9th Urban Mobility India Conference & Expo 2016
Planning Mobility for City's Sustainability

POTENTIAL OF FREIGHT TRANSPORT THROUGH INLAND WATERWAYS

Presented By-
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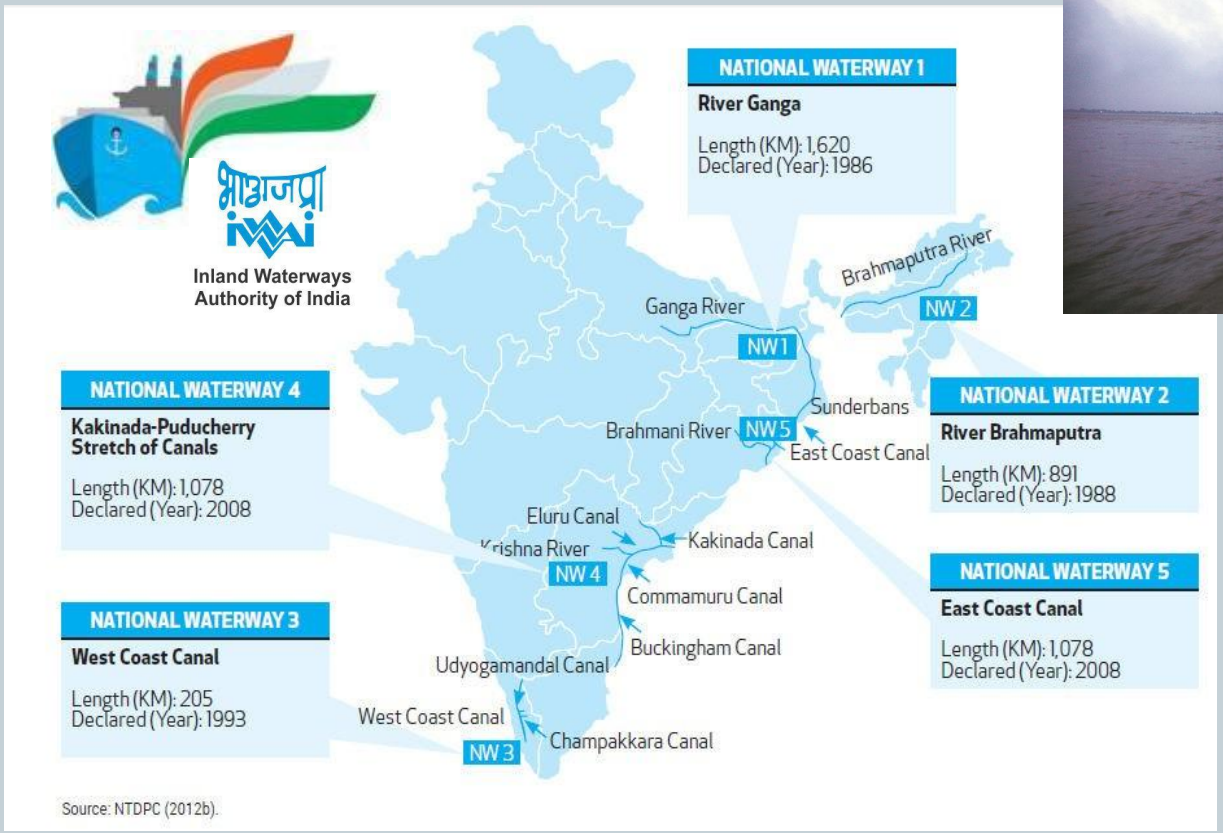
INTRODUCTION

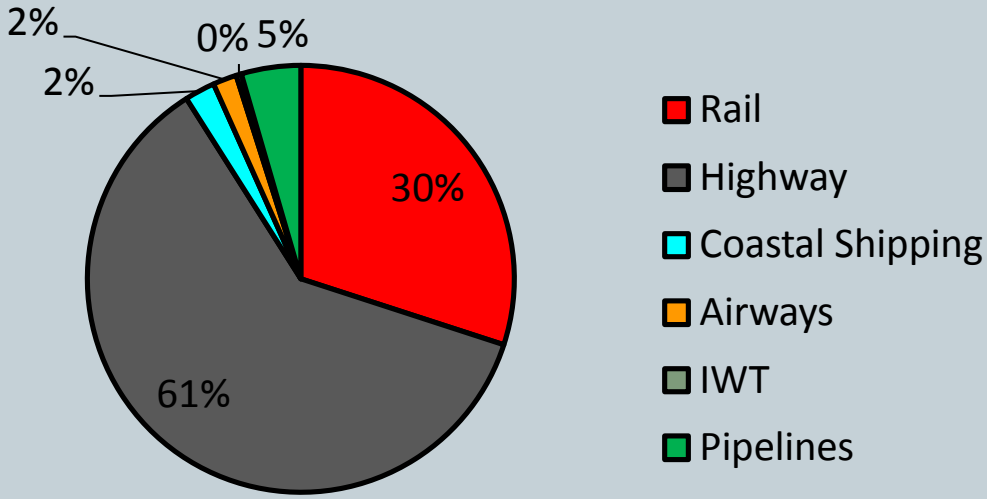


- India has a coast line of **7500 km** spanning 13 marine time states and union territories
- **90%** of India's trade by **value** and **70% by volume** takes place through marine 5me transport

There are five NWs namely the Ganga from Haldia to Allahabad (NW-1, 1620 Km), the Brahmaputra from Dhubri to Sadiya (NW-2, 891 km), the West Coast Canal from Kottampuram to Kollam with Udyogmandal and Champakara canals (NW-3, 205 km), the Kakinda-Puducherry stretch of canals with Godvari and Krishna rivers (NW-4, 1078 km) and the East Coast Canal with Brahmani river and Mahanadi delta (NW-5, 588 km). Declara5on of Barak river from Lakhipur to Bhanga (121 km) as yet another NW is under considerationon of the Government.

INTRODUCTION

Percentage Share in Total Transport Output (%)



Mode	Percentage Share in total transport output (%)
Rail	30
Highways	61
Costal Shipping	2.3
Airways	1.8
IWT	0.4
Pipelines	4.5
Total	100

Percentage Share of different modes in total transport output

- Share of IWT in freight modal mix for different countries:-

  1)India –0.4%

  2)China -24%

  3)Australia -17%

  4)Germany -11%

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Aim And Objectives

AIM: TO FIND THE POTENTIAL OF FREIGHT TRANSPORT THROUGH INLAND WATERWAYS

OBJECTIVES OF THE STUDY:-

The key objectives are as follows

- Identification of the **nature and quantum** of cargo for transportation on national waterway 1
- To study the **effect of the Indo-Bangladesh Protocol** on the national waterway 1
- **Quantification of economic gains** of IWT in NW-1 in terms of :-
  1)Reduction in energy consumption
  2) Reduction in environmental cost
  3)Congestion cost
- To make **specific recommendations** on the basis economic benefits of cargo operations on NW-1

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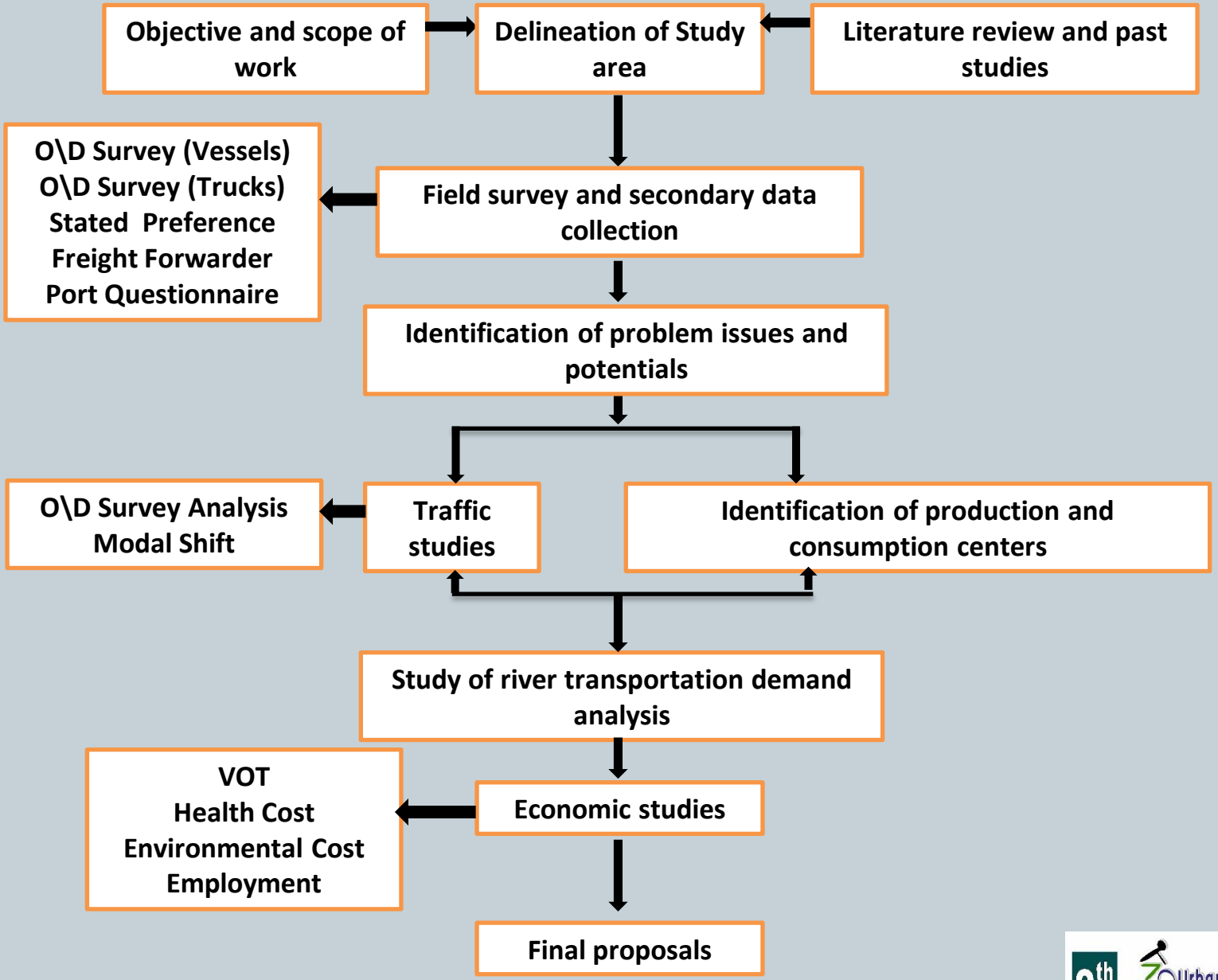
Scope

SCOPE OF STUDY:-

- Geographical coverage of the study will be largely confined to areas served by **NW 1**
- The study will be **confined to cargo operation** and will not include transportation of passengers.
- For the purpose of comparative modal costs, IWT will be **compared to** transportation by **road.**
- To quantify the economic gains of IWT, NW 1 **stretch Haldia- Farakka** cargo services is taken as case study.
- Data on the nature and quantum of cargo available for transportation by IWT is taken through statistics given by **various organizations**
- Data on cargo movement on road network is mainly obtained through **traffic surveys done at Kolkata, Farraka and Haldia** ,some data is also obtained by various authorities

Methodology



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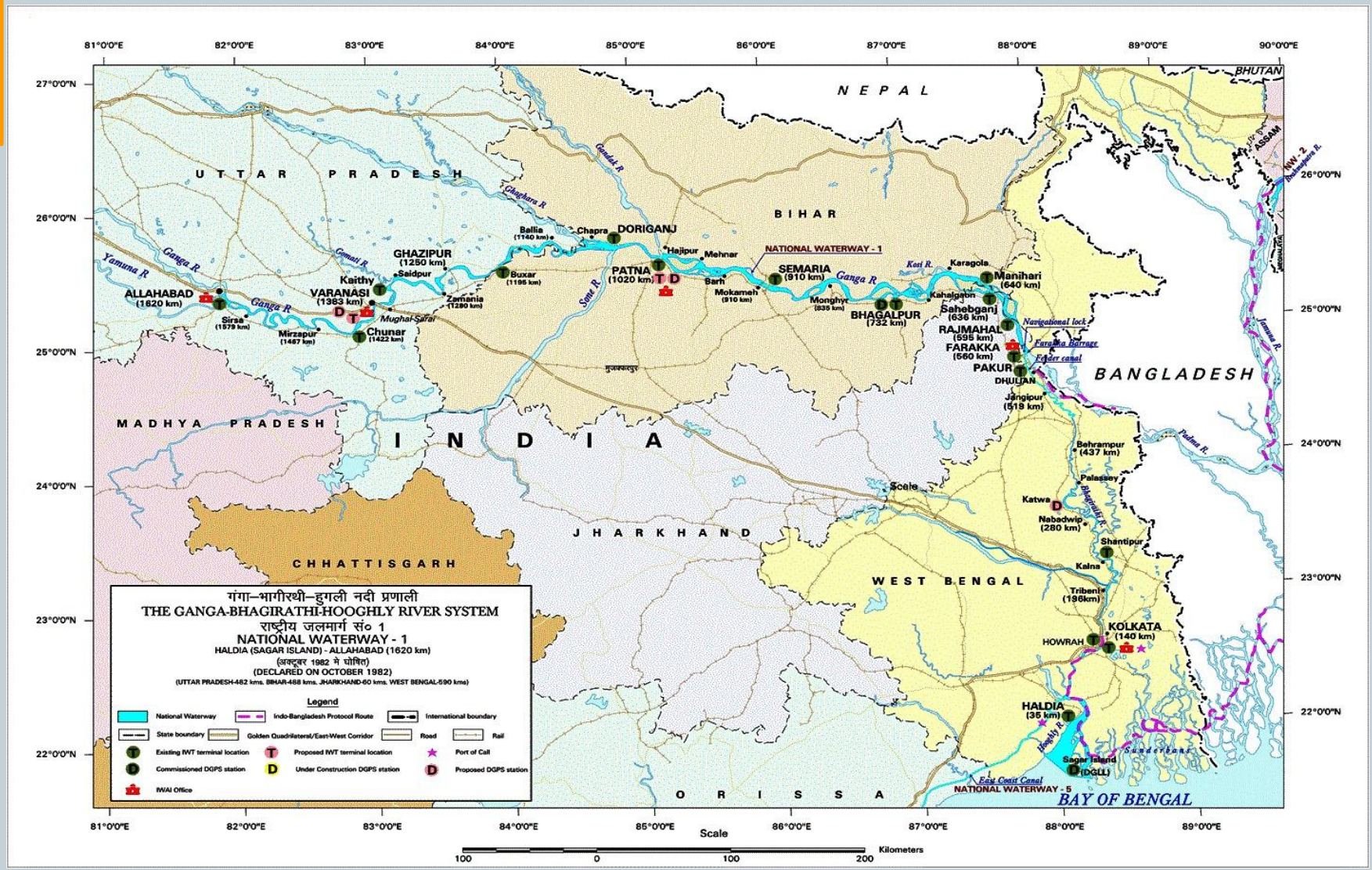
Study Area



गंगा–भागीरथी–हुगली नदी प्रणाली
THE GANGA-BHAGIRATHI-HOOGHLY RIVER SYSTEM
राष्ट्रीय जलमार्ग सं० 1
NATIONAL WATERWAY - 1
HALDIA (SAGAR ISLAND) - ALLAHABAD (1620 km)
(अक्टूबर 1982 मे घोषित)
(DECLARED ON OCTOBER 1982)
(UTTAR PRADESH-482 kms. BIHAR-488 kms. JHARKHAND-60 kms. WEST BENGAL-590 kms)

Legend
National Waterway
Indo-Bangladesh Protocol Route
International boundary
State boundary
Golden Quadrilateral/East-West Corridor
Road
Rail
Existing IWT terminal location
Proposed IWT terminal location
Port of Call
Commissioned DGPS station
Under Construction DGPS station
Proposed DGPS station
IWAI Office

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Need Of Study

- Road freight traffic is estimated to grow at about **6 per cent** per annum over the next 20 years
- Freight trains constitute approximately 35 per cent of the total 19,000 trains run daily on IR network, but yield more than 65 per cent of the revenue. There is a huge imbalance in the pattern of train operations: the **trunk routes** of the railways, which comprise 16 per cent of the network (connecting the four metro cities), **carry close to 60 per cent of the freight** and more than 50 per cent of the passenger traffic and are, therefore, oversaturated
- ***Therefore there is a need to shift traffic from rail and road***
- **6 new power plants** are being proposed on NW-1 and 2 which are expected to run at full capacity by 2019

- The total cargo potential on NW-1 is going to increase from 17 MMT to 32 MMT in 2030
- It is estimated that using the right infrastructure and institutional support, India can coastally move 155- 160 MMTPA of coal **and save INR- 6500 crore per annum**.
- ***This will help to save 1 lakhs rail – rake days that can be used for another commodities. This would directly cut power cost by 50 paisa per unit***.

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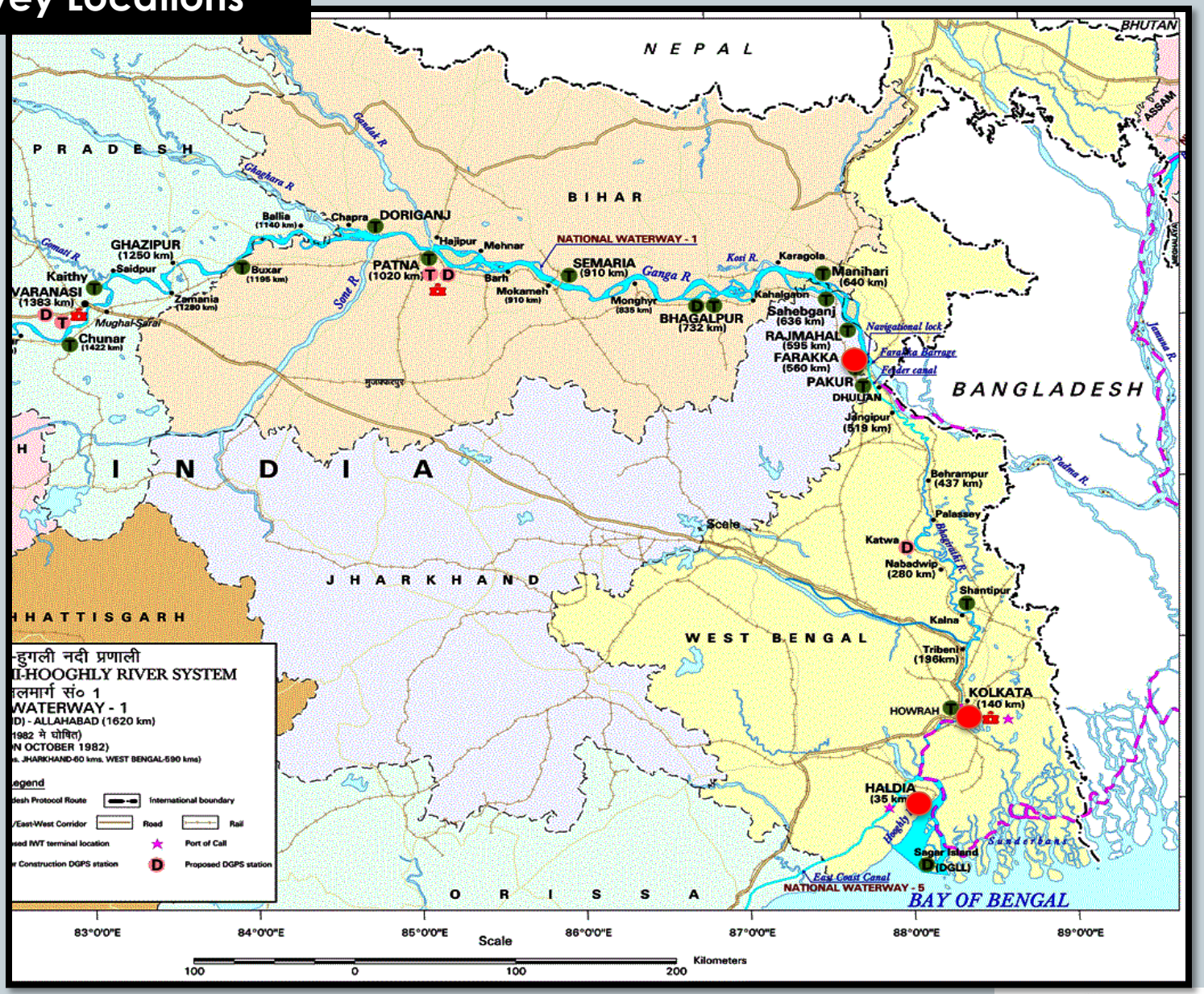
Survey Locations



Map Showing different survey locations

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Survey Conducted

S.no.	Survey Done	Objective	Data Collected
1	Origin and Destination	Freight Transport Characteristics	Origin and Destination Pairs of Trucks as well as vessles
	a) Vessles	Quantum of cargo commuting through survey locations	
	b) Trucks		Type and quantity of cargo carried
2	Stated Prefrence Survey	Modal Shift	Trip length
			Travel Time
		Freight demand analysis	Cost
			Willingness to shift
3	Shipping Line Freight forwarder	Level of service of available infrastructure	Present Vs Desireable Level of service
4	Port Questionaires	To know the present infrastructure	Equipments Available
			Facilities available

Different survey conducted

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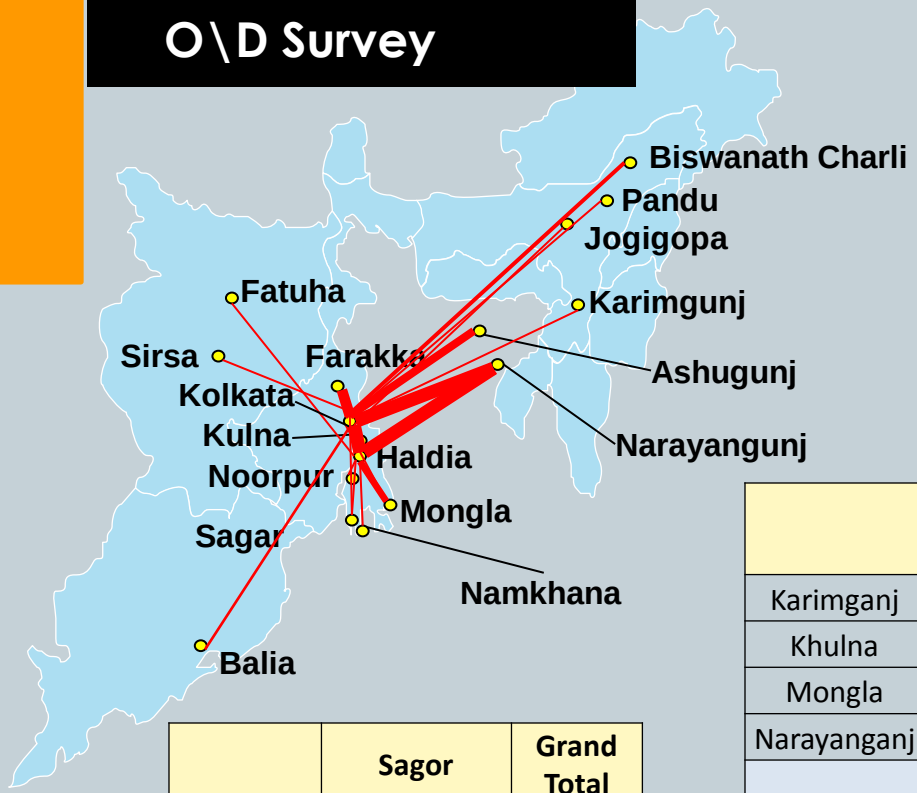
O\D Survey



	Sagor	Grand Total
Farakka	494101.1	494101.1
Grand Total	**494101.1**	**494101.1**

O-D for coal

	Diamond Harbour	G.R.Jetty-2	T.T. Shed	Grand Total
Ashuganj	10161.24	1930.99	0	12092.23
Khulna	0	0	2388.65	2388.65
Mongla	0	972.9	6731.7	7704.6
Narayanganj	0	0	1444.3	1444.3
Grand Total	**10161.24**	**2903.89**	**10564.65**	**23629.78**

O-D for Food Products

	Budge Budge	IWAI BISN Jetty	IWAI Haldia Jetty	Sri Ram Jetty	T.T. Shed	Grand Total
Karimganj	0	3613	0	0	0	3613
Khulna	122706	23245	33388	13602	4112	197053
Mongla	970	0	5050	0	862.9	6882.9
Narayanganj	638910	138511	453037	121976	401328	1753762
Grand Total	**762586**	**165369**	**491475**	**135578**	**406302.9**	**1961310.9**

O-D for Fly Ash

- At present coal movement takes place from Sagar Island to Farakka
- Food products (Maize and Rice) are transported from Kolkata to Bangladesh
- Fly ash is transported from Kolkata and Haldia to north –east to and Bangladesh

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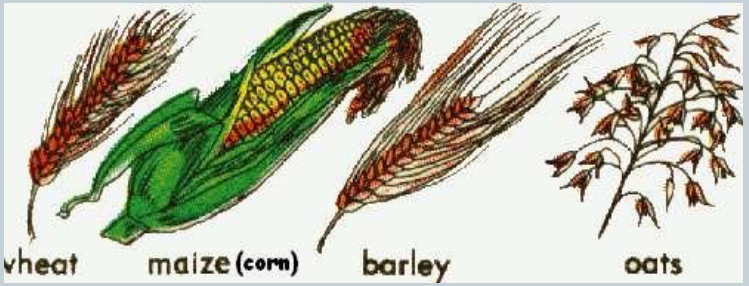
SCENARIO DEVELOPMENT

Components	Rail	Road	IWT
Coal			
Utility Equation	1.7658+ (-0.145)*travel cost+ (-0.462) *travel time	-1.743+ (-0.145)*travel cost+ (-0.462) *travel time	-1.161+ (-0.145)*travel cost+ (-0.462) *travel time
Utility (Present)	-1.66	-1.37	-1.79
Modal Split (Present)	53%	35%	12%
Utility (Fully Devloped)	-1.66	-1.37	-1.15
Modal Split (Fully Devloped)	48%	25%	24%
Fly Ash			
Utility Equation	1.743+ (-1.89) *travel cost+ (-0.679) *travel time	-0.324+ (-1.89) *travel cost+ (-0.679) *travel time	3.217+ (-1.89) *travel cost+ (-0.679) *travel time
Utility (Present)	-1.72	-1.36	-1.19
Modal Split (Present)	24%	34%	42%
Utility (Fully Devloped)	-1.72	-1.36	-1.57
Modal Split (Fully Devloped)	22.50%	26.50%	51%
Food Items			
Utility Equation	2.56+ (-2.381) *travel cost+ (-0.821) *travel time	1.64+ (-2.381) *travel cost+ (-0.821) *travel time	2.15+ (-2.381) *travel cost+ (-0.821) *travel time
Utility (Present)	-3.2	-4.2	-1.73
Modal Split (Present)	26%	68%	6%
Utility (Fully Devloped)	-3.2	-4.2	-1
Modal Split (Fully Devloped)	25%	65%	10%

Modal Shift

PRESENT
- Speed – 12 kmph
- Navigational Hours- 7 hours \ Day
- Loading – Unloading Time – 200 tonnes\ day

FULLY DEVLOPED
- Speed – 12 Kmph
- Navigational hours – 20 hours\ Day
- Loading – Unloading Time- 1000Tonnes\ Day
- Travel Cost -0.13 Rs\ tonne-km
- Thus travel time reduced by 4 times



FOOD ITEMS
- Total 4% shift is seen from rail and road to IWT
- 3% shift from Road
- 1% from Rail

COAL
- Total 15% shift is seen from rail and road to IWT
- 10% shift from Road
- 5% from Rail

FLYASH
- Total 9% shift is seen from rail and road to IWT
- 7.5% shift from Road
- 1.5% from Rail

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Demand Analysis

Demand Analysis

Identification of Commodities

Coal

Identification of traffic demand points

Existing and Proposed power plants

Coal usage – PLF- 85%

Fly Ash

35% - coal used

Food Items

D= d * n*r
D – expected demand
d – per capita consumption
n – population
r-Population Growth Rate

All values are in tonnes

Commodity	19-20	29-30
Coal	20000000	80000000
Fly Ash	10000000	20000000
Food Items	30000	50000

Projected traffic for national waterway 1 by RITES

State	Population
assam	26807034
Bihar	92341436
West bengal	62183113
Total	181331583

Source: Census 2011

Population growth	1.20%
Per capita demand	1.027

Source: Economic survey - 2014-2015

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Demand Analysis

S.no.	Location	Capacity (MW)	Coal Requirement (MMT)	Fly Ash requirement (MMT)
1	Barauni	500	2.65	0.9275
2	Muzaffarpur	390	2.2	0.77
3	Bauxar	1320	6.25	2.1875
4	Lakhirsarai	1320	6.25	2.1875
5	Pirpainty	1320	6.25	2.1875
6	Bhagalpur	2640	12.5	4.375
7	Khalgaon	2000	10.48	3.668
8	barh	1000	5.3	1.855
9	Farraka	1000	5.3	1.855
10	Jogighopa	250	1.5	0.525
Total			58.68	20.538

Demand at different terminals for coal and Fly Ash

- **Annual Increase in coal consumption – 10.36 %** ***(source- Dept. of coal annual report)***
- **Annual Increase in Fly Ash Consumption - 5.11 %** ***(source- Dept. of coal annual report)***

Quantity Transported through IWT (tonnes)				
Year	**Coal**	**Fly Ash**	**Food**	**Total**
19-20	23453878.57	12780245.30	49120.27	36283244.15
24-25	44371726.69	16389011.87	52139.08	60812877.64
29-30	83945609.39	21016788.32	55343.41	105017741.11
34-35	158814314.00	26951313.15	58744.67	185824371.82
39-40	300456289.70	34561573.80	62354.96	335080218.45

Quantity of commodities transported

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Capital Cost Estimation

CAPITAL COST

- Fairway Development
- RT work
- Construction of Jangipur lock gate
- Gauge Station and DGPS station
- Mechanized handling
- Office and terminals
- Physical Contingency
  - Consumer price index for general goods

From 12 working committee report for Inland Waterways

Divided in 4 Phases
- •2016 – 40%
- •2017 – 30%
- •2018 – 20%
- •2019 -10%

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Capital Cost Estimation

DATA FROM 12 TH WORKING COMMITTEE REPORT	
Components	**15-16**
Fairway Development	161.78
Proccurement of vessels (for fairway devlopment)	163.40
Maintainence of vessels (for fairway devlopment)	43.76
River Tranning (RT) work	
Study and cosntruction of semi permanent RT work	32.36
Construction of Permanent (RT) work	161.78
Construction of navigational lock (jangipur)	323.57
Setting up of gauge station	6.47
Setting up of DGPS station	51.77
Construction of offices	16.18
TOTAL	961.07
Construction of terminals	533.89
Maintainece of terminals	80.89
Provision of mechanised handelling facilities	22.65
TOTAL	637.43
Grand Total	1697.11
Physical contingency	129.15
Price escalation	8.49
Total with price escalation	**1527.34**

All values are in crore

Source: 12th working committee report on inland waterways

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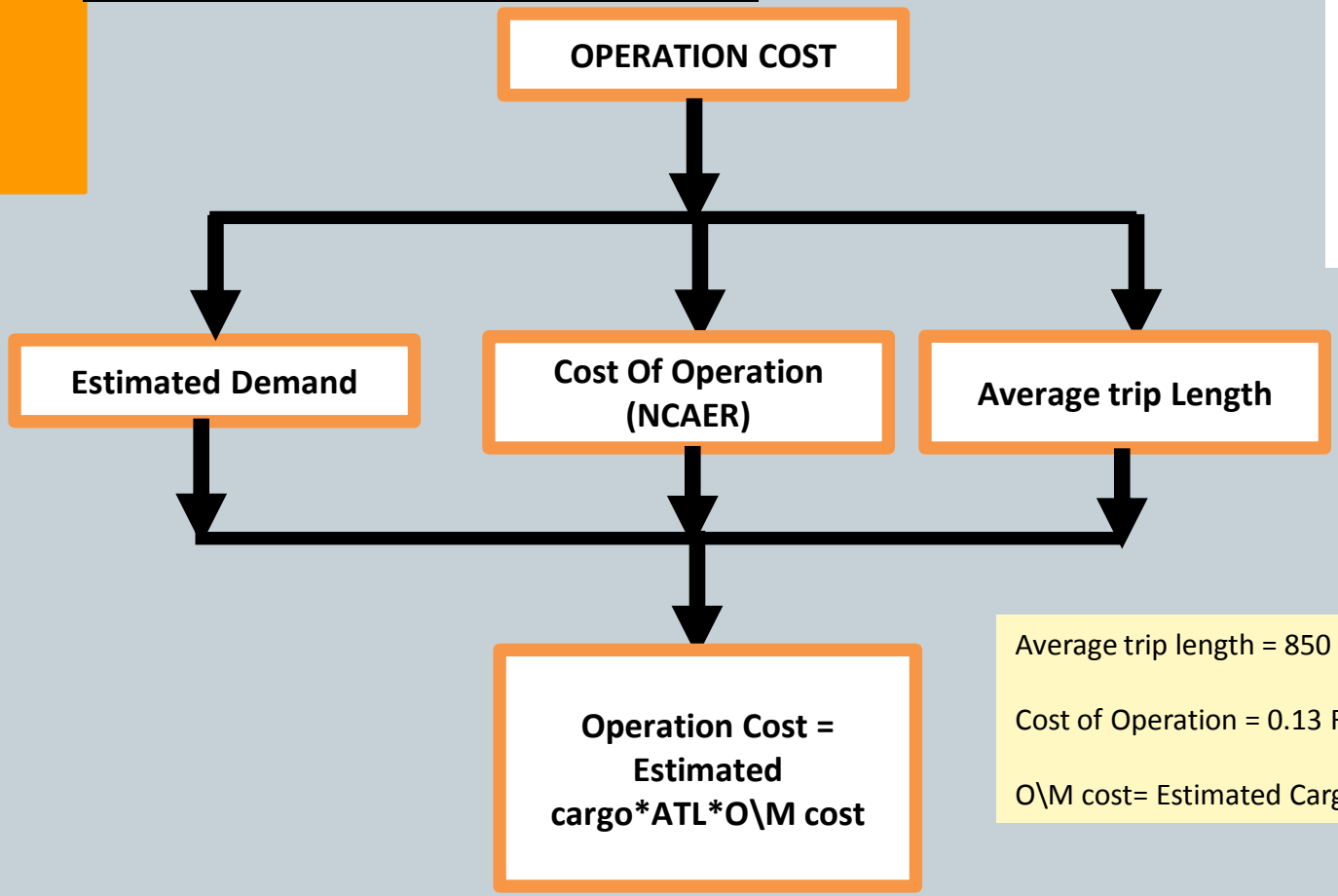
Operation Cost Estimation



Average trip length = 850 km

Cost of Operation = 0.13 Rs\ tonne-km

O\M cost= Estimated Cargo * 850*0.13

Year	Coal	Fly ash	Food Items	Total	Cost (Cr.)
19-20	14083200	10474380	46832	24604411.6	271.8787
24-25	26643606.1	13432038	49710	40125353.6	487.7237
29-30	50406281.5	17224851	52765	67683897.7	822.6978
34-35	95362212.3	22088645	56008	117506864	1428.296
39-40	180413061	28325830	59450	208798340	2537.944

Estimation of Operation cost

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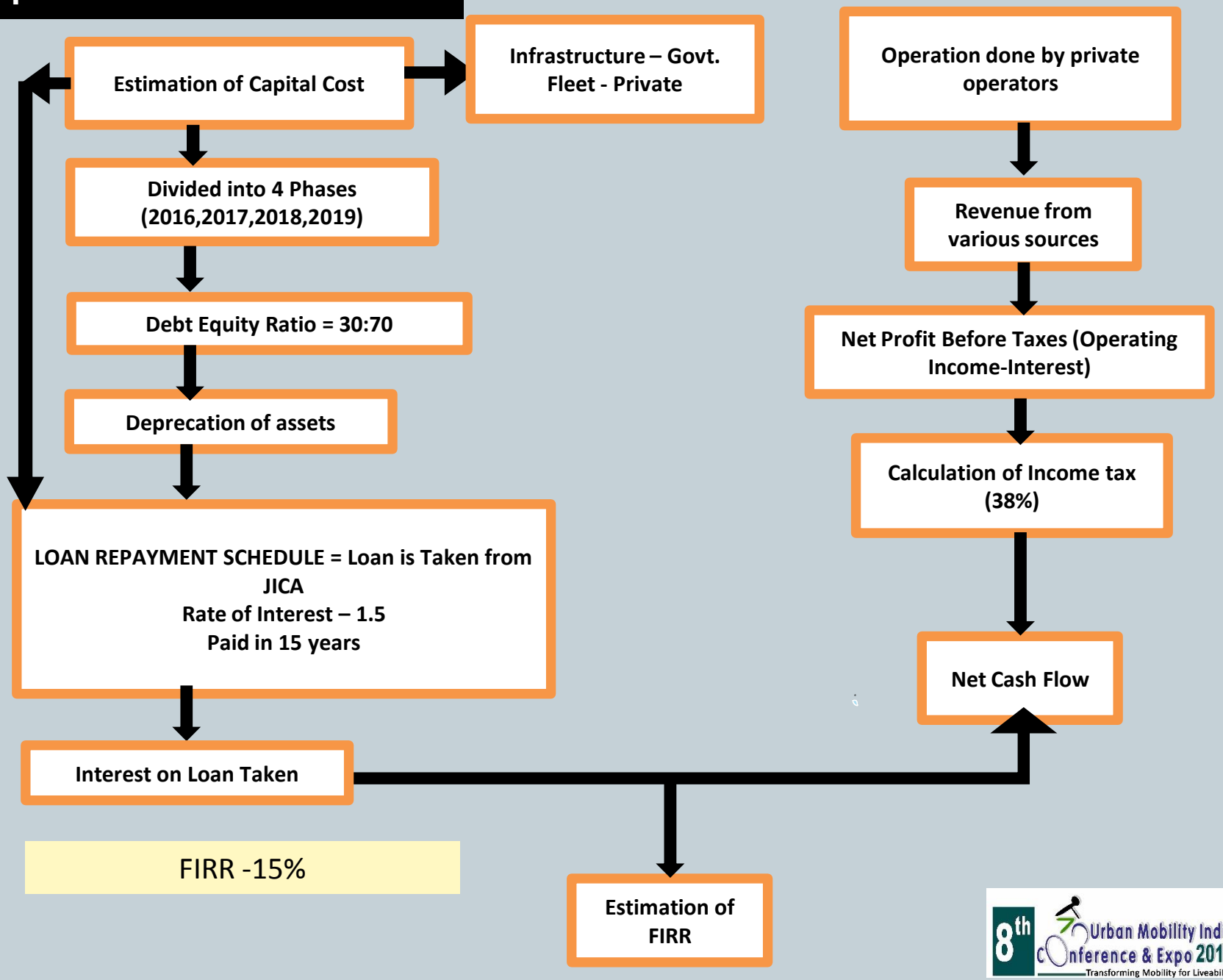
Proposed Financial Model -1



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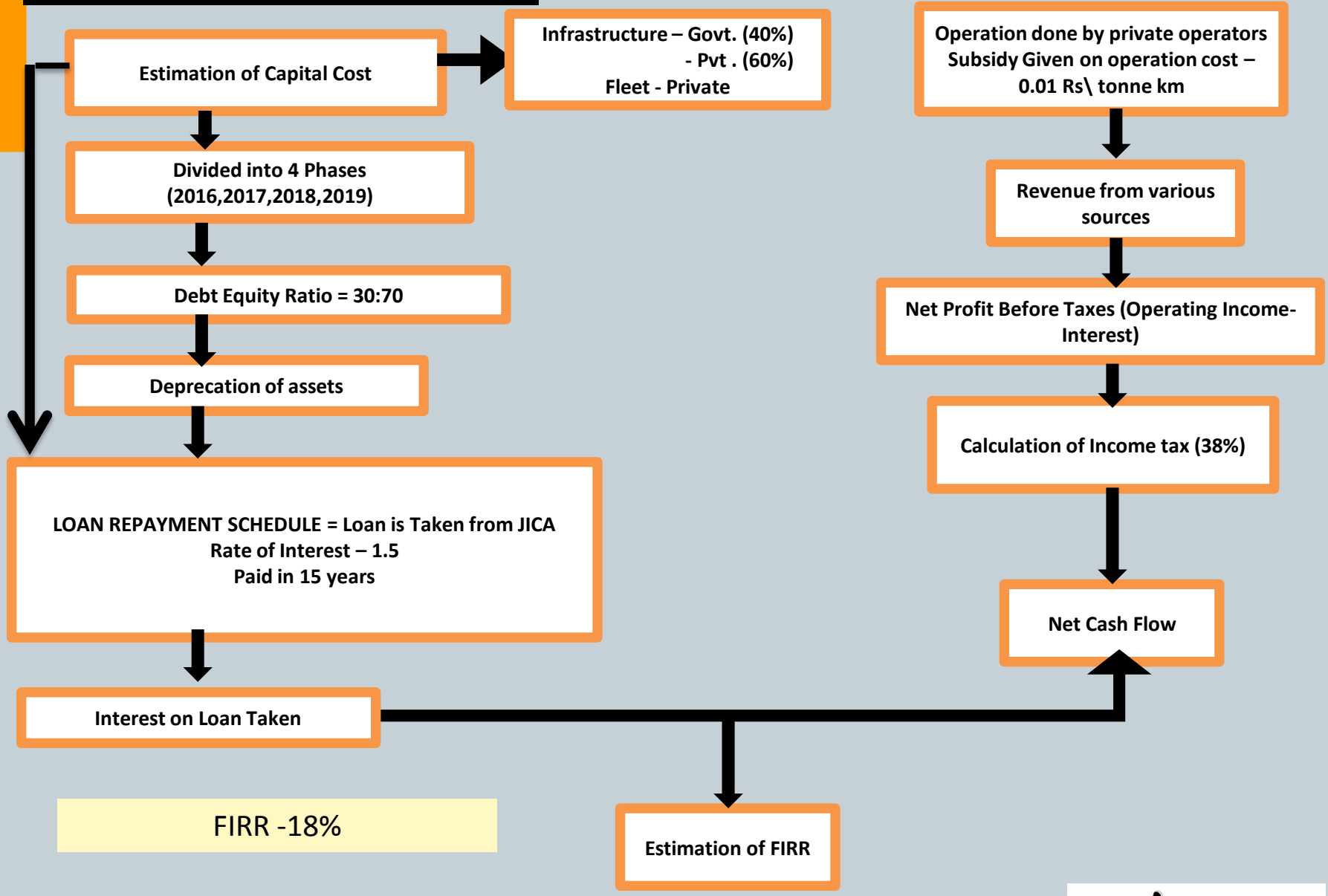
Proposed Financial Model -1



FIRR -18%

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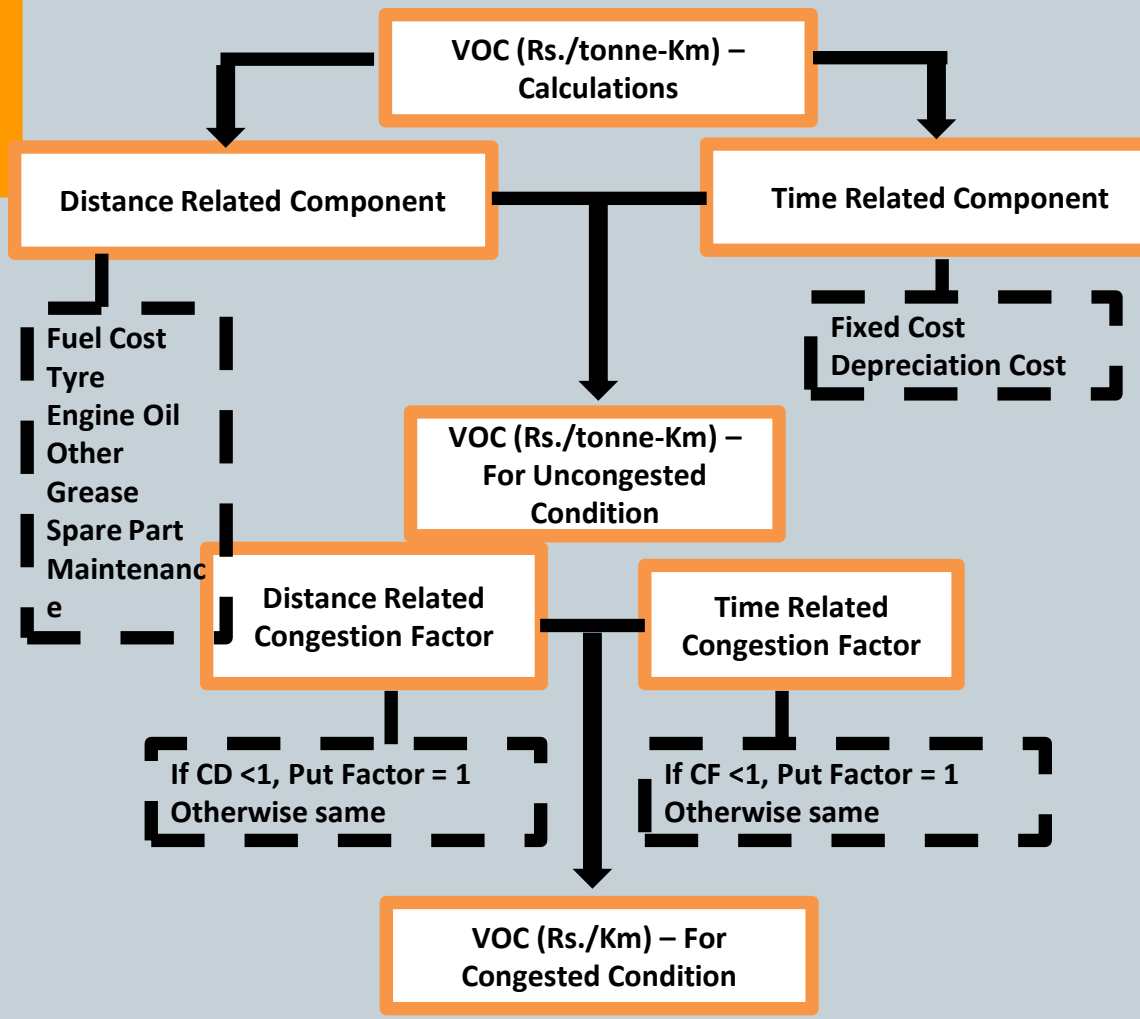
Savings - VOC



Quantity Transported through Road (tonnes)		
Commodity	**Base**	**Shited tonnage**
Coal	205380000.00	5868000.00
Fly Ash	69829200.00	1540350.00
Food	318454.67	14049.47
Total	275527654.67	7422399.47

Average increase in road cargo	6%

Congestion Factor Calculation

- Road is 4 lane divided
- Roughness – 1500 mm\km
- Four Lane Capacity -43000 PCU
- Equation for time related congestion factor – CT- 0.0953+0.839*(V\C)
- Equation for distance related congestion factor- CD= 0.9+1.2 (V\C)

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Savings - VOC

Year	V\C	CT	CD	Dist related operation cost	Time Related conjestion cost	Total VOC
19-20	0.73	1.57	1.78	1.25	1.65	2.91
24-25	1.00	1.79	2.00	1.41	1.86	3.27
29-30	1.00	1.79	2.00	1.41	1.86	3.27
34-35	1.00	1.79	2.00	1.41	1.86	3.27
39-40	1.00	1.79	2.00	1.41	1.86	3.27

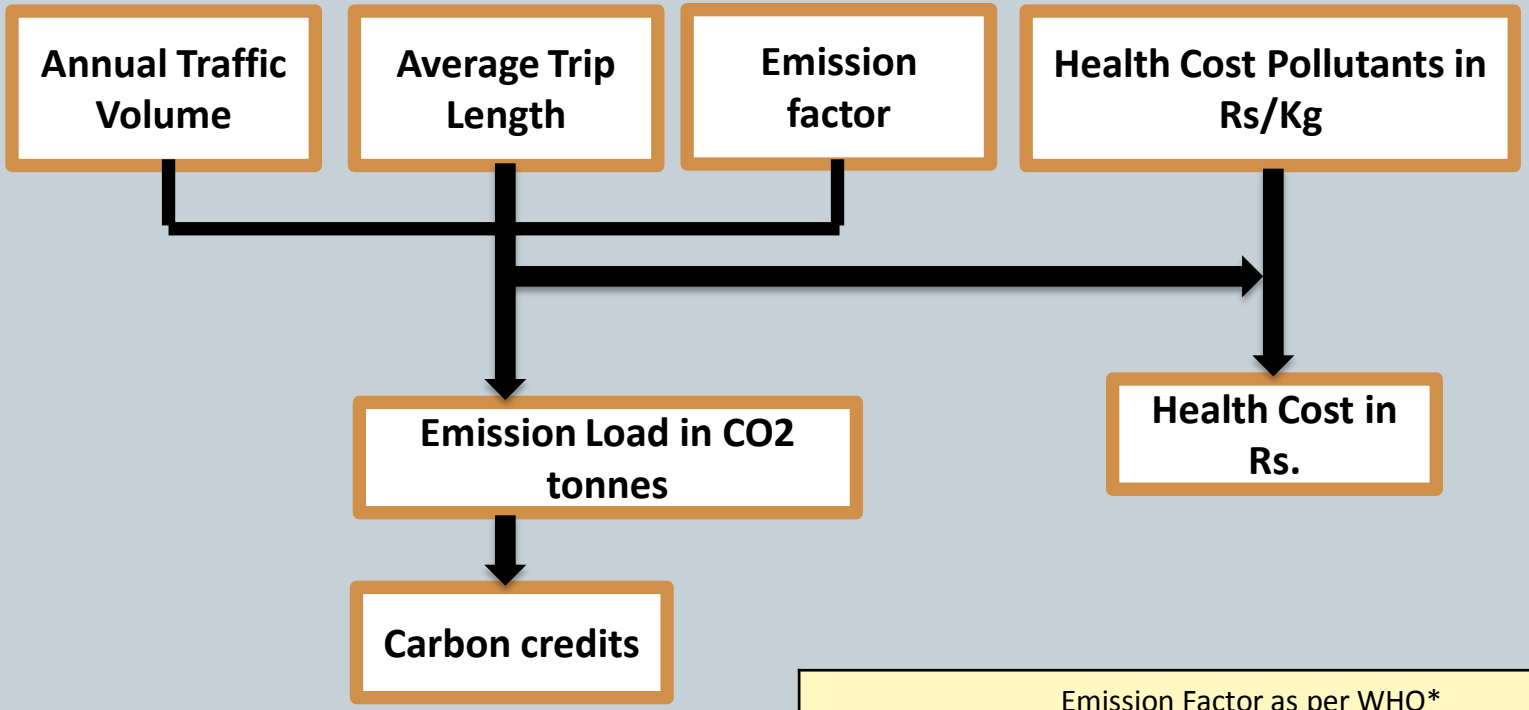
Calculation of VOC

Source of V/C: Improvement of NH-2

Year	Qty (tonnes)	tonne-km	VOC	Total Savings (cr)
19-20	3646497.19	3099522608.88	3.68	98.43
24-25	4879835.80	4147860433.55	4.04	135.74
29-30	6530321.09	5550772924.50	4.04	181.66
34-35	8739042.71	7428186303.01	4.04	243.10
39-40	11694810.48	9940588905.86	4.04	325.32

Savings in VOC

Environmental and Accident Cost



Emission Load (Tonnes)
= Emission Factor * ATL * Traffic Volume

Health cost (in Rs.)
= Health Cost Pollutant factor * Emission Load

1 Tonne CO2 saved = 1 Carbon Credit

1 Carbon Credit = 30 US$

Emission Factor as per WHO*					
Type of Vehicle	SPM	Sox	Nox	HC	CO
Cars	0.33	0.08	0.99	6	40
Bus/Truck	0	0	8	3.77	1.4
Motor Cycle	0.2	0.02	0.07	10	17
AutoRickshaw	0	0	0.2	1.26	1.57
*These values are in Kilogram for per 1000 km utilization of vehicles					
Kg in CO2 Equivalent	2.3	0.44	0.43	3.53	1.57

Environmental and Accident Cost

Health Cost of pollutants (IN Rs/Kg)				
City	CO	HC	NOX	SPM
Delhi	0.46	6.73	108.26	869.57

Source : Study Done by Institute of transport Studies, University of California and adopted in Research paper Health Damage Cost of Automotive Air Pollution : Cost Benefit Analysis of Fuel Quality Upgradation for Indian Cities

Year	Emission Load			Total Health cost (Cr.)
	Nox	HC	CO	
19-20	1354982561	1693728202	2879337943	15.94
24-25	1813272321	2266590401	3853203681	23.47
29-30	2426567399	3033209248	5156455722	31.40
34-35	3247294559	4059118198	6900500937	42.02
39-40	4345612636	5432015796	9234426852	56.24

Estimation of Health cost

Year	Kg in CO2 Equivalent				Carbon Credits	Savings (Cr.)
	Nox	HC	CO	Total		
19-20	72830312.67	597886055.2	265915327.6	936631695.5	936631.7	206.0075
24-25	97463387.24	800106411.5	355854692.9	1253424492	1253424	275.6844
29-30	130427997.7	1070722865	476213852	1677364714	1677365	368.928
34-35	174542082.5	1432868724	637281557.1	2244692364	2244692	493.7089
39-40	233576679.2	1917501576	852826479.9	3003904735	3003905	660.6938

Estimation savings in Environmental cost

Employment Generation

Total length of operation – NW-1,NW-2,Indo Bangladesh Protocol

↓

Employment Created per Km of operation

↓

Total income for 25 years of life at 0% discounted rate= average income*330*25 years of life

↓

Discounting at 10%

↓

Applying Wage rate of 0.5

	Assam	Bihar	West bengal
Total no. of villages	768	1352	1230
total rural population	804211.02	2770243.08	1865493.39
Total working poulation	241263.31	831072.92	559648.02
Average income (Rs)	33.32	16.58	52.92
Income\man day	8038893.36	13779189.08	29616573.06

- Length of National waterway 1 -1620 km
- Length of National Waterway 2 – 891 km
- Length of Indo-Bangladesh Protocol Route- 1530 km
- Total Length =4041
- Employment Created per Km of operation=3000
  (source :Theory of Application of Economics in Highway and Transport Planning: Dr. Vinay Maitri and Dr. PK Sarkar)
- Average income man\day = 35.24

EIRR FOR THIS MODEL IS 32% HENCE THIS MODEL IS ECONOMICALLY VIABLE

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Conclusions

- Most of the cargo is transported Bangladesh, Assam and parts of Bihar

- It is seen that by using night navigation and mechanized navigation travel time is reduced by 4 times and travel cost is reduced to 0.13 Rs\ tonne km

- If the channel is fully developed , 15% ,9% 4% shift is seen for coal, flyash and food items respectively from rail and road to IWT

- Demand for coal , flyash and rice have been work out
  - ✓2019-2020: 3.6 MMT is transported through IWT
  - ✓2029-2030 : 10.5 MMT is transported through IWT
  - ✓2039-2040 : 33.5 MMT is transported through IWT
- Capital cost of investment for inland waterway is 1527.34 cr

- Two financial model have been proposed one with a non subsidized scheme and the other using viability gap funding

- The FIRR for the first model is 15% with an NPV of Rs 5046.91 crore discounted at 10%

- The FIRR for the second model is 18% with an NPV of Rs 7432.45 crore discounted at 10%

- The EIRR for the model used is 32% with an NPV 18497 crore discounted at 10 %

Way Ahead

- Techno feasibility for construction of various lock gates to ensure adequate LAD
- Study of cost effective and sustainable river training measures.
- Redefining the institutional framework of IWAI
- Implementation of various schemes to attract potential shippers
- Construction of tri – modal terminals
- Standardization of waterways in INDIA

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