JETIR.ORG ISSN: 2349-5162 | ESTD Year : 2014 | Monthly Issue
JOURNAL OF EMERGING TECHNOLOGIES AND INNOVATIVE RESEARCH (JETIR)
An International Scholarly Open Access, Peer-reviewed, Refereed Journal

Navigational Problems and Its Mitigation in Bangladesh

[1]Engr. Rabindra Ranjan Saha, PEng, [2]Md. Tanvir Ahmed, [2]Rokhshana Parvin
[1]Associate Professor, [2]Lecturer
[1]Department of Civil Engineering, World University of Bangladesh, Dhaka, Bangladesh

Abstract: Bangladesh is a land of 1007 rivers of varying nature and have different hydraulic characteristics. 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 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 cannot able to perform the expected dredging owing to various reasons like paucity of budget allocation and dredging equipment. 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. 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. Collected data analyzed and found that BIWTA is mandated authority to maintain and develop the waterways all over Bangladesh. BIWTA has only 40 Cutter Suction Dredgers (CSD) with capacity ranges from 250 to 1400 m^3/h. From 2011-2012 to 2021-2022 BIWTA carried out 64.51 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 Annual Development Program (ADP) are 3544.18 million Bangladesh Taka (BDT) for dredging against requirement 4435.56 million BDT respectively. Due to the budget paucity, dredging of channel hampered, resulting reduction of its navigability and die 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 action program and implementation are necessary. To implement this dredging action plan government should look into required budget allocation for procurement of dredgers with ancillary equipment. Otherwise, waterways will lose its navigability and in course of time the dyeing 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

1.1 Background

Bangladesh is a land of rivers spread all over the country as a spider net. 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 cargo transport since it is the cheapest mode of 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 [1]. The GBM basin ranks third in the world river system in terms of sediment transport and water discharge [2,3]. 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. 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 [4]. 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 [5]. Thus, IWT plays a pivotal role to government's effort towards growth and reduction of poverty under National Strategy for Accelerated Poverty Reduction [6,7]. 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 [8]. 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 [9]. Very recently on October 2023, National River Conservation Commission (NRCC) published final report mentioning total number of rivers in Bangladesh are 1007. Bangladesh lies in the biggest river delta of the world - the Ganges Delta system. Waterways are and will remain a very important feature of rural life providing vital links, the waterways help to sustain life in the rural areas and so lessen the drawn of the cities. As per Bangladesh Transport sector study, 1994, 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 [10]. The reasons for gradual deterioration of rivers are stream flow reduction, reduction in cross boundary flow, silting up of off-takes and reduction of tidal volume. All the rivers of Bangladesh discharge about 0.15 million m^3/sec 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. BIWTA government mandated organization cannot dredge out the huge amounts of silts due to various constraints like inadequate budget allocation and dredging equipment resulting gradually dyeing of reiver and reduction of navigable waterways.

1.2 Modal Shares: 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 [11]. As per Improved Mechanization of Country Boats published by NOAMI in 1991, the country boats cater 15-million-ton cargo annually. 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, Table 1.1 explains modal share of passenger and cargo movement through different modes of transport.

Table 1.1: 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 and own calculations

1.2.1 Share of IWT in the passengers and cargoes transport

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.

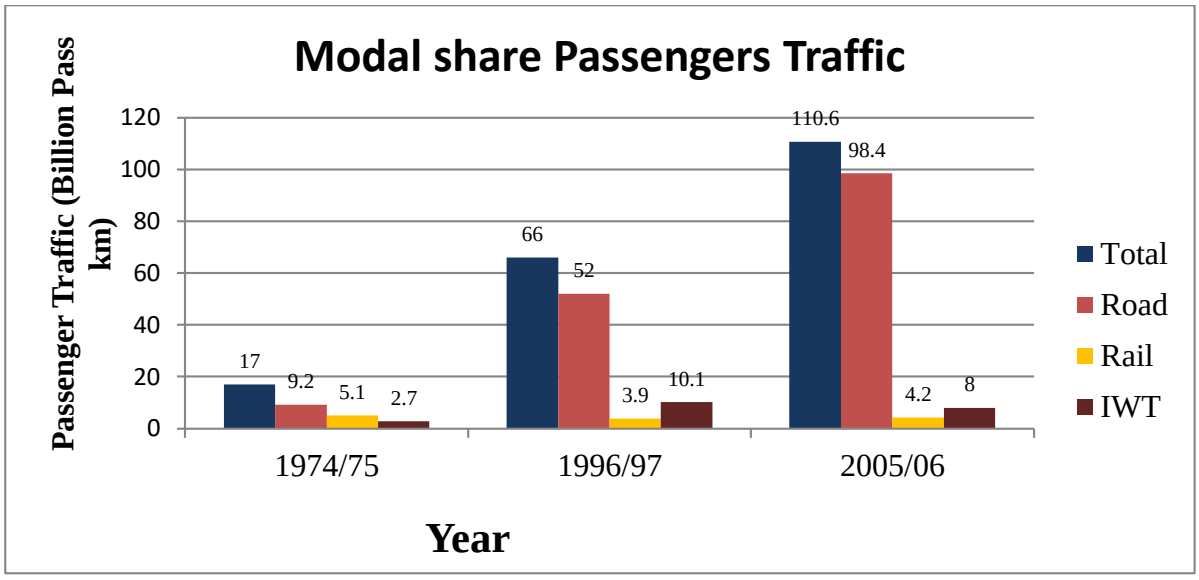

Figure 1.1 Bar chart represents modal share Passengers Traffic (billion pass km)

The road share has dramatically increased from 54 % in 1975 to 88% in 2005, reflecting the heavy investments in the sector. 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 1.1 and 1.2 illustrate the scenario of modal share with respect to passenger traffic, cargo traffic respectively.

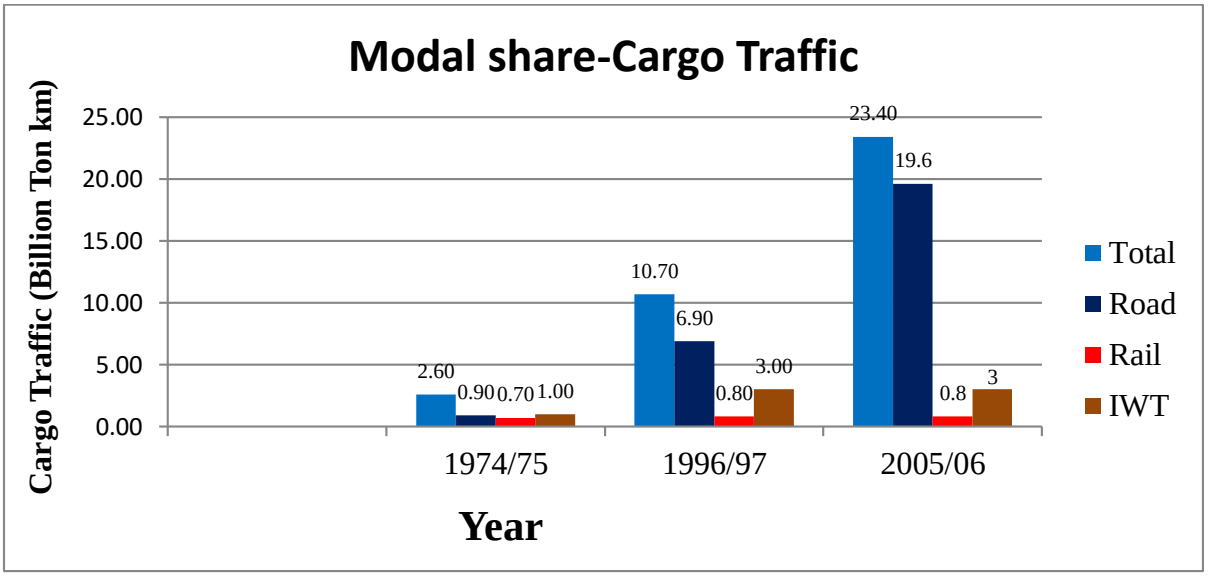

Figure 1.2 Bar chart represents modal share - Cargo Traffic (billion ton km)

1.3 Maintenance of navigational routes

As per ***"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"*** requirement of maintenance dredging for the last 13 years was 130 million m^3 but only 47 million m^3 dredging had been carried out in regular waterways. 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. On the other hand, 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 [12]. However, there are only 211 dredgers in Bangladesh, owned by both the government and private sector. BIWTA is a government institution to develop and maintain waterways but lack of dredge machine and adequate budget, it cannot keep the waterways navigable. As a result, waterways loss navigability and in course of time navigable waterways will reduce extensively.

2.1 Objectives

This research is performed with the objectives

(1) to study the pattern and present situation of the navigable waterways network in Bangladesh and

(2) to identify the problems in navigable waterways and its mitigation.

3.1 Waterways in Bangladesh

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.

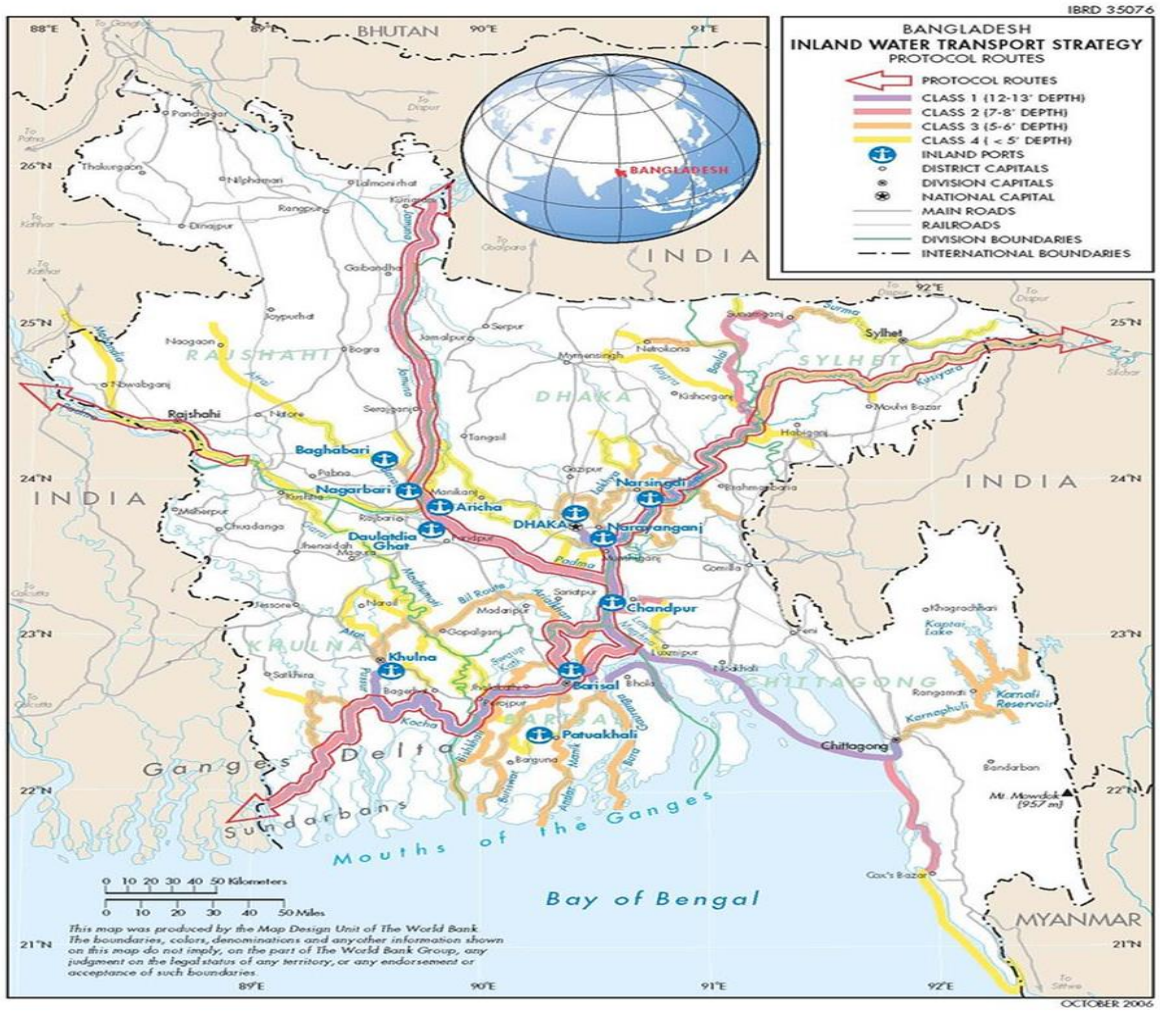

Figure: 3.1 Map of Bangladesh showing the classification of waterways (Source-BIWTA)

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, Least Available Depth-LAD and navigation clearance, Bangladesh Inland Water Transport Authority (BIWTA) classified approximate 6000 km navigable river route into four categories. They are, Class-I: Four trunk routes (depth 3.65m-3.96m, length about 683 km Chattogram-Chowkighata Chandpur-Shambbupura Narayangonj/ Dhaka;Shambhupura-Demra; Shambhupura-Bhairab Bazar/Ashugonj; and Chowkighata-Barisal-Mongla-Khulna-Maheswarpasha; Class-II: Eight link routes (depth 1.83m - 3.65 m, length about 1,000 km)- Mohanpur-Daikhawa; Bhairab Bazar-Chhatak; Chalna-Raimongal; Hijla-Saistabad; Satnal-Daudkandi; Chattogramg-Cox's Bazar; Diara-Barisal via Nandir Bazar; and 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 provides alternative mode of Inland Water Transport (IWT) which serve 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 is a map of Bangladesh explains classified waterways. BIWTA provides pilotage facilities to about 7,000 inland water vessels. They regulate the movement of about 2000 passenger launches and maintains 37 inland ports along with about 800 launch ghats including terminals. Classification of waterways with draught ranging from 3.96 m to1.50 m is shown on Table 3.1 explains classified waterways including vertical and horizontal clearance.

Table 3.1 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 3.65 m maintained round the year for day and night.
Class-2	2.1-2.4m (7-8ft)	12.20 m	76.22 m	1000km (17)	Maintained all the year round.
Class-3	1.5-1.8 m (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 m (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)**	

4.1 Methodology

The research has been conducted based on mainly using primary data, collected from face-to-face interview and field survey. Field visit including waterways dredging vicinity, was most important for this research. 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 maintenance dredging and development dredging projects (executed, ongoing and to be executed), list of existing dredgers and to be procured, annual dredging achievement and dredging requirement etc. and their experience about various navigational techniques to cope up with the challenges arising from navigational problems. Questionnaire was also included present condition, pattern of waterways, water transport and its plying from Dhaka Inland River Port to Barishal Inland River Port - Khulna Inland River Port and all other ghats/landing stations. In this regard, several key persons and stakeholders group discussion including Passenger and Cargo Traffic Vessel Owners Association were interviewed at Dhaka Inland River Port, Sadarghat and Narayanganj Inland River Port vicinity, Narayangonj. Total 30 respondents were interviewed based on random sampling for this research. Among those, 20 respondents were interviewed during visiting and field survey and 10 respondents were interviewed through telephone. The interviews have been taken place in the month of November 2022 to December 2022. Appropriate computer programming method was applied for data presentation and analysis. Data collected from the field survey have been also analyzed manually. To achieve the objectives of research, summary methodology is mentioned below –

1. Collection of previous 10 to 20 years dredging quantity & budget allocation including requirements.
2. Review the hydrographic chart(s).
3. Study dredging alignment
4. Collection of data on dredging capacity
5. Field visits and
6. Questionnaire survey
7. Analysis of data
8. Analyze data found during field survey.

Hydrographic chart(s) and all other data, collected from BIWTA, Bangladesh Water Development Board (BWDB) and Department of Shipping (DOS).

4.2 Data Collection & Analysis

Navigability of inland waterways is intensely influenced by river morphology and hydraulics. 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 IWT-websites, etc. questionnaire survey, 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 are connected to Dhaka through 16 districts. Freight shipping is on the rise due to easy availability of goods by waterways. 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 transport plies on the waterways. At present 3,000 people travel daily from Dhaka to Barisal by launch and only four launches call on and call out in and from the Dhaka Inland River Port using Dhaka-Barishal waterway route. Before the Padma multipurpose bridge was built, 20-25 thousand people used to travel by launches and eight launches used to call on and call out through waterways. As a result, passengers' movement decreases. For the improvement of passengers travel through waterways following steps can be adopted:

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
1	Dhaka -Port	80-85	
2	Mawa – Aricha	90	200
3	Lakhimpur-Bhola-Barisal	20-25	7-8
4	Lakhimpur-Hatia	100	200
5	Bhola-Barisal	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	-

As a result, passengers' movement decreases. For the improvement of passengers travel through waterways following steps can be adopted:

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.

4.3 Status of dredgers in Bangladesh

There are 6 Cutter Suction Dredgers (CSD) with different size in the year 1996 with the private sectors /entrepreneurs in Bangladesh. At present there are 58 private companies having 155 CSD of different sizes 12 " to 26" having physical dredging capacities varies from 250 m^3 /h to 1350 m^3/h. These private companies use their dredgers in land filling and land development works. In many occasions, private company has lack of experienced engineers having knowledge on dredging as such unable to provide navigational dredging works. BIWTA official informs that in many cases their services are much below expectation.

BIWTA at present possess 40 dredgers, collected in between 1971 to 1975 and 2010 to 2022. Size of all the dredgers ranges from 18-inch to 26-inch CSD with physical capacity varies from 200 m^3/h to1350 m^3/h including one amphibian suitable to dredging in waterways. According to BIWTA official, it is known that they are going to procure more 55 dredgers, aiming to increase navigability of rivers of the country to ensure smooth waterway communication.

BWDB possesses 16 CSD of sizes ranges from 18" to 26" having manufacturer capacity varies from 450 m^3/h to 2500 m^3/h. procured within 2000 to 2014. Dredgers under BWDB generally remain busy to irrigation, flood control, river protection and drainage works.

Very limited cases they work with BIWTA on contract basis to maintain and develop waterways. The total capacity is about 2.40 million m^3/year. The total accumulated dredgers (CSD) of Bangladesh are 211 of different sizes shown on the table 4.2.

Table 4.2: Total number of dredgers in Bangladesh

Sl.No.	Size of dredger	Number of dredgers				Physical avg. capacity(m^3/h)
		BWDB	BIWTA	Private Companies	Total	
1	18"	5	23	76	104	200-350
2	20"	2	11	58	71	300-650
3	26”	9	6	5	20	1350-1400
4	16”	-	-	2	2	200
5	15"	-	-	2	2	150
6	12"	-	-	1	1	125
7	24"	-	-	5	5	325
8	22"	-	-	6	6	300
Total=		**16**	**40**	**155**	**211**	**-**

4.4 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.

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

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

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

= 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) × 100 = **40.37 %**

4.5 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: - during leisure period dredging works carried out in pursuance to third party’s requests for their industry operation, land filling etc.

4.6 Crew members of dredger

A dredger has total 26 crew members comprising Master grade- 2, Master Grade -3, Radio operator, Liverman, etc. Generally, Liverman operates dredging works and is responsible to conduct dredging river bed. Most of them have not any institutional diploma/degree at the time of entry except a certificate from Deck personnel Engineering and Technical Centre under BIWTA.

4.7 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 4.3 and 4.4 illustrate dredging contribution of the organization. The table shows that on an average contribution of BWDB and private companies are 10.33 % and 12.48 % respectively which illustrate about 25% of total dredging is conducted by them. Table 4-5 and Figure: 4-1, bar chart respectively explain dredging performance for previous 22 years (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 4.1 illustrates that in the year 2005-2006 and 2010-2011dredging increasing but after then dredging decreases.

Table 4.3: Contribution of dredging performed for BIWTA (2011-2022)

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
Total=Annual	5.86	11.71	17.56

Table 4.4: 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
Annual avg.	4.88	5.24	0.62	0.73
Annual avg, (2000-2022)	5.10	4.26		

Again, in the year 2011-2012 dredging decreases. As a result, channel bed gets deposition of sediments and hence waterways loss navigable depth.

4.8 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 to increases navigable draught to facilitate water transport plying on the waterway. Since siltation is recurring natural

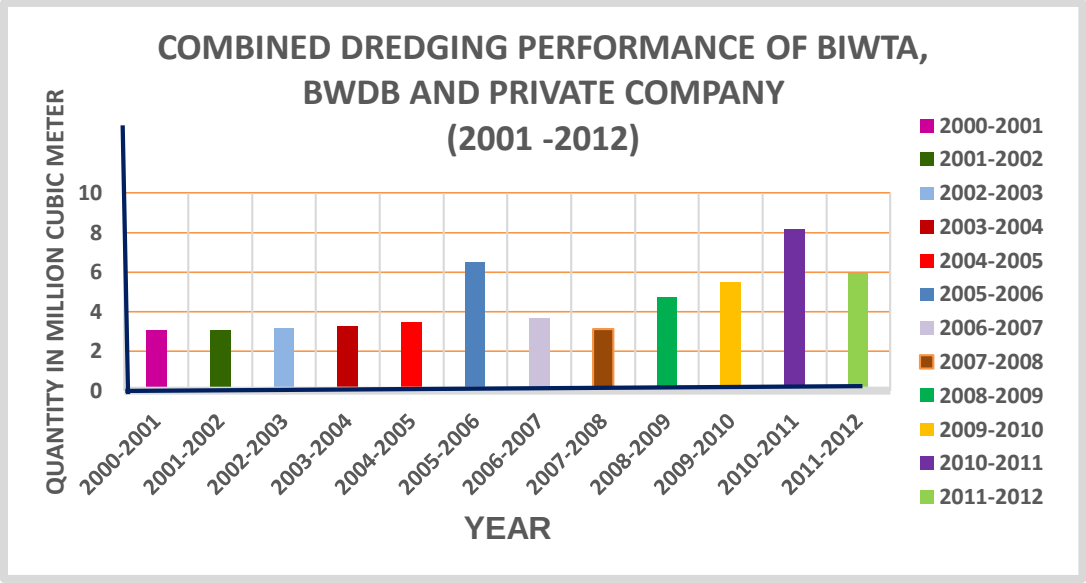

Figure: 4.1: Dredging performance of BIWTA, BWDB and Private company

process, so to maintain navigability recurring dredging is also performed regularly. Due to equipment and budget constraints, BIWTA could not execute much projects. As a result, navigability of the rivers not improved as required 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. Table 4.5 illustrates status of development dredging activities (projects) of BIWTA from July 1992 to June 2022. More projects cannot be undertaken due to inadequate budget allocation. As a result, many navigable routes remain unattended and hence becomes silted.

Table 4.5: 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

4.9 Dredging Budget

BIWTA conducts dredging works for fare navigability by using its own dredgers fleet, dredgers belonging to Directorate of BWDB and private companies as well. Bangladesh government provide fund for these works. The **Table-4.6** 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 allocation 2894.30 million BDT against the demand 13,289.61 million BDT for the said years.

Table 4.6: Year wise (2002-2011 and 2010-2022) 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 (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**

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.

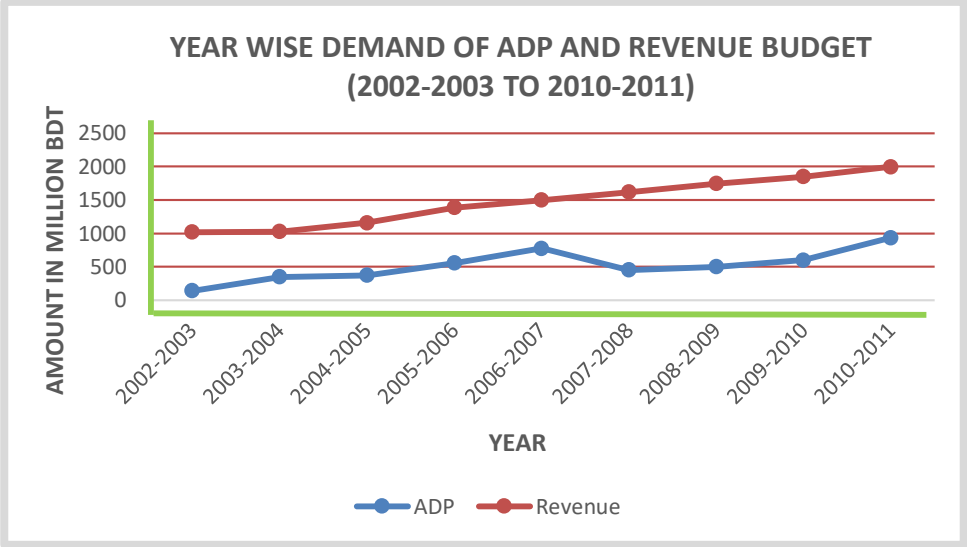

Figure 4.2 : Year wise of demand of ADP and Revenue budget

As a result, siltation aggravates resulting loss of draught of navigation. Figure 4.2 illustrates year wise demand and budget requirement for the year 2002-2011. Figure-4.3**:** Bar chart explains total demand and allocation for both ADP and revenue budget for 2010-2011 to 2021-2022**.** Bar chart shows that in ADP 56031.51 million BDT was allocated against 58053.86 million BDT which was 3.50% less compared to requirement**.** Similarly, in revenue budget, allocation was 23% less compared to requirement. Figure 4.4 explains year wise allocation of ADP and revenue budget.

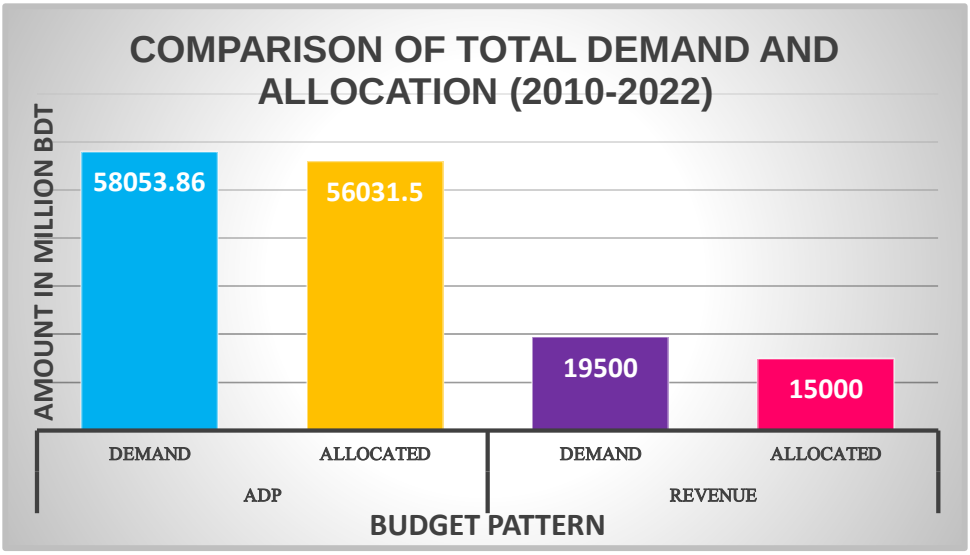

Figure 4.3: Illustrates both demand and budget allocation

The figure 4.4 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.

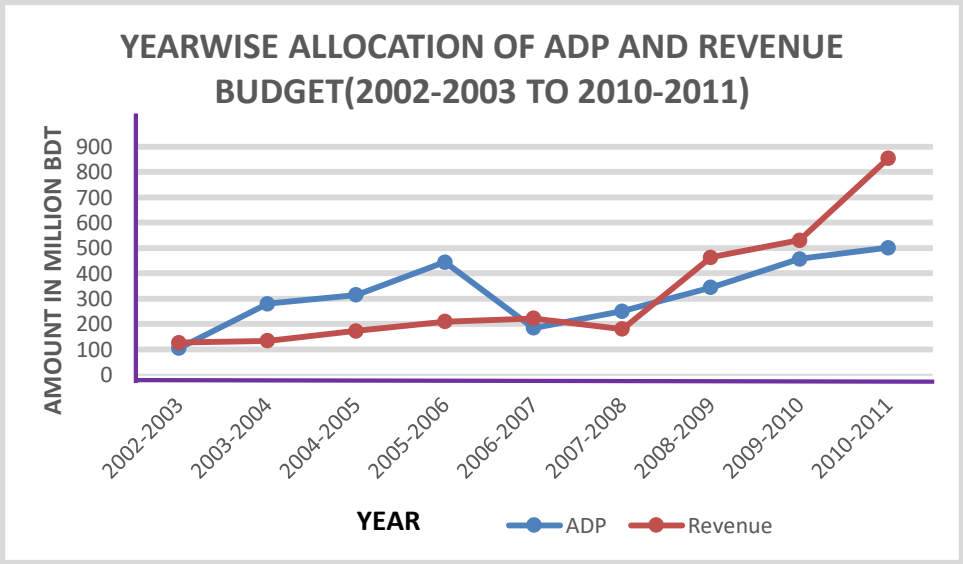

Figure 4.4: Year wise allocation of ADP and revenue budget)

4.10 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. To fulfill the demand of river dredging and realizing the Delta 2100 plan, Bangladesh should give emphasis on manufacture of dredgers locally in the ship building industry though dredging machines are very sophisticated machines. **(*Source: BIWTA and Ministry of Shipping (MoS)-Websites)***

4.11 Dredging requirement

According to the Shipping Ministry, annual requirement of dredging is at least 165.51 million m^3dredged 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 m^3 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 million m^3 sediments from the rivers' bed. 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.

Table 4.7: 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

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 projects are implemented, it will be possible to meet around 70.81 per cent of the annual dredging requirement of the country. **Table 4.7** elaborate the annual shortfall of dredging in the country which is equal to 80.86 million m^3.

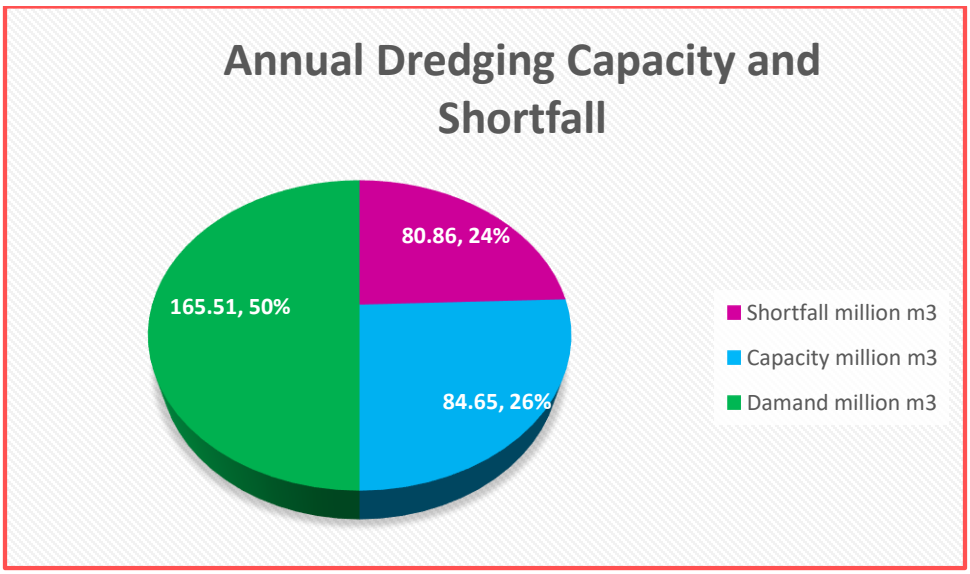

Figure 4.5: Describe annual percent requirement, capacity and shortfall of dredging

The pie chart (**Figure 4.5)** explains annual capacity and shortfall of dredging are 26 % and 24% respectively compared to the total requirement. 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. 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. To cope up this shortfall more 76 CSD require to procure. [Calculation: (=80.86/(0.41*750)*16*221) considering 41% dredger utilization and capacity 750 m^3/h and working period 2 shifts].

5.1 Constraints/Results

Detailed analysis from the collected Data following results/constraints come out:

- Annual dredging requirement 165.56 million cubic meters
- Annual dredging capacity of Bangladesh (Accumulated capacity of BIWTA, BWDB and private companies) is 84.65 million m^3
- Annual unattended dredging 80.36 million m^3
- Inadequate dredging equipment. BIWTA has only 40 CSD including one 42 years old
- Inadequate budget provision.
- Dredging alignment fixes without studying hydraulics, morphological and hydrological conditions of the rivers.

- Crew members are not as qualified as required for the efficient and quality dredging.
- Lack of adequate physical monitoring of dredging works.
- Less utilization of dredgers i.e., 40.37%
- Lack of modern technology application in dredging works.
- Dredging works administered from the Head office at Motijheel, Dhaka which slower the dredging works as well as dynamic dredging of waterways.
- After the inauguration of the Padma multipurpose bridge, waterway transport drastically changes to speed travelling through roadway than waterway.

6.1 Discussions

Sedimentation on river bed is natural phenomenon which creates obstruction to maintain fare navigability of waterways. BIWTA is mandated to keep the waterways navigable. They get allocation from the government under ADP (Annual Development Program) and revenue budget. But table 4-6 expresses inadequacy of budget allocation for both revenue and ADP. The total average requirement for both revenue and ADP 4435.56 million BDT annually for dredging against annual allocation 3544.18 million BDT which is 20% less than the annual requirement. BIWTA has 40 dredgers out of which 6 dredgers are about 45 to 51 years old which are now obsolete. These 6 dredgers need to replace immediately for better production. Other some of them are 10 to 15 years old. On the other hand, 80.86 m^3 dredging volume remains unattended annually which aggravate siltation on the channel bed trend to dyeing of rivers. To cope up this more 76-18" CSD require to procure.

BIWTA from 1992 to 2022 removes 102.28 million m^3 silts (sediment) from the channel bed through completed 14 projects at a cost of 18173.16 million BDT. Five projects are being implemented at a total cost of 79761.40 million BDT aim to dredge 378.58 million m^3. Three projects are programmed to implement from 2023 to 2026 at a cost of 30004.30 million BDT aim to dredge about 124.25 million m^3 to improve waterways navigability. Lack of budget allocation as per requirement, BIWTA cannot undertake new project against capital dredging and resuscitation of dyeing rivers. Intelligent dredging which is environment friendly should be encouraged. On the other hand, low-cost dredging technique like bandalling may be applied in more rivers. Long term dredging program may be helpful to fare navigational waterways.

BIWTA conducts dredging works administering from head office situated in Motijheel, Dhaka. For sharp, efficient, dynamic and proper monitoring of dredging, Dredging Department of BIWTA shall be decentralized. However, at present, it has been programmed to set dredging unit offices at seven different places outside Dhaka. The officials need training in dredging works regularly to enhance the knowledge. GPS and computer-based dredging methodology should be applied to dredging waterways.

7.1 Conclusions

BIWTA as mandated government organization dredges channel by using its own dredgers and those belonging to BWDB and private companies as well. 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 due to alluvial characteristics of soil. Government allocates 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, BIWTA unable to maintain fare navigational waterway. Thus, unattended dredging every year resulting increment of silt deposition on the river bed.

8.1 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 (sediment) of the world. Major parts of silts deposited on the river bed and loss navigability. 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 navigable waterways.
- Dredging can continue round the year specially sedimentation prone area of the river
- Procurement of more new dredgers
- Preparation and implementation of extensive capital and maintenance dredging action plan

- Increase the utilization of dredgers by increasing working hours
- Increase qualified and experienced manpower.
- Close physical monitoring of dredging works.
- Adaptation of modern technology use in dredging works.
- For sharp, efficient, dynamic and proper monitoring of dredging works, Dredging Department of BIWTA shall be decentralized.
- After the inauguration of the Padma multipurpose bridge, waterway transport drastically reduces to speed travelling through roadway than waterway. Government can think to overcome this constraints -which may be improved: (i) introduce speedy launch (ii) introduce tourist launch (iii) reduce travelling fare (iv) reduce fuel cost and spare parts as well
- Application of GPS and computer-based methods may be applied in dredging waterways
- 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 like bed levelling, bandalling may adopt.
- Human interference like construction of infrastructure across the river may be avoided as much as possible.

References

[1] *38009-BD, People's Republic of Bangladesh Revival of Inland Water Transport, Options and Strategies*. 2007.
[2] N. A. Huq and A. M. Dewan, "Launch Disaster in Bangladesh: A Geographical Study," *Geografia*, vol. 1, no. 2, pp. 14–25, 2003.
[3] "A study of sedimentation in the Brahmaputra-Jamuna flood plain," in *Bangladesh Environmental Study and Geographic Information System, Irrigation Support Project for Asia and Near East*, Dhaka, 2007.
[4] "Transport Sector Coordination Wing, Planning Commission, Government of People's Republic of Bangladesh," in *Ministry of Shipping*, 2009.
[5] S. A. Peoples Republic of Bangladesh Schumm and B. R. Winkley, "The character and variability of large alluvial rivers," pp. 1–13, 1994.
[6] *Workshop Summary by GIZ and BIWPCA, Presentation of the GIZ Global Program: Private Sector Adaptation to Climate Change (PSACC)*. .
[7] *A Changing Climate and Extreme Weather Events - Risks and Implications for the Water Transport and Shipbuilding Sector of Bangladesh*. .
[8] *Gov.bd*. [Online]. Available: https://www.biwta.gov.bd/. [Accessed: 09-Jan-2024].
[9] R. Bray and E. Arnold, *A hand book for Engineers*. Huston, David & Charles, 1971.
[10] *Hydraulic Dredging*. Huston, David & Charles, 1971.
[11] "Guidance Manual Cutter Suction Dredge Operations, IWT-III Project," *Finn RA*, 1994.
[12] *A Review of Low-Cost Dredging Methods including Laboratory Study of Water Jetting with Particular Relevance to Bangladesh*. Glasgow, Scotland, UK., 1990.