the outmost importance specially dredging various river routes for making them navigable round the year. To develop a balanced and cheap

transport system in Bangladesh, it is important to improve IWT both from infrastructure and technological points of view. IWT sub-sector suffers from:

(i) Siltation problem in inland waterways,

(ii) Day & night navigational problem of waterways,

(iii) Shortage of passenger & cargo handling facilities including transit shed at river ports,

(iv) Presence of manual loading/unloading of cargo at river ports,

(v) Underdeveloped rural launch landing stations, inadequate number of water crafts both for river and ocean going etc.

Moreover, for transportation of containers by inland waterways to and from three seaports, the container handling facilities is being developed. Inland container river port in Pangaon, Dhaka is in operation. Decades of insufficient investment, and challenged governance the development of the port sector of the country is not flourishing as to be.

Due to geographical position and topological condition of the country rivers are becoming more and more narrow and thin by siltation. As such, implementation of comprehensive capital dredging program is the biggest challenge for the IWT sub-sector. Specific challenges identified in the sub-sector are:

(i) Channeling of the existing waterways through massive dredging and procurement of dredgers,

(ii) Construction of deep- sea port to streamline international trade;

(iii) Improvement of day and night navigation for water crafts by providing navigational aids; and

(iv) Construction of inland container river port for transportation of containers by waterways to/from sea ports etc.

2. 4 Inland water transport

The river network of Bangladesh as the most important transport artery in the country's communication sector plays a vital role in national life. Almost all big cities, towns and commercial centers of the country grew up on the banks of its rivers. In this part of the sub-continent, mechanized steam-powered vessels for inland water transport were introduced in the

private sector by Indian General Navigation (IGN) and River Steam Navigation (RSN) during British rule. They dominated the scene throughout British rule and during the Pakistan regime. In the 1960's, a few local operators such as Pak Bay, Sinclair Murray, and Chalna lighterage started operating in the cargo sector and Pak Waterways in the passenger sector. The entire passenger and cargo traffic was carried by the private sector, 70% of this being managed by the British owned companies. With the creation of the East Pakistan Inland Water Transport Authority (EPIWTA) in 1958, situation charged rapidly. Navigation by waterways improved, Chalna anchorage was established, waterways mileage increased, and numerous points of embarkation/ disembarkation were established throughout the country. IWTA took steps to meet an ever-increasing demand through import and distribution of 400 gray marine diesel engines to local entrepreneurs in the early 1960s.

As a result, the monopoly of the British owned companies in the passenger sector was broken. A number of wooden passenger vessels owned by local operators soon started to ply on the waterways of the country. During British rule, IGN and RSN Co. not only played a predominant role in the water transport sector, but also carried out river conservancy work in important waterways and provided landing facilities at some river side stations to cater to their own commercial interests. Later, IWTA converted the RSN and IGN into Pakistan River Steamers (PRS). After the emergence of Bangladesh, the abandoned companies including the PRS and Pak Bay Flotilla were taken over by the government-owned Bangladesh Inland Water Transport Corporation (BIWTC). Nevertheless, 85% of the passenger traffic is still carried by vessels owned by the private sector.

In the early 1960s, IWTA piloted a scheme for acquisition of 24 coasters in the private sector. These coasters, with carrying capacity ranging from 600 to 1,000 tons, were capable of crossing the bay and plied to and from the port of Chattogram. The private sector thus entered a new field of specialized service and helped in easing the congestion at the seaport and bulk transportation of cargo to various points within the country at cheaper costs. There are as many as 100 coasters now plying on these routes. As an aftermath of the Indo-Pak War of 1965, as many as 193 Indian owned cargo vessels consisting of dumb flats, barges, tugs etc. were seized and adjudicated as prize of war in the High Court (Prize Jurisdiction). Later, most of these vessels were sold to the private sector.

Over the years the pattern in the movement of inland cargo traffic changed and this created a demand for self-propelled cargo vessels with capacity ranging from 80 tons to 350 tons. The

private sector again rose to the occasion to meet the demand. With the expert services rendered by IWTA, a large number of self-propelled cargo vessels were constructed in the private sector. Thus, 1,155 self-propelled cargo vessels with a total capacity of 268,603 tons are now owned in the private sector. Similar growth in the field of oil tankers took place. As a result, the number of oil tankers rose to 72 with a total capacity of 67,936 tons.

2.5 Inland ports and landing stations

BIWTA undertook schemes for development of inland river ports commensurate with the development of the IWT sector as a part of its chartered responsibilities, these ultimately resulted in the creation of five major inland river ports one each in Dhaka, Narayanganj, Chandpur, Barishal and Khulna at the initial stage. By a Gazettee Notification on 9 September 1960, the government extended the provisions of the Ports Act 1908 to the above named five inland river ports. Subsequently, six new inland river ports were created one each at Patuakhali (1975), Nagarbari (1983), Aricha (1983), Daulatdia (1983), Baghabari (1983) and Narsingdi (1989) to cater to the growing requirements in the IWTA sector. BIWTA also developed 5 ferry terminals one each at Aricha, Daulatdia, Nagarbari, Mawa, and Char Janajat to connect the capital city with the districts situated on the other side of the rivers Padma and the Jamuna by ferry services. Subsequently these ferry terminals have been established as inland river ports. After that BIWTA also established inland river ports at Ashugonj, Pangaon, Bhola, Baghabari, Faridpur, Tongi, Chilmari and Lakhmipur. Among all these inland river ports. Pangaon is Inland Container River Port. Above all these inland river ports, BIWTA established additional 37 such river ports. List of inland river ports is annexed as Annexure **V** (collected from traffic department-BIWTA). BIWTA provided facilities in these inland river ports for public use. But after the introduction of the multipurpose Padma bridge on 25 June 2022, the activities of Mawa and Charjanajat port have become useless.

Bangladesh is located in the Bengal Delta, the largest delta in the world. It is crisscrossed by rivers and tributaries. Besides inland river ports cited above there are four sea ports. These are, (1) Port of Chattogram, (2) Port of Mongla, (3) Port of Payra and (4) Port of Matarbari-deep sea port. The Figure 2-4: shows the location of the four sea ports and deep-sea ports of Bangladesh.

Figure 2-4: Location of four sea ports of Bangladesh *(Source: website)*

Out of the four seaports, two are in the process of being developed. The oldest and most important is the Chattogram Sea port. **Table 2-2** indicates description of sea ports. In addition to the development of inland river ports at the main commercial and urban centers, BIWTA took up schemes to provide landing facilities to the people of far-flung areas alongside the waterways by developing launch stations at important wayside ghats (wharf). The first scheme was drawn in 1969 when 50 launch ghats were taken up for development. Subsequently, further schemes for development of wayside launch ghats were taken up in 1970, 1975, 1980 and 1986. The number of launches' ghats so far developed by BIWTA is more than 400. The facilities provided in the launch ghats include floating steel pontoons of different sizes. The pontoons are connected with the shore by wooden jetties and gangways. The pontoons use for berthing of vessels, embarkation and disembarkation of passengers, and loading and unloading of cargo. On board the pontoons, there are waiting facilities with toilets for both ladies and gents. Three departments of BIWTA, namely Engineering, Conservancy and Pilotage, and Port and Traffic Department, involve in the operation, development and maintenance, etc. of inland river ports. The Engineering Department is responsible for construction, repair and maintenance of shore facilities such as terminal buildings, terminal sheds, jetties, gangways, quays, go-downs, roads and parking yards. The Conservancy and Pilotage Department provides floating facilities such as pontoons, buoys and moorings. The Ports and Traffic Department is responsible for operation

and utilization of the above facilities and realization of port revenue from their users. Hydrography Department of BIWTA surveys the waterways and prepare chart for safe and effective navigation and for other uses. Ports are operated and managed under certain specific legal provisions namely Ports Act 1908 and Port Rules 1966. The main areas of port management cover (a) operation of different port facilities, (b) regulating the movement of traffic, and (c) co-ordination of IWT with other modes of transports, sea-ports and trade and agricultural interests. The operational functions of the inland ports include, besides administration and management of personnel employed in the ports:

(i) allocation of berths to vessels
(ii) arranging embarkation and disembarkation of passengers
(iii) arranging loading/unloading and transshipment of cargo
(iv) stopping unauthorized activities within ports
(v) eviction of unauthorized structures/constructions from the port area
(vi) hoisting and announcing of weather signals
(vii) and controlling movement of vessels during inclement weather
(viii) stopping unauthorized operation/plying of vessels
(ix) coordinating with other concerned local agencies
(x) displaying the rates of different port charges at conspicuous places of the ports
(xi) and realizing different port charges within the frame-work of Ports Act 1908, Port Rules 1966 and BIWTA Ordinance 1958.

The port officials work in close cooperation with the River Traffic Police, Inspector of Shipping, and the associations of launch owners.

BIWTA, however, cannot operate directly all the port facilities under its management due to manpower shortage, budget and other physical constraints. Some facilities are, therefore, operated by leasehold operators engaged on annual basis through public auction, re-auction, tender and negotiation. Since 1991-92 leasehold operators have been engaged through sealed tenders only. All the 400 wayside launch stations developed by BIWTA are also operated and managed by leasehold operators engaged on an annual basis through sealed tenders. The activities of the leasehold operators are guided by the terms and conditions of the bilateral agreement executed with the BIWTA and are supervised by the port officials.

Table 2-2 indicates description of sea ports.

Sl.No.	Sea port name	Image	Location	Type	Status	Authority
1.	Port of Chattogram	1887  Chittagong port	Chattogram	Large Sea Port (Major port)	Active	Chattogram
2.	Port of Mongla	 Mongla Port1950	Mongla, Khulna	Large Sea Port (Major Port)	Active	Mongla Port Authority
3.	Port of Payra	Under Construction	Patuakhali, Barsahl	Sea Port (Minor Port)	Active	Payra Port Authority
4.	Matarbari Port	Under construction	Matarbari, Chattogram.	Deep Sea Port		Chattogram Port Authority

2. 6 IWTA fleet and the informal sector

The IWTA network consists mostly of passenger vessels, cargo vessels, tankers, tugboats and dumb crafts. As per Banglapedia ,(https://en.banglapedia.org/index.php/Water Transport) in 2000, the number of registered passenger vessels (including sea trucks and ferries) was 1,868, cargo vessels (including tanker and coaster) 2,160, dumb craft 760 and towing vessel 194. The present (2011) fleet strength of BIWTC is 97, of which 41 are registered passenger vessels and 56 ferries. The static carrying capacity of the IWTA fleet is about 0.20 million passengers and 0.55 million tons cargo. In terms of carrying capacity, the private sector outweighs the contribution of the public sector both for the passenger and cargo movement (private sector 93% for passenger and 95% for cargo). In the informal sector, the country boats plying mainly

in the perennial waterways play the key part. According to 1991/92 Bangladesh Bureau of Statistics, the number of country boats operating within the country was 745,000, a substantial part of which has already been mechanized mostly with low-cost shallow pump engines. Approximately 65% of the country boats are passenger boats and the rest are cargo boats. The static cargo capacity of the country boats is about one million tons, nearly double that of the formal IWTA sector. According to a recent report of ESCAP, Inland Waterways of Bangladesh are estimated to carry about 14% annual passengers (87.80 million per year) and 35% annual freight volume (58 million tons per year).

2. 7 In transit and inter-country traffic

During the British period, IGN and RSN Co used to operate their cargo services from Calcutta to Assam via East Bengal. In late 1950s, the governments of Pakistan and India entered into an agreement to make use of the waterways of both countries for trade between them and for passage of goods between two places of one country through the territory of the other. The agreement was titled 'Protocol on Inland Water Transit and Trade'. The trade continued well up to September 1965, when it was suspended due to the Indo-Pak war. On 28 March 1972, the governments of Bangladesh and India revived the agreement and introduced eight trade routes. These were:

(1) Kolkata- Haldia- Raimongal- -Chalna- Khulna- Mongla- Kawkhali-Barisal- Hizla-Chandpur- Narayanganj- Aricha- Sirajganj- Bahadurabad-Chilmari- Dhubri- Pandu-Shilghat

(2) Shilghat- Pandu- Dhubri- Chilmari- Bahadurabad- Sirajganj- Aricha-Narayanganj-Chandpur- Hizla- Barisal- Kawkhali- Mongla- Khulna-Chalna- Raimongal- Haldia-Kolkata

(3) Kolkata-Haldia-Raimongal- Mongla- Kawkhali- Barisal- Hizla-Chandpur- Narayanganj-Bhairab Bazar- Ashuganj- Ajmiriganj- Markuli-Sherpur- Fenchuganj- Zakiganj-Karimganj.

(4) Karimganj- Zakiganj- Fenchuganj- Sherpur- Markuli- Ajmiriganj-Ashuganj- Bhairab Bazar- Narayanganj- Chandpur- Hizla- Bansal-Kawkhali- Mongla- Raimongal- Haldia-Kolkata

(5) Rajshahi- Godagari- Dhulian.

(6) Dhulian- Godagari- Rajshahi.

(7) Karimganj- Zakiganj- Fenchuganj- Sherpur- Markuli- Ajmiriganj-Ashuganj- Bhairab Bazar-Narayanganj- Chandpur- Aricha- Sirajganj-Bahadurabad- Chilmari- Dhubri- Pandu- Shilghat.-

(8) Shilghat- Pandu- Dhubri- Chilmari- Bahadurabad- Sirajganj- Aricha- Chandpur- Narayanganj-Bhairab Bazar- Ashuganj- Ajmiriganj- Markuli-Sherpur- Fenchuganj- Zakiganj- Karimgan

or such other routes as may be prescribed by the competent Authorities from time to time. "In pursuance of Article VIII of the Trade Agreement entered into between the Government of the Republic of India and the Government of the People's Republic of Bangladesh on the Sixth day of June, 2015 wherein the two governments agree to make mutually beneficial arrangements for the use of their waterways for commerce between the two countries and for passage of goods between two places in one country and to third countries through the territory of the other under the terms mutually agreed upon. To continue the inland waterways transit and inter country traffic, maintenance of smooth navigability in the waterways is the first priority.

(source: https://www.mea.gov.in/Portal/LegalTreatiesDoc/BG15B2421.pdf).

2. 8 Regulation of traffic

Department of Shipping mainly exercises traffic regulation as vested by the government, 'Time and Fare Table Approval Rules 1970' has delegated some regulatory powers to BIWTA also in respect of (a) approval of timetables and route permits of passenger vessels and (b) fixation of fares and freights. Timetables are issued to passenger launches plying on inland waters showing the time of departure from the originating station and time of arrival at the destination along with the timings at the intermediate stations. Applications for approval of timetables of passenger launches are invited twice in two seasons, summer and winter. The former commences from 1st June and ends on 31st October. The latter begins on 1st November and ends on 30th May. Timetables are issued after scrutiny of relevant documents as per the provisions of the Inland Shipping Ordinance (ISO) 1976. 595 timetables have been issued to 739 passenger launches on 230 routes. The government has deregulated the fixation of freight rate with effect from 21 August 1991. The Ports and Traffic Department also conducts traffic survey, collects and compiles traffic statistics, and brings out the annual Ports and Traffic Reports that substantially help in traffic regulation.

2. 9 Present condition of the waterways Network

As the chartered function, BIWTA performs the hydrographic survey to know the waterways condition of Bangladesh. Presently BIWTA performs hydrographic surveys only in the routes and areas which require priority attention. Hydrographic surveys or other related investigations as such have not been carried out over a vast portion of the IWT network in recent years, principally due to lack of funds. However, information gathered from BIWTA officials and operators reveal that navigation during high water periods do not usually face any problems. In the winter seasons, although there exist long stretches of waterways with sufficient depths. Sedimentation and shoals appear in many places and hinder vessel movement, these are the critical spots which influence navigation over an entire fairway and which BIWTA has to dredge in order to make smooth, fare and nonhazardous navigation. The IWT corridor from Dhaka and Narayanganj inland ports to Chattogram seaport is of prime national importance and is classified as class-I with a guaranteed LAD of 3.65 m. The waterway has adequate navigational draught for most of its length even during low water season except for spots where deposition of silt takes place. One of such chronic problem spots lies near about Hizla (near Bhola) in the lower Meghna River. The route also crosses the open coastal waterways of the Bay of Bengal which is subjected to rough waves and therefore requires specially built vessels to ply through.

The next important IWT corridor is the waterways from Dhaka and Narayanganj to Khulna. It is also the route that connects the capital with Barisal Inland River Port and the Mongla seaport, classified as a Class-I waterway. It ensures a LAD of 3.65 m. This waterway also maintains enough navigability round the year for most of its length. The approach of Barisal Inland River Port is known to suffer from acute siltation problem and requires maintenance dredging annually to keep it navigable during winter. The inland waterway corridor to the Northern part of Bangladesh, specifically to Chatak and Sylhet, is classified as class- 1 up to Bhairab Bazar (LAD is 3.65 m) and reduces thereafter to depths ranging from 2.1m to 1.5m, which levels further decrease during the dry seasons. The vessel owners are thus compelled to sail at half to three quarter of full load capacity.

The navigational depths in some 1000 km of classified routes mostly belonging to Class-4 category, reduces in the winter seasons to such an extent that those become unsuitable even for vessels with less than 1.5m draught. In the monsoon seasons too, situations are not favorable every year. The entrance to Chandpur River port which lies at the confluence of three rivers

viz. the Padma, the Meghna and the Dakatia can be cited as an example of creation of eddy. A dangerous eddy is produced there which has proved to be hazardous and which has already been the scene of tragic accidents in the past. This is due to tremendous variation of depths in the three rivers. But very recently this hazardous situation has been lessened by dredging channel, the Meghna River at downstream near Haimchar, Chandpur.

2. 9.1 Hydraulics of shoal formation in inland waterways

Unless other-wise controlled, a river, by nature, does not behave smoothly and regularly. This is true for all rivers, big and small, narrow and wide, as a river is essentially a drainage channel, its main characteristics depend upon the run-off from the catchment's areas, which obviously change with time, place and magnitude.

The most important characteristic of a river is its variation in discharge. Every river, during monsoon i.e., at the periods of peak discharge and low flow have the tendency to occur during the same periods of the year. For example, in Bangladesh, peak discharges for most rivers generally occur in the four monsoon months of high rainfall from June through September and the low-flow periods occur from November through March. The occurrence of alternative high and low discharge in a river has an adverse effect on its channel condition, particularly its bed, which is a function of the sediment content of river.

The transportation of sediment by the river is its second important characteristic. The sediment is eroded materials, originating in the river's catchments area, washed down into the river by the running water and is deposited on it, in its delta or in the sea. The continuous process of material displacement results in a slow alternation in the rivers longitudinal profile. This geological process is continuous and cannot be stopped, and hence must be accepted. [11]

2.9.2 Dredging and dredgers

Dredging is a displacement of soil, carried out under water. It serves several different purposes. One of the applications meet the need to maintain minimum depths in canals and harbors by removing mud, sludge, gravel and rocks. Maintenance dredging is now only a basic task, while other fields are growing in demand much faster: creating new land for port and industrial development; trenching, backfilling and protection work for offshore pipelines, coastal outfall pipelines and for cables laid on the sea bed; environmental dredging and clean-up of contaminated sediments; replenishment of beaches and coastlines, not only for coastal protection but also for recreational uses.[10],[15]. Dredging has a varied activity. It is mainly

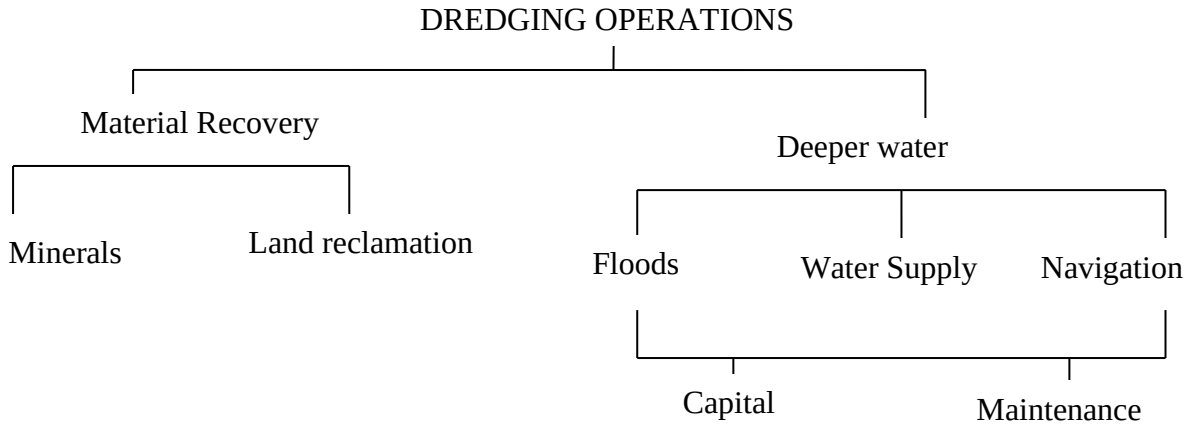
concerned with dredging for navigation and land reclamation. When the objectives of the dredging should be either recovered of materials from below the water surface (usually when that material has a value) or to achieve greater depths of water for easy passage of shipping, dredging can be broadly divided into (1) Capital dredging and (2). Maintenance dredging.

2.9.2.1 Capital dredging

The initial deepening of the area, the full range of soil types can be encountered for example creation of a new canal or the deepening post entrance channel or berth., Capital dredging is usually undertaken by a specialist dredging contractor often designed by specialist consultant and man receive financial assistance in the form of loans and grants.

2.9.2.2 Maintenance dredging

The periodic removal from a previously deepened area of material deposited in that area normally soft material such as silt, mud and sand. Maintenance dredging may be required only once every three or four years, once every year, or continuously depending upon the salutation rate and pattern. Maintenance dredging may be undertaken either by dredgers owned by the port or navigation authority or by a dredging contractor. Dredging is a displacement of soil, carried out under water. It serves several different purposes. One of the applications meet the need to maintain minimum depths in canals and harbors by removing mud, sludge, gravel and rocks. Maintenance dredging is now only a basic task, while other fields are growing in demand much faster: creating new land for port and industrial development; trenching, backfilling and protection work for offshore pipelines, coastal outfall pipelines and for cables laid on the sea bed; environmental dredging and clean-up of contaminated sediments; replenishment of beaches and coastlines, not only for coastal protection but also for recreational uses.[20] There are two methods of dredging: mechanical excavating and hydraulic excavating. Mechanical excavating is applied to cohesive soils. The dredged material is excavated and removed using mechanical means such as grabs, buckets, cutter heads or scoops. On the other hand, hydraulic excavating is done with special water jests in cohesionless soils such as silt, sand and gravel. The dredged material which has been loosened from the river-bed is sucked up and transported further as a mixture (solid material and water) using centrifugal pumps.



2.9.3 Maintenance dredging: Improve navigability

The river beds in Bangladesh are generally made of alluvial soil. As the water streams downstream, the soft character permits it to be cut through and shaped into newer and newer bed forms. Since the rivers are dependent upon the snow melts from the Himalayan range and the monsoon rains, the water discharge from upstream and the corresponding water levels not only differ from year to year but also fluctuate throughout the year. Thus, one single river is found to behave as two different rives one with a large discharge during the monsoon and the other with a low discharge during the winter. Each differ from the other in characteristics, meander patterns, bed forms, sediment transports, depths, flow velocity, etc.

The low discharge in the winter forms a system of channels in the river that is completely destroyed by the high run off during the monsoons. Again, when the floods have receded and the water levels fall down, the low discharge river with its characteristic channels and sandbanks asserts itself, this is never-ending process, continues in cycles and is repeated year after year.

The dual nature of a single river creates problems for navigation. Particularly, the low water season, shoals and sandbars surface in the channels creating obstacles to navigation. So, these have to be cleared off. In most cases, this is the natural phenomenon that occurs in the river of Bangladesh and navigation is improved by removing the shoals and sandbars by dredging.[10]

2.9.4 Waterways System and its contribution

The IWT system in Bangladesh is both extensive and well-connected with the rest of the transport system. In terms of traffic intensity, the inland waterways network generates about 1.57 million passenger-km per route-km of waterway. The density of inland ports and terminals

is much higher on the inland waterways with approximately 3.7 berthing facilities per 100 route-km. The density of passenger facilities on the inland waterways is also high at around 40 berthing facilities per 100 route-km. Even though there is considerable uncertainty attached to the forecasts, it is clear that inland water transport will continue to play a significant role in passenger and cargo movements. The inland ports and landing ghats serve as feeder ports to the four seaports of the country and one inland container port. In addition to the cargo that moves from one inland port to another. Inland ports handle about 40% of the country's total exports and imports. BIWTA at present operates 37 inland river ports. Through those inland ports from 2010-2011 to 2020-2021 carried 116.951-million-ton cargo and 253.5 million passengers (Annexure VI). During floods, cyclones and other natural calamities, IWT and inland ports render essential services to the nation through transportation and handling of relief materials in areas where road and rail communication are not available or have become disrupted. Water transportation is cheaper, safer, and environment-friendly and will thus continue to play a significant role in the economic life of Bangladesh in the future.

2.10 Mechanical dredging

2.10.1 Navigation of Waterways

Just in last decade, dredging works across the country have added in river system of Bangladesh an additional 2,300 kilometers of navigational waterways.

In 2012, following a renewed Bangladesh Government dredging initiative, Ellicott began supplying dredgers to the Bangladesh Inland Waterway Transport Authority (BIWTA) and the Bangladesh Water Development Board (BWDB). In the past decade, these two governmental organizations have purchased 32 dredgers, over half of which are Ellicott dredges. This includes a mix of the Series 1270- 18-inch Dragon, Series 1870 -20-inch Dragon, and the Series 3870- 26-inch Super Dragon dredgers. The first Ellicott brand dredger was supplied to the Bangladesh government- the then of East Pakistan at the time, in 1963. Most recently ten (10) Ellicott dredgers were inaugurated on May 6, 2021 by Prime Minister Sheikh Hasina.

At the inauguration event, the Prime Minister inaugurated over 100 marine vessels including the Ellicott cutter suction dredgers. The new Ellicott units join many privately owned dredgers working throughout Bangladesh. **Figure 2-5** describes Ellicott dredger working in river. Due to lack of maintenance, construction, and natural sedimentation, waterway navigation in Bangladesh can be difficult. With the assistance of Ellicott Dredgers, Bangladesh now has 5,900 km of accessible waterways during the dry season, up from only 3865 km in 2005.

Figure 2-5: Ellicott dredger (Dragon)-Active in the Padma River

Backhoe dredger – A backhoe dredger is based on the giant land-based backhoe excavator that is mounted at one end of a spud-rigged pontoon. Its main advantage is its ability to dredge a wide range of materials, including debris and soft, weathered or fractured rocks. Figure 2-6 is a photograph of Backhoe Dredger.

Figure 2-6: Backhoe dredger in action

Bucket chain dredger – Bucket chain dredge or bucket ladder dredge is a stationary dredger equipped with an endless chain of buckets carried by the ladder. The buckets are attached to a chain and graded according to size (200 to 1000 litres). Bucket dredgers are held in place by anchors.

Figure 2-7: Bucket chain dredger

These days, this classic vessel is mainly used on environmental dredging projects. The bucket chain dredger uses a continuous chain of buckets to scoop material from the bottom and raise it above water. The buckets are inverted as they pass over the top tumbler, causing their contents to be discharged by gravity onto chutes which convey the spoil into barges alongside. Positioning and movements are achieved by means of winches and anchors. Figure 2-7: is a photograph of Bucket Chain Dredger.

Cutter suction dredger – The cutter suction dredger is a stationary dredger equipped with a cutter head, which excavates the soil before it is sucked up by the flow of the dredge pump.

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Figure 2-8: Photograph of Cutter Suction dredger ***(Source: website)***

During operation the cutter suction dredger moves around a spud pole by pulling and slacking on the two fore sideline wires. These dredgers are often used to dredge trenches for pipe lines and approach channels in hard soil. Seagoing cutter suction dredgers have their own propulsion. Figure 2-8 is a photograph of Cutter Suction Dredger in action. BIWTA uses this dredger for excavation.

Trailing suction hopper dredger (TSHD) –

The trailing suction hopper dredger is nonstationary dredger, which means that it is not anchored by wires or spud but it is dynamically positioned; the dredger uses its propulsion equipment to proceed over the track. It is a ship shaped vessel with hopper type cargo holds to store the slurry. At each side of the ship is a suction arm, which consists of a lower and a higher part, connected through carbamic joints. Trailing suction hopper dredgers are used for maintenance work (removal of deposits in approach channels) and dredging of trenches in softer soils. The dredger is powered by two Wartsila 6L32 engines, each of 2760kW MCR output at 750 rpm. Each engine drives through reduction gearbox 2500mm diameter CP propeller running at 230 rpm in the nozzle. The maximum power available for propulsion is 2000 kw per propeller. The single dredge pump is driven directly off the forward end of the starboard main engine through a clutch coupling, a long shaft and a two-stage variable-speed gearbox. An equivalent arrangement is employed for the twin jet pumps on the port side. **Figure 2.9**: is a photograph of Trailing Suction Hopper Dredger. TSHD has several special features, the main one being a drag arm which works as vacuum cleaner. Drag arm consists of a suction bend, lower and upper suction pipes connected via double cardan hinge and a drag head. The suction bend is mounted in a trunnion which forms part of the sliding piece; as the pipe goes outboard the sliding piece enters the guide on the hull and is lowered until the bend is in line with the suction inlet below the waterline. The suction pipe can be equipped with an integral submerged dredge pump. Submerged dredge pumps have become more and more popular with operators of larger trailing suction hopper dredges.

Figure 2-9: Trailing Suction Hopper Dredger (*Source: website*)

Locating the dredge pump in the suction pipe positions is much closer to the seabed than a conventional dredge pump housed in the hull. The drag arm is hoisted outboard and lowered to dredging depth with the aid of gantries. When not in use, it is lifted above the main deck level and pulled inboard with the hydraulically powered gantries for storage**. *(Source: Web site)***

Grab dredger – A grab dredger employs a grab mounted on cranes or crane beams. Dredged material is loaded into barges that operate independently. Grabs can manage both sludge and hard objects (blocks of stone, wrecks) and this makes them suitable for clearing up waters that are difficult to access (canals in cities), or for gravel winning and maintenance dredging on uneven beds. Figure 2-10 is a photograph of Grab Dredger**. *(source: website)***

Figure 2-10 Grab Dredger *(Source: website)*

Suction Dredgers - Plain suction dredger – A plain suction dredger is a stationary dredger

positioned on wires with at least one dredge pump connected to the suction pipe situated in a well in front of a pontoon. The dredged soil is discharged either by pipeline or by barges. Figure 2-11 is a photograph of BIWTA Dredger 1420-2 Cutter Suction Dredger in action.

Figure 2-11: BIWTA Dredger 1420-2 Cutter Suction Dredger

2.11 Institutions of IWT

The main public institutions in the IWT sector are:

(1) The Ministry of Shipping (MOS), which has overall responsibility of the sector,
(2) The department of Shipping (DOS), which is a department of MOS
(3) The Bangladesh Inland Water Transport (BIWTA)
(4) The Bangladesh Inland Water Transport Corporation (BIWTC)

(1) Department of Shipping: DOS is responsible for safety, the provision of the regulatory framework for the sector and for training and scrutiny of maritime staff. It includes the Inland Ship Safety Administration (ISSA), which is responsible for the definition and enforcement of ship safety rules and for registering vessels. ISSA is also the institution responsible for managing environmental aspects of the sector.

(2) Bangladesh Inland Water Transport Authority (BIWTA): is a parastatal responsible for maintenance and development of waterways.

(a) Provision dredging services
(b) Provision of pilots and navigational aids
(c) Provision hydrographic surveys/services

(d) Management and administration of Inland ports and landing facilities of significant importance

(e) Regulations of transport operations including licensing and scheduling of routes and setting up of traffics

(f) Approval of the design of vessels plying in the inland water of Bangladesh

(g) Training and research.

(3) Bangladesh Inland Water Transport Corporation (BIWTC): is also a parastatal providing passengers and freight shipping services. Its main business is the provision of ferry services at four major river crossings and the operation of passenger services in the coastal area.

Chapter 3

Methodology

3.1 General

This research has been conducted mainly using primary and secondary data collected from face-to-face interview and field survey/investigation. Field visit including waterways dredging vicinity (Figure 1-1, 2-1 and Figure 2-3-Waterways network) was most important for this study. The field survey was conducted by interviewing high officials of BIWTA-Mr. Mizanur Rahman, Superintending Engineer, Dredging Department and Mr. Md. Shahid Ullah, Joint Director (Marine Safety & Traffic Management Department) BIWTA at Sadarghat-Dhaka and Narayanganj Inland River Port areas since these two are the major Inland River Ports in Bangladesh. Before starting the survey, a set of questionnaires was prepared for interviewing the Superintending Engineer and Joint Director. The questionnaire survey and interview were limited to the persons who are directly involved with the navigation and dredging waterways. The questionnaire was prepared on the development-maintenance dredging project executed, ongoing and to be executed projects, list of existing dredgers and to be procured, annual dredging requirement etc. and their experience about various navigational techniques to cope up with the challenges arising from navigational problems, meteorological condition and seafaring laws of the Bangladesh Inland Water Transport Authority. In this regard, several key persons interviewed and focus group discussion were conducted including Passenger and Cargo Traffic Vessel Owners Association at Sadarghat-Dhaka and Narayanganj. To achieve the objectives of study the following methodology had been adopted –

i) Collection of previous 10 to 20 years dredging quantity, expenditure & budget allocation including requirements
ii) Review the hydrographic chart(s)
iii) Study dredging alignment
iv) Collection of data on dredging capacity
v) Field visits
vi) Analysis of data using computer programming
vii) Analyze data found during field survey/field investigation.

All the data related to dredging waterways and waterways transport, hydrographic chart(s) collected from BIWTA, Bangladesh Water Development Board (BWDB) and Department of Shipping (DOS). Technical analysis method had been adopted for the analysis of the collected data. **Figure 3-1** is a diagram of the frame work of the research work.[17]

3.2 Location of the study area

3.2.1 Location of interviewing places

Location of Inland River Port namely Dhaka Inland River Port stands on the bank of the Burigonga River. Narayangonj Inland River Port situated on the bank of the Sitalakhya River. Face to face interview was conducted with senior officers of the port authority who are working with the waterway's navigation and dredging waterways. The **Figure 3-2** illustrates the location of the interviewing area.

Flow Diagram of Research work

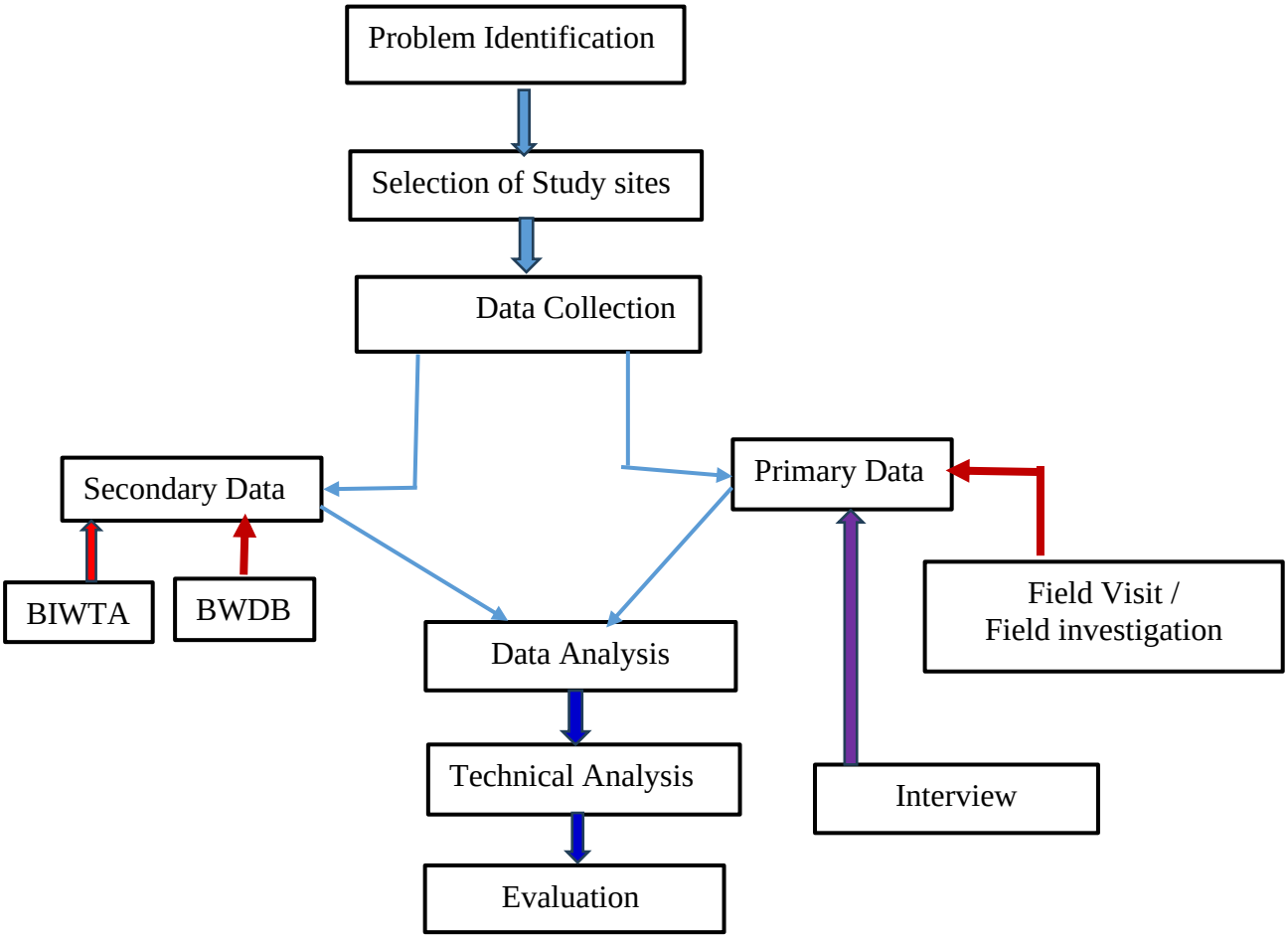

Figure 3-1: Frame Work of Research

3.2.2 Study site area

This research work was embraced the navigational waterways all over Bangladesh and the major rivers like the Meghna River, the Jamuna River and the Padma River (**Figure 1-1, 2-1 and Figure 2-3-Waterways network)**

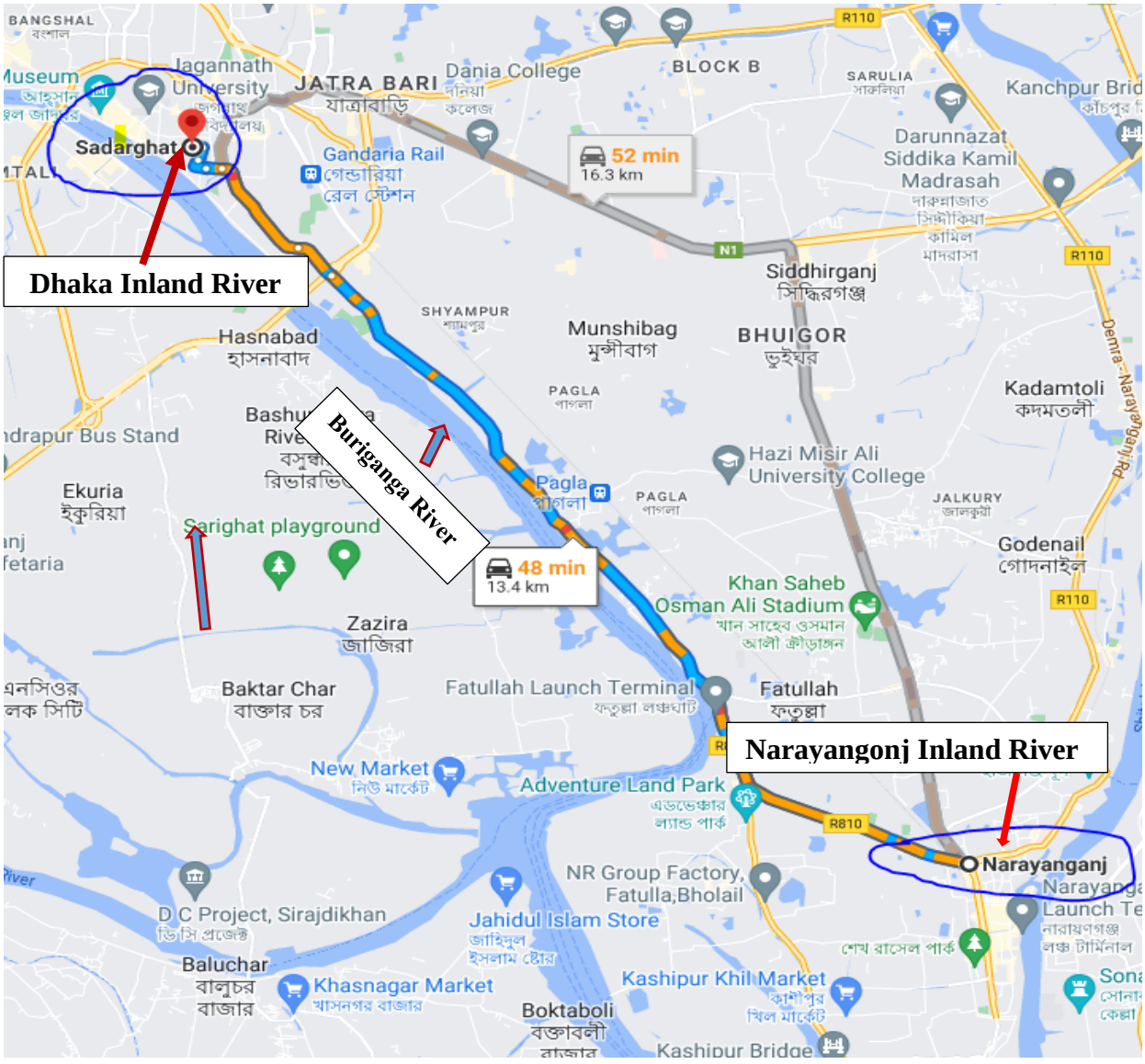

Figure 3-2: Field survey and interviewing area. ***(Source: website)***

3.3 Data collection

This research work needs primary and secondary data. Secondary data collected from the different institutions related to the IWT and dredging waterways. There are three institutions related to the waterways. They are (i) BIWTA (ii) BIWTC and (iii) DOS. These institutions are

controlled by the Ministry of Shipping and IWT (MOS), Government of Bangladesh. Private sectors have also contribution to the development and maintenance of waterways for fare navigation.

(i) BIWTA

Maintains waterways navigable

The then East Pakistan Government on 31st October 1958 promulgated an ordinance called the 'East Pakistan Inland Water Transport Authority Ordinance 1958' (E.P. Ordinance, NO LXXV of 1958). Under this ordinance East Pakistan Inland Water Transport Authority (EPIWTA) was established for development, maintenance and control of inland water transport and of certain inland navigable waterways. After the liberation of Bangladesh EPIWTA has been converted to Bangladesh Inland Water Transport Authority (BIWTA). The prime functions of BIWTA are

1 Disseminate navigational and meteorological information including publishing river charts.

2 Maintain pilotage and Hydrographic survey services.

Figure 3-3: Photograph of Dhaka Inland River Port ***(Source: website)***

3 Draw up programs of dredging requirements and priorities for efficient maintenance of existing navigable waterways and for resuscitation of dead and dying rivers, channels including development of new channels and canals for navigation.

4 Develop, maintain and operate inland river ports, landing ghats and terminal facilities in such ports and ghats.

5 Carryout removal of wrecks and obstruction in inland navigable waterways

6 Conduct traffic surveys to establish passengers and cargo requirements of the main river, feeders and creek routes.

Bangladesh has about 24,000 km length of rivers, streams and canals that together cover about 7% of the surface of the country. Most part of the country is linked by a complex network of waterways which reaches its extensive size in the monsoon period. Out of this length of rivers, streams and canals only about 5,968 km is navigable by mechanized vessels during monsoon period which shrinks to about 3,865 km during dry period. The IWT sector carries over 50% of all arterial freight traffic and one quarter of all passenger traffic.

3.3.1 Dredging Department

Navigability of waterways is developed and maintained by dredging department of BIWTA. Data for this research purpose are collected from Dredging Department. This department is responsible to keep waterways navigable in Bangladesh. The administrative structure of Dredging Department of BIWTA is shown in **Figure 3-4** which illustrates the organogram **of BIWTA Dredging Department.** BIWTA conducts dredging works with the help of 40 Cutter Suction Dredgers (CSD).

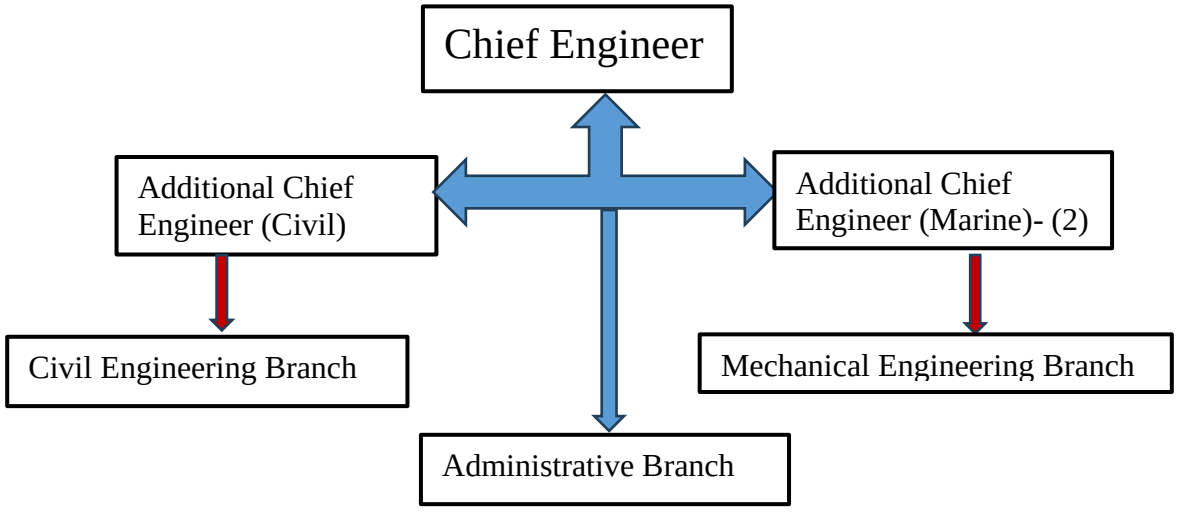

Figure 3-4: Illustrates the organogram of BIWTA Dredging Department

(ii) BIWTC: Bangladesh Inland Water Transport corporation is an institution of the Government of Bangladesh operates water transport both passenger and cargo all over Bangladesh and abroad.

(iii) DOS: Department of Shipping is also an institution of the Government of Bangladesh conduct ship survey. They also provide ship design and fitness to the national and international ships.

There are another government organization named Bangladesh Water Development Board (BWDB). BWDB has 16 Cutter suction dredgers. They are responsible for the development and maintenance of irrigation and drainage channel. Sometimes they engage their dredgers in contract basis with the BIWTA for development and maintenance of waterways. There are 211 dredgers in Bangladesh including private organizations' dredgers. Private dredgers (155) have also contribution to waterways development and maintenance. Sometime private organizations engage their dredgers in maintenance and development of waterways with BIWTA on contract basis.[4]

3.3.2 Dredging data

BIWTA engages 40 Cutter Suction Dredgers having cutter size 23-18", 11-20" and 6-26" sizes cutter suction dredgers. With this dredgers BIWTA maintain waterways navigable for fare transportation of water vessels. Yearly dredging performance is 5.50 million m^3. Table 3-1 and Table 3-2 illustrate year wise dredging performance from 2000-2001 to 2021-2022.

Table 3-1 Maintenance Dredging Data (2000-2012)-*Source: BIWTA*

Year	Total dredging activity			
	Total dredging	By BIWTA dredgers	By BWDB dredgers	By private dredgers
2000-2001	3.07	2.74	0.33	-
2001-2002	3.08	2.71	0.37	-
2002-2003	3.15	3.15	-	-
2003-2004	3.22	3.12	0.10	-
2004-2005	3.48	2.88	0.53	0.08
2005-2006	6.48	2.97	0.17	3.34
2006-2007	3.67	2.93	0.35	0.5
2007-2008	3.12	1.76	0.74	0.62
2008-2009	4.75	3.25	0.80	0.70
2009-2010	5.5	4.0	0.75	0.75
2010-2011	8.15	6.60	0.85	0.70
2011-2012	5.95	5.4	0.55	-
Total	53.62	41.51	5.54	6.69

3.4 Site visit

Site visit is another part of the methodology. BIWTA conducts dredging in different locations of navigational channel where shoal forms cause obstacles to water transport plying on

waterways. The purpose of site visit was to observe and investigate the physical dredging works and to get interview from dredging and dredgers' personnel.

Table 3-2: Maintenance Dredging Data (2011-2022), *Source BIWTA*

Year	Maintenance (million m^3)	Development (million m^3)	Total (million m^3)
2011-2012	5.95	2.447	6.808
2012-2013	4.47	5.603	10.068
2013-2014	5.79	4.702	10.492
2014-2015	5.08	12.015	17.092
2015-2016	5.43	15.021	20.455
2016-2017	5.84	15.00	20.84
2017-2018	6.20	15.6	21.8
2018-2019	6.50	16.20	22.70
2019-2020	6.80	12.31	19.11
2020-2021	6.30	13.56	19.86
2021-2022	6.15	16.25	22.4
Total	**64.51**	**128.71**	**193.22**

3.5 Methods - Dredging of Channel

BIWTA has the vested responsibility to maintain and develop waterways network in Bangladesh. As for this BIWTA keeps the waterways navigable for smooth and safe navigation to water transport. So, BIWTA always engages Dredging Department for this purpose. Dredger engages to keep the waterways navigable. For keeping the waterways navigable, some prerequisite activities have to conduct. These are to conduct engineering survey and hydrographic survey and preparation of charts to identify shoal and access the dredging quantity. Study survey chart and then fix the dredging alignment for the removal of shoal to get the necessary draught for safe navigation. During maintenance and capital dredging, spoil coming out from the dredging, relocate in two processes. These are (i) open dumping in sea/river and (ii) compartmental dumping. Photograph 3-1 illustrates compartmental river dredging and the photograph 3-2 explains open discharge - river dredging by BIWTA.[5],[10]

Photograph 3-1: River dredging by BIWTA *(Source BIWTA)*

Photograph 3-2: River dredging – Open discharge *(source BIWTA)*

Photograph 3-3: Dredging surrounding Barishal Inland River Port areas to ease the navigability crisis for river transportation in Barishal region *(Source:* Dhaka Tribune)

3.5.1 Existing depths

Existing depths can be determined either by reference to up to date, accurate charts or sounding plans of the area or by undertaking a hydrographic (bathymetric) survey. First step is to consult the national and local port authorities, survey service, navy etc. More detailed information is provided by the actual survey drawings rather than the published charts. In most parts of the world areas have been surveyed more than once and comparison of depths over the years can assist in determining possible natural shoaling or deepening. If no information is available, or it is old insufficient or otherwise possibly unreliable, a new survey has to be undertaken, this will usually be in two stages, the first stage will be used for project planning, design and feasibility studies, including an indication of dredged quantities. The second will be undertaken as part of the dredging contract, the pre dredged survey and should be carried out immediately prior to dredging. This survey will be used for actual quantity measurement and possibly as basis for payment. Care needs to be taken to establish a correct datum. This is usually Chart Datum (CD) and not the land datum, CD is usually defined within a country as Mean Sea Level (MSL) and as such will vary relative to land datum from place to place. The relationship in terms of level between CD and the land datum at the dredging site needs to be carefully established and clearly specified on all drawings and contract documents. **Figure 3- 5**:

hydrographic chart showing sounding detail with shoal.

Hydrographic surveying is normally undertaken using an echo sounder, this emits through a transducer an acoustic signal which travels through the water and is reflected off some surface back to the transducer. The time taken is related to the water depth, but is also affected by salinity, temperature, suspended solids and aeration. The echo sounder thus requires careful and frequent calibration. Because of the time involved in manual plotting of surveys the fully automated survey system is now in widespread use, this involves an electronic position fixing

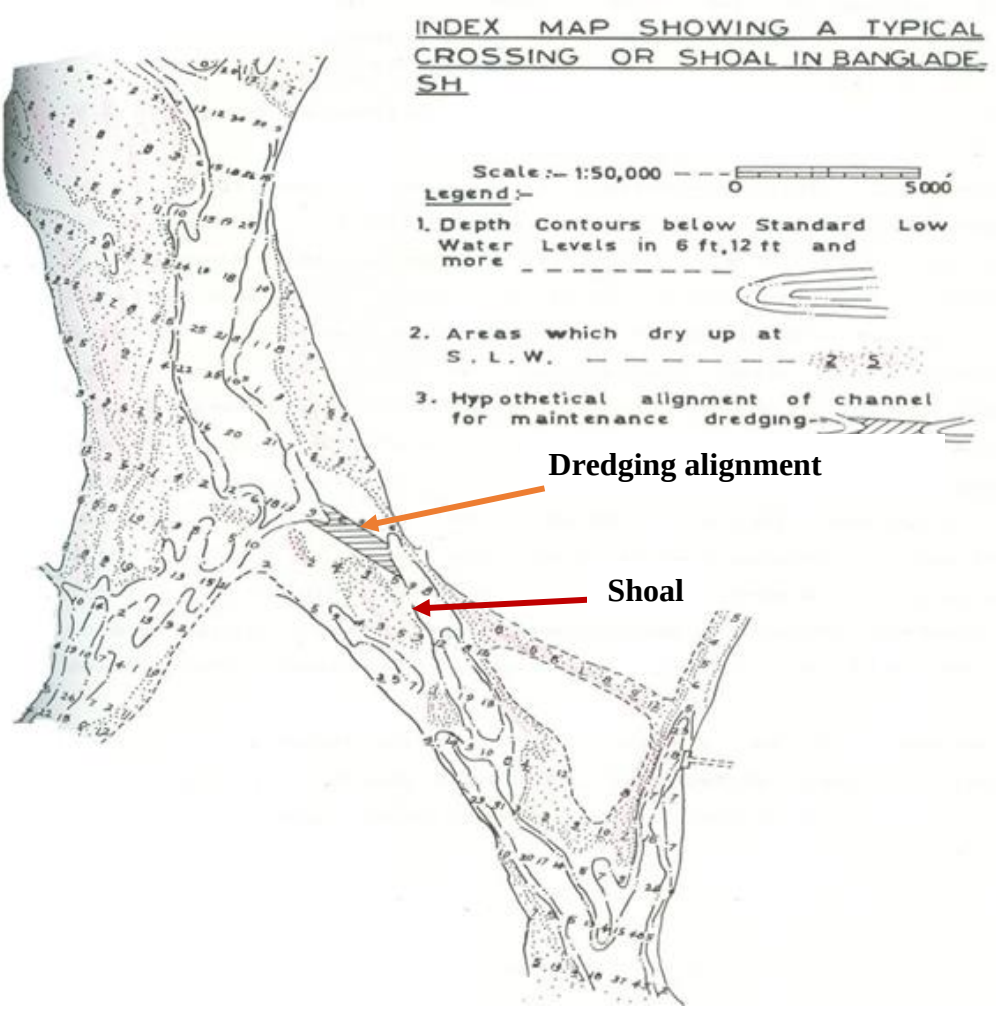

Figure 3- 5: Hydrographic chart showing sounding detail with shoal.

system to give horizontal location, a digital echo sounder, a transmitting tide gauge and a microprocessor controller or computer, the resulting sounding sheet is plotted automatically. The depth plotted is that from the datum to the reselecting surface. Where the sea bed is firm, for example sand, the sea bed easily defined, where the bottom is soft mud, and there is no distinct change between what may be muddy water and watery mud, definition is more difficult.

The ‘bottom’ as measured by the echo sounder will then depend upon the energy or frequency of the acoustic signal. A high frequency sounder of say 200 KHz commonly used for channel survey will reflect off low density material whereas a low frequency sounder (30 KHz) will record a greater depth. This difficulty, common in areas where fluid mud exists on the bottom, has led to the concept of NAUTICAL DEPTH. This is often defined as the depth to a mud level with a density of 1200 kg/m^3. The possible existence fluid mud can be checked by using a dual or multi frequency echo sounder. For physical dredging work, engineering survey plays an important role. Instantaneous depth calculation with respect to field for deploying dredger at dredging alignment engineering survey map plays an important role.

3.5.2 Design depths

The required design depth needs careful consideration and is an economic balance between the cost of capital and maintenance dredging and the benefit from the shipping able to enter safely. The following factors should be considered,

- Size, type and draft of ships using the port
- 24-hour access or tidal working fully loaded in /out or partially loaded with light range consequences of delay or grounding

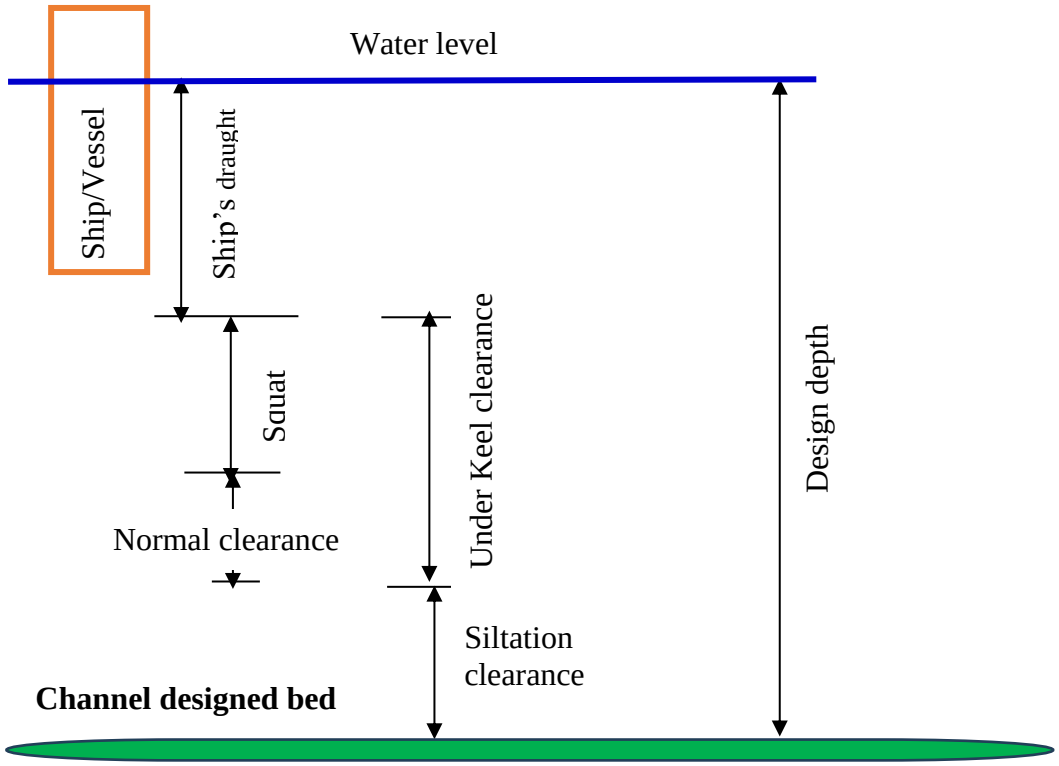

Figure3-6: Represents design depth of ship

As an example, a harbor with mud bottom used by small general cargo ships or coasters does not require the same design standards as one with a hard bottom used by passenger ferries or container ships. **Figure 3-6** represents design depth of ship. The benefit of creation and maintaining adequate depths for what may be a relatively small number of large vessels should also be carefully considered.

The maximum static stable draught of the design vessel must be increased to allow an adequate under keel clearance. Under keel clearance is needed to allow for increased draught caused by squat (dependent upon the shape and speed of the vessel, least possibly caused by cargo movement), waves or swell (common at entrance bars), and reduced salinity (common in estuarine or river ports,) Each of these effects can be calculated and a probability of occurrence determined. This can involve every clearance is simply based on a percentage of the static draft. Recommended values for large vessels are 20-25% in open water, 15% in sheltered channels and 10% in berths and areas where tugs assist. Possible siltation should always be allowed for as should the accuracy of dredging and depth measurement.

Under keel Clearance- is a depth between the bottoms of ship and river bed.

Squat- The increased draft caused by the vessel moving through the water, known as squat. This effect is independent upon the speed, trimmed and shape of the ship and the water depth.

Squat calculation:

$$\text{Squat} = C_B \frac{V^2}{100} \text{ m, open water}$$

Where V = Knots, C_B = 0.55, for container ship, C_B = 0.8, for tanker

$$\text{Squat} = C_B \frac{V^2}{50} \text{ m, confined water, } C_B = \text{Bulk carriers / Tankers} = 0.8/0.9$$

Squat may also be calculated by using graph- **Figure 3-7**

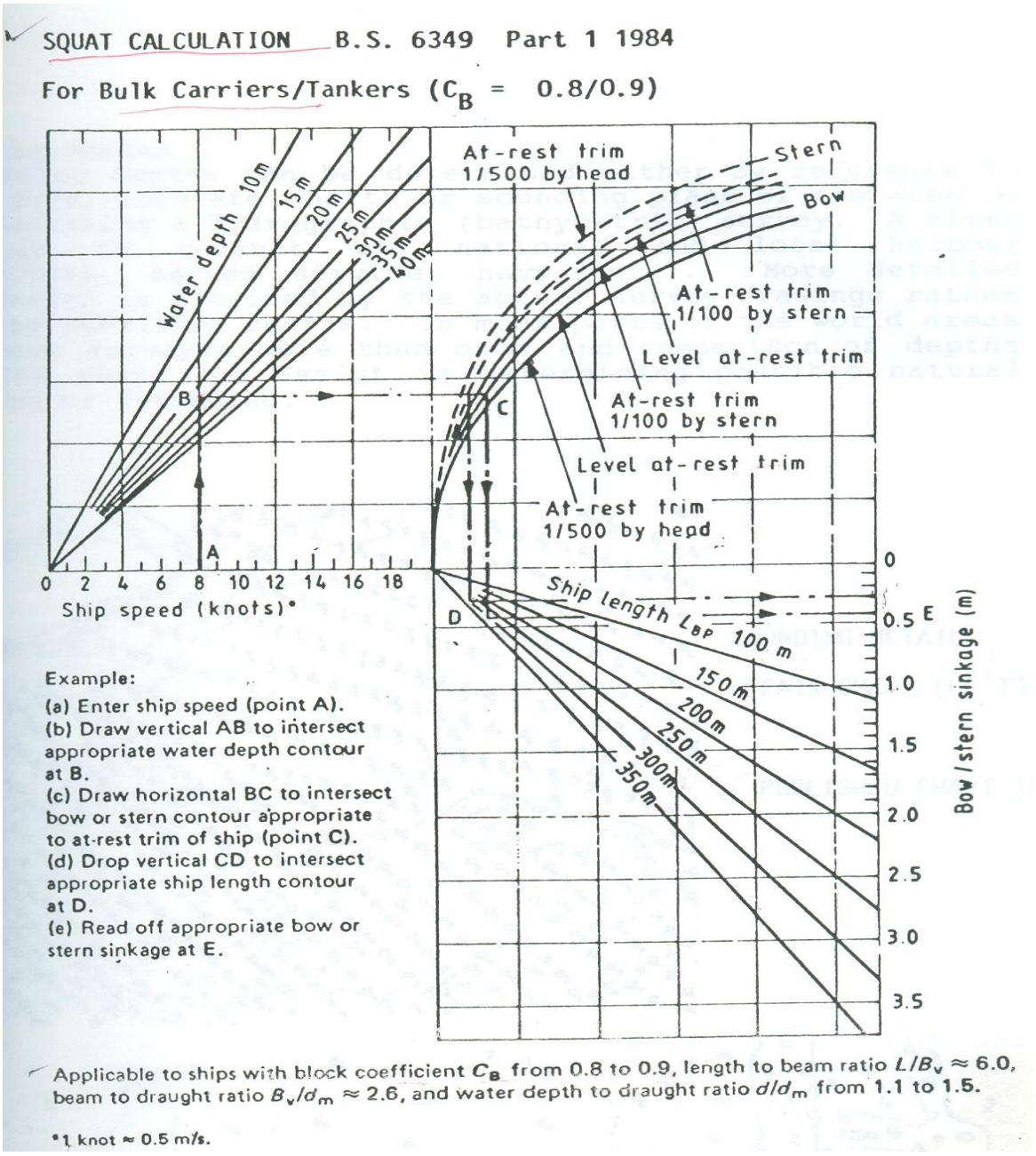

Figure 3-7 Graphs for squat calculation

3.6 Volume Calculation

With the knowledge of the required design depth and the existing depth, the volume of material to be removed can be calculated. Figure 3-8 is a typical section for volume calculation. This requires determination of the area, the side slopes and tolerance. The area over which dredging is to take place dependent upon navigational requirements and advice should be taken from pilots and mariners, as well as possible use of a ship. Recommendations exist as to channel and

wind, the type of ship, navigational aids, allowance for two-way traffic, use of tugs and the consequences of a grounding. The volume calculation depends on the following criteria:

1. Channel breadth
2. Berth size
3. Side slopes and
4. Tolerance

A further factor to be determined is the required side slope to the dredge area. Underwater slopes cannot remain vertical and, in many cases, cannot be cut vertical. If the specified depth is to be obtained over the specified area it will be necessary to allow for proper stable slopes. The side slope should be specified and the volume included in the estimate; if it is not the contractor will be required to make allowance for this work and will adjust unit rate accordingly. The design of stable underwater slope is difficult and depends upon both the material and the expected water movement.

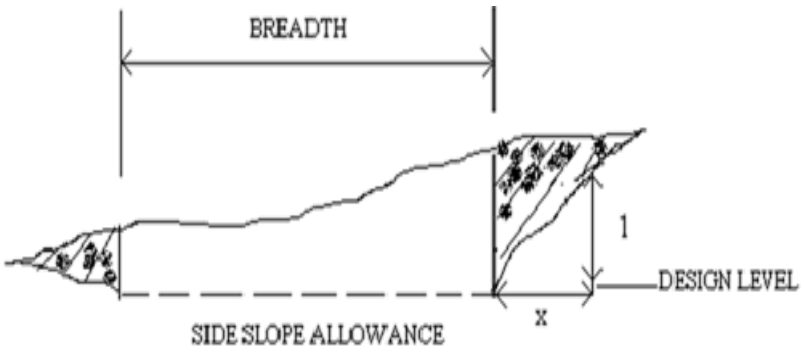

Figure:3-8- Typical Section

The angle of repose of granular material under water is the same as that above water in still conditions, but because of the reduced effective weight under water, reduction of the angle is easily achieved due to waves and currents. A stable slope of 1:5 or 1:6 is not unusual in sand with flatter slopes for silts. Clay can be cut steep but will in time break down and flatten unless firm to stiff.[10],[11],]12]

Over dredging on the bottom and the side slopes to some extent is always necessary. The additional volume resulting from over dredging can be included as a TOLERANCE. If tolerance is not included, the dredge contractor will adjust his unit rate price to take account of the additional volume. A typical allowable tolerance might be 300 mm. The following photograph

3-4 and Photograph 3-5 show dredging works Bhogai-Kongsha River at Netrokona and Pashur Channel at Mongla Port-Bangladesh respectively.

Photograph 3-4: 155-km-long Bhogai-Kangsha river route dredging works in Netrokona ***(Source BIWTA)***

Photograph 3-5: Pashur Channel at Mongla Port-Bangladesh ***(Source BIWTA)***

3.7 Limitations

There are some limitations in collection of the of following data set:

- Insufficient update year wise dredging data
- Insufficient reliable data and statistics
- Lack of survey charts of consecutive years on the study sites
- Lack of pre and post hydrographic survey charts of the study sites

Chapter 4

Data Collection & Analysis

4.1 Introduction

Inland water transport (IWI') has been serving Bangladesh as the most important but cheapest means of communication from long time ago as the country is crisscrossed by hundreds of rivers. At present, out of the 24,000 km of river route, only 25% i.e. around 6,000 km of that remains navigable during monsoon and this quantity even reduce, to about 3,800 km during dry season. The Jamuna River is one of the major rivers in Bangladesh, which imprint, immense importance to national economy, The Jamuna River is very dynamic and its chaotic behavior often makes it difficult to predict planform changes even on medium term scale. ln the dry season, navigation channels shrink drastically and consequently a huge amount of money is required to maintain its Navigability.

The Jamuna River belongs to BJWTA's Class II Water Ways Category, where Least Available Depth (LAD) 2.10-2.40 m (7 to 8 ft) is to be maintained all the year round for safe navigation. BIWTA is the sole authority for maintenance of the navigational channel. Generally, they depend on dredging works to do so but in some reaches they execute it with bandalling a low cost non mechanized dredging method.

The rivers in Bangladesh with a large network of navigation routes spread over as spider nets. Transportation through waterways has always been a natural, environment friendly and relatively cheap mode of transport. Inland waterways have become the very important mode not only for maintaining transport link between various remote parts of the country, it is a mean of transporting export-import cargo as well. Over the decades the navigability during dry season in many rivers of the country has been deteriorating because of morphological processes and for withdrawal of water from the rivers beyond the border and within the country. The navigability has been further aggravated by poor or no maintenance of inland waterways. Navigability of inland waterways is intensely influenced by river morphology and hydraulics. The river systems in Bangladesh exhibits high seasonality over a year i.e. abundant of water during monsoon and scarcity of water during dry season from December to May. Navigability becomes very critical during dry season in many river routes and ferry crossing. To find the

problems of the navigability of waterways and its analysis different data like development and maintenance of waterways have been collected. Data collected from BIWTA, BWDB, Department of Shipping, Ministry of Shipping and websites, etc. **Table 4-1** demonstrates number of passengers launches plying on different waterway routes.

Bangladesh has the largest inland river port in the Asian continent. There are 45 navigational routes. The waterways are connected to Dhaka through 16 districts. Freight shipping is on the rise due to easy availability of goods by waterways.

Table 4-1: Number of water vessel plying on different waterways routes in Bangladesh ***(Source: BIWTA)***

Sl.No.	Name of inland river route	Launch ply (Number)	Number of Speed boat	Remarks
1	Dhaka -Port	80-85		
2	Mawa – Aricha	90	200	
3	Lakhimpur-Bhola-Barishal	20-25	7-8	Steamer
4	Lakhimpur-Hatia	100	200	Dry monsoon
5	Bhola-Barishal	40	200	
6	Patuakhali-Surroundings of Barguna	50	50	
7	Brahmanbrata -Kishoregonj-Sunamgonj	200	100	
8	Khulna- Sundarban	30+	-	
9	Cox's bazzar	-	200	
10	Saintmartin-Tecknaf	15	-	

There are many patterns of water transport, they are:

1. Mechanical boat,
2. Country Boat (both mechanical and manually operated)
3. Launch
4. Cargo
5. Oil tanker
6. Berge
7. Steamer
8. Ferry

14,500 registered and more than 0.2 million unregistered water transport plies on the waterways. At present 3,000 people travel daily from Dhaka to Barishal by launch. Before the Padma multipurpose bridge was built, 20-25 thousand people used to travel by launches through waterways on the Dhaka-Barishal waterway route. Eight launches used to call on and call out in and from the Dhaka Inland River Port. After the introduction of the Padma multipurpose bridge, only four launches call on and call out in and from the Dhaka inland river port on the Dhaka-Barishal waterway route. Passengers launches reduce due to the introduction of the Padma multipurpose bridge. For the improvement of waterways in terms of passengers' travel through waterways can be as follows:

1. Increase quality time table service
2. Increase comfort
3. Increase passenger service quality
4. Reduce fares
5. Reduce fuel prices
6. Removal of waterways restriction due to illegal encroachment, pollution threats
7. Introduce tourist launces

The Dhaka inland river port is called as the gateway to South Bengal. Waterways are under threat due to declining navigability. Because of the bridge and unauthorized encroachment, the river gets silt. Due to the development of roads, culverts, bridges, the passenger traffic on waterways is decreasing. On the other hand, foreign shipping is increasing due to easy availability of goods by river.

BIWTA has undertaken a lot of development projects to procure dredgers aiming to increase navigability of the waterways of the country and ensure smooth waterway communication. The Executive Committee of the National Economic Council (ECNEC) in October 2014 approved a project to procure 35 dredgers at a cost of 44,890.30 million BDT (Bangladesh Taka) to maintain navigability of 100 major rivers.

BIWTA under the Shipping Ministry is being implemented the project by June 2023. The government implements the entire project with its own fund. To remove huge sediments deposited in the waterway, dredgers requirement is very much important. Navigable waterway is the combination of small and big rivers like the Meghna River. Hence different category

dredgers require to dredge out sediments from the river bed. Table 4-2, 4-3 and 4-4 describes number of dredgers with its size owned by private organizations, BIWTA and BWDB respectively.[5]

4.2 Status of dredgers

4.2.1 Private Entrepreneurs.

There are 6 cutter suction dredgers with different size in the year 1996 with the private sectors/entrepreneurs in Bangladesh. At present there are 58 private companies having 155 cutter suction dredgers of different sizes 12 " to 26" having physical dredging capacities varies from 250 m^3 /h to 1350 m^3/h.

With the limited technological know-how of its personnel, these private companies are able to perform well in land filling and land development works. Maintenance dredging of navigation channels requires more detailed engineering planning. In many occasions, private company has lack of experienced engineers having knowledge on dredging. As a result, they cannot provide quality services on dredging performances and unable to complete projects in schedule time. BIWTA official informs that in many cases their services remain much below expectation. However, BIWTA take assistance from those private companies through contract in maintenance and development dredging works/projects where time schedule is a bit relaxed. Table 4-2 illustrates the summary status of private organizations' dredgers. Annexure -1 enumerated details regarding dredgers of private entrepreneurs. Table shows that out of total dredgers of private company, 76-18"; 5-26" and 1-12" sizes and other15 - sizes varies from 15" to 24". On the other hand, they have 58 - 20" dredgers.

4.2.2 Status of BIWTA dredgers fleet

BIWTA at present possess 40 dredgers, collected in between 1971 to 1975 and 2022. All the dredgers are 18-inch to 26-inch cutter suction dredgers including one amphibian and suitable for dredging in waterways. Their salient features are enumerated on the Annexure-II. Dredgers fleet of Dredging Department, BIWTA comprises of all 40 cutter suction dredgers. The physical capacity of those dredgers ranges from 200 m^3/h to1350 m^3/h. Annual dredging requirement is 18.9 million cubic meters. **Table 4-3** illustrates the summary status of BIWTA dredgers. Table explains that they have 23-18", 11-20" and 6-26" sizes cutter suction dredgers.

Table 4-2: Summary status of dredgers belonging to private Company
Total number of private dredging companies (58)

Sl.No.	Number of companies	Size of dredger	Number	Original capacity (m^3/h)	Physical Capacity (m^3/hour)
1.	31	18"	76	350	250
2.	36	20"	58	750	300
3.	4	26"	5	2500	1350-1400
4.	2	16"	2	300	200
5.	1	15"	2	250	150
6.	1	12"	1	200	125
7.	3	24"	5	450	325
8.	2	22"	6	400	300
Total=		**Total =**	**155**		

According to BIWTA official, it is known that they are going to procure 55 dredgers, aiming to increase navigability of the country's rivers and ensure smooth waterway communication. These dredgers will procure under two BIWTA projects – (1) "Procurement of 20 dredgers and Ancillary Machineries" and (2) "Procurement of 35 dredgers and Ancillary Equipment and Accessories". The government undertook the project in 2015 to procure 20 dredgers and necessary equipment at a cost of 20,480 million BDT. The dredging capacity of the BIWTA after procuring those dredgers and other water vessels will be increased by 32.56 million cubic metre per annum.

Table 4-3 Summary status of BIWTA dredgers

Sl.No.	**Size of dredger**	**Number**	**Manufacturer Capacity (m^3/h)**	**Physical Capacity (m^3/h)**
1.	18"	23	450	200-260
2.	20"	11	750	400-450
3	26"	6	2500	1350-1400
	Total =	**40**		

4.2.3 Status of BWDB dredgers

BWDB has 16 cutter suction dredgers of sizes varies from 18" to 26" having manufacturer capacity ranges from 450 m^3/h 2500 m^3/h. All the dredgers procured within 2000 to 2014.

Table 4-4 Summary status of BWDB dredgers

Sl.No.	Size of dredger	Number	Original capacity (m^3/h)	Physical Capacity (m^3/h)
1.	18"	5	450	350
2.	20"	2	750	650
3.	26"	9	2500	1400
	Total =	**16**		

Salient features of all the dredgers are enumerated on the Annexure III. Directorate of Dredgers under BWDB is the organization generally relates to irrigation, flood control, river protection and drainage works. Sometimes they work with BIWTA on contract basis to maintain and develop waterways. The summary status of BWDB dredgers is shown on **Table- 4-4**. The table shows that they have 18"-5, 20"-2 and 26"-9 sizes cutter suction dredgers**.** The physical capacity of those dredgers ranges from 350 m^3/h to 1400 m^3/h. On an average annual performance of Directorate of BWDB is about 0.30 million m^3/year. The total capacity is about 2.40 million m^3/year.

4.3 Utilization of Dredgers

The utilization of dredger is the ratio between time spent for dredging and total calendar time represented in percent. The time spent means actual time engaged for dredging. Utility of dredgers is calculated as below:

Utilization of dredger = (Time spent for dredging) / (Total calendar time) ×100

Theoretically it should be 60-70%. Total calendar time means – 1 year or 365 days.

On the other hand, practically working period is sometimes less, hence actual utilization is less than the theoretical utilization. Actual utilization depends on effective working hours. The effective working hour may be defined as total time has been elapsed for dredging for production only.

Actual utilization = (Effective working time) / (Total calendar time) ×100

= (Effective working time in 1 year) / (365 × 24 hrs) × 100

The flow diagram for computation of utilization of BIWTA dredger shown as **Figure 4-1.**

Time spent for working in a year = calendar time – (dead time).

Dead time = Survey time + no work available + National holidays

Dead Time = 20 days in a year (app.) + 0 + National holidays = 40 days

Weekly holidays = 52 × 2 = 104 days in a year

Total dead time = 40 +104 = 144 days

So, time spent for working /dredging= 365 – 144 = 221 days

Weekly working hour considering 2(two) shifts in a day then,

Total working hour in a year = 221 × 2 × 8 = 3536 hours.

Total hours in a year = 365 × 24 = 8760 hours

Therefore, theoretical utilization of BIWTA= (3536/8760) x 100 = **40.37 %**

Flow diagram of Utilization of dredgers of BIWTA

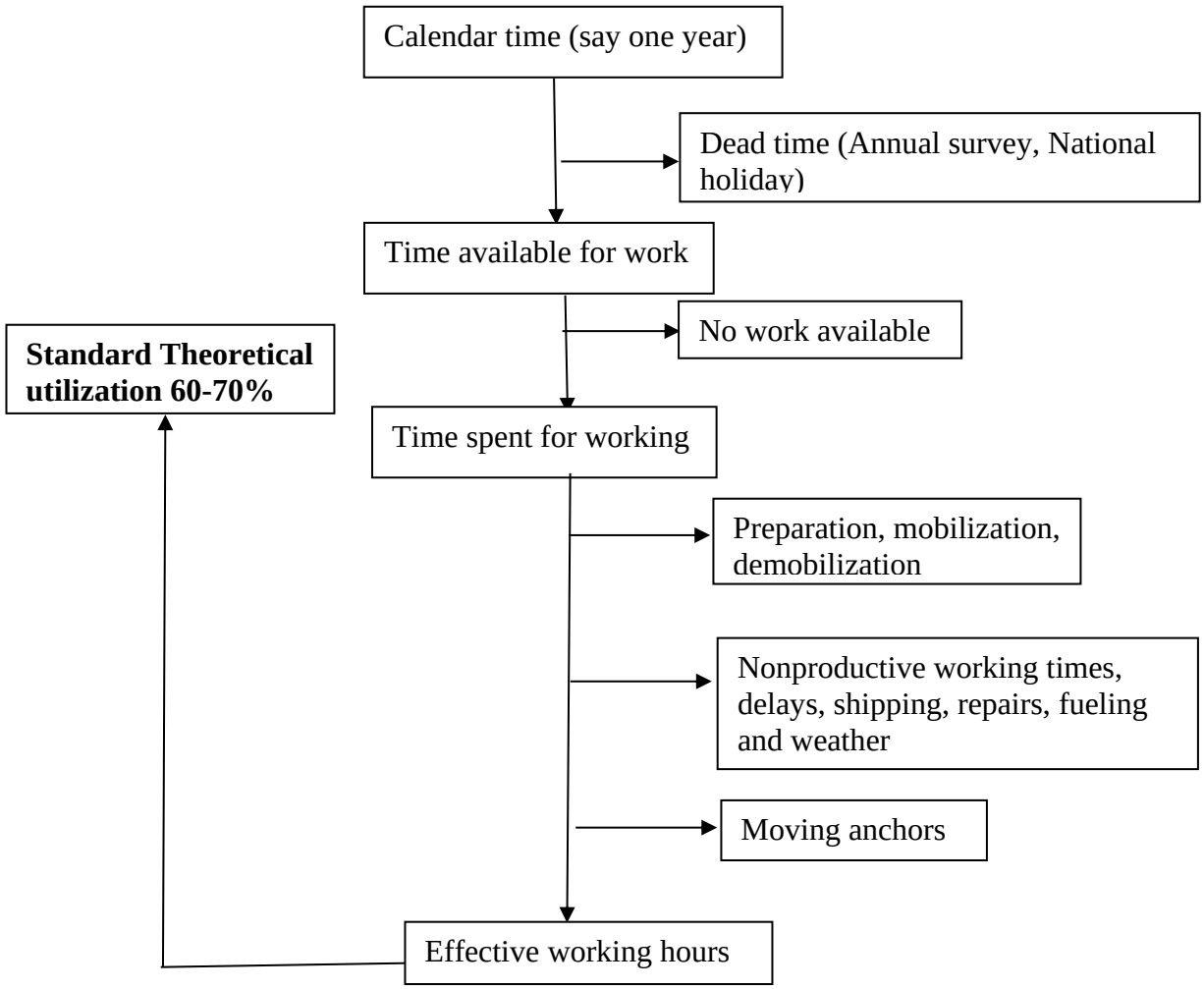

Figure 4- 1 Shows Flow diagram that explains the utilization of dredger

4.4 Ways and means to maintain waterways navigable

BIWTA develops and maintains waterways in three different ways. They are
(1) Mechanized Dredging (2) Natural (3) Low -cost dredging-Bandalling.

4.4.1 Institutions for dredging

There are three institutions to maintain the waterways as cited below: -

1. Bangladesh Inland Water Transport Authority (BIWTA)
2. Directorate of dredgers under Bangladesh Water Development Board (BWDB) and
3. Private Entrepreneurs.

BIWTA is an institution has the vested responsibility to keep the waterways navigable. Dredging Department is under BIWTA maintains and develops the waterways and keep navigable. Towards this end, dredging department acquired a fleet of cutter suction dredgers since in 1972 till today. The need for maintenance dredging is seen every year increasing in quantity. So far Dredging Department, BIWTA has been able to fulfill its responsibility successfully. This has been mainly due to making a thorough evaluation of the dredging needs and the resources available and their efficient and timely implementation. In future, the waterways of Bangladesh will continue to beget problems in respect of maintaining the depth in the dry season. Shifting of the sandbars in the main rivers will continue as unchanged natural process. The shifting of the thalweg in the distributors will also remain unchanged with more and more water withdrawal for irrigation purpose would likely to continue, the off-take problems in the connectors are likely to increase further. So far dredging has been providing solution to navigational problems because the river is untrained and change in every flood season. Only dredging can be successfully limited in such type of changes. Permanent solutions by river training and works like construction of groyns to narrow the cross section to make it deeper and by construction of weirs and barrages in order to raise the water level upstream may be possible in some relatively stable rivers. These measures are however, expensive but in few cases, only they may be economically viable. Dredging is performed by the different types of dredgers namely,

(A) Cutter Suction Dredger (CSD)

(B) Trailer Suction Dredger (TSD)

(C) GRAB Dredger

(D) Cutter Suction Hopper Dredger (CSHD)

(E) Trailer Suction Hopper Dredger (TSHD)

BIWTA maintains a dredger fleet to carry out its dredging works both development (Capital dredging) and maintenance dredging to make waterways navigable throughout Bangladesh. BIWTA under takes maintenance and development dredging works for improvement of navigation in the waterways. The maintenance dredging so far has been concentrated in the following waterways/routes:

(i) Aricha/Paturia- Daulatdia ferry routes

(ii) Nagarbari-Baghabari route

(iii) Buriganga river from Sadarghat Terminal to confluence of the Dhaleswari river Taltala khal

(iv) Barishal- Chattogram route

(v) Dhaka-Barishal route

(vi) Barishal Port area.

(vii) Dhaka-Barishal- Khulna trunk route

4.4.2 Categories of dredging performance

BIWTA performs dredging in three different categories. They are

- Maintenance dredging: - maintain LAD (least available depth) in the waterways channel.
- Development dredging: -dredging works carried out in order to develop new route or basin for inland river port.
- Third party dredging: - dredging works carried out in pursuance to third party's requests for their industry operation, land filling etc. BIWTA performs such works as and when BIWTA dredgers have no work to perform specially in rainy season. BIWTA also do the maintenance dredging through the help of BWDB and private company.

4.5 Crew members of a dredger

A dredger has total 26 crew members comprising Master grade- 2, Master Grade -3. Generally, Master/Liverman operates dredging works. They do not have any institutional training or

/diploma/degree at the time of entry. Liverman is responsible to operate dredgers for dredging river bed.

(a) Deck side

Category		Manpower	Educational qualification
Master-2	ঃ	1	Master of dredger has mastership on ship from Deck personal training institute. Liverman is the main man to operate dredging. Institutional education varies from Class-VIII to HSC.
Master-3	ঃ	1	
Radio operator	ঃ	1	
Laskar	ঃ	6	
Topas	ঃ	1	
Sub-Total-(a) =		12	

(b). Engine Side

Driver-1	ঃ	1	Institutional education varies from Class-VIII to HSC.
Driver-2	ঃ	4	
Liverman	ঃ	4	
Greaser	ঃ	5	
Sub-Total-(b) =		14	
Total man power(a+b) =		**26**	

4.6 Dredgers in Bangladesh

At present Bangladesh has 211 of different sizes cutter suction dredgers accumulated from BIWTA, BWDB and private entrepreneurs shown on the **Table 4-5.**

Table 4-5: Total number of dredgers in Bangladesh

Sl.No.	Size of dredger	Number of dredgers			Total	Physical average capacity
		BWDB	BIWTA	Private Companies		
	18"	5	23	76	104	200-350
	20"	2	11	58	71	300-650
	26”	9	6	5	20	1350-1400
	16”	-	-	2	2	200
	15"	-	-	2	2	150
	12"	-	-	1	1	125
	24"	-	-	5	5	325
	22"	-	-	6	6	300
	Total =	**16**	**40**	**155**	**211**	**-**

4.7 Execution process of maintenance and development-Dredging

There are three steps to dredge the waterways. Such as, hydrographic survey: - The Hydrographic department of BIWTA conduct the hydrographic survey by the help of eco-sound and prepare hydrographic chart indicating the contour of sound i.e., depth of water with respect to LLWL (Lowest Low Water Level). Shoal(char) is identified and then fix the alignment of dredging on the hydrographic survey chart considering LAD 2.10 m and 3.65 m for Class-II and Class –I routes respectively. **Figure: 4 -2 expresses** dredging alignment on hydrographic chart**.** When the depth of cutting becomes more than 1 m, then dredging is performed through stage cut allowing the vessels plying. The **Figure 4-3** shows process of stage cut dredging. Dredger is then deployed on the fixed alignment and dredging is performed. Dredged spoil is disposed in two methods either by open discharge or compartmental discharge depending on the physical conditions of the dredging area. BIWTA is mandated to keep the waterways navigable. Hence, they undertake dredging works in different rivers to maintain /create navigable draught (2.5m/8 ft) to facilitate water transports to ply on it. Dredging is performed by BIWTA alone and with the help of BWDB and private organizations as and when necessary.

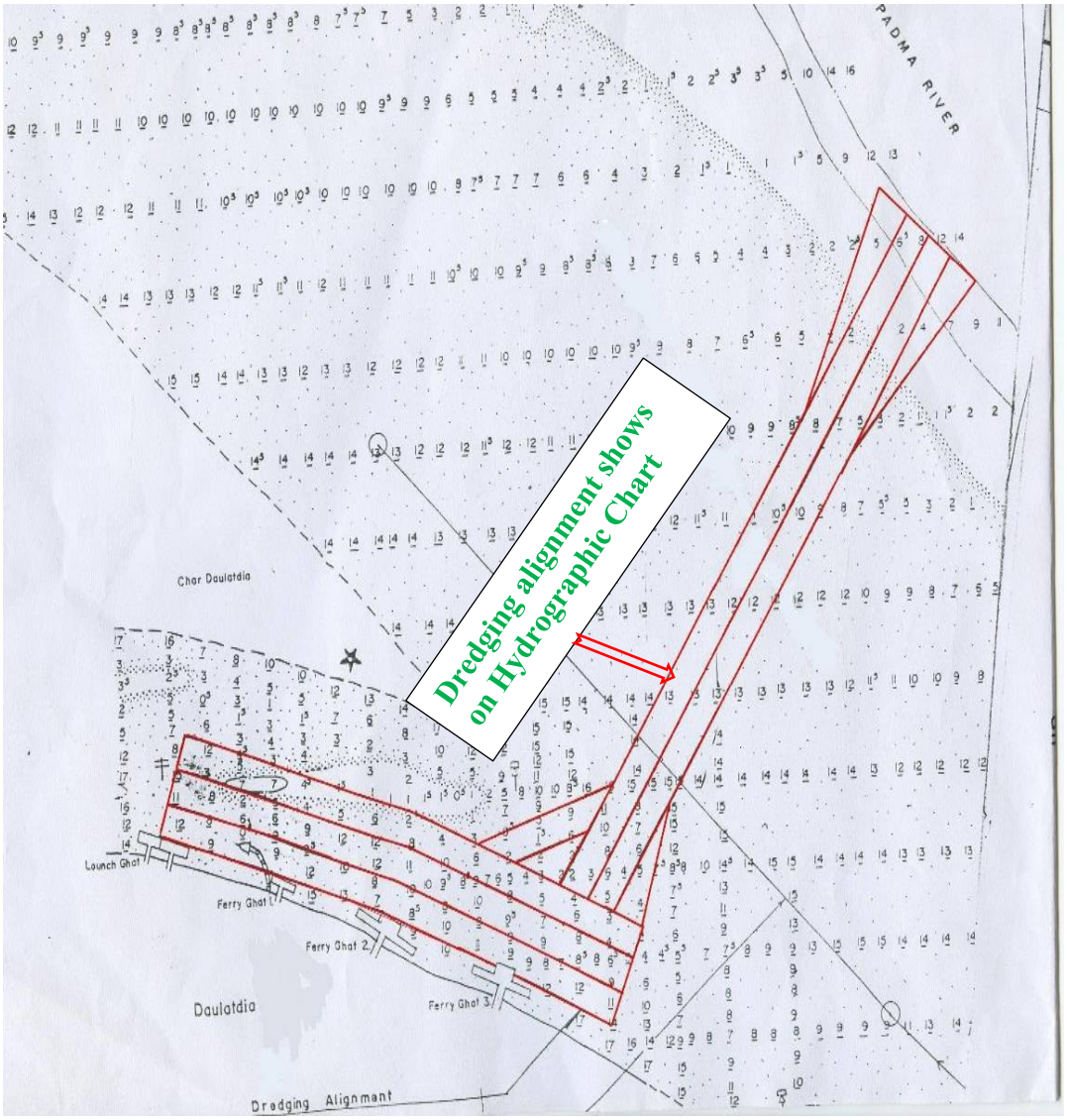

Figure-4-2: Dredging alignment on Hydrographic

4.8 Data Analysis

Detail analysis of the collected data have been analyzed by manual and Technical Analyzed Method

4.8.1 Technical analytical Method

Primary and secondary data required for this research work had been collected from the concern institutions, site visit, conversation with the stakeholders and experienced personnel and BIWTA high officials. All these data found are analyzed by using Excell spread sheet and analytical formula and program.

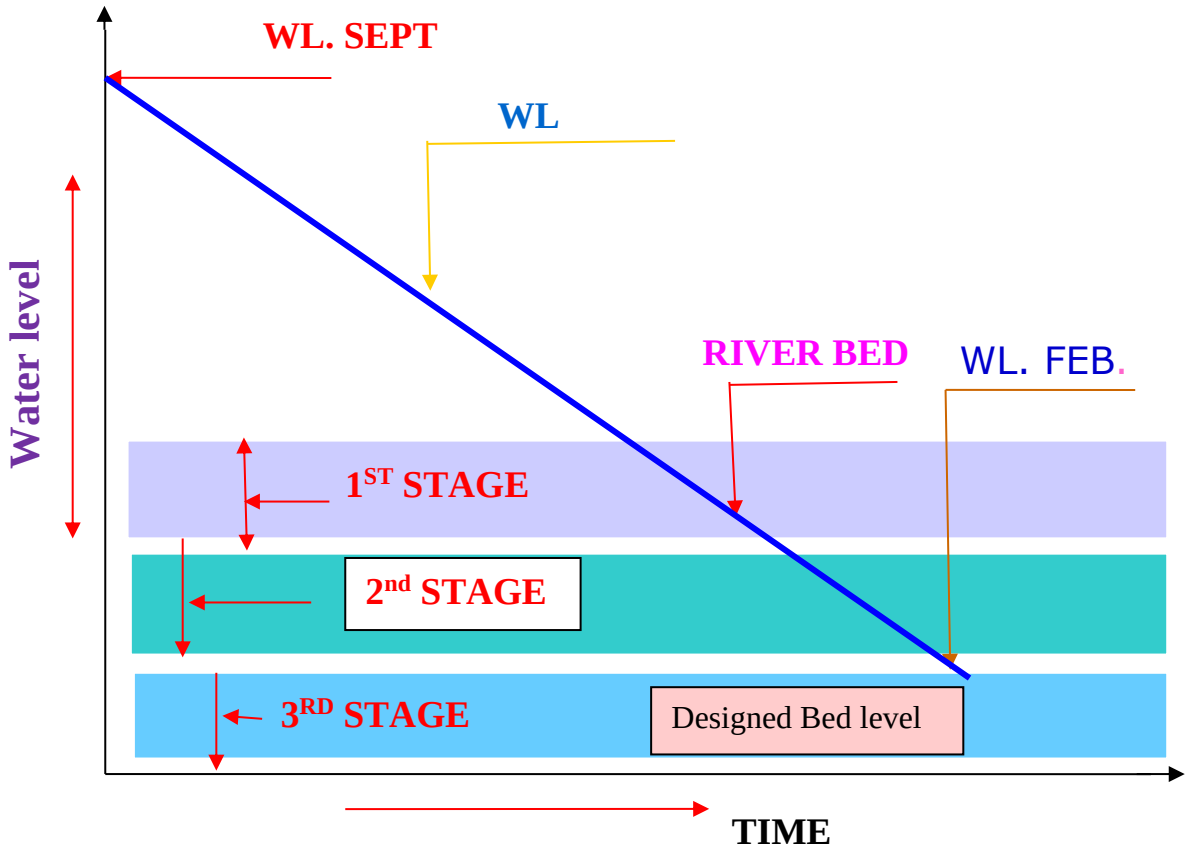

Figure: 4-3 Process of stage cut dredging.

4.9 Dredging performance

Sediments flow along with waterways consequently deposit on the channel bed is natural recurring phenomena. Due to sedimentation, waterways loss navigational ability. Hence it needs dredging to regain navigability of waterways. BIWTA performs dredging work, sometimes get help from BWDB and private companies. The **Table 4-6 a** and **4-6 b** illustrate dredging contribution of the organization other than BIWTA. The table shows that on an average contribution of BWDB and private companies are 10.33 % and 12.48 % respectively which illustrates about 25% of total dredging is conducted by them. **Table 4-6(a)** and **Figure: 4-4** respectively explain dredging performance for previous 22 years.

Table 4-6(a): Contribution of dredging performed for BIWTA (2000-2012)- ***Source: BIWTA***

Year	Dredging performed in million cubic meters (percentage)			
	Total dredging	By BIWTA dredgers	By BWDB dredgers	By private dredgers
2000-2001	3.07	2.74	0.33(10.7%)	-
2001-2002	3.08	2.71	0.37(12%)	-
2002-2003	3.15	3.15	-	-
2003-2004	3.22	3.12	0.10(3.1%)	-
2004-2005	3.48	2.88	0.53(15.2%)	0.08(2.3%)
2005-2006	6.48	2.97	0.17(2.6%)	3.34(51.5%)
2006-2007	3.67	2.93	0.35(9.5%)	0.5(13.6%)
2007-2008	3.12	1.76	0.74(23.7%)	0.62(19.9%)
2008-2009	4.75	3.25	0.80(17%)	0.70(15%)
2009-2010	5.5	4.0	0.75(14%)	0.75(14%)
2010-2011	8.15	6.60	0.85(10%)	0.70(15%)
2011-2012	5.95	5.4	0.55(9.24%)	-
Total	53.62	41.51	5.54 (10.33%)	6.69 (12.48%)
Annual avg,	4.47	3.46	0.46	0.56
2012-2013 to 2021 - 2022	58.56	52.41	6.15	7.32
Average annual	4.88	5.24	0.62	0.73

Table 4-6(b): Maintenance and development dredging performed-BIWTA (2012-2022)

Year	**Maintenance (million m^3)**	**Development (million m^3)**	**Total (million m^3)**
2012-2013	4.47	5.603	10.068
2013-2014	5.79	4.702	10.492
2014-2015	5.08	12.015	17.092
2015-2016	5.43	15.021	20.455
2016-2017	5.84	15.00	20.84
2017-2018	6.20	15.6	21.8
2018-2019	6.50	16.20	22.70
2019-2020	6.80	12.31	19.11
2020-2021	6.30	13.56	19.86
2021-2022	6.15	16.25	22.4
Total	58.56	126.261	184.817
Average annual	**5.86**	**12.63**	**18.82**

(2000-2001 to 2011-2012) and 2011-2012 to 2021-2022). Annual dredging performance (2000-2001 to 2011-2012) 4.47 million m^3 where as in later 2011-2012 to 2021-2022) 5.86 million m^3. Compared these two periods dredging performance increases by 31.1 % but compared to annual requirement of maintenance dredging 10.0 million m^3 very much less. **Figure 4-4** illustrates that in the year2005-2006 and 2010-2011dredging increasing but after those dredging decreases. Again, in the year 2011-2012 dredging decreases. As a result, channel bed gets deposition of sediments and hence waterways loss navigable depth.

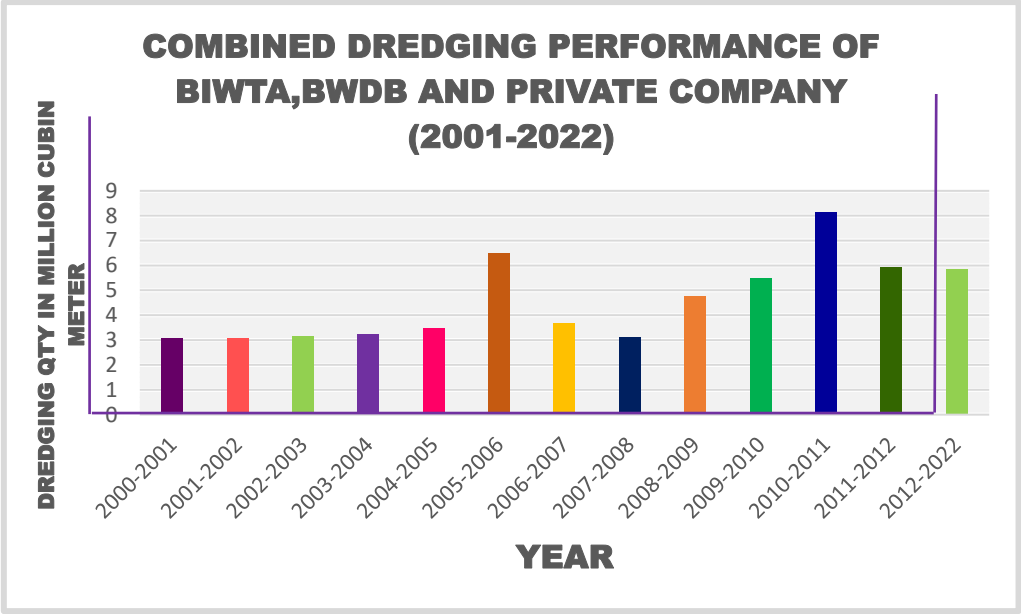

Figure: 4-4: Dredging performance of BIWTA, BWDB and Private company

4.10 Development Dredging

4.10.1 Development Projects

BIWTA has the vested responsibility to maintain and develop inland waterways. They maintain their responsibility by dredging river bed undertaking development project almost every year. Hence increases navigable draught to facilitate water transport plying on the waterway. Since siltation is recurring natural process, so, to maintain navigability recurring dredging is also performed regularly. Since its inception, it executed development dredging/capital dredging through different projects. But due to equipment and budget constraints, could not execute much projects. As a result, navigability of the rivers not improved or new routes as expected to be for the fare navigation. From 1992-2022, BIWTA executed 14 dredging projects including procurement of dredgers at a cost of 18,173.20 million

BDT and total quantity 102.28 million m^3. The details of completed, to be executed and ongoing projects are demonstrated on Appendix IV. **Table 4-7** illustrates summary of development dredging activities of BIWTA under development projects from July 1992 to June 2022. Many projects cannot be undertaken due to allocation of budget or inadequate budget allocation, project yet cannot be implemented. As a result, many navigable routes remain unattended and hence becomes silted.

15-yr master plan for waterways project

The government has taken up a master plan to improve navigability of the waterways across the country as more than 2,000 kilometers of river routes have become inaccessible over the last decade due to loss of navigability. Under the master plan, extensive river dredging will be conducted considering the adverse impacts of poor navigability of rivers. Bangladesh Inland Water Transport Authority (BIWTA) said the master plan will be implemented during a period of 15 years or more at a cost of 21 lakh crore BDT (21 trillion BDT). Poor navigability is causing a continued decline in irrigation and fish production as well as inundation during floods. As a riverine country, Bangladesh still largely depends on waterways for transportation of goods and passengers. A recent report of the World Bank (WB) mentioned that at least 12.3 percent of the country's people depends solely on water transport for moving to cities or elsewhere. The spread of the comparatively less-length 24,000 kilometers of waterways of the country is much more than 274,000-km road network. It is informed from the chief Engineer, Dredging Department BIWTA that the Master Plan has been undertaken as per the decision of an inter-ministerial committee, formed earlier to make the closed river routes active and make them useful. But the Master Plan Project was lying with the Prime Minister's office. But at present the fate of that project is not known. Rivers in Bangladesh are losing navigability mainly due to decline in water flow and cross-boundary flows, increased sediment flows and weakening tidal flow. According to 'Bangladesh Integrated Transport Sector Study-1998', the length of waterways stands at 6000 km during the rainy season and 3800 km during the dry season.

4.11 Dredging Budget

BIWTA is mandated for maintaining and development of waterways by dredging and other feasible/possible ways. BIWTA does it by using its own dredgers fleet and those belonging to Directorate of dredgers of BWDB and private companies as well. Bangladesh government

provides fund for these works.

The **Table-4-8** illustrates year wise (2002-2011 and 2010-2022) dredging demand and budget allocation (both Revenue and ADP allocation). ADP requirement for the year 2002-2011 and 2011-2022 was 62725.00 (=4671.14+58053.86) million BDT whereas allocation was 58911.84 (=2880.34 +56.031.50) million BDT, much less than demand. Similarly, in case of revenue

Table 4-7: Project completed, ongoing and to be executed (under ADP)

Sl.No.	Description	Period	Number of Development project	Total quantity (In million m^3)	Total executed expenditure (In million BDT)
1	Completed Project	1992-2022	14	102.28	18173.16
2	On going project	2017-2027	5	378.58	79761.40
3	Project to be executed	2023-2026	3	124.25	30004.30

allocation 2894.30 million BDT against the demand 13,289.61 million BDT for the said years. Respectively. It shows that revenue budget allocation from 2002-2003 to 2010-2011 is 359 % less than demand. Similarly budget allocation under revenue from 2011-2012 to 2021-2022 is 30 % less than requirement. As a result, siltation aggravates resulting loss of draught of navigation. **Figure 4-5** illustrates year wise demand and budget requirement for the year 2002-2011. **Figure-4-6:** Bar chart explains total demand and allocation for both ADP and revenue for 2010-2011 to 2021-2022**.** Bar chart shows that in ADP 56031.51 million BDT was allocated against 58053.86 million BDT which is 3.50% less compared to requirement**.** Similarly in revenue budget, allocation was 23% less compared to requirement. **Figure 4–7** explains year wise allocation of ADP and revenue budget. The **Figure 4-7** also expresses that after 2007-2008, allocation of revenue budget trends to increase but it is as increased as commensurate with the annual maintenance dredging requirement. Similarly, the development budget increases as not commensurate with the dredging demand.

Table 4-8: Year wise (2002-2011 and 2011-2022) dredging demand and budget allocation (both Revenue and ADP allocation)-*source: BIWTA*

Year	Performance (million m^3)	Demand of budget (million BDT)			Allocation of budget (million BDT)		
		ADP	Revenue	Total	ADP	Revenue	Total
2002-2003	3.15	139.74	1018.55	1158.29	104.24	127.00	231.24
2003-2004	3.22	346.90	1024.80	1371.70	280.50	134.00	414.50
2004-2005	3.48	371.60	1157.09	1528.69	314.60	173.00	487.60
2005-2006	6.48	556.50	1386.08	1942.58	444.30	210.00	654.30
2006-2007	3.67	773.40	1496.15	2269.55	184.20	222.00	406.20
2007-2008	3.12	450.00	1615.68	2065.68	250.50	180.00	420.50
2008-2009	4.75	500.00	1744.03	2244.03	344.60	463.50	808.10
2009-2010	5.5	600.00	1849.63	2449.63	456.50	530.70	987.20
2010-2011	8.15	933.00	1997.60	2930.60	500.90	854.10	1355.00
Total =	**41.52**	**4671.14**	**13289.61**	**17960.75**	**2880.34**	**2894.30**	**5764.64**
Annual average	**4.61**	**519.02**	**1476.62**	**1995.64**	**320.04**	**321.59**	**640.52**
2011-2012 to 2021 - 2022 **(Table 4-7)**	64.51 ***(From Table 3-2)*** (maintenance)+ 189.39+102.28 (Dev)=**356.18**	39880.70 +18173.16 =**58053.86**	**19500.00**	**77553.86**	18173.70+ 37857.80 **=56031.50**	**15000.00**	**71031.50**
Annual average	35.05	4837.82	1625.00	6265.59	4669.29	1250.00	5919.29
Annual average (2002 to 2022)	**22.01**	**2789.18**	**1561.41**	**4435.56**	**2805.33**	**852.11**	**3656.96**

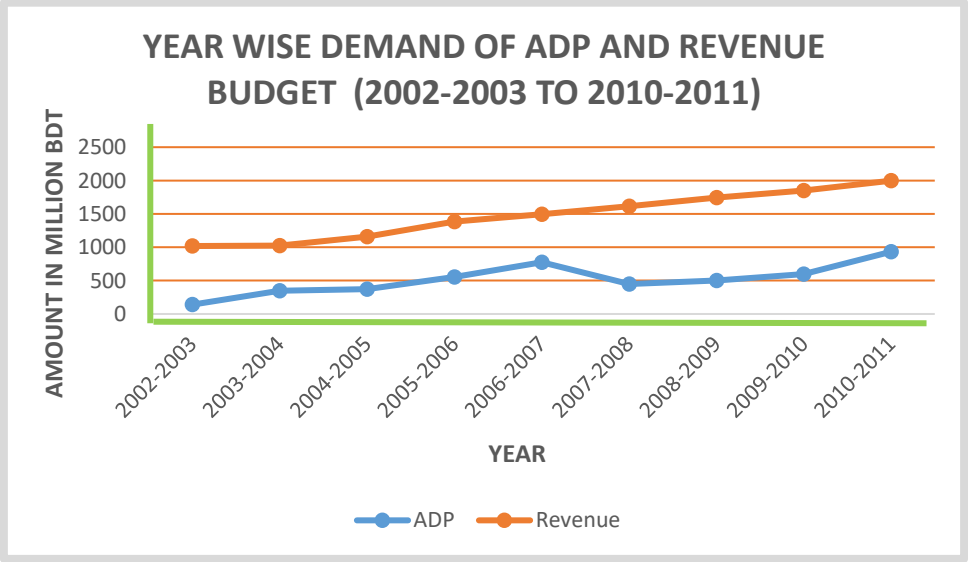

Figure 4-5 : Year wise of demand of ADP and Revenue budget

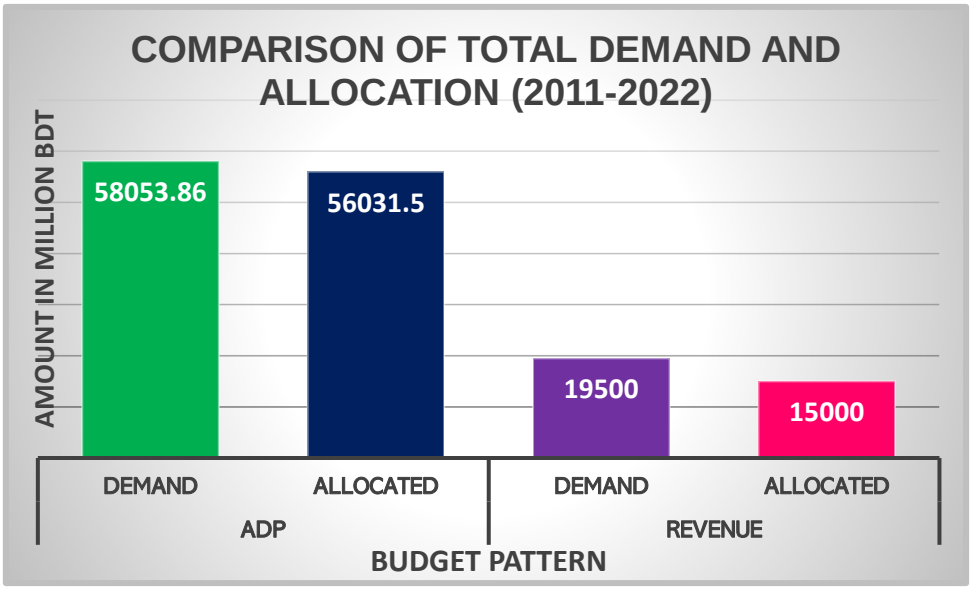

Figure 4-6: Illustrates both demand and allocation budget

4.12 Navigation and Dredging Demand

Out of about 6000 km. navigable Class-I and Class-II are 683 km and 1000 km respectively need to keep navigable for round the year. For this huge shoal have to shift by dint of dredging in about 100 rivers. According to the Shipping Ministry, at least 165.51 million cubic meters dredging are required to be dredged annually from different river routes, while the overall dredging capacity of the country is 84.65 million cubic meters. Once the project is implemented, it will be possible to meet around 70.81 per cent of the annual dredging requirement of the country. The dredging would keep ferries, lunches, cargo vessels and other river vessels functional on domestic river routes round the year. BIWTA has been carried out only 64.51 million cum dredging previously. As a result, number of rivers already silted up almost fully due to unavailability of **maintenance dredging** every year and need re-excavation to make those fully navigable with required draught for designated water craft. On the other hand, there is a need of huge quantity of **development dredging** except the maintenance dredging in order to make the waterways navigable as maintained by BIWTA through the country. Besides navigable waterways, there is a huge requirement of dredging to remove sediments from the rest of the rivers (20,000 km) as maintained by BWDB for irrigation, fisheries, drainage and flood control purpose.

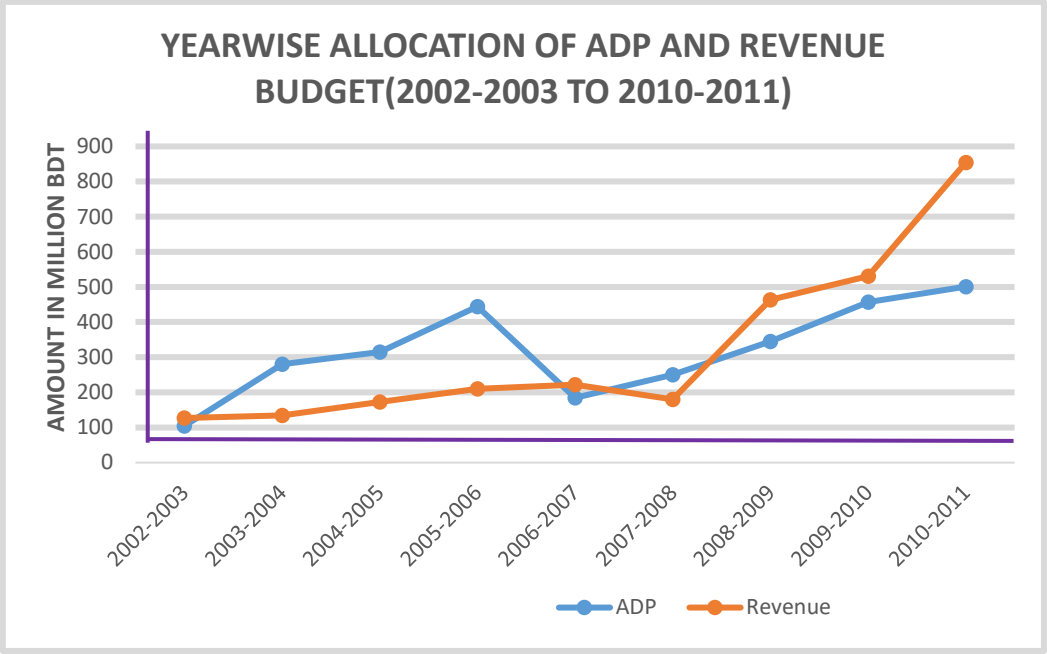

Figure 4-7: Year wise allocation of ADP and revenue budget

BIWTA has carried out 1992 to 2022, 14 projects for dredging of 102.28 million m^3 with 18173.16 million BDT. Some projects have been completed within 2021 to resuscitate the navigability of the waterways. Lack of fund and dredgers as well as application of modern technology for economic dredging most of the projects remain unimplemented.

Dredging department under BIWTA conducts dredging in the rivers to improve and maintain navigability of the waterways. From the administrative organogram of dredging department, it shows that shoal identification, dredging program and implementation, etc. conducted from Dhaka Head of office resulting slow activity of dredging performance. Decentralization of dredging department may enhance the efficiency of the dredging activity of Bangladesh. However, BIWTA plans to establish seven dredging unit offices in different places of the country to make the dredging process more developed and dynamic. These places are-- Shimulia, Barishal, Madaripur, Rampal (Khulna), Aricha, Jamalpur and Chandpur. Government should establish those unit offices as early as possible to increase the dredging activities of Bangladesh and hence improve the navigability of waterways in Bangladesh.

4.13 Impact on Delta plan 2100

There are only 211 dredgers in Bangladesh owned by both the government and private sector whereas total dredger requirement for Bangladesh is about 500, and for Delta 2100, Bangladesh

will need an additional 2,000 dredgers over the next 20 years. Bangladesh needs more dredgers to fulfill the demand of river dredging and realizing the Delta 2100 plan," For full filling the more requirement of dredgers, Bangladesh should give emphasis on manufacture of it locally in the ship building industry though dredging machines are very sophisticated machines. **(*Source: BIWTA and Ministry of Shipping (MoS)*-*Websites)***

4.14 Dredging Problems

The land of Bangladesh is constituted with alluvial soil, that means the land surface is composed of transported silt coming with the flows of water. As a result, the bed surface of river is reduced with the deposition of sediments. Hence, sedimentation is one of the major problems to maintain required Least Available depth (LAD) along the navigational routes, especially during the dry season in order to maintain LAD for ship movement, BIWTA execute dredging works at several pre-defined areas. Bangladesh, mainly uses cutter suction dredgers for dredging. Dredger has a rotating cutter in front of the mouth of suction pipe. This cutter cut loosen sediments and sucked it by its mouth. The dredger can be used for the dredging of sand, clay and even soft rock with different types of cutters, The dredged material collects through a long pipe and dispose it far away in the same channel, Normally the dredger moves from upstream to downstream for operational advantage. This causes huge sediments go into suspension and later resettled due to reduction of threshold velocity. A cutter dredger immediately makes the required depth of channel but this does not remain because relatively large quantities of sediments enter to the channel. As a result, recurring dredging in the waterways become necessary which in the long run needs much budget. BIWTA performs in two ways-Compartmental and open disposed dredging. The disadvantage of the open disposed dredging is that resettlement of dredged spoil on the river/channel bed.

Chapter 5

Results and Discussions

5.1 General

Bangladesh has a long and proud tradition of water transport and seamanship. The people of this country is at ease with the wide range of vessels and water transport infrastructure modern and ancient alike. Conscious of the rapid pace of change and the potential loss of long practiced traditional building methods, there is a need to preserve the history for future generations. It will therefore be in keeping with the age-old tradition of life in Bangladesh to record the evaluation of different types of vessels, skills and handicrafts that have played such a fundamental part in the national development. The solution prevailing in the IWT sector of Bangladesh is special to this country and thus it is of particular importance for evolving appropriate technology for addressing various issues related to the sector. The navigability of the waterways all over Bangladesh is decreasing gradually. BIWTA maintains and develops the waterways network, especially Class-I and Class-II routes all over the Bangladesh. Dredging works which are executed in order to facilitate development, maintenance and /or operation of waterways is termed as navigation dredging. A large part of Bangladesh is an active delta formed by the sediments carried by the rivers flowing down from the Himalayan region. Bangladesh and India share at least 54 such rivers in common and agriculture, navigation, inland fisheries and other economically significant activities are hugely dependent on these rivers' waters. Annually these rivers and water bodies carry around 2.4 billion tons of sediments like sand, clay and silt as mentioned in Chapter 1. Dredging is an integral part of Bangladesh's river system maintenance. It has long been used to maintain the busy channels in major rivers like the Ganges, the Brahmaputra and the Meghna. Dredging is a tool for maintain and development of navigation channel. BIWTA with its dredger fleet performing the dredging works to maintain and develop the waterways. But cannot do the same as per requirement due to the puce of different constraints as illustrated in the Chapter 4.

5.2 Dredging

BIWTA from 2000-2001 to 2011-2012 and later 2012-2013 to 2021-2022, annual dredging performance are 4.47 million m^3 and 4.88 million m^3 respectively i.e., total annual dredging

performance 5.14 million m^3 under maintenance dredging. On the other hand, 2002 to 2022 annual dredging performance of both development and maintenance dredging was 22.01 million m^3. Annual ADP budget allocated 4669.29 million BDT against the demand 4837.82million BDT. Similarly. 1250.00 million BDT allocated against annual demand 1625.00 million BDT under revenue budget. Figure 5-1 describe scenario of budget shortfall. Figure 5-1 expresses ADP and Revenue budget shortfall are 168.53 million BDT and 375 million BDT respectively. As a result, lack of maintenance and development dredging, many of the navigable waterways went under siltation which ultimately hamper smooth navigation. It is to be mentioned here that after completion of capital /development dredging, next year needs about 50% maintenance dredging over there because river bed is formed by alluvial soil.

5.2.1 Dredging requirement

According to the Shipping Ministry, annual requirement of dredging is at least 165.51 million cubic meters dredged in different river routes to keep navigable Class I and Class II 683 km and 1000 km respectively out of 6000 km navigable. To achieve this huge shoal, have to shift by dint of dredging in about 100 rivers. BIWTA executed 14 dredging projects with the expenditure of 18173.16 million BDT and remove 102.28 million sediments from 1992 to 2022. Five projects are progressing from 2017 to 2027 at a cost of 78761.40 million BDT to remove 178.58 m^3 sediments from the rivers' bed and 3 projects are under execution from 2023 to 2026 at a cost of 30004.30 million BDT to excavate 124.25 million m^3 sediments and remove 102.28 m^3 million sediments respectively from 1992 to 2022.

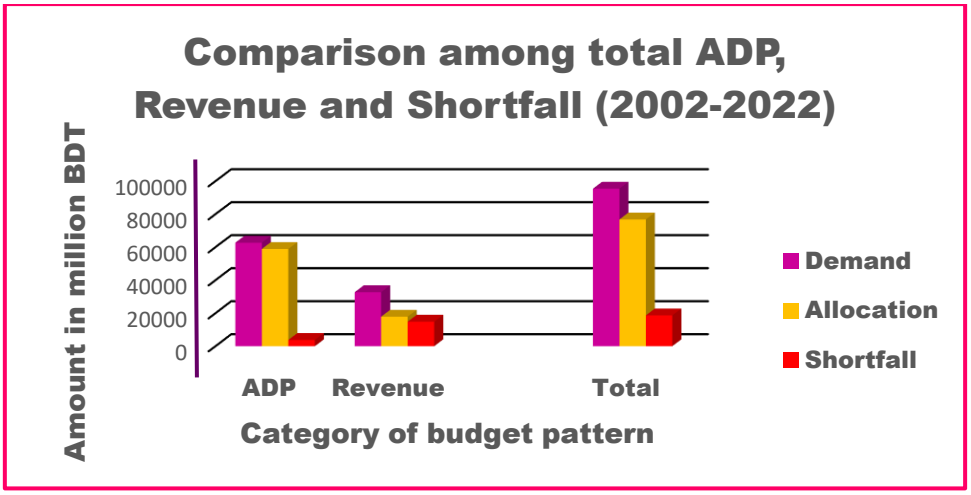

Figure 5-1: Describe comparison among budget regarding demand, allocation and shortfall.

Five projects are progressing from 2017 to 2027 at a cost of 78761.40 million BDT to remove 178.58 million m^3 sediments from the rivers' bed and 3 projects are under execution from 2023 to 2026 at a cost of 30,004.30 million BDT to excavate 124.25 million m^3 sediments. The overall annual dredging capacity of the country is 84.65 million m^3 (*Source: Ministry of Shipping*), the estimate was prepared about 5 years back but present requirement may be more than this. Once the project is implemented, it will be possible to meet around 70.81 per cent of the annual dredging requirement of the country. Table 5-1 elaborate the annual shortfall of dredging in the country which is equal to 80.86 million m^3. Compared percentage among annual requirement, capacity and shortfall shown in Figure 5-2. The pie chart shows that annual capacity and shortfall of dredging is 26% and 24% compared to total requirement. On the other hand, Figure 5-3- the pie chart explains the budget scenario. The chart shows that the annual shortage in budget both in ADP and Revenue is 6.01 % and 45.37% respectively.

Table 5-1: Annual dredging requirement and shortfall

Annual dredging description (million m^3)		
Requirement/Demand	Capacity	Shortfall
165.51	BIWTA BWDB Private Entrepreneurs } = 84.65	80.86

At present Bangladesh has 211 dredgers of size 12" to 26 " Out of 211 dredgers BIWTA has only 40 and BWDB 16. Performance of private company are not good enough in quality dredging. Moreover, they are very much interested in dredging for land filling rather than river dredging. To coup up this shortfall more 76 cutter suction dredgers require to procure. [Calculation: (=80.86/(0.41*750)*16*221) - considering 41% utilization , dredger capacity 750 m^3/h and working period 2 shifts]. On the other hand, BWDB remains busy with the irrigation and flood protecting works. So, it is difficult for BIWTA alone to dredge the waterways for smooth navigation with the limited dredging equipment. Unattended dredging in the waterways aggravate the deposition of sediments in the river bed and thus increase dredging quantity and hence hindrance in fare waterways for plying water transport.

5.3 Utility of Dredger

The utility of BIWTA dredger is only 40.37 % which is much less than standard utilization 60% -70%. As a result, yearly productively of BIWTA dredgers is not satisfactory. For the

increment of productivity, utilization of dredgers shall have to be increased and hence the dredging capacity. This may be achieved by enhancing the working time i.e., increase the working shift from two to three shifts in a working day as well as man power. Crew members are not as qualified as required for the efficient and quality dredging. Liverman must be qualified and experienced on dredging activity as well as river survey.

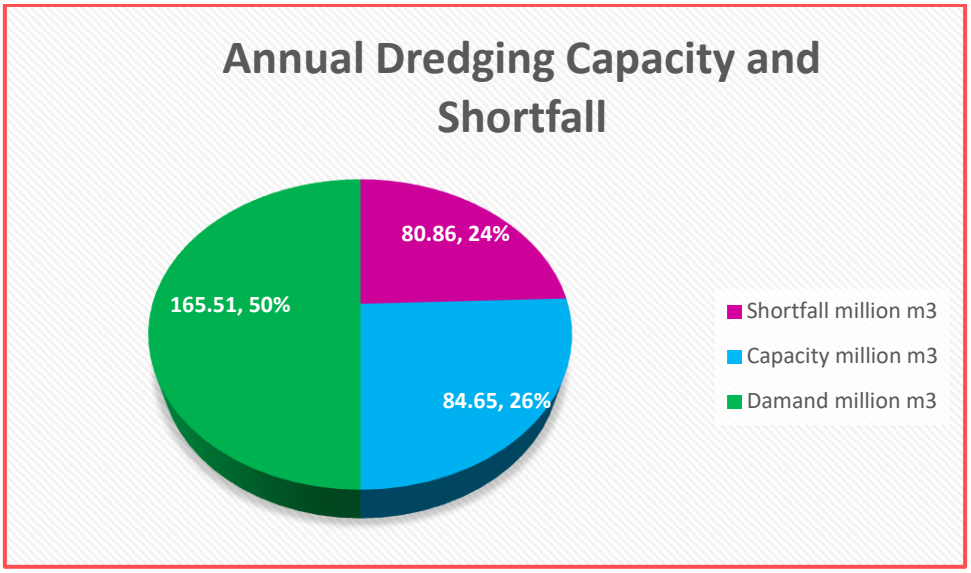

Figure 5-2: Describe annual percent requirement, capacity and shortfall of dredging

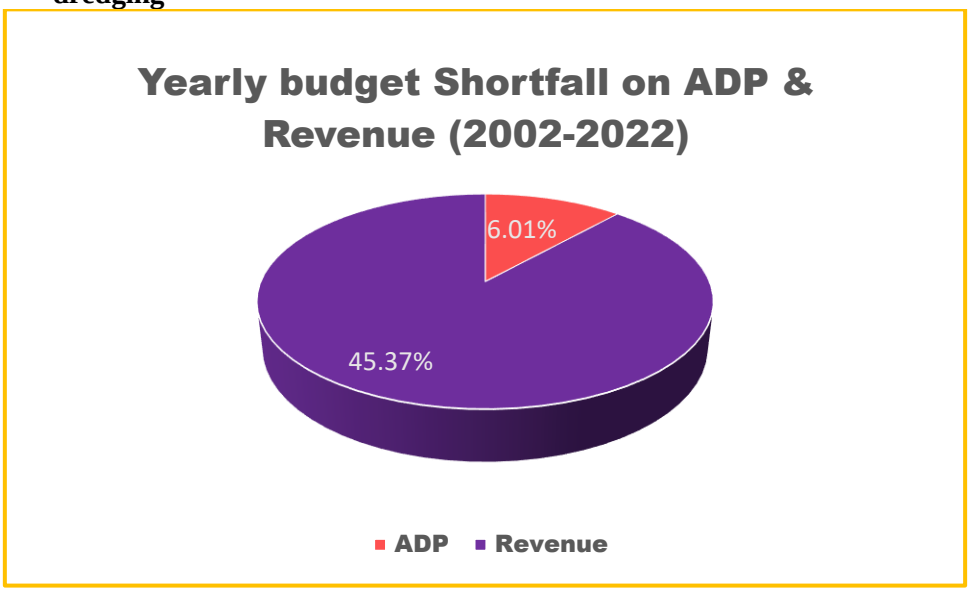

Figure 5-3: Average budget shortfall on ADP and Revenue in percent

5.4 Discussions

Sedimentation on river bed is natural phenomenon which creates obstruction to maintain fare navigability of waterways. As a result, water transport faces inconvenience in plying on the

waterways. For removal of siltation/sediment from the river bed, three processes are adopted by BIWTA. They are dredging, natural/intelligent and low-cost dredging technique like bandalling, BIWTA is mandated to keep the waterways navigable. They get allocation from the government under ADP (Annual Development Program) and revenue budget. But table 4-8 expresses inadequacy of budget allocation for both revenue and ADP. The total average requirement for both revenue and ADP 4435.56 million BDT per year for dredging against annual allocation 3544.18 million BDT which is 20% less than the annual requirement. Similarly, BIWTA has 40 dredgers out of which 6 dredgers are about 47 years old which are now obsolete. These 6 dredgers need to replace immediately for better production with more modern technology. Other some of them are 10 to 15 years old. On the other hand, total annual dredging capacity of Bangladesh is 84.65 million cubic meters out of required 165.51million cubic meters. Thus, shortfall stands 80.86 million cubic meters. As a result, required dredging work cannot be performed every year which aggravate siltation on the channel bed and in course of time causes dying of rivers. To coup up this shortfall more 76-18" Cutter suction dredgers require to procure.

BIWTA from 1992 to 2022 removes 102.28 million m^3 from the channel bed through completed 14 projects with the cost of 18173.16 million BDT. Five projects are being implemented with the total cost 79761.40 million BDT aim to dredge 378.58 million m^3. Three projects are programmed to implement from 2023 to 2026 with a cost of 30004.30 million BDT aiming to dredge about 124.25 million m^3. It may be expected after the completion of all these projects, waterways navigability will improve. For this, government has to allocate required budget for implementation of those projects timely. Lack of budget allocation as per requirement, BIWTA cannot undertake new project against capital dredging and resuscitation of dying rivers. Intelligent dredging should be encouraged. This type of dredging is environment friendly. But this type of dredging is not always feasible in all type of rivers. On the other hand, low -cost dredging technique like bandalling may be applied in more rivers, for which feasibility study is necessary. Long term dredging program may be helpful for fare navigational waterways. For conduction of dredging works throughout the Bangladesh, adequate manpower having qualification and experience in dredging is necessary for economic and quality dredging. For efficient and dynamic dredging, Dredging Department of BIWTA shall be decentralized for sharp, dynamic, efficient and proper monitoring of channel dredging. Because at present BIWTA conducts dredging works administering from head office situated in Motijheel, Dhaka.

However, at present, it has been programmed to set dredging unit offices at seven different places. These places are, Shimulia, Barishal, Madaripur, Rampal (Khulna), Aricha, Jamalpur and Chandpur. Government should set those offices immediately to increase productivity and prompt action. The officials need training in dredging works regularly to enhance the knowledge with modern technology. Adaptation of modern technology both in dredger procurement as well as conduction of dredging works. As per procurement decision of Ministry of shipping, conducted a project namely, "Feasibility Study of Capital Dredging and Sustainable River Management in Bangladesh (FSCD & SRMB)." The study suggested collection of some 216 cutter suction dredgers for dredging some 23 big and medium rivers. There are only 211 dredgers in Bangladesh owned by both the government and private sector whereas total dredgers requirement for Bangladesh is about 500, and for Delta 2100, Bangladesh will need an additional 2,000 dredgers over the next 20 years.

5.5 Constraints

From the detailed analysis and discussions mentioned in articles 5.2 to 5.4, following constraints come out:

- Annual dredging requirement 165.56 million cubic meters but annual dredging capacity of Bangladesh (BIWTA, BWDB and private companies) is 84.65 million cubic meters
- Annual unattended dredging 80.36 million cubic meters due to required budget allocation for the procurement of dredgers
- Inadequate dredging equipment. For fare navigation, BIWTA needs 76 more dredgers to overcome unattended/ shortfall, whereas they have only 40 dredgers. Among them six dredgers are 42 years old require replacement immediately.
- Inadequate budget provision. Total annual average allocation for both revenue and ADP 3544.18 million BDT for dredging against requirement 4435.56 million BDT respectively.
- Dredging alignment should not be fixed without studying hydraulics and hydrological conditions of the rivers.
- Alluvial soil of the country aggravates the draught of the waterways.
- Navigable waterway created by Capital dredging, after one or two years due to alluvial soil character sediments deposited and makes the channel non navigable.

- Requires excess recurring dredging to keep the channel navigable.
- Inadequate qualified and experienced dredger's manpower.
- Lack of adequate physical monitoring of dredging works.
- Less utilization of dredgers i.e., 40.37% must be increased to at least 60%
- Lack of modern technology use in dredging works.
- conduction of dredging works centrally.
- After the inauguration (25 November 2022) of the multipurpose Padma bridge, waterway transport drastically changes to speed travelling through roadway than waterway.

5.6 Evaluation

Rivers of Bangladesh do not have a regular profile but their widths and depths are varying in the longitudinal direction. Most of the rivers in Bangladesh are meandering nature. For meandering rivers, this is caused (amongst others) by the typical erosion in the outer bends of rivers. During floods, the outer bends arc being eroded and the eroded material is deposited in tile next crossings. During low flow period (dry season), the crossing although it is being eroded, is still relatively elevated due to the fact that this erosion is retarded. As a consequence, these crossings become shal1ow reaches that limit the navigation. The reduction of discharges results in a reduction of the available water depth for inland navigation. This reduction of water depths in the river channels become noticeable in the months of February and March, when irrigation is needed on a large scale, whereas the discharges in the rivers are not yet increasing. Navigational routes of different regions arc hampered during dry period. The deterioration of navigability of waterways over the past decades has taken place and will continue.

Chapter 6

Conclusions and Recommendations

6.1 Introduction

BIWTA is mandated for maintaining and development of waterways by dredging and other feasible/possible ways. BIWTA does it by using its own dredgers and those belonging to Directorate of dredgers, BWDB and private companies as well. Bangladesh government provides fund for these works. Dredging is a recurring process. Completion of capital dredging in a channel bed generally require recurring dredging of that dredged channel because again deposition of sediments on the river bed since Bangladesh is a land of transported alluvial soil. As a result, Government has to allocate adequate budget for the maintenance and development of waterways for fare navigation. In the last 2002-2003 to 2021-2022, it was found that about more than 20 % less than required budget allocated. As a result, it has become difficult for BIWTA to maintain fare navigational waterway. It is also found that only fourteen dredging projects implemented from 1992 to 2022 under ADP which was much less for creation and maintenance of fare navigational waterways. Average annual maintenance dredging performance is 5.14 million m^3 against annual requirement 10 million m^3. This scenario shows that 48.6 % dredging works remain as shortfall every year resulting increment of silt deposition on the river bed. Hence hinds the waterways for fare navigation. There are five on going dredging projects for the improvement of waterways navigation with the period from 2017 to 2027. The total estimated cost for those projects is 79761.40 million BDT. While those projects will be completed, 378.58 million m^3 sediments will be removed to get fare navigation. The problems arise for the develoment projects are requirement of recurring dredging that needs allotment of revenue/ development budget.

6.2 Conclusions

Bangladesh has a long and proud tradition of water transport and seamanship. Our people are at ease with the wide range of vessels and water transport infrastructure-modern and ancient alike. Conscious of the rapid pace of change and the potential loss of long practiced traditional building methods, there is a need to preserve our history for future generations. It will therefore be in keeping with the age-old tradition of life in Bangladesh to record the evaluation of

different types of vessels, skills and handicrafts that have played such a fundamental part in our national development. The solution prevailing in the IWT sector of Bangladesh is special to this country and thus it is of particular importance for evolving appropriate technology for addressing various issues related to the sector. In the transport sector, the inland water transport occupies a very vital place. It is a dire need of the hour to develop this sector to the extent it can keep pace with the speed of global development and modernization. Maintenance of navigability across the extensive river network of Bangladesh requires extensive dredging action plan. To implement this dredging action plan required budget allocation for procurement of dredger with ancillary equipment and dredging technology for economic dredging are necessary. Otherwise, development of navigability of waterways will not be possible for which the waterways will become non navigable.

6.3 Recommendations

There are about 1007 rivers including mighty rivers namely the Padma, the Meghna and the Jamuna. These rivers discharge about 0.20 million m^3 water during the flood and 2.4 billion tons of silts are flown annually through the rivers which is 18.5% of the total silts of the world. Major parts of silts/sediments deposited on the river bed and loss navigability. Construction of obstructions across the navigable channel like bridge, culvert and cross dam etc., create obstacle and reduce threshold velocity in the natural flow in the river/channel causes sedimentation in the downstream of the river bed. As a result, waterways loss navigability and hind the fare waterway. This leads to more maintenance and development dredging. Thus, navigability of river network and waterways of Bangladesh require more dredging to maintain appropriate draught. Lack of regular maintenance and development of waterways, rivers loss navigability and in course of time causes dying of rivers. For live rivers, extensive dredging works require. Hence the government of Bangladesh should look into:

- Government ensures consistency between the resources allocate to the sector and the dredging requirements necessary to sustain the level of service defined in the classification of waterways.
- Government can prepare a strategy plan for the contribution of BIWTA, BWDB and private sector to the dredging of waterways to get smooth navigable water routes
- Dredging can continue round the year specially sedimentation prone area of the river
- Procurement of more new dredgers

- Preparation and implementation of extensive development and maintenance dredging action plan. Before preparation of extensive dredging action plan, hydraulics and hydrological conditions of the river must be studied.
- Increase the utilization of dredgers by increasing working hours and efficient management
- Increase qualified and experienced manpower.
- Close physical monitoring of dredging works.
- Adaptation of modern technology use in dredging works.
- Decentralization of dredging department for dynamic dredging in river bed to achieve navigability. BIWTA plans to establish seven outside unit office at Shimulia, Barishal, Madaripur, Rampal (Khulna), Aricha, Jamalpur and Chandpur. This program should implement as early as possible. Because, it is expected, establishment of new unit offices as programmed will increase monitoring, dynamic and quality dredging. As a results, dynamic and fare waterway achievement will increase.
- After the inauguration of the multipurpose Padma bridge, waterway transport drastically changes to speed travelling through roadway than waterway. Government can think to overcome this problem -which may be solved:

  (i) introduce speedy launch
  (ii) introduce tourist launch
  (iii) reduce travelling fare
  (iv) reduce fuel cost and spare parts as well

- Encourage should be given to compartmental dredging rather than open channel disposal because in many cases disposed spoil redeposited on the river bed due to reduction of threshold velocity.
- Low-cost dredging technique like bed levelling, bandalling may adopt.

6.3.1 Low-Cost dredging

6.3.1.1 Natural Way/Intelligent dredging

Nature is the best tool for dredging waterways. Actually, artificial dredging is no dredging for the maintenance of waterways because own phenomenon of nature dredged channel again silted

up or diverted to another waterway. So, in some cases depending on the hydrographic survey chart, BIWTA in many occurrences does not dredge the silted-up channel but leave it to nature with intelligent dredging so that flow and current can guide away silt from depositing in the dredged channel.

6.3.1.2 Bandalling (Other method adopted to keep the route navigable)

Dredging is not always possible due to fund paucity and non-availability of dredgers and obstacle to enter in the proposed waterways due to heavy current. In such a situation bandalling a low-cost dredging technique is adopted by BIWTA for improvement of navigational draught during the low flow season. This is also being practiced in Assam of India since the British period. The use of bandals result in local changes of sediment and water distribution by deliberately causing erosion and (related to it) deposition. Bandals are made of bamboo mats. The mats have dimensions of 0.60 m, 0.90 m or 1.20 m height while their length varies between 0.91 m to 1.80 m. The mats supported by a frame of vertical bamboo posts having center to center distance of about 0.60 m to 0.90 m. In addition, horizontal bamboo pieces are fastened to improve the stability. One bandalling unit has length of about 12m. In most of the cases, a number of bandals are combined to form large units that have lengths of multiples of 12 m. The vertical poles are driven into the river bed. Inclined bamboo struts support the bandals.

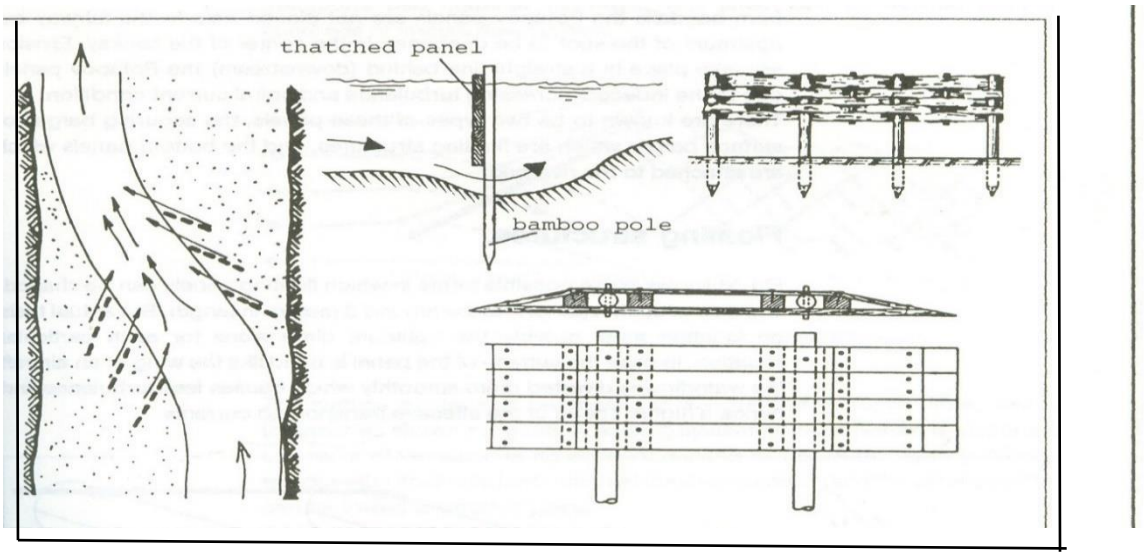

Figure 6-1: Sketch of typical Bandalling

All the fastenings are made with coconut ropes. Bandals are placed at an angle of 30^0 to 40^0 to the downstream flow. The positioning of the Bandals in the vertical direction is very important.

The function of bandals is based on directing the surface and bottom current in different directions. If the bandals are too close to river bed the bandals may even act as counter productive. According to the practice followed in BIWTA, bandals are depth one foot above the bed level of river and one foot below the water surface. Bandalling is primarily used for improvement of a single channel or closing a secondary channel. Bandalling works are being undertaken in Barahmaputra-jamuna, the Ganges-Padma and the Kushiyara rivers. **Figure-6-1** illustrates typical bamdalling. [13], [20]

Table 6-1: Comparison of the effect of dredging and bandalling (Limitations)

Description	Dredging	Bandalling
Tidal rivers	+ +	- -
Dead-end Channels	+ +	- -
Thick layers	+ +	- -
Shallow layers	-	+ +
In rivers with high sediment transport	-	+ +

Legend: + + Very suitable; -- Unsuitable; - Poor

6.4 Cost of installation of Bandalling

Bandal1iog is mainly installed and effective for small reach i.e. not more than 300 m. Around 300 m of reach, total bandalling cost is 0.15 million BDT. Bandal suits of different length of reaches.

6.5 Limitations of the use of bandals (Table-6-1)

- Bandals can only be applied in rivers with relatively fine bed materials (0.60-0.25mm).
- The velocity in the river should remain sufficient to allow scouring of the channel below the bandals.
- Bandals cannot use in tidal rivers.

Annexure I List of Private dredgers

SL No	Company name, Business / Mailing Address	Owner name, Mobile No, E-Mail	Dredger Nos
01	AZ Dredging Limited Sutie C/16, Rupayan Karim Tower,80 Kakrail, Dhaka-1217	MD. Liaquat Ali Phone: 88029340237 azdredge12@gmail.com	I No-18” 1 No-16" 2 Nos
02	S.S Rahman International Limited 116, Hossain Tower, Box Culvert Road, Naya Palton, Dhaka1000,	MD. RakibulAlam Phone:029344321, 029344918 ssrahmanint@yahoo.com	3 Nos 18”
03	Dredger S.S Rahman Limited 116, Hossain Tower, Box Culvert Road, Naya Palton,Dhaka-1000,	MD. RakibulAlam Phone:01711544526 ssrahmanint@yahoo.com	2 Nos 18”
04	Mayar Limited A-8,Brisa,De Silvestra, House-31, Road-4, Block-F, Banani, Dhaka-1213.	Mohammed Yasir Rabbi Phone: 01815502020 yrrabbi@yahoo.com	2 No-20" 2 No-18" 4 Nos
05	Castle Construction Company Limited House No: 44, Road No: 27(Old), Dhanmondi, Dhaka-1209.	Lt.C0L.Kazi Shahid Ahmed (RTD) Phone:9138242-25 info@castle-bd.com	1 No-26" 1 No-18" 2 Nos-20" 4 Nos
06	Orient Trading and Builders Limited House #80, (6Th floor), Road #2, Chairman Bari, Dhaka 1213.	MD. ShamsulAlam Phone: 01713004229 otbl@dhaka.net	2 Nos-18" 4 Nos-20" 6 Nos
07	Anwer Khan Modern Dredging Corporation suit, 7-B/C/D, Rupayan, Khan Plaza, Dhaka-1209,	Anwer Hossain Khan anwerkhanmderndredging@gmail. com	2 Nos-20"
08	JB Dredger Limited 87, Suhrawardi Avenue, (2nd floor), Block-k, Baridhara, Gulshan, Dhaka- 1212.	Md. BalayetHossin Phone:0177523769 gmjsjv@gmail.com	1 No-18"
09	Vincen Consultancy private Limited Kawran Bazer, Tejgong, Dhaka- 1215.	Samrin Ahmed Kusum Phone: 01920959595	4 Nos 18”
10	YusraConstration Kawran Bazar, TCB Bhaban(9th floor), Tejgaon, Dhaka- 1215.	MD. Sharawer Zaman Dhali Phone: 01920959595	2 Nos 18”
11	IBC power Limited 42, Kamal Ataturk Road, Gulshan, Dhaka-1213.	Bashir Ahmed Phone: 01711527184 Ibc power@com.bd	5 Nos 18”
12	Western Engineering Private Limited TCB Bhaban (10th floor), Kawran Bazar, Dhaka-1215.	Bashir Ahmed Phone: 01711527184 info@weplbd.com	10 Nos 18”
13	Reve Dredging and Engineering Limited 5Th floor, Dumri, khikhet, New Boyalia Bridge, 300 Fit Road, Dhaka,	MD. Saifur Rahaman Phone: 01833360221	1 No-20" t No- Grab Dredger 1 Nos-18" 3 Nos
14	United Progressive Dredging Limited Road-191B, house-299, New Dohs, Mohakhali, Dhaka	MD. Shirajul Islam Phone: 01711548948, info@updlbd.com	3 Nos-20"

SL No	Company name, Business / Mailing Address	Owner name, Mobile No, E-Mail	Dredger Nos
15	Matri Bangla Dredging & Engineering Limited 1/1 Rupayan Taj Tower, (5th floor K-5), NayaPalton, Dhaka-1000.	Tmhemayet Hossain Phone: 01730373025, tmossain@yahoo.com	1 No-18"
16	Spectra EnginccrsLimitcd House-17, Road-106, Block-C-EN(F), Gulshan-2, Dhaka-1212.	Khan Md. Aftab Uddin Phone: 0171 1595450 Intosel@Sectrarou .com.bd	3 Nos-18"
17	Nabarun Traders Limited House -99, (flat A-5), Road # 11/A, Dhanmondi R/A, Dhaka-1209.	MD. Harun Ar Rashid Phone: 01819246088, nabaruntradersltd@gmail.com	3 Nos-18" 2 Nos-20" 5 Nos
18	M.S Kanak Construction Company Limited SadharanBima Sada, 24/25, Dilkusha C/A, Motiheel, Dhaka-1OOO.	Asadur Rahman Khan Phone: 01997014080 kanakkcc @mail.com	I No-18" I No-20" 2 Nos
19	Sonali Dredger Limited 51, Central road,Dhanmondi, Dhaka- 1205. Bangladesh.	Mohammed Younus Phone: 01678205502 information@younusgroup.com	1 No-18" 1 No-20" 2 Nos
20	Banga Dredger Limited Skylark point (9di floor), Suite # 9-Jl-175, 24/A Bijonagar old Dhaka-1000.	Md. Ayenul Islam Phone: 01711052217 info@ bangadred er.com	7 Nos-18" 5 Nos-20" 12 Nos
21	M/S MD. Jamil Iqbal Road-28, Brammonpara, Shibgonj. Sylhet-3100.	Md. Jamil Iqbal Phone: 01973557838 msjamilibal@ mail.com	2 Nos-18"
22	Abdul Moncm Limited I I l, BirUttam C.R Datta road(Sonargaon road), Dhaka-1205.	Abdul Monem Phone:88029632011-13, makalam@amlbd.com	3 Nos 18"
23	S.S Dredgers & Engineers Company Limited 75-76, Rahbar Tower, Link road, Adabar,	Aowlad Hossain Phone: 88029898456	1 No-12" 1 No-18" 1 No-20" 3 Nos
24	Asian Dredgers Limited Sharif Mansion 2nd floor 56-57 Moti'heel C/	Md. Shamim Reza Phone: 88029551015	3 Nos 18"
25	Aqua Marine Dredging Limited BGMEA Complex, Level-7, Block-C, 23/1, Panthaath link road Karwan Bazar Dhaka-1215.	Md. Siddiqure Rahman Phone:+88-02-8140293 sakarim@aquamarin-bd.com	5 Nos-18t'
26	Radiant Dredging Limited MCT Ally's Centre- 12th floor, 186 Nazrul Islam Sarani,	A K M Alauddin , alauddin381@yahoo.com	1 No-18" 1 No-20" 2 Nos
27	Bashundhara Infrastructure Development Limited Plot-125/A, Block-A, Baridhara, Dhaka-1212.	Sayem Sobhan Phone:01799998088 bdcl@gb.com.bd	2 Nos-24" 2 Nos-18" 4 Nos
28	Shah River Dredging& Company 40, Segunbagicha, Dhaka-1000.	Shah Abdul Latif Phone: 01755627040, salatif @yhoo.com	3 Nos-18" 3 Nos-20" 6 Nos
29	Frist S.S Enterprise Private Limited House#55, RoadÅ05,Mohammadiya Housing Society,Mohammadpur Dhaka- 1207	MD. Abu Sadeq. Contact No: 0258156213,01716418432. E-mail: sadeq340@yahoo.com	1No-26" 2Nos-18" 3Nos-20" 6 Nos
30	Ronji Construction Limited Modern Mansion (Level-5),55 Motijheel C/A	Wasim Hossain Phone: 02- 9567727, 9562991. :moderngroupbd@gmail.com	3 Nos 20"

SL No	Company name, Business / Mailing Address	Owner name, Mobile No, E-Mail	Dredger Nos
31	Jamuna Dredging &Engincering Limited Nokshi home, 6/1/A, Topkhana road (Y[d]floor), Se unbaicha Dhaka-1000.	Md. Abdur Rahim Khan Phone: 01678700501 Jdealmg2015@gmail.com	2 Nos-20"
32	Quest International Limited TCB Bhaban, 8[th] floor, 01,Kawran Bazar, Dhaka-1215.	MD. Mahabubul Alam Hanif Phone: 01712231024, info@questintltd.com	4 Nos-20"
33	SS Engineering & Construction Limited Rupayan Trade Center, 6[th] floor, 1 14, KaziNazrul Islam Avenue, Ban lamotor Dhaka-1000.	Shahabuddin Ahmed Phone:+88029353993-4 ho@stcgroup -bd.or	1 No-24" 3 Nos-20" 4 Nos
34	Greatwalt Ships and Drcdgcrs Ltd. Navanazohura, Square (12th Floor) 28, KaziNazrul Islam Avenue, Banlatmotor, Dhaka - 1000.	Asif Iqbal Mahmud Phone: 880255168031-37 E-mail: aminul@greatwallceramic.net	2 Nos-20"
35	Bond Collection International House-17,Road 1/4, sec 1/3, Uttara, 1230, Dhaka.	MD. Hanif(ALl) Phone: 01747448563 E-mail: bondbdltd@gmail.com	I No-20" 2 Nos-22" 2 Nos-24"
36	BARAKA ENGINEERS Limited House #25, Road #34, Gulshan -2, Dhaka-1212, Bangladesh.	AKM RUHUL AMIN. Phone: +8802-8812395 E-mail: barakadreding@gmail.co mail.com	4 Nos-20"
37	MONDOL TRADERS Limited Suite -908, Lavel -8, 2/8 SaheraFopieal, Center,Bata Signal Dhaka.	Kabi Shanker Roy Phone: 01713993958 E-mail: mondolfiroz@gmail.com	
38	Rupayan Dredging Ltd. Rupayan Center, 9th floor, BiruttamAkKhandakar Road, Mohakhali C/A, Dhaka 1212.	Md. Liaquat Ali Khan Mukul Phone: 01749466722 E-mail: info@rupayangroup.com	2 Nos-20"
39	Southern Dredging & Engineering.Ltd. 1108 DT. Lane, Bandon -4100, Double Mooring Chottogram .	Md. Feroz Uddin Phone: 01711761619,01713168494, E-mail: southern.dreadger@gmail.com	1 Nos-20"
40	SQL Engineers SuvastuSuraiya Trade Center (Level No. 10) Plot #57, Road #21, Block {B, Kamal/Avenue Banani, Dhaka-1213	AZM Shofiuddin, Imrur Anwar Phone: 01711526827 E-mail: quader@sq.bd.com	6 Nos-20"
41	Hydro Solutions Ltd. House No; 531(3rd floor), Road No;11, Baridhara DOHS,Dhaka -1206.	Iftekhyrul Islam Chowdhury Phone: 01711549001 E-mail: hydrosloution ltd. gmail.com	3 Nos-20"
42	DBL Dredging. Capital South Avenue Tower 6th floor), House No- 50, Road no -03, Gulshan Avenue ,Dhaka -1212.	M.A.Jabbar Phone: 880-2-58817735, 01704112771 E-mail: info@bdl-group.com	4 Nos-20" 1 Nos-26" 5 Nos
43	BishkhaliDerdgers Limited 07, House -12, S -07, Sector -07, Uttara, Dhaka-1230.	Md. FazlulHaque Phone: 02-48959706, 02-48959708 Email:mahmud.bdl@starlinggroup .com.bd	2 Nos-20"
44	National Development Engineers Ltd. House -22, Road -4, Block -C, Banani, Dhaka - 1213.	RizwanMustafiz Phone: +880258811504 E-mail: info@ndebd.com	2 Nos-20"
45	H Enterprise 2 No, Bangobandu Avenue, Gulistan Shopping Complex.	Md. TawhidulHaque Phone: 01712744046 E-mail: inf.group52@gmail.com	1 No-20"

SL No	Company name, Business / Mailing Address	Owner name, Mobile No, E-Mail	Dredger Nos
46	KSE MARINE WORKS (BANGLADESH).LTD. Ka-13/I Kalachndpur, Gulshan, Dhaka-1212, Bangladesh.	Capt. K. Munirulislam. Phone:(880)19911350085 E-mail: captmunir@gmail.com.web:www.ksemarine.com	1 No-18"
47	Bengal Structure Development ltd. 95/A Tejgaon Industrial Area, Tejgaon, Dhaka, Bangladesh.	Saiful Alam Phone: (8802) 9888248-49, +88029847507, E-mail: info@bsdl.com.bd	3 Nos-20"
48	Dredge Bangla Limited. 121B, R.K. Mission road, Dhaka -1203	MOHAMMADMOHSIN Phone: 02-57165217, 01714091720 E-mail: info@dredgebangla.com	2 Nos-1S"
49	DREAM CONSTRUCTION House no 492/1, Lane -09, Cantonment, Dhaka	AshrafulAlam Reason Phone:01711327335, E-mail: info@dreamconstructionbd.com	1 No-18"
50	WASEQ DREDGING LTD. Road # 8, House # 5, Sater -6, Uttara	Md. Aktar Hossain Phone:01719325456, E-mail: waseqgroup.ltd@gmail.com	1 No-20"
	B.J.GEO -TEXTILE LTD. 16, Kemal Ataturk Avenue, Banani, Dhaka - 1213.	NasimulAlam Chowdhury Phone: 01711531133, 01911359209, E-mail:info@bangjin.com	2 Nos-20"
51	Chakda dredging & Engineering (Pvt) Ltd. Chakda, Kadamtoly, Dhaka -1204.	Haji Md. Shahjahan Phone:01711583087	2 Nos-22"
52	M.J.N Dredging Limited Bashati Condominium Ltd, Flat No: D/9, House -15, Road -17, Bananips; Dhaka - 1213.	Mohammad Zakir Phone: 02-22227427279, 01910-100003 E-mail: mjndredging@gmail.com	1 No-18" 1 No-20" 2 Nos
53	QAMAR NAZ ENTERPRISE Double mooring, 4100, Chattogram.	Asif Mahmud Phone: 01707381121, 01619381121 E-mail: asif@qamarnaz.com	1 No-18"
54	Dredging &Devclopment Union Ltd 9/1(9th floor), City Heart 67, NayaPaltan, Dhaka -1000	Abdullah Nahid Niger Phone:01730738992, E-mail: niger@anandagroup.biz	1 No-20" 1 No-20" 2 Nos
55	DARUN HARBOUR CONSTRUCTION LTD Address: 10th Floor, Akhteruzzaman Center, Agrabad C/A, Double Mooning PS; Chittagong -4100.	MD. Omar Faruque Phone: 01817235125 , E-mail: dhcdredging@gmail.com	1No-22"
56	DOMINAGE STEEL BUILDING SYSTEMS LIMITED CHANGE House No; 31/8, Road No: 03, Block -D, Aukpara, Ashulia, Dhaka: Ashulia PS; Dhaka-1362.	Mohammad Rafiqul Islam Phone:+8802222282140-43, E-mail: info@dominage.net	1 No-16" 1 No-20" 2 Nos
57	PBL-JANATA, JV. House-199 (5th floor), Road-1, New DOHS Mohakhali, Dhaka Cant. Dhaka-1206.	Md. Rofiqul Islam, Md. Borkat Ali Phone: +88-02-222260495, +88-02-8711753 E-mail: premierbangladeshhltd@gmail.com , janatadredging@gmail.com	1 Nos-20" 2 Nos-22" 2 Nos-26" 5 Nos

Annexure II List of BIWTA Dredgers

Collected from BIWTA, 141-143 Motijheel, Dhaka

Sl.No.	Designation	Year of procurement	Size of dredger (inch): Cutter Suction	Ladder Depth(m)	Main Engine capacity (HP)	Manufacturer Capacity (m^3/h)	Present physical capacity (m^3/h)
1	Kirtankhola	2011	18"	14	1125	450	200-260
2	Meghna	2016	18"	14	1125	450	200-260
3	Surma	2014	20"	14	1400	750	600-650
4	Bagshi	2018	26"	16	2000	2500	1350-1400
5	D-139	1975	18”	14	1125	450	200-260
6	D-137	1975	18"	14	1125	450	200-260
7	Karnaphuly	2011	18"	14	1125	450	200-260
8	Sugandha	2020	20"	14	1400	750	600-650
9	Bishkhali	2018	26"	14	2000	2500	1350-1400
10	Bangali	2018	26"	14	2000	2500	1350-1400
11	Sandha	2020	20"	14	1400	750	600-650
12	Padma	2016	18"	14	1125	450	200-260
13	Shitalakha	2014	20"	14	1400	750	550-600
14	Rupsa	2014	18"	14	1125	450	250-290
15	Delta -2	1972	18"	14	1125	450	20-190
16	D-138	1975	18"	14	1125	450	200-260
17	Jamuna	2016	18"	14	1125	450	200-260
18	Punarbhaba	2018	20"	14	1400	750	600-650
19	Kumar	2020	18"	14	1125	450	300-350
20	Sangu	2020	20"	14	1400	750	600-650
21	Baleshwar	2018	26"	16	2000	2500	1350-1400
22	D-136	1975	18"	14	1125	450	190-200
23	Atrai	2014	18"	14	1125	450	200-260
24	Modhumati	2020	18"	14	1125	450	250-300
25	Brahmaputra	2019	26"	16	1200	2500	1350-1400
26	Kaptai	2020	18"	14	1125	450	250-300
27	Sutang	2020	20”	14	1400	750	600-650
28	Kushiara	2011	18"	14	1125	450	200-260
29	Piain	2019	20"	14	1400	750	600-650
30	D-135	1975	18"	14	1125	450	190-200
31	Pashur	2019	20"	14	1400	750	600-650
32	D-Chitra	2014	18"	14	1125	450	200-250
33	Borak	2019	26"	16	2000	2500	1350-1400
34	Gomati	2014	18"	14	1125	450	200-260
35	Shibsha	2020	20"	14	1400	750	600-650
36	Kapotakho	2011	18"	14	1125	450	200-260
37	Buriganga	2014	18"	14	1125	450	200-260
38	Kaliganga	2020	18"	14	1125	450	250-300
39	Dhaleshawri	2014	18"	14	1125	450	200-260
40	Payra	2019	20"	14	1400	750	600-650

Annexure III

List of BWDB dredgers

Collected from dredger Directorate, BWDB, Narayangonj

Sl.No.	Name of dredger	Year of collection	Size of dredger (Size of cutter)	Country make (m^3/s)	Ladder depth (m)	Manufacturer Capacity (m^3/hr)	Field capacity (m^3/hr)
1.	Padma	2014	26"	USA	16/14	2500	1400
2.	Gorai	2014	26"	USA	16/14	2500	1400
3.	Rupsa	2014	26"	USA	16/14	2500	1400
4.	Turag	2014	26"	USA	16/14	2500	1400
5.	Modhumoti	2014	26"	USA	16/14	2500	1400
6.	Meghna	2014	26"	USA	16/14	2500	1400
7.	Joltana 1	2014	26"	USA	16/14	2500	1400
8.	Joltana 2	2014	26"	USA	16/14	2500	1400
9.	Bohdana	2014	26"	USA	16/14	2500	1400
10.	Biskhala	2014	20"	Netherlands	14/13	750	650
11.	Dhansiri	2014	20"	Netherlands	14/13	750	650
12.	Chitra	2000	18"	Netherlands	13/12	450	350
13.	Nobogoda	2000	18"	Netherlands	13/12	450	350
14.	Burigonga	2000	18"	Netherlands	13/12	450	350
15.	Shitolokkha	2000	18"	Netherlands	13/12	450	350
16.	Mohanonda	2000	18"	Netherlands	13/12	450	350

Annexure IV

List of BIWTA Development projects

(a) List of Completed Projects of BIWTA (From July 1992 -June 2022)

SL No.	Name of Project	Implementation Period	Quantity (million m^3)	Expenditure incurred (million BDT)
1	Dredging of existing waterways and improvement of dredging operation & efficiency.	July 1992-June 2000	3.40	680.61
2	Rehabilitation of BIWTA's 2(two) Nos. Dredger and related Ancillary crafts (1st Revised).	June 2009 June 2010	1.68	335.43
3	Introduction of waterways around Dhaka City, 1st phase: Development of navigability and providing landing facilities from Sadarghat to Ashulia Bridge.	July 2000 – June2005	1.76	359.96
4	Widening and development of navigability by dredging of Gabkhan canal connecting Dhaka-Mongla and Chittagong-Mongla river route .	July 2004 – December 2007	0.87	173.96
5	Development of navigability of 4 nos. important inland water ways by dredging	Jan' 2005-June 2008	2.30	460.53
6	Long-term dredging Programme for maintaining waterways navigable including procurement of 3 No. dredgers and 1 no. booster pump with other accessories.	July 1998 – June2009	1.79	357.39
7	Introduction of Circular Waterways in and around Dhaka city (2nd phase) 1st Revised)	July 2007- June 2013	3.03	545.41
8	Dredging of Madaripur-Charmuguria-Takerhat-Gopalganj River Route (2nd Revised)	Jan' 2011 – June 2016	5.80	1160.22
9	Procurement of 2 dredgers, crane boats, crew house boat and tug boat with other accessories for maintaining the navigability of inland waterway 2nd revised,	Jan' 2009 – June 2016	7.11	1422.61
10	Feasibility Study for River Management. By enhancing the navigability, removing/ minimizing drainage congestion, tourism, wetland ecosystem, irrigation and landing facilities by capital dredging in the Haor region.	August 2017- June 2018	2.37	47.48
11	Dredging on 12 important river routes.	Oct'2011-June 2020	30.30	5084.60
12	Feasibility Study for construction of walkway, Eco-Park and other allied infrastructure on the foreshore land of the river Buriganga, Turag, Balu & Sita Lakhya (3rd phase) and waste removal from the river bed along the circular waterways of Dhaka city.	July 2018-Sept'2019	0.24	47.67
13	Feasibility Study for River Management by enhancing the navigability. Minimizing drainage congestion. Wetland ecosystem, irrigation and landing facilities by capital and maintenance dredging in Barisal division	Feb' 2019 – Dec'2020	0.21	41.27
14	Procurement of 10 dredgers, crane boats, tugs, officer house boats and crew house boats with other accessories (2nd Revised).	July 2011 – June 2021	41.42	7456.02
		Total=	102.28	18173.16

b. List of ongoing development dredging project

Sl. No.	Name of Project with waterway routes	Implementation Period	Quantity (million m^3)	Cost (million BDT)
1	Improvement of navigability from Mongla to Pakshi River via Chandpur -Mowa-Goyalanda	July 2017 to June 2025	52.13	12900.00
2	Improvement and restoration of navigability for old Brahmaputra, Dharala, Julai and Punarbhaba river	July 2018 to June 2024	207.30	43710.00
3	Establishment of Dhaka-Lakshmipur navigational route on the Meghna(lower) river	Jan 2020 to June 2023	3.10	498.80
4	Improvement and restoration of of navigation for portion of Ghorautra river , Bhola-Sreegang river under upazila of Mithamaoin and Dhanu river under the upazila of Itna and of Dholeshari river under the upazila Astagram.	July 2022 to 2027	19.85	3422.60
5	Capital Dredging of 53 river routes ininland waterways (1st phase: 24 River Routes) (2nd revised)	July 2012 – June 2022.	96.20	19230.00
	Total=	-	378.58	79761.40

c. List of development project to be executed

Sl. No.	Name of project with waterway route	Period	Quantity (million m^3)	Cost (million BDT)
1.	River management by enhancing the navigability, removing/minimizing drainage congestion, tourism, wetland ecosystem, irrigation and landing facilities by capital dredging in Haor region	Jan 2023 to Dec.2027	72.60	167,50.30
2.	Improvement and restoration of Gomti river	July 2023 to Dec 2026	17.30	3530.00
3.	River management by enhancing the navigability, removing/minimizing drainage congestion, tourism, wetland ecosystem, irrigation and landing facilities by capital dredging in Haor region	July 2022 to June 2026	34.35	9724.46
	Total=	-	124.25	30004.30

Annexure V :

List of Inland River Ports (collected from Traffic department-BIWTA)
(Original document)

গেজেট বিজ্ঞপ্তি দ্বারা জারীকৃত নদী বন্দরের সংখ্যা ৩৭টি, যার তালিকা নিম্নরূপ ঃ

ক্রম নং	নদী বন্দরের নাম	জেলার নাম	গেজেট বিজ্ঞপ্তি নং	গেজেট জারীর তারিখ
১.	ঢাকা নদী বন্দর	ঢাকা	Notification No. HTD-462, HTD-463, HTD-464 পরবর্তীতে এস,আর,ও নং-৩০২ আইন/২০০৪ মোতাবেক সীমানা পুণঃ নির্ধারণ করা হয়েছে।	১২-০৯-১৯৮৩ ১৯-১০-২০০৪
২.	নারায়ণগঞ্জ নদী বন্দর	নারায়ণগঞ্জ	Notification No. HTD-462, HTD-463, HTD-464 পরবর্তীতে এস,আর,ও নং-৩০২ আইন/২০০৪ মোতাবেক সীমানা পুণ ঃ নির্ধারণ করা হয়েছে।	১২-০৯-১৯৮৩ ১৯-১০ ২০০৪
৩.	খুলনা নদী বন্দর	খুলনা	Notification No. HTD-462, HTD-463, HTD-464 মোতাবেক	১২-০৯-১৯৮৩
৪.	বরিশাল নদী বন্দর	বরিশাল	Notification No. HTD-462, HTD-463, HTD-464 মোতাবেক	১২-০৯-১৯৮৩
৫.	চাঁদপুর নদী বন্দর	চাঁদপুর	Notification No. HTD-462, HTD-463, HTD-464 মোতাবেক	১২-০৯-১৯৮৩
৬.	চরণী নদী বন্দর	গাজীপুর	Notification No. HTD-462, HTD-463, HTD-464 পরবর্তীতে এস,আর,ও নং-৩০২ আইন/২০০৪ মোতাবেক সীমানা পুণঃ নির্ধারণ করা হয়েছে।	১২-০৯-১৯৮৩ ১৯-১০-২০০৪
৭.	পটুয়াখালী নদী বন্দর	পটুয়াখালী	এস, আর ও নং-৩৮৮ এল/৭৫	২২-১১-১৯৭৫
৮.	বাঘাবাড়ী নদী বন্দর	সিরাজগঞ্জ	এস, আর ও নং-৩৭৩ এল/৮১/ডব্লিউটি/১৫-১৬/৮১-২২১	১৭-১১-১৯৮১
৯.	আরিচা নদী বন্দর	মানিকগঞ্জ	এস, আর ও নং-২৪৭ এল/৮৩	০৫-০৭-১৯৮৩
১০.	দৌলতদিয়া নদী বন্দর	ফরিদপুর	এস, আর ও নং-২৪৭ এল/৮৩	০৫-০৭-১৯৮৩
১১.	নগরবাড়ী- কাজিরহাট নরোদহ নদী বন্দর	পাবনা/রাজবাড়ী	এস, আর ও নং-২৪৭ এল/৮৩ পরবর্তীতে এস আর ও নং-২৯৪-আইন/২০১১ মোতাবেক নগরবাড়ী নদী বন্দরের নাম পরিবর্তনসহ সীমানা পুনঃ নির্ধারন করা হয়।	০৫-০৭-১৯৮৩ ২২-০৯-২০১১
১২.	নরসিংদী নদী বন্দর	নরসিংদী	এস, আর ও নং-২৭৩ আইন/৮৯	৩০-০৭-১৯৮৯
১৩.	ভোলা নদী বন্দর	ভোলা	এস, আর ও নং-১০৭ আইন/২০০৪	২১-০৪-২০০৪
১৪.	মীরকাদিম (মুন্সিগঞ্জ) নদী বন্দর	মুন্সিগঞ্জ	এস আর ও নং-১১৫ আইন/২০০৪	২৯-০৪-২০০৪
১৫.	শিমুলিয়া নদী বন্দর	মুন্সিগঞ্জ/পরিয়তপুর	পরবর্তীতে এস, আর ও নং-৭০- আইন/২০১৬	২৮-০৩-২০১৬
১৬.	নওয়াপাড়া নদী বন্দর	যশোর	এস, আর ও নং-১১৭ আইন/২০০৪	২৯-০৪-২০০৪
১৭.	আশুগঞ্জ-ভৈরব বাজার নদী বন্দর	ব্রাহ্মণবাড়িয়া	এস, আর ও নং-২৯২ আইন/২০০৪	১২-১০-২০০৪
১৮.	বরশুনা নদী বন্দর	বরশুনা	এস, আর ও নং-২৯৩ আইন/২০০৪	১২-১০-২০০৪
১৯.	চরজানাজাত নদী বন্দর	মাদারীপুর	এস, আর ও নং-৩০৪ আইন/২০০৪	২০-১০-২০০৪
২০.	ছাতক নদী বন্দর	সিলেট	এস, আর ও নং-১৯২ আইন/২০০৬	০১-০৮-২০০৬
২১.	মেঘনা নদী বন্দর	নারায়ণগঞ্জ	এস, আর ও নং-১৯৩ আইন/২০০৬	০১-০৮-২০০৬
২২.	কক্সবাজার (কক্সরাঘাট) নদী বন্দর	কক্সবাজার	এস, আর ও নং-৩০ আইন/২০১০	০৩-০২-২০১০
২৩.	ফরিদপুর নদী বন্দর	ফরিদপুর	এস, আর ও নং-২৬০ আইন/২০১৫	১৬-০৮-২০১৫
২৪.	ঘোড়াশাল নদী বন্দর	গাজীপুর	এস, আর ও নং-২৫৮ আইন/২০১৫	১৬-০৮-২০১৫
২৫.	টেকনাফ নদী বন্দর	কক্সবাজার	এস, আর ও নং ২২৯- আইন/২০১৬	১৭-০৭-২০১৬
২৬.	টেকেরঘাট নদী বন্দর	সুনামগঞ্জ	এস, আর ও নং ২৮৭- আইন/২০১৬	২৫-০৯-২০১৬
২৭.	চিলমারী নদী বন্দর	কুড়িগ্রাম	এস, আর ও নং-৩৬৮ আইন/২০১৬	০৮-১২-২০১৬
২৮.	মজুচৌধুরীর হাট নদী বন্দর	লক্ষীপুর	এস, আর ও নং-০৮ আইন/২০১৭	১৬-০১-২০১৭
২৯.	সুনামগঞ্জ নদী বন্দর	সুনামগঞ্জ	এস,আর,ও নং-১০৭-আইন/২০১৭ এবং এস,আর ও নং-১০৬ আইন/২০১৭	১১-০৫-২০১৭
৩০.	দাউদকান্দি ও বাউশিয়া নদী বন্দর	কুমিল্লা/চাঁদপুর	এস,আর,ও নং-৫০ আইন/২০১৮ এবং এস,আর ও নং-৫১ আইন/২০১৮	০৭-০২-২০১৮
৩১.	রূপপুর নদী বন্দর	পাবনা	এস,আর,ও নং-২৩৫ আইন/২০১৮ এবং এস,আর ও নং-২৩৬ আইন/২০১৮	২২-০৭-২০১৮
৩২.	মেঘাইঘাট-নাটুয়ারপাড়া নদী বন্দর	সিরাজগঞ্জ	এস,আর,ও নং-০৬ আইন/২০১৯ এবং এস,আর ও নং-০৭ আইন/২০১৯	১৩-০১-২০১৯
৩৩.	মিরসরাই-রাসমনি নদী বন্দর	ফেনী/চট্টগ্রাম	এস,আর,ও নং-৬৪ আইন/২০২০	১২-০৩-২০২০
৩৪.	বালাগঞ্জ নদী বন্দর	হবিগঞ্জ / সিলেট	এস,আর,ও নং-১৬৭ আইন/২০২০	২২-০৬-২০২০
৩৫.	বেতুয়া নদী বন্দর	ভোলা	এস,আর,ও নং-৩১২ আইন/২০২১	১২-১০-২০২১
৩৬.	কোম্পানীগঞ্জ-সোনাগাজী নদী বন্দর	ফেনী ও নোয়াখালী	এস,আর,ও নং-৩২৭ আইন/২০২১	২৪-১০-২০২১
৩৭.	গাজীপুর নদী বন্দর	গাজীপুর	এস,আর,ও নং-৭২ আইন/২০২২	১৩-০৪-২০২২

Annexure V :

List of Inland River Ports(Translated copy)

Total number of Inland River Ports in Bangladesh as per issued government gazette are 37, they are listed below:

Sl.No.	Name of river port	District Name	Gazette Notice No.	Date of issuing gazette
1.	Dhaka Inland River Port	Dhaka	Notification No.HTD-462,HTD-463,HTD -464,afterworsds S,R, O No.302 Rule/2004 accordingly area rede marketed.	12-09-1960 19-10-2004
2.	Narayangonj Inland River Port	Narayangonj	Notification No.HTD-462,HTD-463,HTD -464,afterworsds S,R, O No.302 Rule/2004 accordingly area redemarketed.	12-09-1960 19-10-2004
3.	Khulna Inland River Port	Khulna	Notification No.HTD-462,HTD-463,HTD -464, accordingly area rede marketed.	12-09-1960
4.	Barishal Inland River Port	Barishal	Notification No.HTD-462,HTD-463,HTD -464, accordingly area rede marketed.	12-09-1960
5.	Chandpur Inland River Port	Chandpur	Notification No.HTD-462,HTD-463,HTD -464, accordingly area rede marketed.	12-09-1960
6.	Tangi Inland River Port	Gazipur	Notification No.HTD-462,HTD-463,HTD -464,afterworsds S,R, O No.302 Rule/2004 accordingly area rede marketed.	12-09-1960 19-10-2004
7.	Patuakhali Inland River Port	Patuakhali	S.R.O No.388 L/75	22-11-1975
8.	Baghabari Inland River Port	Shirajgonj	S.R.O No.373L/81/WD/15-16/81-221	17-11-1981
9.	Aricha Inland River Port	Manikonj	S.R.O No -247L/83	5-07-1983
10.	Dauladia Inland River Port	Fardpur	S.R.O No -247L/83	5-07-1983
11.	Nogobari-Kazirhat Noradoha Inland River Port	Pabna/Rajbari	S.R.O No.-247 L/83 afterwards S.R.O No.-294-Rule/2011 accordingly the name of Nogorbari Inland River Port had been changed including redemarketed the area/boundary	5-07-1983 22-09-2011
12.	Norsingdi Inland River Port	Norsingdi	S.R.O No.-273 Rule/89	30-07-1989
13.	Bhola Inland River Port	Bhola	S.R.O No.-107 Rule/2004	21-04-2004
14.	Mirkadim(Munsigonj) Inland River Port	Munsigonj	S.R.O No.-115 Rule/2004	29-04-2004
15.	Shimulia Inland River Port	Munsigonj/Shariatpur	S.R.O No.-70 Rule/2016	28-03-2016
16.	Noapara Inland River Port	Joshore	S.R.O No.-117 Rule/2004	29-04-2016
17.	Ashugonj-Bhairab Inland River Port	Branhambaria	S.R.O No.-292 Rule/2004	12-10-2004

18.	Borguna Inland River Port	Borguna	S.R.O No.-293 Rule/2004	12-10-2004
19.	Charjanajat Inland River Port	Madaripur	S.R.O No.-304 Rule/2004	20-10-2004
20.	Chhatak Inland River Port	Sylhet	S.R.O No.-192 Rule/2006	1-08-2006
21.	Meghna Inland River Port	Narayangonj	S.R.O No.-193 Rule/2006	1-08-2006
22.	Cox's bazar (Kasturighat) Inland River Port	Cox's bazar	S.R.O No.-30 Rule/2010	3-02-2010
23.	Faridpur Inland River Port	Faridpur	S.R.O No.-260 Rule/2015	16-08-2015
24.	Ghorashal Inland River Port	Gajipur	S.R.O No.-258 Rule/2015	16-08-2015
25.	Technaf Inland River Port	Cox'sbazar	S.R.O No.-229 Rule/2016	17-07-2016
26.	Takerhat Inland River Port	Sunamgonj	S.R.O No.-287 Rule/2016	25-09-2016
27.	Chilmari Inland River Port	Kurigram	S.R.O No.-368 Rule/2016	8-12-2016
28.	Mojuchowdhuri Inland River Port	Lakhimpur	S.R.O No.-08 Rule/2017	16-01-2017
29.	Sunamgonj Inland River Port	Sunam gonj	S.R.O No.-107 Rule/2017 and S.R.O. No. 106 Rule/2017	11-05-2017
30.	Daudkandi and Baousia Inland River Port	Cumilla/Chadpur	S.R.O No.-50 Rule/2018 and S.R.O No. 51 Rule/2018	7-02-2018
31.	Ruppur Inland River Port	Pabna	S.R.O No.-235 Rule/2018 and S.R.O No. 236 Rule/2018	22-07-2018
32.	Meghaighat-Ntuapara Inland River Port	Sirajganj	S.R.O No.-06 Rule/2019 and S.R.O No. 07 Rule/2019	13-01-2019
33.	Mirsarai-Rasmoni Inland River Port	Feni/Chattogram	S.R.O No.-64 Rule/2020	12-03-2020
34.	Balagonj Inland River Port	Hobigonj/Sylhet	S.R.O No.-167 Rule/2020	22-06-2020
35.	Betua Inland River Port	Bhola	S.R.O No.-312 Rule/2021	12-10-2021
36.	Companyganj-Sonagaji Inland River Port	Feni and Noakhali	S.R.O No.-327 Rule/2021	24-10-2021
37.	Gajipur Inland River Port	Gazipur	S.R.O No.-72 Rule/2022	13-04-2022

Annexure VI

Passengers carried in inland waterways through different river ports from 2010-2011 to 2020 – 2021

(Collected from Port and Traffic Management Department, BIWTA)

Passengers and cargo carried in inland waterways through different river ports in last Eleven years

a) Passengers (Figure in lac)

Sl.	Name of river ports	2010-11	2011-12	2012-13	2013-14	2014-15	2015-16	2016-17	2017-18	2018-19	2019-20	2020-21
1	Dhaka River Port	600.90	513.09	643.16	658.89	653.45	699.99	678.08	713.46	704.03	535.52	504.74
2	Sadarghat & others	-	-	-	-	-	-	-	-	288.09	216.90	223.04
3	Tangi River Port	20.09	20.22	20.41	20.78	20.76	21.36	22.09	22.66	22.98	17.24	15.69
4	Narayanganj River Port	301.90	315.28	324.08	327.89	382.49	398.10	399.06	399.28	396.83	293.32	303.68
5	Munshiganj River Port	42.11	47.35	52.74	58.93	61.39	64.41	66.99	69.87	68.78	55.24	52.15
6	Meghna River Port	7.58	7.94	7.70	8.02	8.26	8.59	8.93	9.29	9.34	8.34	8.39
7	Ashuganj Bhairab River Port	19.52	20.04	20.18	20.32	20.68	21.47	22.33	23.22	50.79	45.71	42.13
8	Chandpur River Port	8.68	8.84	8.76	8.92	9.52	9.11	9.21	9.58	11.30	9.27	9.31
9	Sonargaon River Port	-	-	-	-	-	-	-	-	44.00	41.10	39.05
10	Taltoli ghat River Port & others point	-	-	-	-	-	-	-	-	2.00	1.94	1.88
11	Narsingdi River Port	23.40	28.22	32.49	38.62	41.28	42.94	44.66	46.45	44.07	42.18	38.20
12	Ghorashal River Port	-	-	-	-	-	-	-	-	-	-	-
13	Khulna River Port	12.58	13.75	13.99	14.10	14.59	14.75	15.34	15.36	14.54 3.00	14.67 2.76	12.13
14	Nawapara River Port	-	-	-	-	-	-	-	-	-	-	-
15	Chandpur River Port	34.00	38.30	41.50	44.39	47.99	51.77	54.28	56.99	54.98	40.13	39.68
16	Barisal River Port	72.00	77.60	91.60	109.81	120.10	164.11	173.96	188.40	195.00	201.32	217.30
17	Bhola River Port	20.00	21.50	23.40	24.45	25.02	26.02	27.06	28.14	23.10	24.00	20.50
18	Patuakhali River Port	30.41	32.13	36.54	38.07	40.43	41.43	43.96	45.74	43.97	39.15	83.34
19	Barguna River Port	13.89	13.60	13.65	13.84	14.35	14.75	15.32	15.93	14.95	15.50	15.45
20	a) Dawlatdia & Paturia port, 4 out side ports b) Dawlatdia & Paturia Ferry	402.26	414.25	423.50	430.31	445.90	476.44	507.15	537.58	500.00 260.00	120.00 221.00	85.28 207.05
21	a) Aricha port area b) Aricha port side of port area	150.36	158.25	160.50	162.33	155.50	172.54	179.44	186.62	94.00 34.25	128.00	104.80
22	a) Nagarbari-Kazirhat, Mawdola port area b) Nagarbari-Kazirhat, Mawdola (Ferry & out side port)	128.80	130.65	133.38	134.56	142.20	147.89	153.81	159.96	94.00 34.25	92.00 30.25	68.80 23.74
23	Pakshi pur CNB ghat	-	-	-	-	-	-	-	-	-	-	-
24	Baghabari River Port	1.82	1.88	1.94	2.00	2.07	2.10	2.16	2.22	2.50	2.65	2.70
25	Mawa shimulia Port & Ferry	92.35	98.24	104.13	110.36	117.00	124.02	131.46	139.35	142.75	115.00	140.83
26	Kathalbari (Charjanajia) Port & Ferry	92.35	98.24	104.13	110.36	117.00	124.02	131.46	139.35	142.75	113.00	137.00
27	Cox's bazar Cantony Ghats River Ports	14.36	14.52	14.60	14.64	14.88	15.33	15.89	16.16	21.57	22.04	20.94
28	Different Ghats under Chittagong office	11.78	11.88	11.95	11.98	12.13	13.14	13.47	13.86	3.22	31.60	30.02
29	Teknaf River Port	-	-	-	-	-	-	-	-	11.34	11.26	13.70
30	Cuhmari River Port	-	-	-	-	-	-	-	-	8.00	7.60	7.22
31	Dawodkandi & Baushia River Port	-	-	-	-	-	-	-	-	-	22.36	20.76
32	Rajpur river port	-	-	-	-	-	-	-	-	-	-	-
33	Meghaghat Nalsapara river port	-	-	-	-	-	-	-	-	-	-	-
34	Mirsarai Rasoni river port	-	-	-	-	-	-	-	-	-	-	-
35	Sulagaon river port	-	-	-	-	-	-	-	-	-	-	-
	Total=	1110.50	2191.91	2386.73	2568.25	2447.21	2587.25	2580.63	2836.84	3047.40	2506.34	2515.30

Annexure VII

Cargoes carried in inland waterways through different river ports from 2010-2011 to 2020 – 2021

(Collected from Port and Traffic Management Department, BIWTA)

B) Cargo (Figure in lac Metric Ton)

Sl.	Name of river ports	2010-11	2011-12	2012-13	2013-14	2014-15	2015-16	2016-17	2017-18	2018-19	2019-20	2020-21
1	Dhaka River Port	34.77	36.86	39.07	41.41	43.89	46.52	49.13	52.08	55.73	58.52	61.45
2	Showarighat & others	.	.	.	.	.	.	.	.	.	.	.
3	Toagi River Port	6.14	6.49	6.98	7.26	7.55	7.85	8.16	8.49	8.96	9.41	116.64
4	Narayanganj River Port	8.80	9.60	9.78	10.37	10.99	11.65	12.35	13.09	44.06	51.35	58.22
5	Markadim River Port	2.64	2.88	2.93	3.05	3.17	3.30	3.43	3.57	3.65	3.52	6.44
6	Meghna River Port	4.40	4.80	4.85	5.09	5.34	5.61	5.89	6.18	6.29	6.92	169.60
7	Ashuganj-Bhairab River Port	2.20	2.40	2.44	2.59	2.75	2.92	3.10	3.29	5.13	33.12	34.78
8	Chattak River Port	1.09	1.19	1.23	2.10	2.17	2.30	2.44	2.59	79.0	82.95	87.10
9	Sunamgonj River Port	.	.	.	.	.	.	.	.	79.00	82.95	87.10
10	a) Taker ghat River Port b) Taker ghat (others point)	.	.	.	.	.	.	.	.	5.76	7.92 31.50	8.32 33.08
11	Narsingdi River Port	0.66	0.72	0.73	1.26	1.30	1.35	1.40	1.46	1.53	1.68	2.01
12	Ghorashal River Port	2.20	2.40	2.44	2.59	2.75	2.92	3.10	3.29	3.29	3.45	5.50
13	Khulna River Port	0.50	0.54	0.56	0.58	0.60	0.62	0.64	0.66	4.44	5.01	5.94
14	Nawapara River Port	2.01	2.18	2.29	2.40	2.52	2.65	2.78	2.92	6.00	7.50	7.70
15	Chandpur River Port	1.39	1.41	1.44	1.46	1.48	1.50	1.53	1.55	1.55	4.55	3.07
16	Sarisal River Port	9.10	10.20	11.35	12.61	13.22	14.65	15.45	16.69	26.08	29.21	30.67
17	Bhola River Port	2.00	2.50	2.75	3.20	4.56	5.35	6.66	7.15	8.20	7.00	8.00
18	Patuakhali River Port	1.70	1.92	2.00	3.70	4.95	5.73	6.58	7.22	7.36	7.01	7.82
19	Borguna River Port	0.91	1.03	1.08	2.00	2.66	3.18	3.58	3.92	4.06	3.60	3.55
20	a)Dawlatdia & Paturia (port & out side port) b) Dawlatdia & Paturia (Ferry)	17.70	18.82	20.02	22.14	23.58	25.41	26.48	27.12	15.50 13.75	12.50 13.75	13.13 112.69
21	a) Aricha (port area) b) Aricha (out side of port area)	17.70	18.82	20.02	22.14	23.58	25.41	26.48	27.12	14.50 13.50	11.60 13.50	12.18 14.17
22	Nagarbari-Kazirhat, Noradoho (port,Ferry & out side port)	17.70	18.82	20.02	22.14	23.58	25.41	26.48	27.12	37.00	30.00	31.50
23	Faridpur CMB ghat	5.92	6.29	6.66	6.98	7.12	7.42	7.61	7.91	27.00	21.50	22.58
24	Baghaberi River Port	0.53	0.61	1.10	1.85	2.38	2.90	3.14	3.32	1.60	1.80	1.90
25	Mawa /shimulia (Port & Ferry)	.	.	.	.	.	.	.	.	1.74	1.30	30.20
26	Kathalbari /Charjanajat (Port & Ferry)	.	.	.	.	.	.	.	.	1.74	1.20	28.13
27	Cox's bazar (Costory Ghat) River Ports	0.42	0.44	0.64	0.94	1.22	1.41	1.69	1.98	1.98	1.41	1.51
28	Different Ghats under Cittagong office	0.52	0.53	0.54	0.61	0.82	1.12	1.34	1.67	31.29	31.60	33.18
29	Teknaf River Port	.	.	.	.	.	.	.	.	4.32	4.75	4.99
30	Chilmari River Port									0.37	0.39	0.42
31	Dawudkandi & Baushia River Port									45.07	17.66	86.34
32	Ruppur river port	.		.	.	.	.	.	.	.	.	.
33	Meghaighat-Natuapara river port	.	.	.	.	.	.	.	.	.	.	.
34	Mirsarai-Rasmoni river port	.	.	.	.	.	.	.	.	.	.	.
35	balagang river port	.	.	.	.	.	.	.	.	.	.	.
36	Protocol on Inland Water Transit & Trade between Bangladesh & India											39.60
	Total=	141.00	151.45	160.92	178.47	192.18	207.18	219.44	230.39	559.45	600.13	1169.51

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