Chapter 5

Identification And Ranking of Key Inland Water Ports

5. Identification And Ranking of Key Inland Water Ports

5.1 Identification of the inland water ports

As per methodology and based on secondary data available with the government departments, the key inland water port locations along the major waterways Brahmaputra (NW2) and Barak (NW16) have been identified. A total of seven inland water ports on NW2 and three ports on NW16 have been identified and shortlisted for the AHP based inland water port exercise.

Table 5.1: Key Inland Water Ports (for ranking)

Brahmaputra (National Waterway 2)	**Barak (National Waterway 16)**
Dhubri	Karimganj
Jogighopa	Badarpur
Pandu	Silchar
Biswanath	
Silghat	
Nematighat	
Dibrugarh	

Source: Researcher's own compilation

5.1.1 Brief Description of the selected ports

Physical visits to the ten shortlisted inland water ports have been undertaken to understand the geographical and physical attributes of the port infrastructure system across the state. Sussman (2016) and Concato et al. (2010) among other researchers have highlighted the significance of observational methods in drawing practical assumptions about research areas. To get the actual on-ground as-is scenario, the port visits were extremely important and a comparison could be drawn among the different ports based on the criterion. Secondary data in the form of physical attributes of the inland water ports relevant for the research work has been collected and used for drawing a comparison among the facilities. A brief description of the shortlisted inland water ports are provided below:

Inland Water Ports on Brahmaputra (NW2)

Dhubri Port is an important inland water port located at the extreme end of river Brahmaputra (NW2) near Bangladesh border. Despite operational challenges, the port by virtue of its geographical location has the potential to transform into a major export hub for the Southeast Asian countries. With an RCC Ro-Ro terminal, floating terminal (Appendix B Plate 4) and covered godowns (Appendix B Plate 3) for cargo storage, the port is equipped to handle all weather bulk cargo. The major commodities handled are coal, cement, stone aggregates, food grains, tea, jute. The port office (Appendix B Plate 1) supports the neighboring ports on the Protocol route by facilitating the customs and immigration for outgoing and incoming cargo loads through a customs office in the port premises. Weighbridge facility as seen in Appendix B Plate 2 is also available within the port terminal. Navigational aids in the form of DGPS (Differential Global Positioning System) are available for the vessel operations at Dhubri Port. The port is managed by IWAI while operations and maintenance is carried out by a private operator.

Jogighopa Port is a relatively smaller yet highly accessible inland water port location primarily handling interstate cargo. This port plays a pivotal role of acting as a connecting link to export facilities and offers excellent multi modal connectivity. This port also recently has been declared as an extended port of call on the IBP route. With a floating terminal, the Jogighopa port also acts as a feeder port for Dhubri port. The port can handle bulk cargo and passenger vessels. Major commodities include stone aggregates, coal, cement, food grains and bamboo. A DGPS station has been established at this terminal. The port operations is managed by IWAI. In the near vicinity of the inland water port, India's first international multimodal logistics park is being developed at a huge investment.

Pandu Port is the largest inland water port in the northeast and it serves as the entry point to the northeastern states. Located in Guwahati, the port is having excellent connectivity to highways, railways and air transport. With fixed terminals and godown facilities (Appendix B Plate 5), the port provides for cargo storage. Major commodities include coal, cement, stone aggregates, food grains, tea, jute fertilizer and salt. The port has multilevel RCC jetties (Appendix B Plate 6) and supports Ro-Ro vessels in terms of infrastructure and equipment (Appendix B Plate 7). Pandu Port also serves as the port of call for the IBP route and handles over dimensional cargo (Appendix B Plate 8). The port

is managed by IWAI while operations and maintenance are carried out by a private operator. Development of a ship repair facility within the port terminal is underway.

Biswanath Port, commonly known as Biswanath Ghat, is a smaller port situated near Tezpur town which handles over dimensional cargo vessels and PDS cargo for Food Corporation of India. The cargo operations is facilitated by the presence of a floating terminal and DGPS station. This port also operates as a connecting link between the bigger ports. The port is managed by IWAI.

Silghat Port is a small picturesque and critical inland water port on the south back of the Brahmaputra. Located near to Koliabor road junction, this port is a port of call in the IBP route. The port has a floating terminal (Appendix B Plate 9) with steel pontoon to support cargo vessels and local ferry services (Appendix B Plate 10). Major commodities include tea, food grains, cement, chemicals and timber. Navigational aids and night navigation are available at this port. Operations at the port is managed by IWAI.

Neamati Port or Neamatighat is an inland water port in Jorhat primarily serving passengers between Jorhat and Majuli. It serves as the entry point to the largest river island of the world- Majuli. The port has a floating terminal with a steel pontoon and can handle cargo vessels and local ferry service. The port operations are managed by IWAI for cargo and IWT for ferry service.

Dibrugarh Port is located within the prominent Dibrugarh town and serves the upper assam stretches of the Brahmaputra. Although the port development work is underway, the port has a floating terminal with a steel pontoon to handle over dimensional cargo and ferry services. A passenger cum cargo terminal has been recently inaugurated at the port. The Port is managed by IWAI.

Inland Water Ports on Barak (NW16)

Karimganj Port is a major inland water port on the Barak River which is sharing border with Bangladesh. Notified as a port of call in the IBP route, the port serves as a major import export hub. With a fixed RCC jetty (Appendix B Plate 11), the port supports bulk cargo and passenger vessels. For cargo storage, open and covered storage facilities are available (Appendix B Plate 12 & 13). This port serves as a customs checkpoint for the region and the operations are managed by IWAI. Development of the port terminal is presently underway. The port has direct accessibility with Bangladesh ports by virtue of

sharing the international border on the opposite bank of Barak river (Appendix B Plate 14).

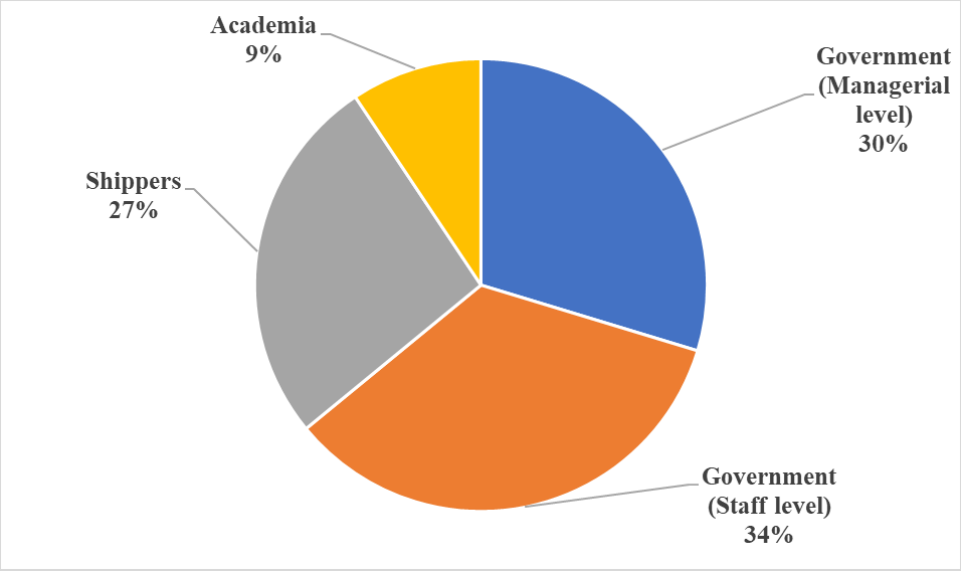
Badarpur Port is a significant inland water port in the vicinity of the international border. The port has a fixed RCC jetty (Appendix B Plate 15) to handle bulk cargo and passenger vessels. The port provides for open and covered storage of cargo and being on the IBP route as an alternate port of call, this port is a customs notified port. Port operations is managed by IWAI (Appendix B Plate 16).

Silchar Port is a relatively smaller inland water port on NW16 and supports primarily ferry services (Appendix B Plate 17). The ferry operations are mainly managed by IWT-Assam (Appendix B Plate 18). DPR studies for the infrastructure development of the port is underway and historically, this port was connecting Kolkata along the Barak-Surma-Meghna navigation channel.

5.2 Profile of the Respondents for AHP questionnaire

Following AHP methodology, a total of 64 responses has been collected for the pairwise comparisons among the criteria and sub criteria. The experts belong to different segments as described in chapter 4. A broad classification includes respondents from the government organizations across managerial and staff levels, shipping organizations and academia. The responses have been collected in person using the AHP adapted questionnaire.

Figure 5.1: Respondent profile for the AHP questionnaire



Source: Researcher's own compilation

5.3 Pairwise Comparison Matrices

As per objective 1, the ranking exercise for the selected inland water ports has been accomplished using the multi criteria decision making technique- Analytic Hierarchy Process (AHP). Responses provided by the experts of the inland waterway transport domain was recorded on the adapted AHP questionnaire for each pairwise comparison of the criteria/sub criteria. Geometric mean, being a better estimator, has been used to collate the responses and input the same in the developed AHP tool on Microsoft Excel. For the ease of data representation and analysis, each of the criteria/sub criteria has been coded as per following table.

Table 5.2: Coding of the Criteria/Sub Criteria

Criteria/Sub Criteria No.	Criteria Description	Code
CRITERIA 1	Port Geographical Location	PG
Sub Criteria 1a	Proximity to import/export	IE
Sub Criteria 1b	Closeness to highways/railroads	HR
Sub Criteria 1c	Proximity to dry ports	DP
Sub Criteria 1d	Proximity to carriers	PC
CRITERIA 2	Port Physical Conditions	PP
Sub Criteria 2a	Water Depth	WD
Sub Criteria 2b	Operating Weather Conditions	WC
Sub Criteria 2c	Port Total Area	TA
CRITERIA 3	Port Infrastructure	PI
Sub Criteria 3a	Terminal Size	TS
Sub Criteria 3b	Port Equipment	PE
Sub Criteria 3c	Port Docking Size	PD
Sub Criteria 3d	Port Management IT Systems	PM
Sub Criteria 3e	Safety Mechanisms	SM
CRITERIA 4	Port Costs	PC
Sub Criteria 4a	Docking Cost	DC
Sub Criteria 4b	Hauling Cost	HC
Sub Criteria 4c	Loading/Unloading Cost	LU
Sub Criteria 4d	Applicable Tax Structure	TX
CRITERIA 5	Port Efficiency and Performance	EP

Sub Criteria 5a	Loading/Unloading efficiency	LE
Sub Criteria 5b	Barge waiting time	BW
Sub Criteria 5c	Barge Turnaround time	TT
Sub Criteria 5d	Customs Efficiency	CE

Source: Researcher's own compilation

5.3.1 Sub criteria weightage calculation

The first task in the AHP ranking exercise consists of pairwise comparison matrices wherein geometric means of the responses received have been used to calculate weightages of the sub criteria. At first, the pairwise comparison matrices are developed for the sub-criterion attributes and finally, comparison between the five identified criteria are done. The weightages calculated are the local weights.

5.3.1.1 Pairwise Comparison for Sub criteria of Criterion 1 Port Geographical Location

Table 5.3: Pairwise Comparison matrix for Sub criteria of Criterion 1

	IE	HR	DP	PC
IE	1	1.41	7.54	7.86
HR	0.70922	1	6.9	7.86
DP	0.132626	0.144928	1	3.79
PC	0.127226	0.127226	0.263852	1
Sum	*1.96907*	*2.68215*	*15.7039*	*20.51*

Source: Researcher's own compilation

Table 5.4: Pairwise Comparison (standardized) matrix for Sub criteria of Criterion 1

	IE	HR	DP	PC
IE	0.507853	0.525697	0.480137	0.383228
HR	0.36018	0.372835	0.439383	0.383228
DP	0.067355	0.054034	0.063679	0.184788
PC	0.064612	0.047434	0.016802	0.048757

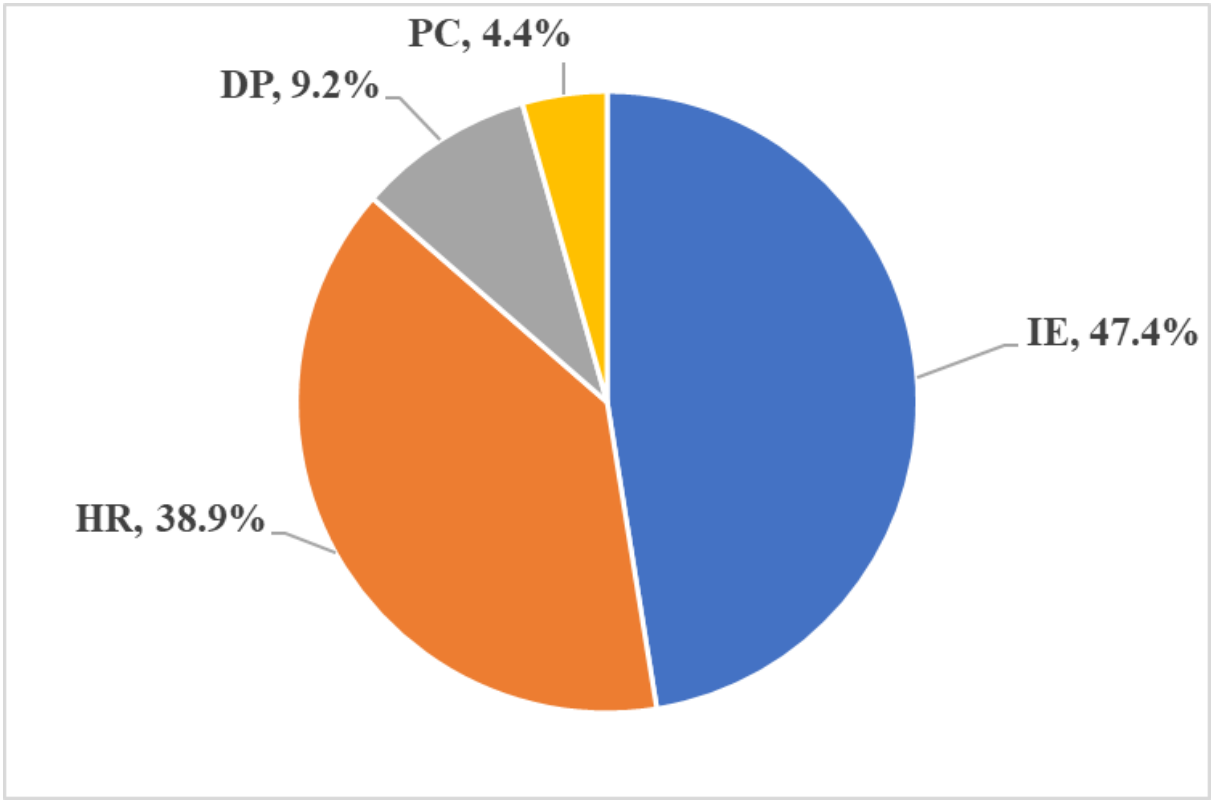
Source: Researcher's own compilation

Table 5.5: Calculation of weights and ranks for Sub criteria of Criterion 1

	Weight	Rank
IE	47.4%	1
HR	38.9%	2
DP	9.2%	3
PC	4.4%	4

Source: Researcher's own compilation

Figure 5.2: Weights for Sub criteria of Criterion 1



Source: Researcher's own compilation

From the AHP standardized matrix of the sub criteria of Criterion 1, it has been found that factors Proximity to import/export (IE) and Closeness to highways/railroads (HR) are among the top decision factors with weightages of 47.4% and 38.9% respectively. These two sub criteria have emerged to have substantial impact on the calculated total scores of the ports.

5.3.1.2 Pairwise Comparison for Sub criteria of Criterion 2 Port Physical Conditions

Table 5.6: Pairwise Comparison matrix for Sub criteria of Criterion 2

	WD	WC	TA
WD	1	4.99	7.96
WC	0.200401	1	4.34
TA	0.125628	0.230415	1
Sum	1.32603	6.22041	13.3

Source: Researcher's own compilation

Table 5.7: Pairwise Comparison(standardized) matrix for Sub criteria of Criterion 2

	WD	WC	TA
WD	0.754131	0.802197	0.598496
WC	0.151129	0.160761	0.326316
TA	0.09474	0.037042	0.075188

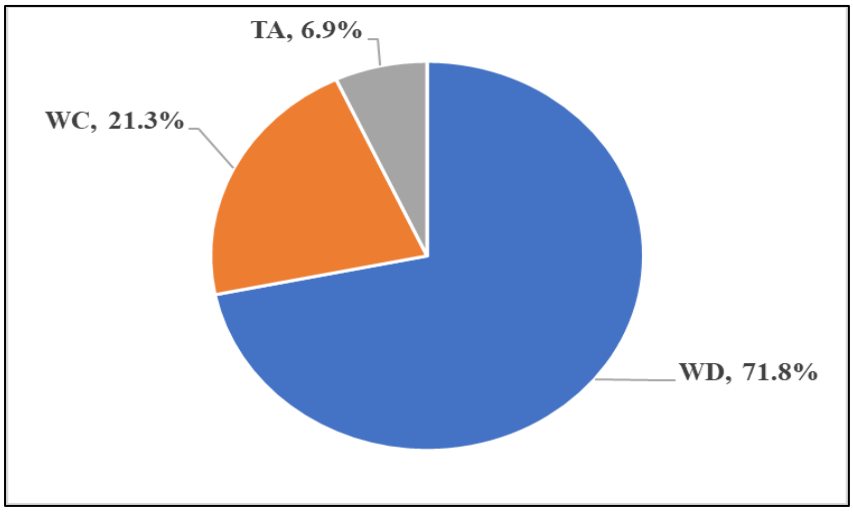
Source: Researcher's own compilation

Table 5.8: Calculation of weights and ranks for Sub criteria of Criterion 2

	Weight	**Rank**
WD	71.8%	1
WC	21.3%	2
TA	6.9%	3

Source: Researcher's own compilation

Figure 5.3: Weights for Sub criteria of Criterion 2



Source: Researcher's own compilation

From the AHP standardized matrix of the sub criteria of Criterion 2, water depth (WD) has emerged as the sub criteria with the highest weightage of 71.8% which is substantially high than the other two factors. Weather Condition (WC) which is attributed to the inland water port's operation ability follow with a weightage of 21.3%.

5.3.1.3 Pairwise Comparison for Sub criteria of Criterion 3 Port Infrastructure

Table 5.9: Pairwise Comparison matrix for Sub criteria of Criterion 3

	TS	PE	PD	PM	SM
TS	1	1.45	2.77	2.92	1.28
PE	0.689655	1	5.12	4.53	1.48
PD	0.361011	0.195313	1	1.79	1.43
PM	0.342466	0.220751	0.558659	1	1.48
SM	0.78125	0.675676	0.699301	0.675676	1
Sum	3.17438	3.54174	10.148	10.9157	6.67

Source: Researcher's own compilation

Table 5.10: Pairwise Comparison (standardized) matrix for Sub criteria of Criterion 3

	TS	PE	PD	PM	SM
TS	0.315022	0.409403	0.272961	0.267505	0.191904
PE	0.217257	0.282347	0.504535	0.415	0.221889
PD	0.113726	0.055146	0.098542	0.163984	0.214393
PM	0.107884	0.062328	0.055051	0.091611	0.221889
SM	0.246111	0.190775	0.06891	0.0619	0.149925

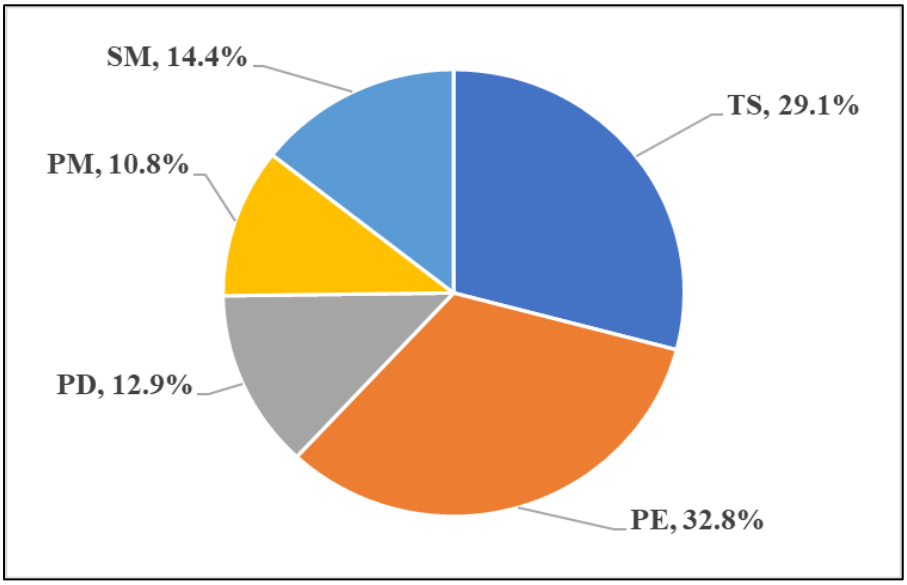
Source: Researcher's own compilation

Table 5.11: Calculation of weights and ranks for Sub criteria of Criterion 3

	Weight	**Rank**
TS	29.1%	2
PE	32.8%	1
PD	12.9%	4
PM	10.8%	5
SM	14.4%	3

Source: Researcher's own compilation

Figure 5.4: Weights for Sub criteria of Criterion 3



Source: Researcher's own compilation

From the AHP standardized matrix of the sub criteria of Criterion 3, port equipment (PE) and terminal size (TS) emerge as the impactful factors with weightages of 32.8% and 29.1% respectively.

5.3.1.4 Pairwise Comparison for Sub criteria of Criterion 4 Port Costs

Table 5.12: Pairwise Comparison matrix for Sub criteria of Criterion 4

	DC	HC	LU	TX
DC	1	3.8	2.45	1.41
HC	0.263158	1	1.43	1.4
LU	0.408163	0.699301	1	1.49
TX	0.70922	0.714286	0.671141	1
Sum	2.38054	6.21359	5.55114	5.3

Source: Researcher's own compilation

Table 5.13:Pairwise Comparison(standardized) matrix for Subcriteria of Criterion 4

	DC	HC	LU	TX
DC	0.420073	0.611563	0.441351	0.266038
HC	0.110545	0.160938	0.257605	0.264151
LU	0.171458	0.112544	0.180143	0.281132
TX	0.297924	0.114955	0.120901	0.188679

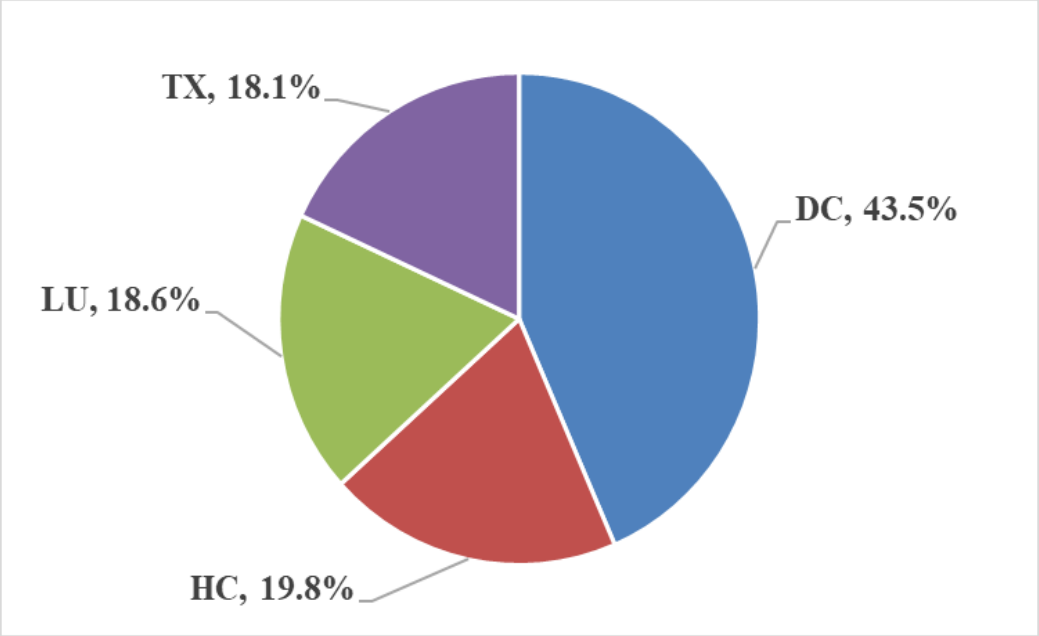
Source: Researcher's own compilation

Table 5.14: Calculation of weights and ranks for Sub criteria of Criterion 4

	Weight	Rank
DC	43.5%	1
HC	19.8%	2
LU	18.6%	3
TX	18.1%	4

Source: Researcher's own compilation

Figure 5.5: Weights for Sub criteria of Criterion 4



Source: Researcher's own compilation

For Criterion 4, it has been found that docking cost (DC) emerge as the criterion with maximum priority (43.5%) while weightages of the other factors are similar.

5.3.1.5 Pairwise Comparison for Sub criteria of Criterion 5 Port Costs

Table 5.15: Pairwise Comparison matrix for Sub criteria of Criterion 5

	LE	BW	TE	CC
LE	1	4.53	6.97	6.11
BW	0.220751	1	6.19	2.48
TE	0.143472	0.161551	1	1.35
CC	0.163666	0.403226	0.740741	1
Sum	1.52789	6.09478	14.9007	10.94

Source: Researcher's own compilation

Table 5.16: Pairwise Comparison(standardized) matrix for Subcriteria of Criterion 5

	LE	BW	TE	CC
LE	0.654498	0.743259	0.467762	0.558501
BW	0.144481	0.164075	0.415416	0.226691
TE	0.093902	0.026506	0.067111	0.1234
CC	0.107119	0.066159	0.049712	0.091408

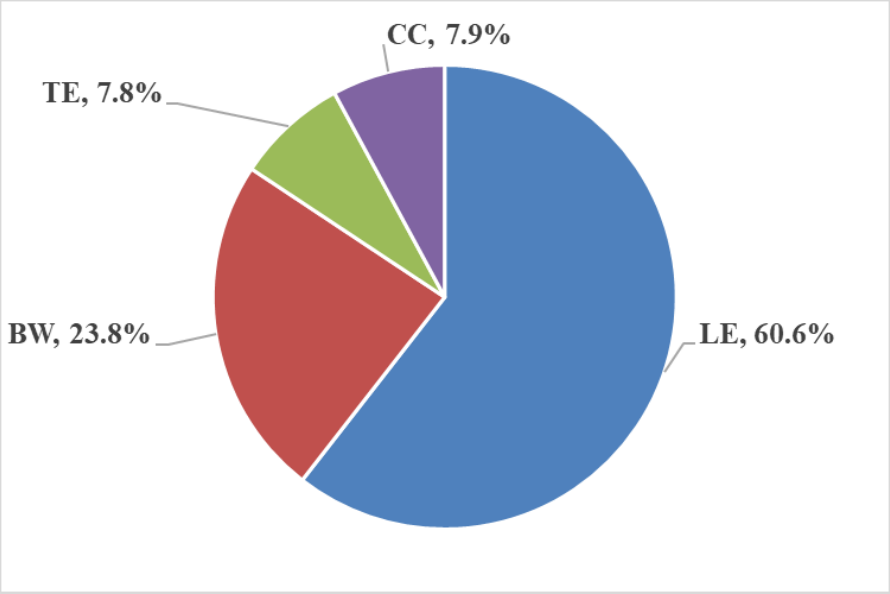
Source: Researcher's own compilation

Table 5.17: Calculation of weights and ranks for Sub criteria of Criterion 5

	Weight	**Rank**
LE	60.6%	1
BW	23.8%	2
TE	7.8%	4
CC	7.9%	3

Source: Researcher's own compilation

Figure 5.6: Weights for Sub criteria of Criterion 5



Source: Researcher's own compilation

From the AHP standardized matrix of the sub criteria of Criterion 5, it is seen that loading unloading efficiency (LE) emerges as a significant criterion with a weightage of 60.6% while barge waiting time (BW) with a weightage of 23.8% assumes second priority in decision making.

5.3.2 Main Criteria weightage calculation

Table 5.18: Pairwise Comparison matrix for the Main Criteria

	PG	PP	PI	PC	EP
PG	1	2.13	3.21	7.08	6.12
PP	0.469484	1	3.23	8.05	3.15
PI	0.311526	0.309598	1	2.82	3.86
PC	0.141243	0.124224	0.35461	1	2.11
EP	0.163399	0.31746	0.259067	0.473934	1
Sum	2.08565	3.88128	8.05368	19.4239	16.24

Source: Researcher's own compilation

Table 5.19: Pairwise Comparison (standardized) matrix for Main Criteria

	PG	PP	PI	PC	EP
PG	0.479466	0.548788	0.398576	0.364499	0.376847
PP	0.225102	0.257647	0.401059	0.414437	0.193966
PI	0.149366	0.079767	0.124167	0.145182	0.237685
PC	0.067721	0.032006	0.044031	0.051483	0.129926
EP	0.078344	0.081793	0.032168	0.024399	0.061576

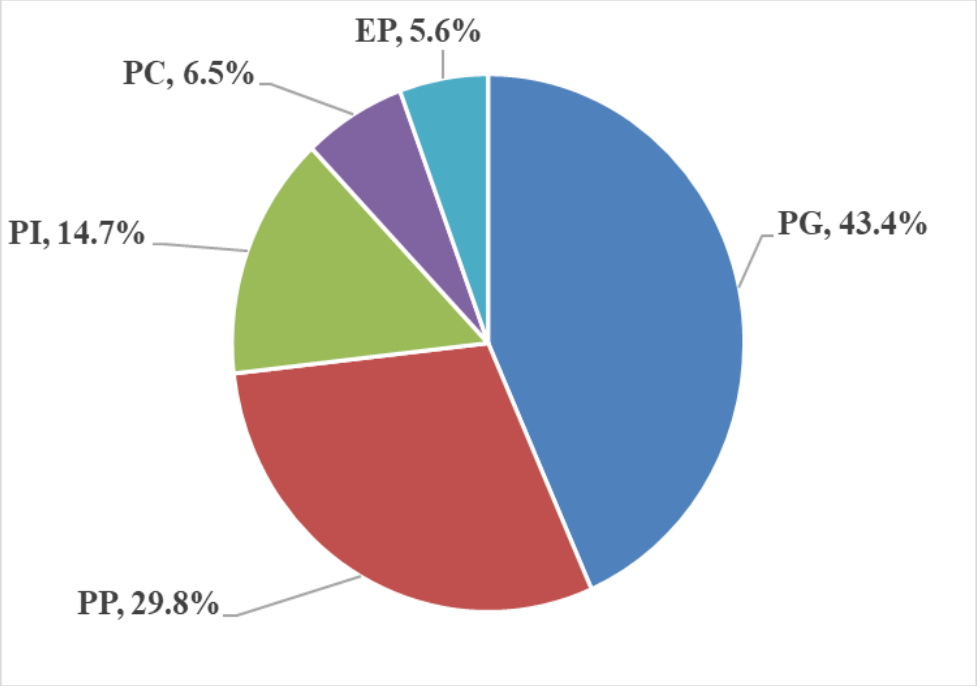
Source: Researcher's own compilation

Table 5.20: Calculation of weights and ranks for Main Criteria

	Weight	**Rank**
PG	43.4%	1
PP	29.8%	2
PI	14.7%	3
PC	6.5%	4
EP	5.6%	5

Source: Researcher's own compilation

Figure 5.7: Weights for the Main Criteria



Source: Researcher's own compilation

From the AHP standardized matrix of the main criteria, it has been found that Port Geographical Location (PG) has secured the highest weightage of 43.4% followed by Port Physical Conditions (PP) and Port Infrastructure (PI) at 29.8%. and 14.7% respectively. These three are corresponding to the tangible factors related to inland water ports while Port Costs (PC) and Port Efficiency and Performance (EP) have been accorded paltry weightage of 6.5% and 5.6% respectively.

5.3.3 Consistency ratio calculation

Although AHP is a widely used method for multi criteria decision making, yet there is an apprehension on the measure of reliability in the judgement quotient associated with expert opinion in the analysis. To address this, Basaran (2012) highlighted the significance of consistency ratio as an indicator for ascertaining the reliability of individual judgement based pairwise comparisons. Lukinskiy et al. (2021) found through an empirical investigation that there is a need to revise expert judgements if the consistency ratio (CR) is greater than 0.10. Consistency ratio (CR) for each of the pairwise comparisons have been computed using the random index (RI) table (Saaty, 1980).

Table 5.21: Random Index (RI) Table

No of comparisons	Random Index (RI)
2	0
3	0.58
4	0.9
5	1.12
6	1.24
7	1.32
8	1.41
9	1.45
10	1.51

Source: Saaty (1980)

Table 5.22: Consistency Check for Pairwise Comparison of Criterion 1 sub criteria

	Consistency	No of comparisons	4
IE	4.362362688	Average Consistency	4.22436719
HR	4.402689338	Consistency Index (CI)	0.07478906
DP	4.109750371	Random Index (RI)	0.9
PC	4.02266635	Consistency Ratio (CR)	0.08309896
Total	16.89746875	**Consistent? (<0.1)**	**Yes**

Source: Researcher's own compilation

Table 5.23: Consistency Check for Pairwise Comparison of Criterion 2 sub criteria

	Consistency	No of comparisons	3
WD	3.242467115	Average Consistency	3.11500312
WC	3.084090384	Consistency Index (CI)	0.05750156
TA	3.018451858	Random Index (RI)	0.58
Total	9.345009357	Consistency Ratio (CR)	0.09914062
		Consistent? (<0.1)	**Yes**

Source: Researcher's own compilation

Table 5.24: Consistency Check for Pairwise Comparison of Criterion 3 sub criteria

	Consistency	No of comparisons	5
TS	5.571730652	Average Consistency	5.44667475
PE	5.761542426	Consistency Index (CI)	0.11166869
PD	5.3930882	Random Index (RI)	1.12
PM	5.239361785	Consistency Ratio (CR)	0.09970419
SM	5.267650695	**Consistent? (<0.1)**	**Yes**
Total	27.23337376		

Source: Researcher's own compilation

Table 5.25: Consistency Check for Pairwise Comparison of Criterion 4 sub criteria

	Consistency	No of comparisons	4
DC	4.369076294	Average Consistency	4.22236627
HC	4.195542876	Consistency Index (CI)	0.07412209
LU	4.14109085	Random Index (RI)	0.9
TX	4.18375505	Consistency Ratio (CR)	0.08235788
Total	16.88946507	**Consistent? (<0.1)**	**Yes**

Source: Researcher's own compilation

Table 5.26: Consistency Check for Pairwise Comparison of Criterion 5 sub criteria

	Consistency	No of comparisons	4
LE	4.463082053	Average Consistency	4.26547161
BW	4.407522421	Consistency Index (CI)	0.08849054
TE	3.977605859	Random Index (RI)	0.9
CC	4.213676095	Consistency Ratio (CR)	0.09832282
Total	17.06188643	**Consistent? (<0.1)**	**Yes**

Source: Researcher's own compilation

Table 5.27: Consistency Check for Pairwise Comparison for main criteria

	Consistency	No of comparisons	5
TS	5.403129233	Average Consistency	5.32103012
PE	5.617256606	Consistency Index (CI)	0.08025753
PD	5.249800187	Random Index (RI)	1.12
PM	5.120440175	Consistency Ratio (CR)	0.07165851
SM	5.214524379	**Consistent? (<0.1)**	**Yes**
Total	26.60515058		

Source: Researcher's own compilation

5.4 Calculation of global weights

Pairwise comparison has been accomplished for each of the 20 sub-criteria under the main criteria. Each of the pairwise comparisons have been checked for consistency and the responses received have been found to be consistent as per random index (Saaty, 1980). This exercise has provided local weights for each of the sub-criteria and in the next subsequent step, it is required to convert the local weights to global weights. The global weights of each sub criterion have been calculated with the help of the criteria weights.

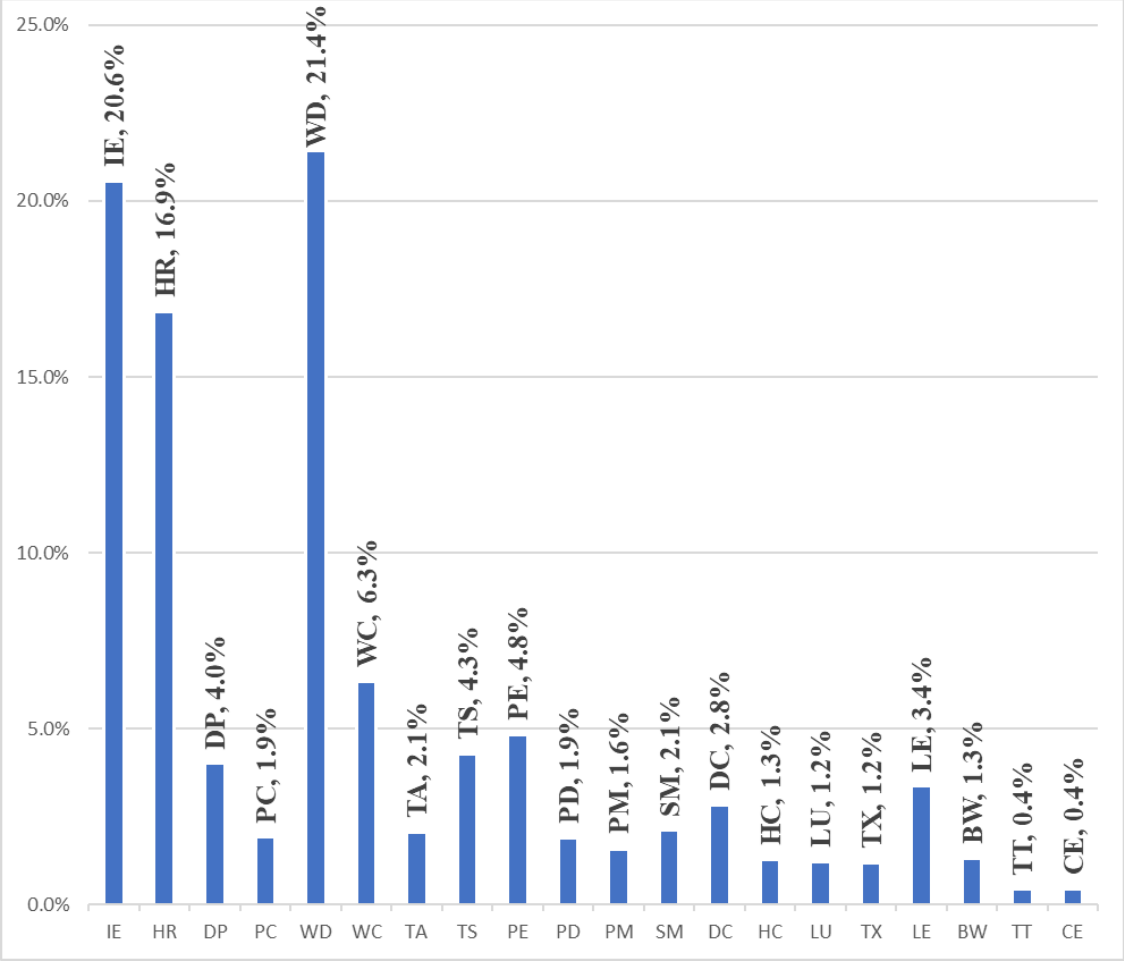
Table 5.28: Calculation of global weights for the twenty sub criteria

Criteria	**Sub criteria**	**Weights of Criteria**	**Local Weights of Sub criteria**	**Global Weights of Sub Criteria**
Port Geographical Location	Proximity to import/export	0.4336	0.4742	0.2056
	Closeness to highways/railroads		0.3889	0.1686
	Proximity to dry ports		0.0925	0.0401
	Proximity to carriers		0.0444	0.0193
Port Physical Conditions	Water Depth	0.2984	0.7183	0.2144
	Operating Weather Conditions		0.2127	0.0635
	Port Total Area		0.0690	0.0206
Port Infrastructur	Terminal Size	0.1472	0.2914	0.0429
	Port Equipment		0.3282	0.0483

e	Port Docking Size		0.1292	0.0190
	Port Management IT Systems		0.1078	0.0159
	Safety Mechanisms		0.1435	0.0211
Port Costs	Docking Cost	0.0650	0.4348	0.0283
	Hauling Cost		0.1983	0.0129
	Loading/Unloading Cost		0.1863	0.0121
	Applicable Tax Structure		0.1806	0.0117
Port Efficiency and Performance	Loading/Unloading efficiency	0.0557	0.6060	0.0337
	Barge waiting time		0.2377	0.0132
	Barge Turnaround time		0.0777	0.0043
	Customs Efficiency		0.0786	0.0044

Source: Researcher's own compilation

Figure 5.8: Global weights of the sub criteria



Source: Researcher's own compilation

Table 5.29: Global ranks of the sub criteria

Sub Criteria	Criteria	Global Weights	Rank
Water Depth	Port Physical Conditions	0.2144	1
Proximity to import/export	Port Geographical Location	0.2056	2
Closeness to highways/railroads	Port Geographical Location	0.1686	3
Operating Weather Conditions	Port Physical Conditions	0.0635	4
Port Equipment	Port Infrastructure	0.0483	5
Terminal Size	Port Infrastructure	0.0429	6
Proximity to dry ports	Port Geographical Location	0.0401	7
Loading/Unloading efficiency	Port Efficiency and Performance	0.0337	8
Docking Cost	Port Costs	0.0283	9
Safety Mechanisms	Port Infrastructure	0.0211	10
Port Total Area	Port Physical Conditions	0.0206	11
Proximity to carriers	Port Geographical Location	0.0193	12
Port Docking Size	Port Infrastructure	0.0190	13
Port Management IT Systems	Port Infrastructure	0.0159	14
Barge waiting time	Port Efficiency and Performance	0.0132	15
Hauling Cost	Port Costs	0.0129	16
Loading/Unloading Cost	Port Costs	0.0121	17
Applicable Tax Structure	Port Costs	0.0117	18
Customs Efficiency	Port Efficiency and Performance	0.0044	19
Barge Turnaround time	Port Efficiency and Performance	0.0043	20

Source: Researcher's own compilation

5.5 Comparison among the selected ports in terms of Sub Criteria

To accomplish the AHP ranking exercise, a comparative analysis of the alternatives i.e. the inland water ports in terms of the twenty sub criteria have been carried out. This is required for calculating the total scores of the inland water ports. Using secondary and

observational data from the port visits, the relative rating of the individual ports has been carried out for each of the twenty sub criteria. As per AHP methodology, for each sub criteria, a rationalized score out of 1 is computed for each port. This score has been calculated from the relative performance of that port specific to a sub criterion. For the relative scoring of individual port against each attribute, either maximum or minimum value is considered to calculate the ratio.

Table 5.30: Data Details for calculating sub criteria score for the inland water ports

Sub Criteria	**Data details**
Proximity to import/export	Rating out of 10 based on proximity to import/export
Closeness to highways/railroads	Distance (kms) from nearest highway/railroad
Proximity to dry ports	Distance (kms) from Amingaon dry port
Proximity to carriers	Distance (kms) from the nearest shipper office
Water Depth	Least Available Depth (metres) report
Operating Weather Conditions	Port operational period (months) in a year
Port Total Area	Total area (in hectare)
Terminal Size	Terminal area (in hectare)
Port Equipment	Count of available equipment
Port Docking Size	Docking area (in sq. m.)
Port Management IT Systems	Rating out of 10 based on actual usage of IT systems
Safety Mechanisms	Rating out of 10 on the availability of safety installations
Docking Cost	Notified rates (in Rs. per TEU)
Hauling Cost	Notified rates (in Rs. per TEU)
Loading/Unloading Cost	Notified rates (in Rs. per TEU)
Applicable Tax Structure	Notified tax rates (in percentage)
Loading/Unloading efficiency	Loading/Unloading rates (tons per hour)
Barge waiting time	Waiting time (in hours)
Barge Turnaround time	Turnaround time (in hours)
Customs Efficiency	Rating out of 10 based on ease of customs clearance

Source: Researcher's own compilation

5.5.1 Stakeholder rating-based sub criteria

The rating for the following four (4) sub criteria namely IE, PM, SM and CE has been decided through discussion with managerial stakeholders at IWAI. For each of the sub-criteria, the strengths and weaknesses of the inland water ports were deliberated upon and finally with consensus of the stakeholder expert group, the subjective score was decided for each of the inland water ports.

Table 5.31: Stakeholder scores (out of 10) for sub-criteria IE, PM, SM and CE

Inland Water Port	Proximity to import/export	Port Management IT Systems	Safety Mechanisms	Customs Efficiency
Dhubri	9	7	6	8
Jogighopa	8	3	4	8
Pandu	7	7	9	7
Biswanath	6	3	3	4
Silghat	7	3	4	7
Nematighat	5	3	4	4
Dibrugarh	5	6	6	4
Karimganj	9	8	8	9
Badarpur	9	7	8	9
Silchar	5	4	6	7

Source: Researcher's own compilation

For IE, the rating has been provided after consideration of the various factors- physical proximity to import/export and the average cargo (international) handled by the inland water ports. In this regard, the inland water ports of Dhubri, Karimganj and Badarpur which have secured the highest ratings are adjacent to the international border and these three ports along with Pandu, Jogighopa and Silghat also have been notified as Ports of Call as per IBP route.

Considering the sub criteria PM, Karimganj has secured the highest rating by virtue of usage and maintenance of IT systems for port operations. The promptness and accuracy of data upload to the online portals by the administrators at the ports was yet another factor which impacted the rating.

In case of SM, the highest rating has been secured by Pandu Port on Brahmaputra followed closely by Karimganj and Badarpur ports on Barak. Presence of safety equipment and procedures have been a contributor for this rating.

For the sub criteria CE, custom notified ports have fared better in terms of rating. Karimganj and Badarpur ports have secured the highest score in this attribute considering the fact that custom clearance facilities are housed within the port premises. Proximity to international border positively influences the rating of the ports in this attribute.

For all the four sub criteria, a higher rating implies a better score and thus, more preferred in terms of priority.

5.5.2 Distance based sub criteria

Rating of the inland water ports with respect to the three (3) sub criteria HR, DP and PC is based on actual distance measurement (in kms). For these attributes, the road distance from the port terminal to the nearest highway/railroad, dry port (Amingaon) and carrier site location has been measured by using GPS application during the field visits.

Table 5.32: Distance measurement (in kms.) for sub-criteria HR, DP and PC

Inland Water Port	Distance (kms) to		
	Nearest Highway	Dry Port	Carrier Site
Dhubri	2 (NH17)	220	2
Jogighopa	0.5 (NH17)	146	20
Pandu	1.5 (NH27)	8	10
Biswanath	2 (NH715)	238	80
Silghat	12 (NH715)	185	25
Nematighat	1.5 (NH715)	326	16
Dibrugarh	1.5 (NH15)	453	4
Karimganj	0.75 (NH37)	323	5
Badarpur	0.75 (NH37)	297	20
Silchar	6 (NH37)	310	5

Source: Researcher's own compilation

In context of the distance-based criteria, a higher distance implies a lesser relative rating.

5.5.3 Area based sub criteria

Comparative scores of the inland water ports in relation to the three (3) sub criteria TA, TS and PD is based on the documented records for area measurement. For these sub criteria, the total area (in hectares) for port and terminal size and docking area (in sq. m.) has been collected from the port specification documents and DPR reports during the port visits.

Table 5.33: Area measurement for sub-criteria TA, TS and PD

Inland Water Port	Port Total Area (hectares)	Terminal Size (hectares)	Port Docking Size (in sq. m.)
Dhubri	3	1.79	2790
Jogighopa	1.5	0.5	1750
Pandu	10	5	2000
Biswanath	1	0.5	1750
Silghat	1	0.5	1750
Nematighat	1.5	1	1750
Dibrugarh	1	0.5	1750
Karimganj	4	1.5	1972
Badarpur	2	0.75	3367
Silchar	3	1	1750

Source: Researcher's own compilation

The river ports of Pandu, Karimganj and Dhubri have a relatively larger area than most of the other inland water ports. The area based criteria have a positive effect on the rating and thus, a higher value denotes a higher score.

5.5.4 Time based sub criteria

The comparison of the inland water ports in context of the three (3) sub criteria WC, BW and BT is based on measurements of time. The operating weather conditions on an average is reflected by the no. of operational months, information for which has been

collected from the site offices. Regarding the barge waiting time and turnaround time, the information has been retrieved from the log books maintained at the port locations.

Table 5.34: Time measurement for sub-criteria BW, BT and WC

Inland Water Port	**Barge waiting time (hrs.)**	**Barge Turnaround time (hrs.)**	**Port operational period (months)**
Dhubri	2	6	12
Jogighopa	4	6	12
Pandu	4	6	12
Biswanath	5	8	9
Silghat	4	6	9
Nematighat	5	6	9
Inland Water Port	**Barge waiting time (hrs.)**	**Barge Turnaround time (hrs.)**	**Port operational period (months)**
Dibrugarh	3	6	9
Karimganj	4	4	8
Badarpur	4	6	8
Silchar	3	4	8

Source: Researcher's own compilation

The inland water ports of Dhubri, Jogighopa and Pandu operates all throughout the year but for the other ports, the operations get hampered due to less depth and adverse weather for vessels Lower values of barge waiting and turnaround time while a higher value of port operational period leads to a better score.

5.5.5 Cost based sub criteria

The relative scores of the inland water ports with respect to the four (4) sub criteria DC, HC, LU and TX is based on estimation of cost. The cost element pertaining to each sub criteria have been captured from tariffs published by the government agencies for the services at inland water ports.

Table 5.35: Cost estimation for sub-criteria DC, HC, LU and TX

Inland Water Port	Docking Cost (Rs. per TEU)	Hauling Cost (Rs. per TEU)	Loading/Unloading Cost (Rs. per TEU)	Tax Structure (%)
Dhubri	462	935	4950	GST Exempted
Jogighopa	420	850	4500	
Pandu	462	935	4950	
Biswanath	420	850	4500	
Silghat	420	850	4500	
Nematighat	420	850	4500	
Dibrugarh	420	850	4500	
Karimganj	420	850	4500	
Badarpur	420	850	4500	
Silchar	420	850	4500	

Source: IWAI Annexure XIV of IWAI Amendment Regulations 2021

Since the costs are regulated by the state, the scores across the three attributes of docking, hauling and loading/unloading costs are almost comparable for all the inland water ports. A lower cost provides for a higher rating of the port. Presently, the GST is uniform across all ports and exempt for inland water cargo services and therefore, the relative rating in this sub criteria shall be same for all the ports.

5.5.6 Specific data-based sub criteria

The three (3) sub criteria WD, PE and LE had specific data requirements pertaining to Least Available Depth (LAD), physical count of equipment available and loading/unloading efficiency respectively. For WD, the information of LAD for each stretch of waterway is available in the periodic hydrographic survey reports as well as on the PANI Portal. For PE, the physical count of common equipment available in the ports have been taken during the inland water port visits. On the other hand, since all the inland water ports have manual material handling systems, average loading/unloading time was estimated from the log book records of the jetties.

Table 5.36: LAD information (average for the year 2023) for sub-criteria WD

Inland Water Port	LAD (in metres)
Dhubri	2.3
Jogighopa	2.4
Pandu	2.2
Biswanath	2.2
Silghat	2.4
Nematighat	2.3
Dibrugarh	2
Karimganj	2
Badarpur	2
Silchar	2

Source: PANI Portal (2023)

Ports with higher LAD can accommodate larger vessels and thus, provide more accessibility. In this regard, ports in Brahmaputra have substantially higher LAD than those in the Barak River. Based on this sub-criterion as well as on the basis of waterway classification, huge expenses are spent for fairway creation.

Table 5.37: Port Equipment information for sub-criteria PE

Ports	Container Crane	Crane Pontoons	Shore Cranes	Dredgers	Anchor Pontoons	Floating Platforms	Forklifts	Cargo Vessels	Weighbridge	Survey vessels	Equipment Count
Dhubri	0	0	1	0	1	1	1	1	1	1	7
Jogighopa	0	1	0	0	1	1	0	0	0	0	3
Pandu	0	0	2	0	1	1	1	1	1	1	8
Biswanath	0	0	1	0	1	1	0	0	0	0	3
Silghat	0	0	1	0	1	1	0	0	0	1	4
Nematighat	0	0	1	0	1	2	0	0	0	1	5

Dibrugarh	0	0	1	1	1	1	0	0	0	1	5
Karimganj	0	0	0	1	1	1	1	0	0	1	5
Badarpur	0	0	1	1	1	1	0	0	0	0	4
Silchar	0	0	1	0	1	1	0	0	0	0	3

Source: Researcher's own compilation

Port equipment is an integral part of port operations; at some port locations, the equipment are hauled in by the shippers themselves. Higher the number of equipment, better is the serviceability of the inland water port and thus, leading to a higher priority. During the port visits, it has been observed that the available equipment is inadequate to support the cargo projections.

Table 5.38: Loading/Unloading rate (2023) for sub-criteria LE

Inland Water Port	Loading/Unloading rate (tons/hr.)
Dhubri	200
Jogighopa	200
Pandu	300
Biswanath	100
Silghat	200
Nematighat	200
Dibrugarh	300
Karimganj	400
Badarpur	300
Silchar	100

Source: Researcher's own compilation

Material handling efficiency of ports is an important indicator of the modernization level of ports. Container transport is considered as among one of the major innovations of the transport industry and provides for extremely high efficiency of loading/unloading apart from other tangible benefits. However, none of the inland water ports support container transport in terms of the equipment required. A higher rate of loading/unloading implies a faster turnaround thereby bringing down docking and other related costs for shippers.

The individual ratings and secondary data collected sub criteria wise for the inland water ports are consolidated for facilitating conversion to relative ratings out of a total score of one (1).

Table 5.39: Consolidated sub-criteria wise comparison of the inland water ports

SUB-CRITERIA	Proximity to import/export	Closeness to highways/railroads	Proximity to dry ports	Proximity to carriers	Water Depth	Operating Weather Conditions	Port Total Area	Terminal Size	Port Equipment	Port Docking Size	Port Management IT Systems	Safety Mechanisms	Docking Cost	Hauling Cost	Loading/Unloading Cost	Applicable Tax Structure	Loading/Unloading efficiency	Barge waiting time	Barge Turnaround time	Customs Efficiency
Dhubri	9	2	220	2	2.3	12	3	1.79	7	2790	7	6	462	935	4950	1	200	2	6	8
Jogighopa	8	0.5	146	20	2.4	12	1.5	0.5	3	1750	3	4	420	850	4500	1	200	4	6	8
Pandu	7	1.5	8	10	2.2	12	10	5	8	2000	7	9	462	935	4950	1	300	4	6	7
Biswanath	6	2	238	80	2.2	9	1	0.5	3	1750	3	3	420	850	4500	1	100	5	8	4
Silghat	7	12	185	25	2.4	9	1	0.5	4	1750	3	4	420	850	4500	1	200	4	6	7
Nematighat	5	1.5	326	16	2.3	9	1.5	1	5	1750	3	4	420	850	4500	1	200	5	6	4
Dibrugarh	5	1.5	453	4	2	9	1	0.5	5	1750	6	6	420	850	4500	1	300	3	6	4
Karimganj	9	0.75	323	5	2	8	4	1.5	5	1972	8	8	420	850	4500	1	400	4	4	9
Badarpur	9	0.75	297	20	2	8	2	0.75	4	3367	7	8	420	850	4500	1	300	4	6	9
Silchar	5	6	310	5	2	8	3	1	3	1750	4	6	420	850	4500	1	100	3	4	7
Minimum	**5**	0.5	8	2	2	8	1	0.5	3	1750	3	3	420	850	4500	1	100	2	4	4
Maximum	**9**	12	453	80	2.4	12	10	5	8	3367	8	9	462	935	4950	1	400	5	8	9

Source: Researcher's own compilation

5.6 Computation of weighted scores for each of the selected inland water ports

As per AHP methodology, for each inland water port, a composite score is calculated by using the global weights of the twenty sub criteria and secondary data as derived from the comparative analysis of the selected ports. The total weighted composite score forms the basis for the ranking of the selected inland water ports.

Table 5.40: Calculation of total scores for the selected inland water ports

SUB-CRITERIA	Proximity to import/export	Closeness to highways/railroads	Proximity to dry ports	Proximity to carriers	Water Depth	Operating Weather Conditions	Port Total Area	Terminal Size	Port Equipment	Port Docking Size	Port Management IT Systems	Safety Mechanisms	Docking Cost	Hauling Cost	Loading/Unloading Cost	Applicable Tax Structure	Loading/Unloading efficiency	Barge waiting time	Barge Turnaround time	Customs Efficiency	
GLOBAL WEIGHTS	0.2056	0.1686	0.0401	0.0193	0.2144	0.0635	0.0206	0.0429	0.0483	0.0190	0.0159	0.0211	0.0283	0.0129	0.0121	0.0117	0.0337	0.0132	0.0043	0.0044	**Total Score**
Dhubri	1	0.25	0.036	1	0.958	1	0.3	0.358	0.875	0.829	0.875	0.667	0.909	0.909	0.909	1	0.5	1	0.667	0.889	**0.742033**
Jogighopa	0.889	1	0.055	0.1	1	1	0.15	0.1	0.375	0.52	0.375	0.444	1	1	1	1	0.5	0.5	0.667	0.889	**0.779419**
Pandu	0.778	0.333	1	0.2	0.917	1	1	1	1	0.594	0.875	1	0.909	0.909	0.909	1	0.75	0.5	0.667	0.778	**0.776598**
Biswanath	0.667	0.25	0.034	0.025	0.917	0.75	0.1	0.1	0.375	0.52	0.375	0.333	1	1	1	1	0.25	0.4	0.5	0.444	**0.555412**
Silghat	0.778	0.042	0.043	0.08	1	0.75	0.1	0.1	0.5	0.52	0.375	0.444	1	1	1	1	0.5	0.5	0.667	0.778	**0.582758**
Nematighat	0.556	0.333	0.025	0.125	0.958	0.75	0.15	0.2	0.625	0.52	0.375	0.444	1	1	1	1	0.5	0.4	0.667	0.444	**0.586011**
Dibrugarh	0.556	0.333	0.018	0.5	0.833	0.75	0.1	0.1	0.625	0.52	0.75	0.667	1	1	1	1	0.75	0.667	0.667	0.444	**0.583445**
Karimganj	1	0.667	0.025	0.4	0.833	0.667	0.4	0.3	0.625	0.586	1	0.889	1	1	1	1	1	0.5	1	1	**0.758897**

Badarpur	1	0.667	0.027	0.1	0.833	0.667	0.2	0.15	0.5	1	0.875	0.889	1	1	1	1	0.75	0.5	0.667	1	**0.732636**
Silchar	0.556	0.083	0.026	0.4	0.833	0.667	0.3	0.2	0.375	0.52	0.5	0.667	1	1	1	1	0.25	0.667	1	0.778	**0.512791**

Source: Researcher's own compilation

5.7 Ranking of the key inland water ports

The inland water ports are arranged in descending order of the total scores. This provides the final AHP based ranking of the selected inland water ports.

Table 5.41: Final Ranking of the inland water ports

Inland Water Ports	Scores	Rank
Jogighopa	0.77941	1
Pandu	0.77659	2
Karimganj	0.75889	3
Dhubri	0.74203	4
Badarpur	0.73263	5
Nematighat	0.586011	6
Dibrugarh	0.58344	7
Silghat	0.58275	8
Biswanath	0.55541	9
Silchar	0.51279	10

Source: Researcher's own compilation

The inland water ports of Jogighopa, Pandu and Karimganj emerge as the top three ports during the study period. The criterion weights and the ranks can be used as inputs for decision support systems in taking shipping and investment decisions.